



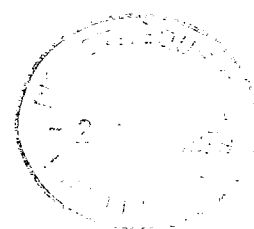
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REPORT TO THE INTERNATIONAL COMMISSION
FOR THE CERTIFICATION OF SMALLPOX ERADICATION
IN THE YEMEN ARAB REPUBLIC. JUNE 1979



MINISTRY OF HEALTH
YEMEN ARAB REPUBLIC
WORLD HEALTH ORGANIZATION

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Finally, to the hospitable villagers throughout Yemen goes a special warm appreciation.

GLOSSARY^{*}

Empty Quarter -- or Rub-Al-Khali, large unpopulated inland desert extending to the north-east of Yemen.

Mahalla -- a group of houses subordinate administratively to a village.

Mashriq -- literally, "eastern", the region to the east of the central plateau.

Mouhafaza -- governorate.

Nahiya -- district.

Ozlah -- A group of villages whose inhabitants belong mainly to one tribe headed by a sheikh.

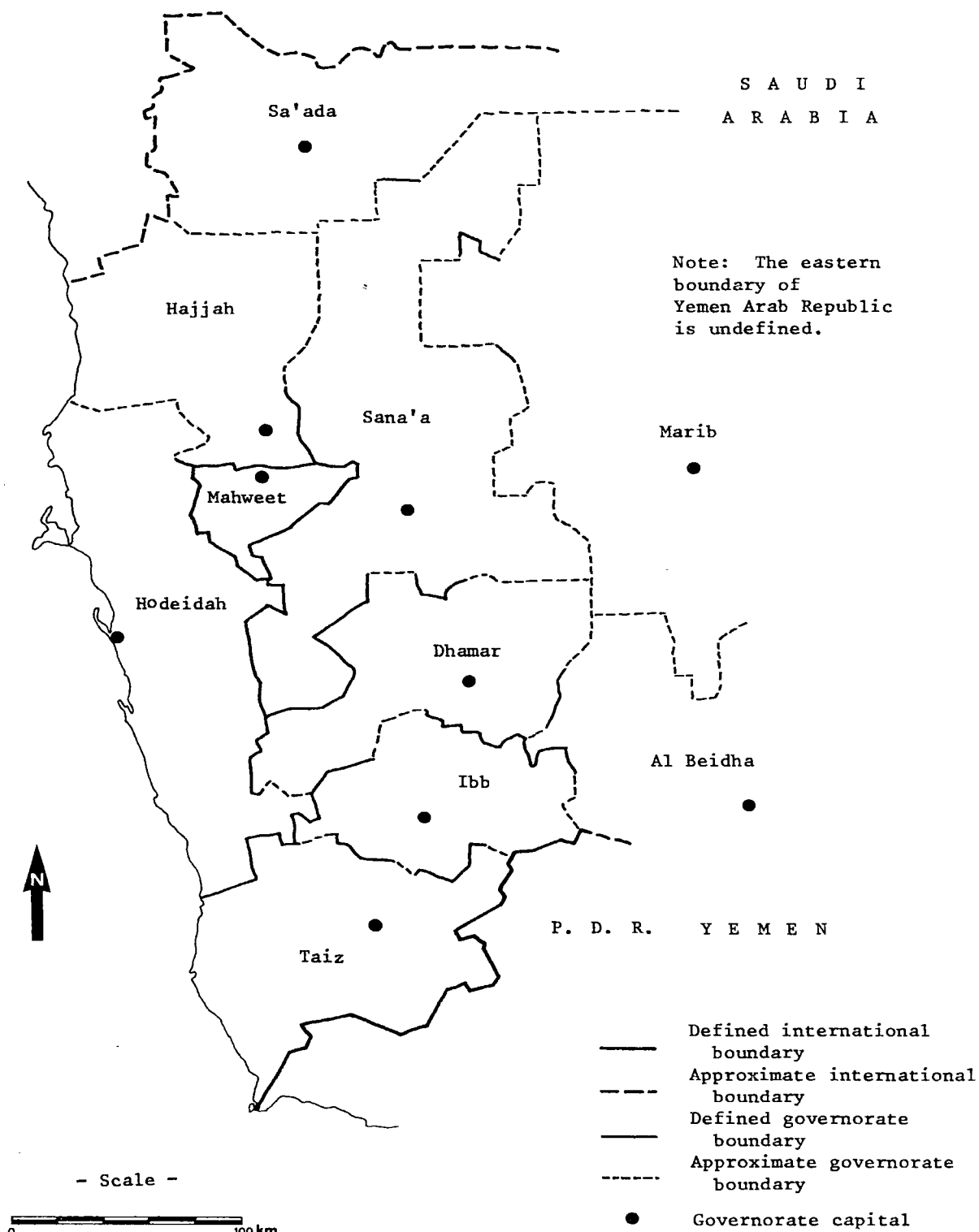
Qada -- sub-governorate.

Qat -- Catha edulis, a leaf with stimulant properties when chewed.

Tihama -- hot semi-desert coastal plain extending the length of the country along the Red Sea with a width of 30 to 70 kilometers.

* Throughout this report reference to the glossary is indicated - *

FIG. 1: YEMEN ARAB REPUBLIC ADMINISTRATIVE DIVISIONS



Source: Reference 2

1. Background Information

1.1 Geography

Situated in the south-western corner of the Arabian Peninsula, the Yemen Arab Republic (YAR) is bordered on the north by Saudi Arabia, on the south and south-east by the People's Democratic Republic of Yemen (PDY), and on the west by the Red Sea. The eastern border, within the great Arabian desert Rub-Al-Khali, or the Empty Quarter, is not clearly defined. A map of the YAR is presented in Figure 1.

Extending over approximately 200 000 square kilometers, Yemen can be divided topographically into four natural regions, each having distinct climatic characteristics. The Tihama, a hot, sandy semi-desert plain 30 to 70 kilometers wide, extends the length of the country bordering the Red Sea. A second region, the western foothills and middle heights with an altitude ranging from 200 to 1 500 meters is cut by deep wadis running through narrow gorges. Above an altitude of 1 500 meters and extending from Ibb in the south to Saudi Arabia in the north, the rugged central highlands frequently exceed 3 000 meters elevation. The high table-lands above 2 000 meters elevation in the central highlands gently slope eastwards, forming the fourth natural region - the eastern semi-desert plateau, which terminates at 1 000 meters elevation in the Empty Quarter. The mountain areas are characterized by a temperate climate and by extensive terracing, which helps to prevent soil erosion and to distribute rain water.

1.2 Demographic Features

The first country-wide census, in 1975, with adjustments based on subsequent analytic studies, enumerated 5 237 893 Yemenis within the country and an additional 1 234 000 residing abroad - mostly in Saudi Arabia. 90% of the Yemenis resident within the country live in rural areas and 73% of the entire population is engaged in agriculture.

The three largest cities - Sana'a, Hodeidah and Taiz - have a combined population of less than 350 000. The only other towns with population greater than 10 000 are Dhamar (ca. 22 000), Ibb (ca. 21 000) and Bayt Al Faqih (ca. 14 000). A demographic comparison of all ten governorates is presented in Table 1. A map of the population distribution of Yemen is provided in Figure 2.

TABLE 1
DEMOGRAPHIC COMPARISON OF GOVERNORATES

Governorate	Population ^a	% of total population	Area ^b (km ²)	Persons per km ²	% Urban	Sex Ratio	Emigration Rate ^c	Emigrants per km ²
Sana'a	807 269	17.8	20 310	41.0	15.0	0.95	4.7	2.1
Hodeidah	676 693	15.0	13 580	51.2	11.8	1.02	4.7	2.6
Taiz	873 876	19.3	10 420	84.7	9.0	0.84	7.8	7.2
Ibb	789 518	17.4	6 430	126.5	2.4	0.88	8.2	11.4
Dhamar	455 132	10.0	8 870	52.9	4.2	0.87	6.7	3.8
Hajjah	396 578	8.7	9 590	43.1	1.5	0.96	4.7	2.2
Sa'ada	154 361	3.4	12 810	13.8	2.7	0.91	7.1	1.1
Mahweet	174 639	3.9	2 160	83.8	1.4	0.86	6.8	6.2
Beidha	157 764	3.5	11 170	15.5	55.0	0.82	11.4	2.0
Marib	40 896	1.0	39 890	1.8	0.7	0.95	3.1	0.1
Total	4 526 326	100.0	b	34.8	10.0	0.91	6.5	2.5

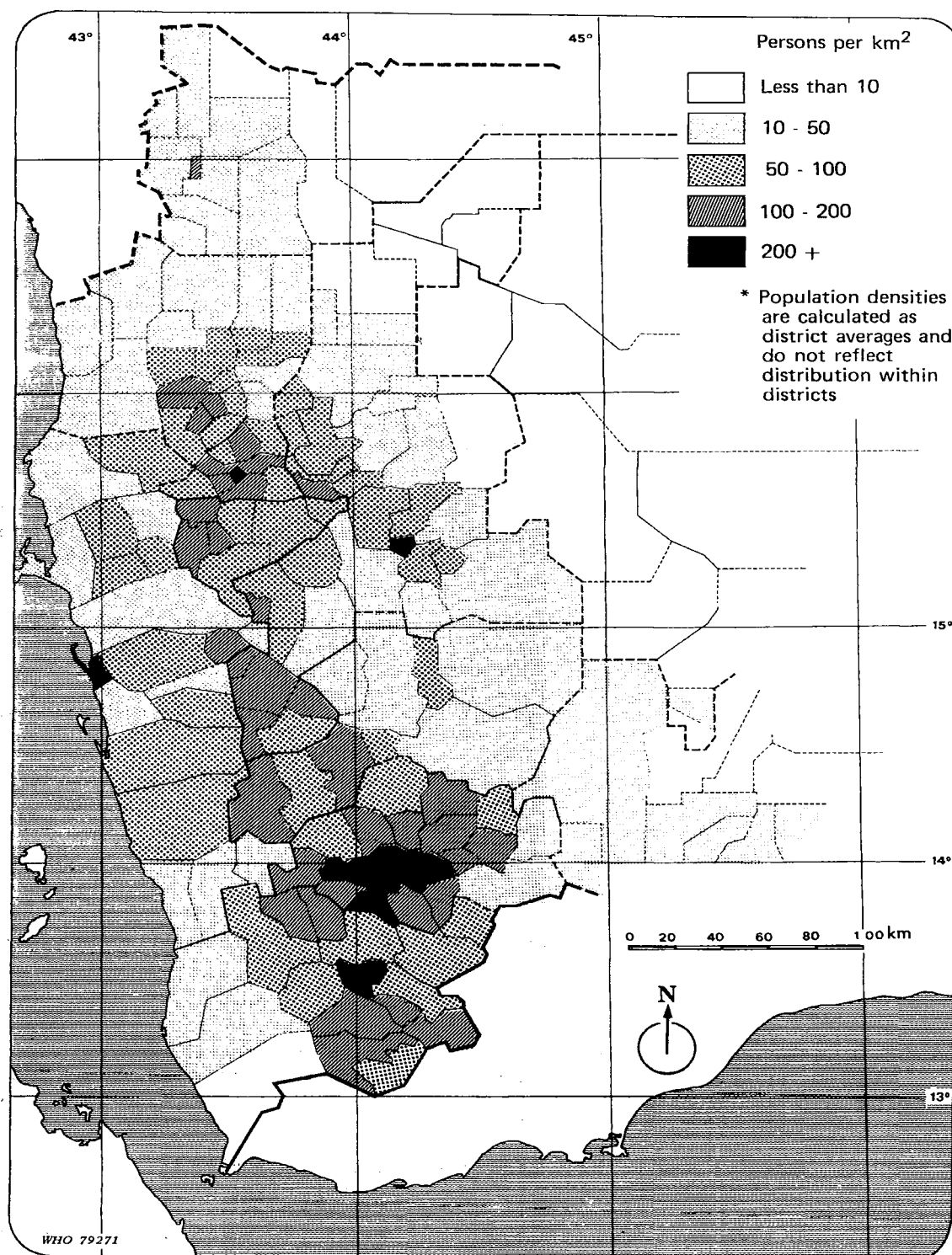
^a Population figures are based on the population actually recorded by the 1975 census and do not reflect subsequent aggregate corrections made for under-counting.

^b Due to the various undefined boundaries, the total of governorate areas shown here is less than the estimated 200 000 km² total area of the country.

^c Emigration rate is the percentage of short-term emigrants (mainly intermitted Yemeni labourers in Saudi Arabia) of the original population (1975 figures).

Source: Reference 1, 2, 3

FIG. 2 POPULATION DENSITY*



Source: Reference 2

Perhaps the cardinal demographic feature of Yemen in the context of the Arabian Peninsula is its high population density of 35 persons per square kilometer (based on mid-1979 population projections and including short-term emigrants abroad). This compares to a population density of 5 or less persons per square kilometer in neighbouring Saudi Arabia and Democratic Yemen.

The Tihama* is inhabited by about 20% of the country's overall population, the lower western slopes by 5-7%, the higher western slopes by 33-35%, the high plateau by 30%, the higher Mashriq* by 10%, and the lower Mashriq* merging on the Empty Quarter by 2%. (4) There is wide variation in population density both between and within governorates, with the southern highlands being most densely settled. The eastern borders are very sparsely settled, with no more than 5% of the country's population living in the entire rural area of Marib, Beidha, and eastern Sa'ada Governorates - an area comprising over one-third of the country.

The emigration of Yemenis engaged in trade to all areas of the world has been a long-standing tradition. A low male to female sex ratio of .91 reflects the large number of able-bodied men going to oil-rich countries in recent years. This ratio is lower in the more densely settled south with a low of around .66 in several districts (nahiya) of Taiz Governorate. At the other extreme, Hodeidah District in Hodeidah Governorate records a sex ratio of 1.45 due to its port which attracts male workers from elsewhere in Yemen and from abroad. From some rural districts in overcrowded areas of the south, as many as 40 emigrants per square kilometer have departed. Other southern districts have lost up to 16% of their original population as short-term emigrants.

Another population movement of considerable epidemiological importance is the arrival to Yemen of refugees from neighbouring states, including unknown thousands from Democratic Yemen over the past decade and from the Horn of Africa in recent years. Somalis and Ethiopians are principally found in the three largest cities.

The semi-nomadic population is estimated at less than 5% of the total. They are found primarily in the sparsely settled eastern regions from the north all the way to the south. Some are also present in the extreme south-west corner of the country down to the Bab-Al-Mandeb border with Democratic Yemen. Some Tihama residents also lead semi-nomadic lives, in search of manual work. They can be found squatting outside cities, towns and villages all over Yemen.

Due to the almost complete absence of birth and death registration, many demographic indicators can only be estimated: a crude birth rate of 45.8 and a crude death rate of 26.9 yield a crude annual rate of natural increase of 18.9 per 1 000 population; an infant mortality rate of 159 per 1 000 live births; a life expectancy at birth of 43 years; and a general fertility rate of 210 per 1 000 women of reproductive age. The age distribution is characterized by a high percentage of people in the younger age groups (47% below age 15).

The ethnic composition of the population is 90% Arab and 10% Afro-Arab. Virtually 100% of the population is Muslim.

1.3 Administrative Divisions

The YAR is divided administratively into 10 governorates (mouhafaza), each of which is divided into sub-governorates (qada) and further divided into districts (nahiya). Each governorate capital bears the same name as the governorate in which it is situated. Table 2 provides an estimated breakdown of the administrative divisions by governorate.

With the long isolation imposed during the rule of the Imams ending in 1962, central government administration at the provincial, district and local level has been introduced only recently. The transition from traditional to modern administration is still in progress; in many areas the central government tacitly accommodates the old system of tribal authority. The formation of a modern state with an efficient administration, closer integration of remote areas, and expansion of the transport and communication infrastructure are some of the principal goals enumerated in the national development plan.

TABLE 2
ADMINISTRATIVE COMPARISON OF GOVERNORATES^a

Governorate	Nahiya [*]	Ozlah [*]	Village	Mahalla [*]	Mean Village Size ^a	Capitals ^b Population (1975)
Sana'a	33	292	3 707	7 258	187	134 588
Hodeida	18	106	1 952	439	294	80 314
Taiz	18	268	1 666	4 307	495	78 642
Ibb	20	261	2 559	3 208	313	19 066
Dhamar	9	311	1 995	2 597	233	19 467
Hajjah	31	172	1 929	6 325	211	5 814
Sa'ada	12	110	1 546	97	114	4 252
Mahweet	7	134	1 415	1 454	131	2 421
Beidha	10	68	729	847	223	5 975
Marib	4	25	353	364	192	292
Total	162	1 747	17 851	26 896	244	350 831

^a Numbers of administrative divisions are 1976 estimates. Population figures based on 1975 census.

^b Capitals bear the same names as the governorates.

Source: Reference 1

The traditional administrative structure includes a sub-division of the district called an "ozlah", which is a set of villages whose inhabitants belong mainly to one tribe headed by a sheikh. The villages themselves consist, in some cases, of clusters of houses called "mahalla", which are administratively subordinate. Sometimes distant from the village proper, a mahalla can consist of even a single house.

Tribal definitions vary from area to area regarding what constitutes a village as opposed to a mahalla. A "village" may include all the semi-nomads of a district, or it may simply consist of a few dwellings, or it may cover a 20 square kilometer area with 50 dispersed mahalla.

Settlement patterns also vary between governorates with mean village size ranging from 495 in Taiz Governorate to 114 in Sa'ada Governorate. There are an estimated 17 851 villages in the country.

The boundaries between districts and between governorates frequently are not clearly defined. Similarly, much of the international boundary is not officially defined and demarcated.

1.4 Education

The long-standing paucity of governmental schools, and social services of any kind, is abating as localities with a keen sense of self-betterment are increasingly benefiting from the development assistance provided by the Government. The past inadequacies are reflected, however, in a literacy rate estimated at 10% overall - and at only 2% for women.

The education system includes a six year primary course, followed by three years of preparatory and three years of secondary school. However, it is estimated that less than 20% of primary school-aged children are actually enrolled and 2% of secondary school-aged

adolescents. Non-completion of schooling is usual; only 20% of entering students continue through the sixth grade. Due to social and religious customs, male school children outnumber female school children by 7 to 1.

Due to shortages of teachers and facilities, 60% of the 1 528 primary schools have 3 grades or less. The average number of pupils per primary school is 145 - with the averages ranging in the governorates from a low of 64 to a high of 231.

Table 3 presents data on the number of schools and pupils by governorate. In addition to these facilities, there are 17 teachers' training institutes, 3 commercial schools, and one technical school. Higher education is available at the University of Sana'a.

TABLE 3
NUMBER OF SCHOOLS & PUPILS BY GOVERNORATE

Governorate	Primary:		Preparatory: ^a Schools	Secondary:	
	Schools	Pupils		Schools	Pupils
Sana'a	294	49 473	19	3	2 363
Hodeida	151	24 557	12	3	1 028
Taiz	316	72 885	34	9	3 207
Ibb	119	20 291	11	5	392
Dhamar	170	15 822	7	1	99
Hajjah	210	13 522	5	1	69
Sa'ada	106	8 579	1	-	-
Mahweet	62	5 045	1	-	-
Beidha	65	8 601	4	2	39
Marib	35	2 707	3	-	-
Total	1 528	221 482	97	24	7 197

^a Number of pupils at the preparatory level was not available.

Source: Reference 1

1.5 Transport and Communication

Until the 1962 revolution, Yemen was virtually closed to the outside world with a totally undeveloped transport and communication system. These systems have expanded rapidly in recent years despite the formidable topographic constraints, such as rugged terrain, vast mountain areas, deep gorges and wadis, seasonal flooding, and sand movements.

The basic highway system linking the 3 principal cities was completed 5 years ago. As of late 1977, Yemen had 1 039 kilometers of asphalt roads and 2 049 kilometers of secondary and feeder roads - including 662 kilometers of gravel, 429 kilometers of graded track, and 958 kilometers of earth track. These cliff-hanging tracks, many of which were chiselled by hand, have opened up much of the interior from its previous physical, economic and political isolation. Consequently, the number of cars privately owned is rising dramatically.

There are 3 international airports at Sana'a, Taiz and Hodeidah and several smaller air-strips throughout the country. Principal connections are through Cairo, Jeddah, Damascus, Addis Ababa and Bahrain. There are no railways in Yemen. The modernized port of Hodeidah is an important Red Sea port of call. Salif port also handles larger ships, while Mocha and Khokha ports are limited to smaller cargo vessels.

Postal services are very limited in coverage, since their systematic development began only in 1969. Telephone density has expanded rapidly from 4 700 telephones in 1975 to 40 500 in 1976. While the radio broadcasting stations which exist in the 3 major cities cover most of the country, television serves at present the Sana'a area only.

There are two daily newspapers with a total circulation of 6 500, 13 weekly newspapers with 22 000 total circulation, one bi-weekly newspaper with 1 000 circulation, and four monthly magazines with 8 000 total circulation.

2. Health Services

2.1 General

The Ministry of Health (MOH) exercises general responsibility for the health affairs of the country. These encompass both curative and preventive programmes, as well as the development of health manpower and the provision of medical supplies. Over the years since its creation in 1963, the MOH has increasingly stressed preventive health services.

The first five year health plan (5), for the period 1976/77 - 1980/81, has given priority to providing basic health services to rural areas, to improving hospitals, to strengthening the health administration, and to controlling debilitating diseases - such as schistosomiasis, tuberculosis and malaria. Mother and child health and immunization programmes are also stressed.

The MOH has identified (3) many of the obstacles which diminish the effectiveness of health sector activities and is now gradually overcoming them. Among the stated obstacles are the low geographic coverage of comprehensive basic health services and of the information and reporting system, an overall lack of supervision and no referral system, a recurrent breakdown in logistic support systems, and an absence of standardization as regards official staffing patterns, physical plant, job descriptions and drug and supply lists.

2.2 Medical Care Organization

The chart of the current organizational structure of the Ministry of Health presented in Annex I illustrates the services provided and the lines of authority and responsibility. The organizational structure at the governorate level repeats that of the central level. With overall responsibility for health services at the governorate level, the Directors General of Health Services report directly to the Deputy Ministry (Under-Secretary) and are in close contact with the four Directorate Generals, who give technical support to the governorate health offices in their respective fields.

The MOH is concerned (3) that in most governorates, preventive and promotive services are marginal due to the inclination of the Directors General to provide mostly curative services because of their own predominantly clinical training, as well as staff shortages and the heavy concentration of the few available physicians in the hospitals.

A 1976 breakdown by governorate of health facilities and selected categories of health personnel is presented in Table 4. By 1978, there were 24 hospitals with 2 910 beds - including approximately 700 reserved for tuberculosis and leprosy patients - giving a ratio of 5.3 beds per 10 000 population. Two-thirds of all hospital beds are located in Sana'a and Taiz Governorates, while Marib and Al Mahweet Governorates have no hospitals at all.

By definition, dispensaries are in-patient facilities equipped with beds (usually 20) and headed by a physician. Health centres are usually directed by a physician and health sub-centres by a qualified nurse. Rural health units are generally staffed with a health assistant who is, in most cases, an un-graded worker.

TABLE 4
HEALTH FACILITIES AND SELECTED HEALTH PERSONNEL BY GOVERNORATES (1976)^a

Governorate	Hospitals		Hosp. Beds per 10 000 pop. ^b	Dispensaries		Health Centres	Sub- Centres	Rural Health Units	Physicians		Population per Physician ^b	Qualified Nurses and Midwives		Auxiliary Staff ^d
	No.	Beds		No.	Beds				Y ^c	E ^c		Y ^c	E ^c	
Sana'a	5(4)	900	10.9	1	20	6(3)	0	11	54	58	7 400	118	68	125
Taiz	7(5)	970	10.8	3	60	3(2)	3	16	36	22	15 500	53	16	159
Hodeidah	3(2)	340	4.9	4	160	2(1)	8(6)	16	17	17	20 400	18	17	69
Dhamar	1(1)	55	1.1	0	0	0	0	6	3	4	69 400	0	1	6
Ibb	4(2)	232	2.9	1	30	1(1)	0	6	5	6	73 700	11	9	47
Hajjah	1	68	1.6	3	60	2	0	6	2	0	208 300	0	1	24
Sa'ada	1	14	0.9	0	0	0	0	3	1	2	54 600	0	6	11
Al Mahweet	0	0	0	1	25	1	0	4	0	0	—	0	0	0
Al Beidha	2	58	3.6	0	0	0	0	3	6	1	23 100	0	5	12
Marib	0	0	0	0	0	1	0	4	0	0	—	0	0	0
Total	24(14)	2 637	5.0	13(0)	355	16(7)	11(6)	75	124	110	23 000	200	123	453

^a Although breakdowns by governorate are not available, there have been substantial increases in some categories of manpower - 505 qualified nurses and midwives and 399 physicians as of 1978.

^b Using 1976 mid-year population estimates of Yemenis resident in the country.

^c Y = Yemeni E = Expatriate

^d Including X-ray technicians, laboratory technicians, assistant pharmacists, assistant nurses, X-ray aides, laboratory aides, medical assistants, anaesthesiology technicians and aides.

() Facilities located in urban areas (as defined by population greater than 20 000).

Source: Reference 1

As of 1978, there were 22 dispensaries, 34 health centres and sub-centres, and 113 rural health units. Sa'ada and Al Beidha Governorates do not have any dispensaries, health centres, or sub-centres. The rapid un-coordinated construction of health facilities by local development boards has outstripped the production of trained health personnel. Consequently, lists of facilities overestimate the availability of health services since some establishments are not yet staffed and functioning - particularly rural health units - and others are operating only part-time when visited by mobile staff or staff from nearby larger facilities. Approximately 70% of the 162 districts have no health facility at all.

The total number of patient visits to the health facilities in 1976 was approximately 900 000.

2.3 Health Manpower

In recent years, there have been substantial increases in some categories of Yemeni health manpower. Consequently, the reliance upon expatriate staff may decrease in coming years. As of 1978, there were 399 physicians (including 147 expatriate), 20 dentists (9 expatriate), 44 pharmacists (19 expatriate), 441 qualified nurses (160 expatriate), 64 qualified midwives (33 expatriate) and a total of 1 196 auxiliary staff (45 expatriate).

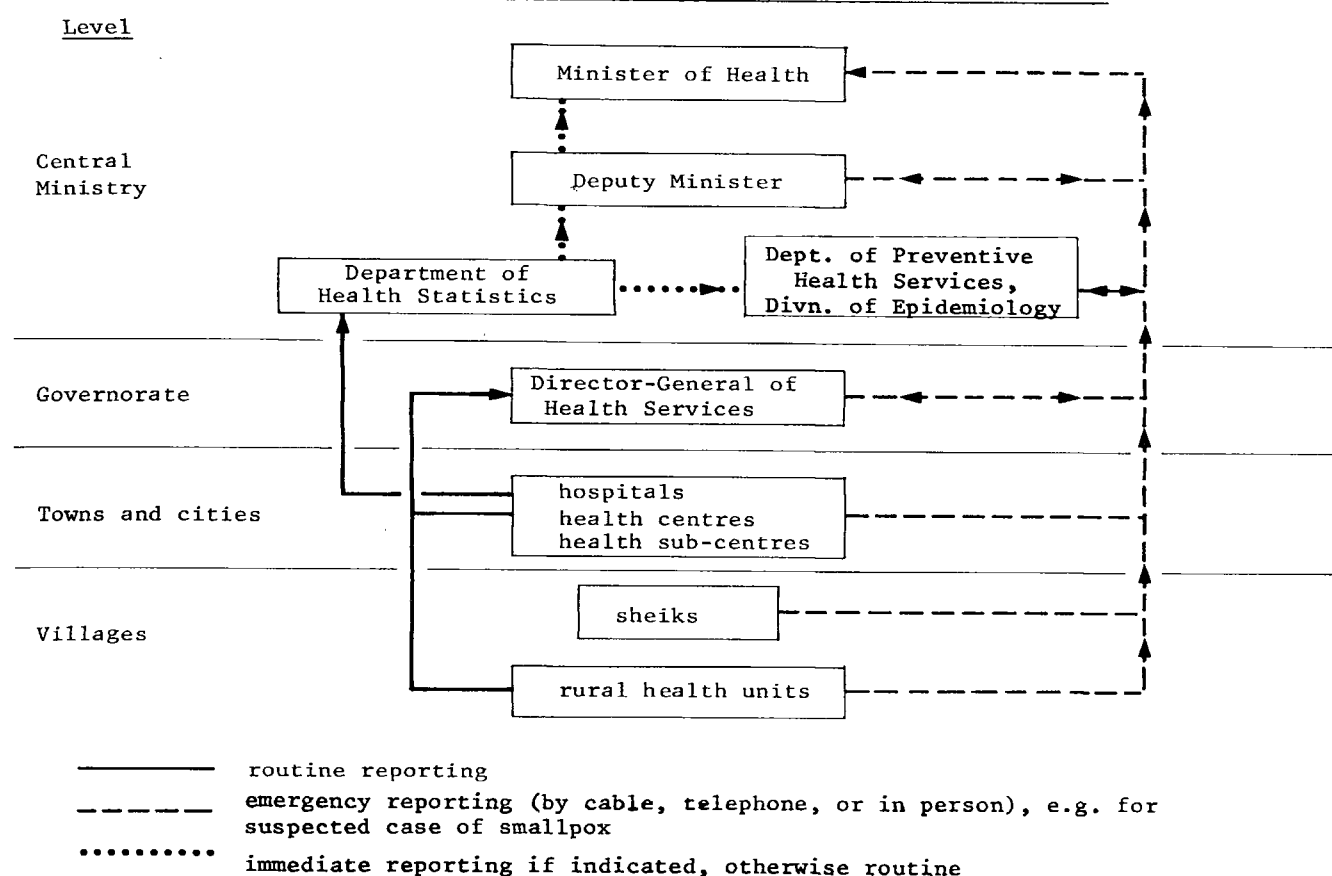
Some governorates - Al Mahweet and Marib - have received their first physicians and auxiliary staff since 1976. Nationwide as of 1978, there was one physician for every 13 900 persons and one auxiliary for every 4 600 persons. However, Sana'a, Hodeidah and Taiz Governorates in 1976 accounted for 87% of the physicians, 91% of the qualified nurses and 78% of the auxiliary staff.

Approximately 50% of the Yemeni physicians have been trained in the Union of Soviet Socialist Republics.

2.4 Communicable Disease Control

Established in 1967, the Preventive Health Service is responsible for all communicable disease activity. A Division of Epidemiology was established centrally in 1974 to collect, analyze and interpret data concerning diseases of public health importance and to apply appropriate control measures. Technical staff consists of the Director of Preventive Health Services, an epidemiologist, the WHO Epidemiologist, and two sanitarians. The health service structure relevant to communicable disease control is illustrated in Figure 3.

FIG. 3: REPORTING SYSTEM FOR NOTIFIABLE COMMUNICABLE DISEASES



In order to respond more effectively to disease outbreaks in peripheral areas, preventive health services have been decentralized with the creation of epidemiological units in Taiz and Hodeidah - each staffed with a single medical officer and a sanitarian. With Sana'a Governorate being the responsibility of the central unit, the Directors General of Health Services, some of whom are not physicians, in the remaining 7 governorates are expected to fulfil these epidemiological duties with the aid of a variable number of sanitarians.

Hospital facilities for treatment of acute and communicable diseases are limited, with no single hospital exclusively devoted to infectious diseases. Wards for admitting infectious diseases in times of need exist in a single hospital in each of the five largest cities.

Information on disease outbreaks in the towns is obtained from hospitals and health centres, and in the rural areas, in which almost 90% of the population lives, usually from the sheikhs. The normal procedure for investigating outbreaks is to visit the area by car or on foot, attempt to define the aetiology, decide on such preventive measures as may be possible and leave a sanitarian to apply them, and to treat cases of the epidemic disease and other

diseases which may be present. A laboratory technician with the necessary equipment for obtaining and transporting specimens often accompanies the team. However, competing duties and a shortage of sufficient trained manpower limit the contribution to field epidemiology.

Another important aspect of communicable disease control - immunization - has been entrusted to the central epidemiology unit. The Expanded Programme on Immunization, begun in 1977, covers the three principal cities and is presently being extended to smaller accessible cities and towns.

2.5 Reporting System for Notifiable Communicable Diseases

Communicable disease reporting systems were introduced for the first time in 1975 by the newly-created Department of Health Statistics in cooperation with the Division of Epidemiology. Previously, record-keeping, if it existed at all, had been casual and not uniform; consequently, information on disease conditions and health sector activities is sparse.

The number of notifications received annually has steadily increased, but the completeness, regularity and frequency of reporting still needs improvement. Patient registers and registers of communicable diseases are not kept in most health facilities. No system of "nil" reporting exists.

In order to improve peripheral data collection in the governorates, sub-units for health statistics, manned by statistical clerks who have undergone 6 weeks of in-service training organized by the Department of Health Statistics and who receive periodic refresher courses, have been established in 6 governorates. However, the compliance of most rural health facilities has not yet been secured.

Medical workers are overburdened with curative demands and often unaware of the importance of precise data. Furthermore, the underdeveloped transport and communication infrastructure, the rugged terrain, and occasionally the climatic conditions combine to isolate many smaller units.

There are two systems for communicable disease reporting:

- i) Routine monthly reports of specified communicable and endemic diseases are sent in each governorate to the Director General of Health Services, who then forwards them to the Department of Health Statistics in Sana'a.
- ii) The prompt notification of selected diseases, including smallpox and chickenpox, can result in immediate action. Information on individual cases with complete identifying information is posted or hand-carried from the health facility directly to Sana'a, with a copy to the Director General of Health Services in the governorate. When urgent action is required, direct reporting by telephone or cable is expected.

The general public also actively participates in disease reporting.

3. Smallpox Data

3.1 General

The yearly numbers of smallpox cases and deaths, as officially reported to WHO (6, 7, 8), from 1950 through 1978, appear in Table 5. However, owing to the obvious under-reporting, the past prevalence of smallpox in Yemen is not reflected.

It is well-known that variola major was endemic in Yemen with yearly incidence. The factors which favour endemicity were all present, including: inaccessibility of most of the population with resultant low levels of conferred immunity; resistance of many of the tribal areas to vaccination; poorly developed reporting system impeding prompt and effective containment measures; dense but highly mobile population; location along well-travelled pilgrimage

route; cultural practices, such as daily qat* chewing sessions in small poorly ventilated rooms; practice of variolation; a cool and dry climate throughout much of the country conducive to the droplet survival of the virus.

TABLE 5
REPORTED SMALLPOX CASES & DEATHS, 1950 - 1978

Year	Cases	Deaths	Year	Cases	Deaths
1950 - 1957	a	a	1966	1	0
1958	20	a	1967	3	0
1959 - 1962	a	a	1968	0	0
1963	5	1	1969	29	0
1965	0	0	<u>1970 - 1978</u>	0	0
			Total	63	1

^a No reports available.

Source: References 6, 7, 8

In 1960, at the time when smallpox was still endemic, a visiting WHO epidemiologist reported (8) that smallpox behaved no differently in Yemen than in other endemic countries where peaks of high incidence occurred every 5-7 years. This was attributed to the accumulation of a high number of susceptibles in the absence of any programme to vaccinate newborns or re-vaccinate the population at large.

Since data concerning the past epidemiological features of smallpox are non-existent, owing to the prolonged absence of the disease and to the disease's eradication before the implementation of the mass vaccination effort in late 1969, intensified nationwide smallpox case search and surveillance was launched in June 1978 as part of the special operations for the confirmation of smallpox eradication (see Section 7). Results of these searches and surveys are presented in Section 8.

3.2 Last Smallpox Epidemic

Yemen suffered its last major epidemic in the late 1950's, at the same time that wide areas of the Eastern Mediterranean region were similarly infected. According to a visiting WHO Regional smallpox survey team (9), official and unofficial sources in 1959 reported that at least 30 000 cases of variola major affected unspecified areas of Yemen from 1957-59, resulting in a purported 18 000 fatalities. (The poorly developed transport and communications network did not permit verification of these reports at the time.) The source of the epidemic was allegedly a pilgrim returning from Mecca. The Weekly Epidemiological Record (10) specifies some localities in Yemen as being the source, in turn, for the epidemic of smallpox reported from Democratic Yemen during the same period. Although no official data are available indicating what containment measures, if any, were taken throughout the country, it is known that a team from a WHO-assisted project in Sana'a mass vaccinated residents of the city.

Facial pockmark surveys conducted since mid-1978 throughout the country (see Section 8) have confirmed the magnitude and widespread range of this last major epidemic, with 116 (79%) of the 146 visited districts reporting smallpox during the period 1956 to 1960. Indeed, in 65% of the visited districts which reported smallpox during this period, smallpox transmission ceased after this same epidemic had run its course.

3.3 Last Smallpox Outbreak

As a consequence of the civil strife of the 1960's, it is speculated (11) that the number of importations to Yemen resulting from the overland movement of pilgrims from smallpox-infected countries, particularly from the Asian sub-continent, was reduced. Smallpox foci smouldered in several areas of the country into the late 1960's, until in 1969 Yemen officially reported its last outbreaks. These outbreaks appear to have been limited first to Taiz and then to Sana'a, with a total of 29 cases occurring from 24 March through June of 1969. Owing to delays in notification, verification by WHO never took place; as such, precise information regarding the source, exact number, timing, geographical distribution, and age, sex and vaccination status of the cases is lacking.

What surveillance, case-finding, and containment measures were initiated, and by whom, was apparently not reported in complete detail. It is known that all 9 or 10 cases in Taiz occurred in an army camp amongst males aged 20-30 and were allegedly due to an importation from Democratic Yemen. All were isolated in a Taiz hospital while camp personnel and inhabitants of a nearby village were vaccinated. No deaths were reported and no cases occurred after June. One correspondent, however, refers to the occurrence of a total of 47 cases until June 1969 with 28 in Sana'a, 16 in Taiz, and 3 also in Hodeidah. Although exhaustive archival searches 10 years after this outbreak cannot fully trace what was so elusive at the time, current surveillance activities were sufficiently sensitive to discover evidence of smallpox with onset in 1969 in Sana'a City.

A subsequent pockmark and vaccination scar survey, including a line-listing of all deaths in the past 15 years, was conducted among 350 persons in house-to-house visits in this last infected neighbourhood. Nearby primary schools with 1 175 students were also visited. No evidence of smallpox transmission after 1969 was encountered. A single adolescent was found to be recovering from chickenpox.

3.4 Suspected Smallpox Cases and Major Rumours Since 1969

A file is kept in the central smallpox office giving details of all suspected smallpox cases and major rumours, for which records are available, which have occurred since the inception of the Smallpox Eradication Programme in 1969. Any case from which a specimen is collected is included as a "major rumour" in this file. Of 71 separate incidents investigated, 64 were investigated within one week of notification, while information pertaining to the dates of the remaining 7 investigations is not sufficiently complete to calculate the time intervals. More than 60% were investigated by a WHO expert, usually accompanied by a senior level national from the Ministry of Health; while the remaining investigations were conducted by trained national surveillance officers. 48 of these incidents occurred after the special certification operations began in 1978.

Two-thirds of the 71 incidents involved rural areas and all governorates except Marib were visited for investigations. Over one-half of the resultant cases were clinically diagnosed as chickenpox and all were confirmed upon laboratory examination to be negative for smallpox. Other clinical diagnoses at the time of investigation included suspected smallpox, vaccinia, impetigo, infected scabies and measles.

Of the 12 incidents since 1970 in which patients were initially suspected by a practitioner of having smallpox (including 4 since 1976), clinical, epidemiological and immunological investigation by WHO and Ministry central staff, and subsequent laboratory analysis, revealed all to be negative for smallpox, with 4 positive for herpes varicella. A complete breakdown of specimens collected is presented in Section 6.

Two deaths were associated with 1971 and 1973 incidents, but in both instances the WHO epidemiologist strongly doubted on clinical and epidemiological grounds the diagnosis of smallpox. Laboratory analyses were negative for smallpox.

Stern measures employed by quarantine officials in the port of Hodeidah in late 1977 against an arriving sailor infected with chickenpox exemplified the authorities' willingness to act once suspicion arose.

During the special certification operations, most rumours of smallpox were detected by smallpox surveillance workers during active locality searches and all were promptly investigated. Rumours of smallpox were only rarely received from outlying health facilities, which could, in part, be explained by the fact that chickenpox cases were infrequently brought to their attention.

Any rumour of smallpox or suspected smallpox received centrally, whether from health units or, much more commonly, from private citizens, merited a prompt and thorough clinical and epidemiological investigation by the central smallpox office. When appropriate, a specimen was collected for laboratory examination and challenge vaccination was sometimes performed. However, the rather Draconian measures outlined in the operational guidelines (12), including urgent notification, isolation, specimen collection, challenge vaccination, ring vaccination, contact tracing, house-to-house search and line-listing of cases, were to be used in the event of a case being suspected by the central staff to be smallpox. These containment measures were never required.

4. Smallpox Vaccination Data

4.1 National Smallpox Eradication Programme, 1969-1978

In keeping with the resolution of the World Health Assembly which in 1967 launched a coordinated worldwide smallpox eradication effort in concert with national authorities, the Yemen Arab Republic embarked in late 1969 on a project to maintain its apparent smallpox-free status by establishing a National Smallpox Eradication Programme with the advice and some logistic support of WHO. The Programme enjoyed close organizational ties within the Ministry of Health central office through a specialized central unit within the Department of Preventive Health Services. The aim was to vaccinate 100% of the population in a three year attack phase, followed by a maintenance phase integrated within the basic health services, emphasizing the routine vaccination of newborns and immigrants and the regular vaccination of the entire population at 3-4 year intervals. Multiple puncture, using WHO-donated freeze-dried vaccine and bifurcated needles, was the technique practised.

Considering the vulnerable position of Yemen to an importation from East Africa, the Ministry of Health in 1977 ordered emergency vaccination measures along the entire coast. Executed by mobile national teams, these efforts were assessed by WHO to have been effective. Consequently, vaccination in mid-1978 ceased to be a part of the programme, as more attention was devoted to rigorous searches and surveillance. Vaccination continues to be offered in health centres, primarily by the Expanded Programme on Immunization. As part of containment preparedness, vaccination technique has been taught to all Programme staff and emergency stocks of vaccine are maintained. Yemen has adopted the resolution of the Twenty-ninth World Health Assembly, recommending that governments restrict their requests for smallpox vaccination certificates to travellers who, within the preceding 14 days, have visited a smallpox-infected country.

4.2 Vaccination Coverage

Table 6 presents the number of smallpox vaccinations performed yearly since 1969. These figures must be regarded with extreme caution since records are incomplete for some years, and for other years records may overlap, with figures thus being tallied more than once. Whereas the Smallpox Eradication Programme always recorded vaccinations according to age and sex of the recipient and whether it was a primary or re-vaccination, bilateral agencies rarely followed suit.

TABLE 6
SMALLPOX VACCINATIONS PERFORMED^a, 1969 - 1978 (x 1,000)

Year	Type of Vaccination			Total
	Primary	Re-vaccination	Unknown	
1969	b	b	200	200
1970	234	550	21	805
1971	107	153	30	290
1972	103	95	33	231
1973	59	75	36	170
1974	b	b	21	21
1975	137	173	115	425
1976	48	44	186	278
1977	b	b	155	155
1978	48	b		48
Total	736	1 090	797	2 623

^a Includes incomplete and estimated figures.

^b Data not available.

With over 2.6 million smallpox vaccinations performed since 1969, the vaccination coverage achieved by the Ministry of Health in the face of formidable obstacles is truly worthy of praise. Nevertheless, the 5.7 million Yemenis resident within the country in mid-1979 cannot be considered well protected against smallpox. Furthermore, the vulnerable age groups did not necessarily receive the bulk of these vaccinations. In 1973, the resident WHO epidemiologist reported that during that year 60% of all vaccinations were given to adults leaving for other countries.

The contribution of one bilateral agency - the Swedish Save the Children Federation - deserves special mention. Their internal vaccination programme within their clinic in Taiz and their external mobile vaccination campaign throughout Taiz, Ibb and Hodeidah Governorates resulted in over 300 000 smallpox vaccinations from 1967 through 1978.

Although regular assessment of vaccine potency and "take" rates due to proper vaccination technique was to be incorporated into the programme, only very few survey results can now be located. The most widespread vaccination coverage assessments have been conducted during the current special operations for the certification of smallpox eradication (see Section 8).

Variolation is known to have been widely practised at one time, however, no evidence of variolation during the past twenty years has been detected, and no scabs have been retained.

5. Chickenpox Data

Chickenpox has been a notifiable disease since 1974, however, the names, age and sex of individual cases are not always entered on the notification form, as required. Table 7 presents the number of cases of rash diseases, including chickenpox, reported by governorate since 1974, but owing to the inaccessibility of health services for much of the population and the nature of the disease, chickenpox cases are generally not brought into the health establishments.

TABLE 7
CASES OF RASH DISEASES NOTIFIED BY GOVERNORATE, 1974-78

Governorate	1974		1975		1976		1977		1978	
	C	M	C	M	C	M	C	M	C	M
Sana'a			24	180	17	582	90	1 512	6	717
Hodeidah			6	86	1	369	5	1 814	8	1 588
Taiz			31	255	59	367	11	704	1	735
Ibb			12	169	3	425	1	51	0	2 167
Dhamar			0	67	4	883	2	5 093	0	1 342
Hajjah			5	27	4	6	1	82	3	370
Sa'ada			0	13	0	0	1	727	0	580
Mahweet			0	0	0	0	0	0	0	19
Beidha			1	4	0	22	1	0	0	16
Marib			0	0	0	0	0	0	0	16
Total	198 ^a	^a	79	801	88	2 654	112	9 983	18	7 550

C - chickenpox M - measles

^a Chickenpox information not available by governorate. Measles information not available at all.

Source: Division of Health Statistics, Ministry of Health, YAR.

Owing to the relatively recent introduction of a nationwide communicable disease reporting system, most reports of chickenpox, 87% of the 297 reported cases from 1975-1978, for example, still arrive from Sana'a, Hodeidah and Taiz Governorates. Two governorates, Marib and Al Mahweet, have never reported a case. The uneven distribution of health facilities, rather than Yemen's uneven population distribution or any variations in local incidence patterns, is presumed to be the reason for this imbalance.

As there is no compulsory registration system, deaths due to chickenpox would generally only be reported if they occurred within a hospital which sends discharge sheets to the Department of Health Statistics in the MOH. Of the 495 cases of chickenpox notified since 1974, no deaths were reported.

Peak months of chickenpox incidence are from January through April.

Since the most likely misdiagnosis of smallpox is chickenpox, rash-with-fever case search was a strategic component of the special certification operations (see Section 8).

6. Laboratory Data

6.1 Summary of Laboratory Investigations

Until the last reported smallpox cases in 1969, diagnosis was based on clinical findings. Thereafter, in all cases where the diagnosis appeared to be smallpox or remained in doubt, specimens were collected to confirm the diagnosis by laboratory analysis. From 1970 until March 1979, 68 specimens from rash-with-fever cases were examined for poxviruses in WHO reference laboratories. All were found negative for smallpox, with 12 being positive for herpes varicella. A line-listing of these specimens collected appears in Annex II. The results of laboratory testing of specimens by year of collection appear in Table 8. The distribution of specimens according to governorates, age group, and sex appears in Table 9.

TABLE 8
RESULTS OF LABORATORY TESTING OF SPECIMENS, 1971-79

Year	No. of Specimens tested	Results - number positive for:		
		Variola	Herpes varicella	Other
1971	1	0	0	0
1972	2	0	0	0
1973	7	0	0	0
1974	6 ^a	0	2	0
1975	5	0	5	0
1976	2	0	1	0
1977	3	0	0	0
1978 ^b	30	0	1	0
1979 ^b	12	0	3	0
Total	68	0	12	0

^a Includes two specimens for which no data are now available although results were negative for smallpox.

^b Through March.

DISTRIBUTION OF SPECIMENS ACCORDING TO:

(a) GOVERNORATE		(b) AGE GROUP		(c) SEX	
Governorate	No.	Age group	No.	Sex	No.
Sana'a	23	1	6	male	37
Hodeidah	6	1 - 4	17	female	28
Taiz	10	5 - 9	15	<u>unknown</u>	<u>3</u>
Ibb	13	10 -14	9	Total	68
Dhamar	4	15+	18		
Hajjah	4	<u>unknown</u>	<u>3</u>		
Sa'ada	0	Total	68		
Mahweet	0				
Beidha	4				
Marib	0				
<u>unknown</u>	<u>4</u>				
Total	68				

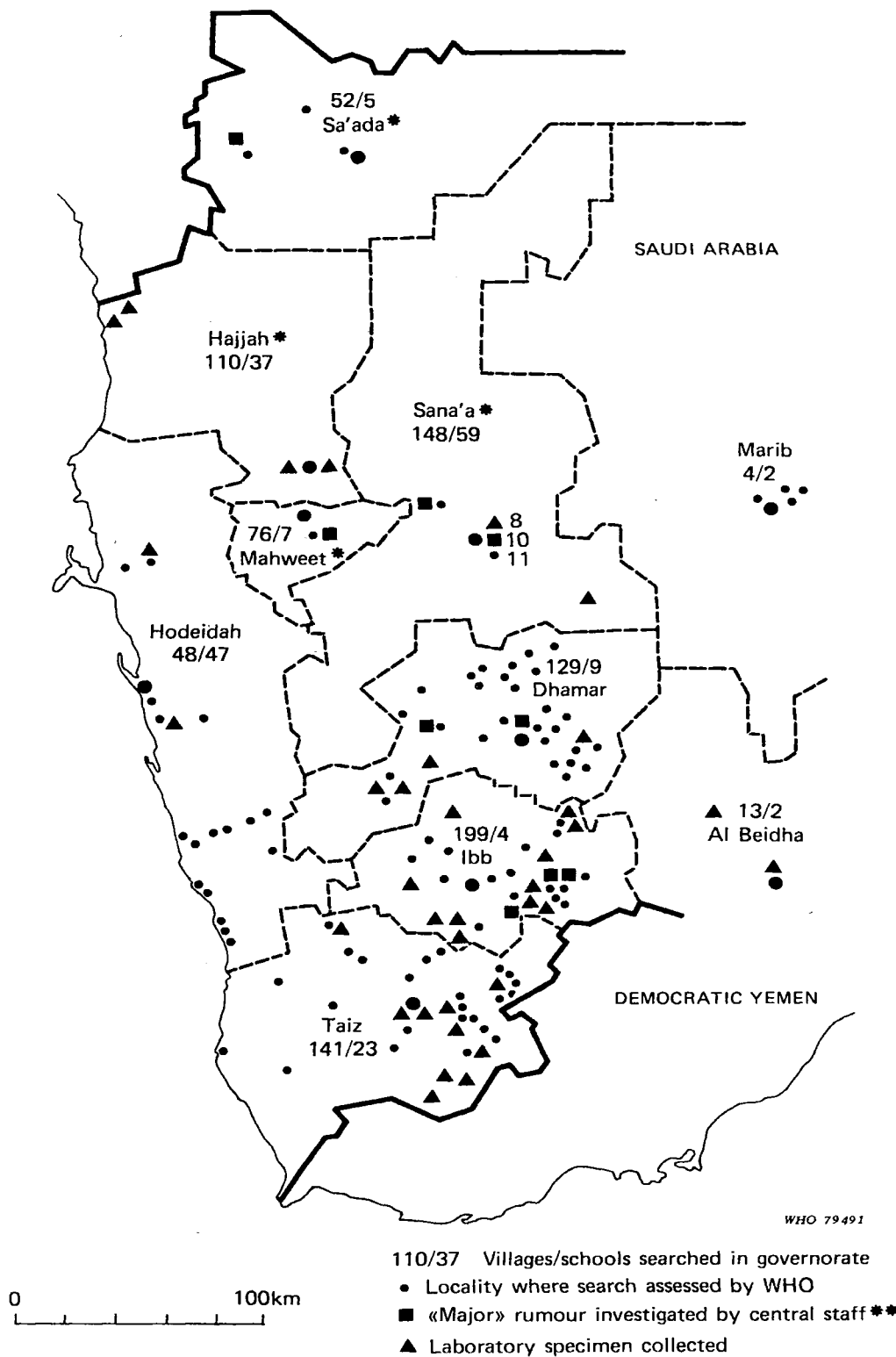
Although 40 of the specimens were collected during the period of intensified special certification operations, which commenced in mid-June 1978, specimens have been analysed every year since 1971. The wide geographical coverage achieved since mid-1978 in the collection of specimens is apparent in Figure 4.

The 68 specimens were collected in 56 distinct episodes from 41 villages and 2 urban centres. However, no specimens were collected from Sa'ada, Mahweet or Marib Governorates. Thirty-six of the specimens were collected by WHO experts, 25 by the present smallpox national staff, 3 by expatriate physicians, and 2 by national physicians.

- * WHO assessment of randomly selected 10% of searched villages completed after preparation of this report.
- ** Includes only those investigations by a WHO expert, usually accompanied by senior level MOH staff, in response to centrally received notifications. Does not include the countless rumours routinely investigated during field operations.

FIG. 4

COVERAGE ACHIEVED BY SPECIAL SURVEILLANCE
OPERATION 1978-1979



7. Special Operations for the Confirmation of Smallpox Eradication, 1978-79

7.1 Components of Special Certification Operations

In June 1978, bearing in mind that smallpox had not been reported anywhere in the world for eight months and that the last reported cases had occurred within the same epidemiological unit of which Yemen is considered a part, the Ministry of Health with the technical and operational collaboration of WHO embarked on an intensified programme of smallpox search and surveillance activities to establish with careful documentation, and beyond reasonable doubt, the absence of smallpox from the country.

The programme had the following broad aims:

- i) to find any hidden foci which might have existed by intensifying the surveillance system and by conducting active searches and special surveys;
- ii) to be prepared to contain outbreaks that might be detected, and
- iii) to document thoroughly the absence of smallpox transmission at the present time and since the last reported outbreak in 1969, so that the Global Commission for the Certification of Smallpox Eradication would be able to proclaim the disease's absence.

The lack of widespread coverage achieved by the basic health services, the relatively recent introduction of the communicable disease reporting system, and the previous lack of a national smallpox surveillance programme operating in all areas of the country, had all combined to leave most of the country unsurveyed for smallpox foci. Data on past epidemiological features were incomplete owing to the prolonged absence of smallpox and to the disease's eradication before the implementation of a mass vaccination effort in 1969. The special certification operations were therefore designed to diminish this information gap.

In each locality and school visited, multiple tasks were performed, including:

- searching for active cases of rash with fever;
- investigating rumours of smallpox;
- investigating any reported deaths due to chickenpox;
- collecting specimens from suspect cases and selected chickenpox cases for laboratory analysis;
- maintaining containment preparedness in the event of active smallpox being discovered;
- conducting facial pockmark surveys to ascertain the history of past smallpox infection;
- conducting vaccination scar prevalence surveys to determine past programme coverage and accomplishments;
- visiting any markets or health facilities present; and
- thoroughly documenting all activities.

Routine vaccination was discontinued by the National Smallpox Eradication Programme at the start of the special certification operations, as it was believed that vaccinations would otherwise interfere with the primary task at hand - surveillance, and that if smallpox should eventually surface, random vaccination before active case-finding would not have been effective for containment purposes.

Guidance for the field workers regarding the execution of their multiple duties was provided in detailed operational guidelines. (12)

While the clinical and epidemiological investigation of major rumours, of deaths from chickenpox and of cases of suspected smallpox was the responsibility of experienced public health officers from the Department of Preventive Health Services and WHO, during the course of field surveillance the smallpox teams investigated any alleged case of rash-with-fever to exclude a diagnosis of smallpox. Specimens for laboratory testing were collected from every chickenpox outbreak, with special priority given to suspected smallpox, severe or atypical chickenpox, hospitalized chickenpox, an outbreak in which a death had occurred, chickenpox in an adult and chickenpox in a person unvaccinated for smallpox.

Facial pockmark surveys were conducted in all localities and schools visited, in areas surrounding the last smallpox outbreak and in sites of any reported chickenpox death. The name, age and the date and place of affliction were recorded for those who possessed at least 5 round and depressed facial scars, one or more millimetre in diameter. Information was also elicited (and kept separate) by questioning family and friends regarding facial pockmarks in residents who were absent. While extrapolation from a representative sample of the population, when corrected for mortality and pockmark disappearance, can provide an estimation of past smallpox incidence, the primary purpose of the surveys during the special certification operations was to ascertain a history of past smallpox infection with careful attention paid to the more recent occurrences of the disease.

Between 10% and 15% of the residents in visited localities and 100% of the pupils in visited schools were examined on both arms for the presence of a smallpox vaccination scar. In villages, these persons were randomly selected from houses and gathering places in all quarters of the village. Care was taken not to bias the sample by selecting children who came running up to display proudly their "badge of courage", while unvaccinated siblings, sensing an imminent vaccination, scampered off in all directions. By-passers in the street were approached only if the surveillance worker himself selected these persons for examination.

To stimulate the reporting of smallpox rumours, the WHO reward of \$1 000 for the first person notifying a laboratory-confirmed active case of smallpox caused by person-to-person transmission was publicized by means of posters and by the various mass media. In December 1978, the surveillance teams began announcing the reward to the headmen and elders during the active locality search. All Ministries were requested to cooperate by disseminating news of the reward to their sub-offices. Health facilities were informed in person of the reward at the start of the special certification operations.

7.2 Programme Structure

To assure quality of performance and maximum control over output, it was most cost-effective to deploy a small number of mobile surveillance teams to cover each governorate in turn and then to move on. Moreover, again to maximize effect, the multiple tasks described above were performed concurrently in each visited locality and school.

The bulk of the funds financing the special certification operations were channelled by the Ministry of Health through the Swedish Save the Children Federation, who then administered the broader aspects of the programme with the experience gained from years of mobile operations in rural areas. This bilateral agency also contributed the salaries of the previous field supervisor and of two team leaders, who all maintained their status as national employees of the Swedish Save the Children Federation. The United States Peace Corps also contributed the services of two volunteers serving as surveillance workers.

Each of the three teams was assigned a suitable 4-wheel drive vehicle and consisted of a team leader, one additional surveillance worker and a driver. Each field team had access to the imprest account administered by the field supervisor for the operating and maintenance of the vehicles, for the hiring of temporary guides, etc. Field supervision was the responsibility of the field supervisor, while technical and operational guidance was provided by the WHO Operations Officer.

These teams were responsible for active search operations and pockmark and vaccination scar surveillance, for investigating field rumours and distinguishing rash-with-fever cases, for visiting health facilities and schools to stimulate vigilance and reporting, for collecting specimens, for implementing containment efforts (if needed) and for keeping careful records.

Recruited by the national administrators on the basis of past performance and reliability, staff received an average of three days of theoretical and practical field training. During this time, an overview of the worldwide status of smallpox eradication was presented, the status in Yemen was reviewed, and the purpose of the certification operations in Yemen was explained. The nature of facial pockmarks and of smallpox vaccination scars and the method of conducting pockmark and vaccination scar surveys were described. The staff were instructed in the basic components of containment, including vaccination technique. They were taught to differentiate smallpox from chickenpox, and how and from whom to collect laboratory specimens. Finally, the teams were trained in the general conduct of field visits, in the selection of unsampled "replacement" villages, and in the required method of recording and reporting. All staff received periodic training according to the requirements of any new programme element.

At the central level and under the guidance of the Director of Preventive Health Services in the MOH and WHO epidemiologist, the WHO Operations Officer was responsible for planning the overall programme and the necessary forms; training the surveillance teams; deploying the teams and assessing their work; providing administrative and logistical back-up; investigating priority rumours and cases of chickenpox; supervising containment activities (if needed); securing the cooperation of other reporting units, such as expatriate development agencies; and collecting and analysing the data for summary reports and for final presentation of the country report to the International Commission for the Certification of Smallpox Eradication. Final responsibility for successful programme implementation rested with this central unit.

7.3 Selection of Localities for Active Search and Surveillance

No single area of the country was considered of greater priority than any other - with the exception of areas surrounding the last known outbreaks. The coastal area, formerly so considered, has been sufficiently covered over the past year, both by vaccination teams and by special surveys for pockmarks and vaccination coverage, to ensure that no importations or indigenous undetected foci had occurred during the past 10 years. (13)

With a total of approximately 18 000 villages and an average population of 245 per village, and with nearly 90% of its population living off main roads in barely accessible terrain, Yemen posed difficult logistical problems.

The selection of a random sample of villages to be visited was considered disadvantageous in that this would have ignored the known epidemiology of smallpox while committing substantial efforts to even the most sparsely settled hamlet. Given the rather low immunity status country-wide, it is inconceivable that smallpox could have escaped the notice of the recent active village search. On the contrary, any outbreak would either have involved wide areas of the country or larger villages, in which case the searches would have detected it, or it would have long ago "burned itself out" for want of susceptibles in the remote sparsely settled regions.

Since it was thought that for smallpox transmission to have persisted uninterrupted for the approximate 200 generations of the disease which would have been required since the last known case in 1969, the major population centres, both accessible and inaccessible, would have to have been involved, the larger villages and towns in each governorate were selected to be actively searched and surveyed a single time. The aim was to visit as many as possible of the 162 districts (nahiya) throughout the country to ensure complete geographic coverage, while visiting the larger settlements so that 20% of the total population in each governorate was covered.

To bias the sample further in favour of rural areas, each of the five major urban centres in excess of 15 000 residents was subtracted from its respective governorate's total population, and then the 20% requirement was applied against the remaining population. These five urban centres were later visited using a modified strategy. For a district not to be visited, it needed to have been off-limits for security reasons or very inaccessible, although the latter was insufficient reason for overlooking the district if it was reasonably well-populated.

Localities were sampled on the basis of 1975 census data. (14) Depending on the settlement patterns in each governorate, it was usually necessary to include in the sample all villages down to the size of 300-700 persons in order to satisfy the 20% objective.

Since the census books were not available when the Taiz Governorate search began, a different sampling method was employed. As the total number of villages in each district was known, it was decided to visit in each district either 10% of the villages or 10 villages, whichever number was the smaller. The application of this formula ensured complete geographic coverage while those districts with a greater number of villages contributed more villages to the sample. An upper limit of 10 villages selected per any one district effectively equalized the contribution to the sample of those few districts with more than 100 and so eliminated the epidemiological "overkill" inherent in visiting too many nearby localities. The actual names of the largest villages to be searched were then obtained from the governmental office in each district centre.

After the Ibb Governorate search early in the programme, it was found that the number and size of mahalla, or clusters of houses, present in a village was another criterion which had to be considered in advance, along with population size, in selecting the sample, since some "villages" may consist of over 50 distinct housing clusters dispersed over an extremely large area. Furthermore, for some districts in most of the governorates, it was necessary to lower the village threshold size for inclusion in the sample in order to ensure wider geographic coverage, since these districts would not otherwise have been visited if the cut-off was rigidly applied.

A district breakdown of sampling data and relevant comments is presented for each governorate in its respective summary report of surveillance/assessment activities (see Bibliography).

7.4 The Village, School and Urban Search

Upon arriving in a village, the team at once introduced their purpose to the headman in order to increase the likelihood of being accepted by the residents. He was asked in a general fashion whether there was any illness in the village. Gradually the surveillance worker became aware of rash-with-fever cases, such as chickenpox and smallpox. In such a way, the reliability of the information thus elicited was often greater than if the surveillance worker had asked initially if there was any smallpox or chickenpox in the village - for a stranger to ask such pointed and unexpected questions immediately after the first salutation might be regarded with some suspicion.

The team asked the headman when the last cases of smallpox had occurred in the village and who had been afflicted. He was requested to provide an escort so that door-to-door visits could be carried out to search for current rash-with-fever cases and deaths due to a vesicular disease, to inquire about persons, particularly children, with facial pockmarks and to conduct the vaccination scar prevalence survey. All information acquired was recorded on the appropriate forms. The team also questioned persons in the market, by the mosques, and in the drug stores and tea shops, as well as floating population groups, repeating the same questions they had asked the headman. As there are often local names for smallpox and chickenpox, the smallpox recognition card was prominently displayed.

The card was signed and dated by the team and was presented to the headman or to the owner of a much-frequented shop as a reminder of the importance of prompt notification of any suspected smallpox case to the nearest health facility. The existence of the reward was announced.

Search and surveillance activities were also conducted in all government and large Koranic schools located in the sampled villages. Information obtained from schools was recorded on separate forms so that the denominator for rates derived from facial pockmark surveys - the number of children examined - could be known exactly.

When visiting a school, the cooperation of the headmaster was first secured. A smallpox recognition card and usually a smallpox-chickenpox differential diagnosis chart were presented as a reminder to maintain vigilance. In all classrooms, a short presentation was given regarding the prompt notification of any suspicious eruptive fever to the nearest health facility. All pupils were then examined for facial pockmarks and vaccination scars.

Whereas in other countries visits to schools were a relatively easy way to examine large numbers of children, in the Yemen, where schools average only 145 pupils, it was usually not possible, given the formidable terrain, to visit more than two or three rural schools in a full day. For this reason, the teams sampled the larger villages where they could examine more children for facial pockmarks than if they had restricted themselves to schools.

Although the vast majority of Yemen's population dwell in rural areas, the energetic construction of roads has reduced the importance of local weekly markets, as people can increasingly purchase their daily requirements from well-stocked permanent shops in even the smallest village. The absence of large rural markets further necessitated that active search and surveillance be conducted primarily in the larger localities.

The five largest urban centres with a total population of less than 400 000 were visited using a modified strategy emphasizing schools and health units.

7.5 Health Facility Enquiry

The assumption could not be made that no reports of smallpox received centrally necessarily signified the disease's absence. Even if medical workers in outlying clinics wanted to comply with "nil" reporting, reliable means of communication simply did not exist. To strengthen continuous routine surveillance it was therefore necessary for the teams to visit hospitals, dispensaries and health centres in two systematic nationwide health facility enquiries using standardized procedures and forms. Only fixed health facilities permanently staffed and currently operating were visited.

A single person within each facility was responsible for keeping all smallpox-related records, together with forms and special kits supplied by the visiting smallpox teams; for promptly notifying, by cable or telephone, the Department of Preventive Health Services in Sana'a of a smallpox rumour or any reported deaths due to chickenpox; and for despatching any specimens collected to Sana'a by the quickest means available.

All available staff involved in direct patient care were briefed by the visiting teams, who enquired as to the recent occurrence of any suspected smallpox or chickenpox or deaths due to chickenpox; reviewed the staff's understanding of the procedure for collection and despatch of specimens and for prompt notification of smallpox, chickenpox, and rumours of smallpox; and informed the staff about the WHO reward. Smallpox-chickenpox differential diagnosis charts were distributed and the importance of increased vigilance was stressed.

The senior medical officer in each facility was requested to sign in triplicate a "nil" report if, during the past two months or since the last visit of the smallpox teams, no smallpox cases had been detected. He retained one copy, one was deposited with the Director General of Health Services in that governorate, and the third was filed in the central smallpox office.

As patient registers are not kept, any report of recent chickenpox within the preceding two months from villages within a two-hour radius could only be investigated if the medical staff recalled the name of the infected village.

In all the governorates, close contact was maintained with the Director General of Health Services, who was informed of the findings of the active locality search and of the health facilities enquiries so as to maintain his active interest and cooperation. He was presented with his copy of the "nil" reports.

7.6 Secondary Surveillance

Since there are few health facilities, on-going passive surveillance was extended by enlisting the support of the school authorities and teachers, village headmen, local development boards, and rural representatives of the numerous bilateral development agencies. Regular formal reporting, however, could not be expected.

7.7 Assessment

A randomly selected 10% of all localities visited by the surveillance teams in each governorate were assessed by the WHO Operations Officer in order to monitor the progress and reliability of the field surveys and the performance of the teams. If feasible, cases from whom specimens were collected were visited to verify the clinical diagnosis. Schools in the assessed villages were also visited to check on the quality of the teams' work.

In the assessed village, the presence or absence of a dated and signed smallpox recognition card was noted. A comparison was made between the number of rash-with-fever cases found during the search and during the assessment. The number of the latter which were determined to have been present during the search were entered. A serious failing of the original search occurred, for example, if chickenpox cases found during the assessment were known to have resulted from an outbreak which had been present, but went unreported at the time of the search.

Blinding himself as much as possible to the information initially recorded during the search, the assessor searched for persons with pockmarks in order to fix the apparent date of the last occurrences of smallpox. This date was then compared to that found during the search. A spot-check was made on the accuracy of the pockmark information recorded for individual persons at the time of the search. It was considered serious if smallpox which had occurred in the 1960's was detected during the assessment but had been overlooked during the search.

Finally, an age-specific comparison of vaccination coverage was conducted on the basis of vaccination scar prevalence surveys.

The teams were informed of the assessment findings in post-search meetings. Overall programme direction was occasionally reviewed with interested Ministry and WHO officials.

7.8 Recording and Reporting

Both the original and the analysed documentation, as well as graphs, maps and diagrams, are available in the central smallpox office. In the office of each Director General of Health Services is found the summary report of surveillance/assessment activities in his respective governorate, and also copies of "nil" reports submitted by health facilities within his jurisdiction. Results of major rumour investigations were also sometimes filed at the governorate level.

Field search and surveillance activities and results were recorded on the following routine and special forms, which were in Arabic or in English, as appropriate:

1. District Search Schedule
2. Village Search Form
3. Investigation Form for Pockmarks
4. Smallpox Rumour Sheet and Investigation
5. Health Facility Enquiry
6. "Nil" Report for Smallpox

7. Assessment of Active Search and Special Surveys
8. Monthly Summary Form
9. Investigation of Person with Facial Pockmarks (acquired since 1969) and of Smallpox Suspect
10. Patient and His Family Investigation
11. Line-Listing of Patients
12. International Smallpox Rumour Cross-Notification Form
13. Information on Patient for Smallpox Laboratory Test

The various uses of these forms are detailed in operational guidelines. (12)

8. Survey and Search Results of Special Operations for the Confirmation of Smallpox Eradication, 1978-79

8.1 Coverage Achieved During Active Governorate Searches, 1978-79

The wide geographic coverage achieved in village searches is noteworthy and strikingly represented on a population distribution map in the smallpox office. Figure 4 illustrates the coverage which was achieved in specimen collections, "major rumour" investigations conducted by central staff, and WHO-assessed localities.

Of 977 larger villages and towns sampled throughout the country, 766 (78%) were subsequently visited. In addition, another 154 unsampled localities were searched when sampled ones could not be visited. The total of searched localities, therefore, was 920.

These localities were situated in all 10 governorates and in 146 (90%) of the country's 162 districts. The 920 searched localities represented 5.2% of the total villages in the country. For the country as a whole, the 20% objective was reached with 21.4% of Yemen's total population resident in the searched localities. In one half of the searched districts, 100% of the sampled villages were searched. The average size of the visited villages and towns was 976.

Table 10 presents by governorate the coverage achieved since mid-1978 during the active searches and surveys. Governorate-wide searches were possible in all but Marib, which was considered a "closed" area. The actual location of the 16 districts throughout the country which could not be visited is evident in Figure 5. 12 of these 16 districts were not visited due to local security considerations, and another 3 were too inaccessible and too sparsely settled to warrant the two days of travelling required in each case to visit the single small sampled village. With only 4% of the country's total population and an average population density of 3.8 persons per square kilometre (compared to the national figure of 34.8), these 16 districts contributed only 31 villages to the sample.

In all governorates, there were various problems encountered in trying to visit 100% of the sampled villages, and so the field supervisor had authority (exceptionally) to replace some villages with others. Sometimes the census data listed several similar-sounding villages or even two villages with the same name (or the formal name listed in the census books was not well-known in everyday speech); as a result, pinpointing the sampled one often proved difficult. Sometimes a sampled village with many small mahallah* dispersed over a large area was bypassed in favour of an unsampled village which had a larger and more densely settled core. Occasionally, all the sampled villages, selected in Sana'a without a detailed map, turned out to be located in one corner of the district, and so, in the interest of geographic coverage, one or two were left unvisited in favour of smaller villages elsewhere in the district. Finally, security considerations necessitated flexibility in the field.

When the various factors restricting smallpox search and surveillance activities within each governorate could be foreseen, an intentionally large sample was drawn in order to compensate. Thus, in Beidha, 29.3% of the governorate's total population resided in the sampled localities. However, due to local circumstances beyond the programme's control, many sampled areas could not be visited. Nevertheless, following a second visit to the governorate 6 weeks after the initial search, 18.0% of the governorate's population was covered.

FIG. 5
YEAR OF LAST SMALLPOX BY DISTRICT
ACCORDING TO POCKMARK SURVEY
Y.A.R. 1978-1979

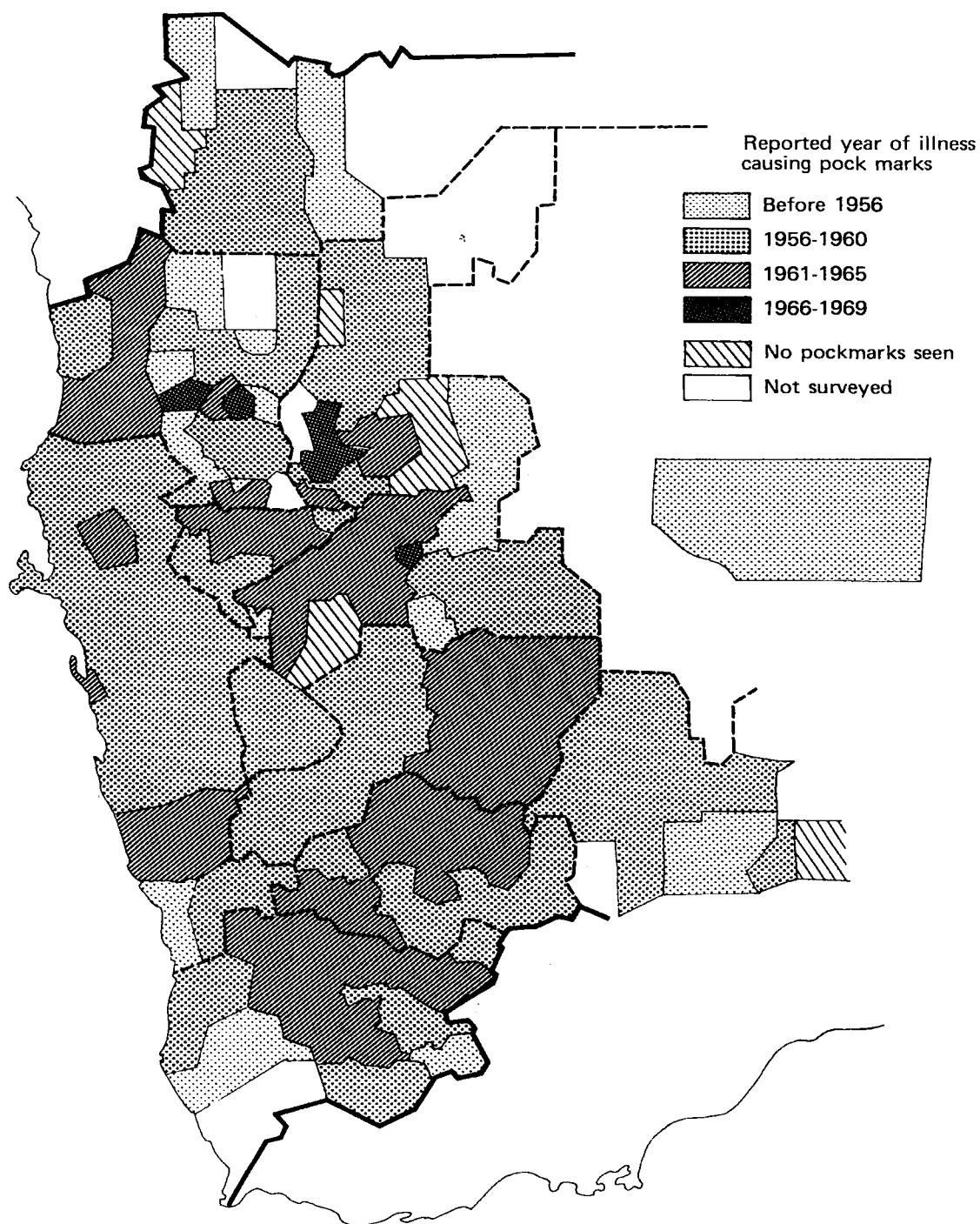


TABLE 10
COVERAGE ACHIEVED DURING ACTIVE GOVERNORATE SEARCHES AND SURVEYS, 1978-79

Governorate	Number districts present	Number districts searched	Number villages searched	Population in searched villages ^a	as % of Governorate's total population ^b	Number of Governmental schools surveyed
Sana'a	33	29	148	127 973	19.0	59
Hodeidah	18	18	48	135 441	22.8	47
Taiz	18	17	141	206 500 ^c	26.0 ^c	23
Ibb	20	20	199	183 797	23.8	4
Dhamar	9	9	129	81 360	18.5	9
Hajjah	31	28	110	72 647	19.0	37
Sa'ada	12	10	52	27 102	17.7	5
Mahweet	7	7	76	32 266	18.4	7
Beidha	10	7	13	28 376	18.0	2
Marib	4	1	4	2 026	5.0 ^d	2
Total	162	146	920	897 488	21.4	195

^a Based on 1975 census data.

^b Excluding the five major urban centres with populations greater than 15 000.

^c Estimated figures since census data were unavailable when the Taiz Governorate search began.

^d Since Marib is a "closed" area, governorate-wide searches were not possible.

In addition to the 920 localities searched, numerous small daily markets and small non-government Koranic schools were visited. Enquiries were made at over 60 other places, including large weekly markets, rural drug stores, Governorate Health Offices, special gatherings, offices of bilateral and international technical assistance groups and at homes of headmasters when the schools were closed. The coverage achieved during the health facility enquiry is discussed in Section 8.5 below.

195 large government schools with 50 404 pupils were also searched. The overwhelming majority of these were primary schools. Visits to 86 of these schools located in the five largest urban centres with over 15 000 population constituted, along with health facility enquiries, the primary component of the urban search.

8.2 Results of Rash-with-Fever Search and Rumour Investigations

No case of smallpox or suspected smallpox was encountered during extensive field operations. The results, by governorate, of the active locality and school searches appear in Table 11, and Table 12 provides the age distribution of all rash-with-fever cases found. A total of 78 cases of chickenpox and 384 other cases of rash-with-fever were found. The majority of the latter were measles cases. 65% of the chickenpox cases and 73% of the other rash-with-fever cases occurred in children under 5. Chickenpox or other rash-with-fever cases were encountered during each of the 9 governorate-wide searches.

All rumours received centrally, whether from health facilities or from private citizens, were considered "major" and were promptly investigated by central staff of WHO and, in most cases, of the Ministry of Health. Five of the governorates were thus visited for "major" rumour investigations. Chickenpox or measles cases were most frequently found. In addition, countless rumours in all 9 governorates in both searched and in other nearby villages were

routinely investigated during the course of field operations. In one instance, one week before the team's visit, a discrete eruptive disease on the trunk had allegedly claimed the life of a 3-year-old. No other cases were discovered and the most recent year of smallpox attack was 1958, according to a village pockmark survey.

A more complete discussion of all the suspected smallpox cases and major rumours investigated since the last smallpox outbreak in 1969 appear in Section 3.4, and there is a discussion of the results of laboratory investigations in Section 6. The 40 specimens collected since special certification operations began in mid-1978 were all negative for smallpox.

TABLE 11
RESULTS OF ACTIVE LOCALITY AND SCHOOL SEARCHES BY GOVERNORATE, 1978-79

Governorate	No. smallpox and suspected smallpox cases	No. chickenpox cases ^a	No. other "rash with fever" cases	Total	No. major rumours investigated ^a	No. specimens collected
Sana'a ^b	0	9	28	37	11	9
Hodeidah ^b	0	4	12	16	0	2
Tai ^z ^b	0	12	47	59	0	10
Ibb ^b	0	32	178	210	3	11
Dhamar ^b	0	16	43	59	2	4
Hajjah	0	1	64	65	0	4
Sa'ada	0	0	2	2	1	0
Mahweet	0	0	10	10	1	0
Beidha	0	4	0	4	0	2
Marib	0	0	0	0	0	0
Total	0	78	384	462	18	42

^a Includes only those investigations by a WHO expert, usually accompanied by senior level Ministry of Health staff, in response to centrally-received notifications; does not include the countless rumours routinely investigated in the course of field operations.

^b Includes assessment activities in these governorates.

TABLE 12
AGE DISTRIBUTION OF "RASH WITH FEVER" CASES, 1978-79

Age	No. of smallpox or suspected smallpox cases	No. of chickenpox cases	No. of other "rash with fever" cases	Total
0 - 4	0	51	255	306
5 - 9	0	13	64	77
10+	0	14	29	43
Total	0	78	348 ^a	426 ^a

^a Excludes 36 cases found on assessment visits for which age was not recorded.

8.3 Facial Pockmark Survey Results

Facial pockmark surveys were a cornerstone of the special certification operations. Since more than 99% of smallpox cases regularly went unreported when Yemen suffered from endemic smallpox, tracing of transmission so long after the event was not feasible. Pockmark surveys were therefore especially crucial in confirming the absence of smallpox in children born since the occurrence of the last case 10 years ago and the absence of smallpox dating since 1969 in older persons with pockmarks.

The surveys were conducted on an unprecedentedly large scale, covering the 920 villages and 195 schools searched. In addition, the area around the last smallpox outbreak and around any deaths due to an eruptive fever were similarly surveyed. Tables 13 and 14, respectively, present the survey results by governorate during the active locality search and the school search.

The faces of an estimated 149 850 persons were scrutinized during the village searches, including 54 050 children less than 10 years of age and 35 600 between the ages of 10 and 20. In addition, the exact number of schoolchildren examined was 50 404, the overwhelming majority of whom were between 6-13 years of age. In total, the pockmark survey thus covered approximately 80 000 children under the age of 10, or 5.1% of this entire age group in the country.

A total of 1 920 persons with facial pockmarks were seen and documented during the village search, with another 5 investigated during the school search. The most recent case of smallpox found during the survey occurred in 1969, and the youngest person seen with pockmarks was approximately 11 years old. Thus, no history of any undetected outbreak since the last officially reported cases in 1969 was obtained.

TABLE 13
FACIAL POCK MARK SURVEY RESULTS^a DURING ACTIVE LOCALITY SEARCH, 1978-79

Governorate	No. of searched villages	% of villages where pock marks found ^b	Population of searched villages ^c	Number of persons with facial pock marks aged:		Year of latest infection
				0 - 9	10+	
Sana'a	148	57%	127 973	0	205	1966
Hodeidah	48	75%	135 441	0	300	1963
Taiz	141	62%	206 500	0	194	1965
Ibb	199	83%	183 797	0	404	1965
Dhamar	129	88%	81 360	0	390	1964
Hajjah	110	77%	72 647	0	229	1967
Sa'ada	52	42%	27 102	0	59	1959
Mahweet	76	66%	32 266	0	93	1964
Beidha	13	92%	28 376	0	36	1958
Harib	4	50%	2 026	0	10	1953
Total	920	72%	897 488	0	1 920	

^a Excludes the 615 persons with facial pock marks who were absent but were nevertheless investigated by questioning family and friends.

^b Excludes villages where absent persons with pock marks were investigated but where no pock-marked persons were actually seen.

^c In each governorate, 15-20% of the residents in the searched villages - excluding school children - are estimated to have been examined during the facial pock mark survey. Thus, an estimated 149 850 persons were examined country-wide.

TABLE 14
FACIAL POCK MARK SURVEY RESULTS DURING THE SCHOOL SEARCH, 1978-79

Governorate	aged 0 - 4		aged 5 - 9		aged 10+*		Total no. examined	Year of latest infection
	No. examined:	with PM	No. examined:	with PM	No. examined:	with PM		
Sana'a	1 100	0	10 572	0	10 446	4	22 118	1969
Hodeidah	357	0	4 406	0	7 403	1	12 166	1964
Taiz	146	0	5 517	0	2 881	0	8 544	-
Ibb	4	0	1 086	0	204	0	1 294	-
Dhamar	38	0	830	0	525	0	1 393	-
Hajjah	85	0	1 690	0	1 639	0	3 414	-
Sa'ada	41	0	182	0	158	0	381	-
Mahweet	50	0	429	0	251	0	730	-
Beidha	0	0	61	0	115	0	176	-
Marib	1	0	90	0	97	0	188	-
Total	1 822	0	24 863	0	23 719	5	50 404	

PM - facial pock marks

* Ten years or older, but of school-going age.

Since in most searched villages a sizable number of persons was absent at the time of the visit, the teams also enquired about those absent persons who had pockmarks. The information thus recorded by questioning family and friends of the allegedly stricken person was kept separate, since its reliability could not always be verified. In this way, another 615 persons were documented. For this group, the last year of attack was reported to have been in 1965 and the youngest person with pockmarks was reportedly 18 years old.

The surveys provided basic epidemiological data on past smallpox in Yemen. Documentation on the absent persons with pockmarks was excluded in determining all the following rates (see Table 15).

TABLE 15
FACIAL POCK MARKS DISTRIBUTED ACCORDING TO

(a) AGE OF ATTACK ^a (b) YEAR OF ATTACK ^a (c) PRESENT AGE

Age	Persons with pock marks	%	Year	Persons with pock marks	%	Age	Estimated persons examined	Persons with pock marks
0 - 9	887	46.1	1900-29	164	8.5	0 - 9	80 727	0
10-19	734	38.1	1930-39	271	14.1	10-19	59 342	11
20+	304	15.8	1940-49	301	15.6	20-29	16 805	562
Total	1 925	100.0	1950-59	968	50.3	30-39	15 971	506
			1960-69	221	11.5	40-49	11 449	294
			1970-79	0	0	50-59	7 491	272
			Total	1 925	100.0	60+	8 466	280
						Total	200 251	1 925

^a Because the survey's purpose was to confirm the absence of smallpox since 1969, greater attention was given to younger persons and more recent year of attack.

46.1% of persons with pockmarks claimed to have been afflicted with smallpox when they were aged less than 10. Another 38.1% were infected between the ages of 10-19. This age distribution is consistent with patterns observed in other countries. 50.3% of the persons with pockmarks claimed to have suffered from smallpox in the 1950's and another 11.5% in the 1960's. Despite the team's intentional introduction of a selection bias in favour of younger persons and more recent years of attack, no evidence of smallpox transmission in the 1970's was found.

Although adults as well as children were included in the survey, the following age-specific pockmark prevalence rates must be regarded with caution since the actual number of persons whose faces were examined (the denominator) and their ages could only be estimated. This is particularly the case since the teams, their primary purpose being to confirm the absence of smallpox in the recent past, visited larger villages in which more smallpox cases were likely to have occurred, with the result that any incidence rates derived from this non-representative sample and applied to the country as a whole would probably represent an over-estimate of the true past incidence of smallpox. While it was recognized that a limited number of outbreaks in a single chain of transmission might escape a survey conducted on less than 100% of the population, it was felt that the larger villages visited by the teams would, on epidemiological grounds, have been likely to have been involved in any prolonged smallpox transmission.

Despite these statistical limitations, the past extent of the smallpox problem in Yemen was apparent. Even without any corrections for mortality and pockmark disappearance, 1.5% of the entire population showed pockmark evidence of past smallpox infection. The overall pockmark prevalence rates for the governorates varied from 0.8% to 3.1%. The age-specific rates varied considerably from one governorate to the next, but for the country as a whole, the prevalence rates for each progressively older age group, beginning with the 20-30 year-olds, were all very nearly the same - averaging 3.2%. (Survey results appear in detail for each governorate in the individual summary reports of surveillance activities, which are listed in the bibliography.)

Cultural constraints against examining women, who in some places are veiled and in others obscured by green vegetable dyes, resulted in a 5.6:1 sex imbalance in the facial pockmark survey results. Owing to the fact that women with pockmarks were not fully represented in the survey, the findings, extrapolated to the entire population, would underestimate the true past incidence of smallpox.

Persons with pockmarks were seen in 72% of the 920 searched villages and in 95% of the searched districts. This percentage would have been even higher if those villages had been included in which absent persons with pockmarks were investigated. Over 99% of the persons with pockmarks claimed to have been infected in Yemen; other countries mentioned were Saudi Arabia and Democratic Yemen.

When questioned regarding the date of their infection, respondents probably "rounded off" the years in multiples of five by saying they were afflicted 15, 20, 25, etc. years before. It was not possible, therefore, to reconstruct the precise temporal behaviour of smallpox. Whether there was a continuous unbroken chain of transmission in each governorate or whether the disease was re-introduced from time to time could not therefore be determined. Nevertheless, the frequency throughout the country with which 1956-1960 was cited as the time of attack is apparent in Figure 5. As reported previously, 116 (79%) of the 146 visited districts reported smallpox during this period; smallpox transmission ceased in the wake of this major epidemic in 75 (65%) of these 116 districts.

A localized wave of high incidence in 20 of the 37 searched districts in Ibb and Taiz Governorates in the south of the country occurred around 1961-63. Although this is the most densely settled area in Yemen, the mobility of the people living in their isolated mountain-top villages was, in the complete absence of roads, severely limited. Although no mass containment measures were implemented here, nor elsewhere in the country, smallpox transmission died out. A few isolated foci apparently lingered until the middle and late 1960's in the remote north-west of Yemen.

A noteworthy impression gained during the course of the search was the uniform unfamiliarity among the young adults with the disease pictured on the smallpox recognition card. On the other hand, the older adults were not only familiar with the pictured disease, but also could in many cases provide a local history of past transmission. In fact, many of the rumours investigated by programme staff were due to the elder villagers' eagerness for smallpox vaccinations in the face of a chickenpox or measles outbreak.

Because pockmark surveys are not a sensitive method of screening for cases of variola minor, which was recently prevalent in neighbouring Ethiopia and Somalia, the detection of rash-with-fever cases and, if indicated, the collection of specimens complemented pockmark surveys in confirming the current absence of smallpox.

8.4 Vaccination Scar Prevalence Survey Results

Table 16 presents the vaccination scar prevalence survey results by governorate. Investigation of 116 256 persons revealed the age group with the highest vaccination coverage to be the 10+ age group (72.7%), followed by those aged 5-9 (65.6%) and finally those aged less than 5 (22.9%). The high level of coverage in the 5-9 age group relative to the 0-4 age group was consistent with the fact that the national smallpox vaccination programme was most active during the early 1970's and emphasized the maintenance of smallpox absence by concentrating on routine vaccination of newborns. Those newborns are today in the 5-9 age group. Another factor contributing to the low coverage level amongst those aged less than 5 was the lack of collection points, such as schools, where these children could be reached. The governorates with a greater number of medical facilities recorded the highest coverage levels amongst those aged less than 5.

38 683 children were examined during the urban school search. The age-specific vaccination coverage levels were 70%, 76% and 87% in, respectively, the 0-4, 5-9 and 10+ age groups.

TABLE 16
VACCINATION SCAR PREVALENCE SURVEY RESULTS BY GOVERNORATE, 1978-79

Governorate	Aged 0 - 4		Aged 5 - 9		Aged 10+		Total seen	Vaccination level
	No. seen	% with scar	No. seen	% with scar	No. seen	% with scar		
Sana'a	2 849	33	14 219	73	13 837	84	30 905	61.9
Hodeidah	2 619	42	7 378	77	9 996	84	19 993	76.7
Taiz	3 371	30	10 419	68	6 591	71	20 453	56.0
Ibb	3 694	27	7 039	72	4 498	73	15 231	66.0
Dhamar	2 099	20	3 241	61	3 011	76	8 351	63.0
Hajjah	1 964	9	4 617	59	4 719	77	11 300	59.3
Sa'ada	698	12	1 320	59	1 347	82	3 365	64.0
Mahweet	1 079	8	2 001	57	1 741	79	4 821	59.7
Beidha ^b	392	19	672	53	568	73	1 632	54.3
Marib ^b	1	0	95	38	109	64	205	<u> </u>
Total	18 766	22.9 ^a	51 073	65.6 ^a	46 417	72.7 ^a	116 256	63.4 ^a

^a Adjusted for population distribution by age group and by district; figure includes active locality surveys, but excludes urban school surveys.

^b Since Marib is a "closed" area, governorate-wide searches were not possible.

Of the 116 256 persons examined, 16% were aged 0-4, 44% were 5-9 and 40% were over 10. It was necessary to examine both arms, and higher up the deltoid than is customary, since smallpox vaccination scars were as frequently found on the right as on the left arms.

As the teams surveyed the larger villages within each district, the reported findings probably overestimate to an unknown extent the actual coverage levels. Faced with the predictable restraints, the original vaccination teams probably succeeded in visiting and vaccinating these same populous localities. However, the omission from vaccination scar surveys of the major urban centres, except the schools, where the population is easily accessible and is presumably better immunized would serve to underestimate the coverage levels for the respective governorates.

A distinction between vaccination coverage and immunity levels should be stated. The teams searched for evidence of a vaccination scar, but the important immunological significance of whether the vaccination was a primary one or a re-vaccination and whether it was administered in the past 3 to 5 years was necessarily overlooked. Variations in individual immunological response, as well as variation over time in the potency of the vaccine utilized, were additional factors beyond the scope of the survey which would affect subsequent immunity levels. Finally, until the recent introduction of the Expanded Programme on Immunization, there had been little smallpox vaccination activity for a considerable length of time. For these reasons, the coverage levels in Table 16 probably overstate current immunity levels.

During the scar surveys, it was noted that even if the women were willing to have their upper arms examined, the rather tight long sleeves of their dresses did not easily permit it. Presumably, this same problem would have faced the vaccination teams. Owing to the fact that the scar survey under-represented women, extrapolation of the survey results to the entire population might also over-estimate overall coverage levels.

The various summary reports of surveillance activities provide vaccination scar survey results for all the districts in each governorate. Survey results were standardized by adjusting for age using preliminary age distribution figures for each governorate provided by the Central Planning Organization. Otherwise, in those districts where the 10+ age group represented a greater proportion of the total number of persons examined, the consequently higher overall levels of coverage would have been misleading. Survey results were weighted according to the contributions of individual districts to the total population of the governorate in order to arrive at the governorate-wide vaccination coverage levels. Overall vaccination coverage levels in the governorates ranged from a low of 54.3% to a high of 76.7%. Approximately 63% of Yemen's entire population was found to be vaccinated against smallpox.

8.5 Health Facility Enquiry

Fixed and permanently staffed health facilities were visited in an organized nationwide campaign in October 1978. The second such systematic health facility enquiry is currently in progress. The importance of continuous surveillance was stressed during these visits, as it was whenever governorate health offices, health facilities, mobile teams or rural drug stores were encountered during the governorate searches.

None of the visited medical staff had seen any suspected smallpox cases in the recent past, nor had they heard of any smallpox rumours or of any chickenpox deaths in the past 5 years. "Nil" reports were willingly signed in all health facilities and governorate health offices confirming the absence of smallpox. The procedures were reviewed regarding prompt notification of smallpox rumours and specimen collection. Reward publicity was disseminated.

At the time of the enquiries, several facilities reported having seen chickenpox cases in the recent past. However, because patient registers are rarely kept, in only one instance was an investigation possible. As staff and facilities were frequently new in the area,

respondents often did not know when the last local smallpox had occurred. Only one medical worker claimed that smallpox had occurred since 1969; repeated attempts to contact the second physician who reportedly saw the case were unsuccessful. An investigation is planned once this physician has been questioned.

As a direct result of the teams' visits, physicians from two health units reported a total of three cases which they believed were smallpox. All proved negative for smallpox on the basis of clinical, epidemiological and laboratory findings.

Lists of health facilities and their locations proved to be neither current nor comprehensive. As a result, the completeness of coverage thus far achieved during the health facility enquiries was difficult to assess with precision. Out of an estimated 85 fixed and functioning health units in the country, 63 (74%) were visited a total of 91 times. By the time of the visit by the International Commission, it is anticipated that approximately 90% will have been visited at least once and 60% twice or more. Most of the facilities which will remain unvisited are located in "closed" areas. On the past round of health facility enquiries, some units were not visited because no one was present the day the team arrived.

In conclusion, the visited health facilities have increased their vigilance, but no smallpox cases have been reported.

8.6 Assessment

The assessment results of 4 of the 9 searched governorates are presented below. In another 4 governorates, results of the assessment are not yet complete. One governorate which was searched could not be assessed owing to security considerations.

Of a randomly selected 51 villages (10%) of the 510 searched localities in Taiz, Ibb, Dhamar and Hodeidah Governorates, 45 (86%) were assessed by WHO. When to visit a single village would have required one or more full days of travelling from the nearest other sampled village, replacement sampling was employed. Thus, another 4 villages were assessed. The 49 assessed villages were located in 29 (45%) of the 64 searched districts. It was concluded that all 49 villages had in fact been visited, although in 4 instances the smallpox recognition card could not be produced owing to the recipient's absence. The quality of the search varied according to the different tasks performed.

In total, the original searches had found 44 cases of rash-with-fever in these villages. Upon assessment, 40 cases were discovered. However, chickenpox which had been present at the time of the search had gone undetected in one village.

The assessors found persons with facial pockmarks in 46 villages, compared to the 47 villages in which the searchers had recorded pockmarks. The date of latest smallpox in 84% of the villages was revealed on the assessment to be the same [±]5 years as on the original search. This finding confirmed the reliability of the pockmark surveys conducted during the search. In only two villages in which this difference was greater than 5 years were cases reported to have occurred after 1960. In any case, the most recent year of smallpox attack found on the search was 1964, while the assessment revealed it to be 1965.

A spot-check in each village on the accuracy of the information acquired by the pockmark surveys conducted during the searches found it to be "good" in 77% of the villages, "fair" in 16% and "poor" in 7%. Illegible handwriting or omission of the all-important family, or third, name were usually the cause of the "poor" ratings.

During the assessment, a child from whom a specimen had been collected was re-examined, the original diagnosis was verified, and the specimen collection forms were found to have been accurate. Specimens were collected from two separate villages. It was ascertained that schools and health facilities had been visited. Medical staff were able in each case to present the forms and supplies which they had been given and to discuss the purpose of each. Additional schools and health facilities which had been closed at the time of the search were visited. Cases of chickenpox reported from one clinic were investigated.

Paired comparisons of the age-specific vaccination coverage levels on the search and on the assessment in the same villages revealed that the searchers reported higher figures one half of the time and the assessors the other half. However, discrepancies between the search and the assessment were sometimes considerable. Depending on the age distribution of persons investigated within the three age groups, the results could prove quite different. Ambulatory four-year olds sought out on the search would give higher results than infants seen on assessment, for example. Discrepancies might also have been caused by the frequent movements of people, with the result that the population present varied depending on time of day (work schedules), day of the week (market days) and even month (Ramadan).

Immediately after each governorate search, the raw data were reviewed and analysed with the aim of spotting any weaknesses or discrepancies. Programme staff were also informed of the results of the previous assessment in pre-search or post-search meetings. Operational and technical problems were identified and discussed and appropriate remedial actions were taken. For the most part, assessments confirmed the findings of the search.

Special WHO and Ministry of Health assessments were also conducted in two regions. Formerly designated a high-risk area vulnerable to an introduction of smallpox, the Tihama benefited from a mobile mass vaccination campaign in 1977. These vaccination efforts and the current smallpox status of the area have been assessed many times since late 1977. The latest assessment (13) found the coverage levels to be high among all age groups, particularly among the 0-4 year olds. No pockmark evidence of smallpox after 1963 was encountered.

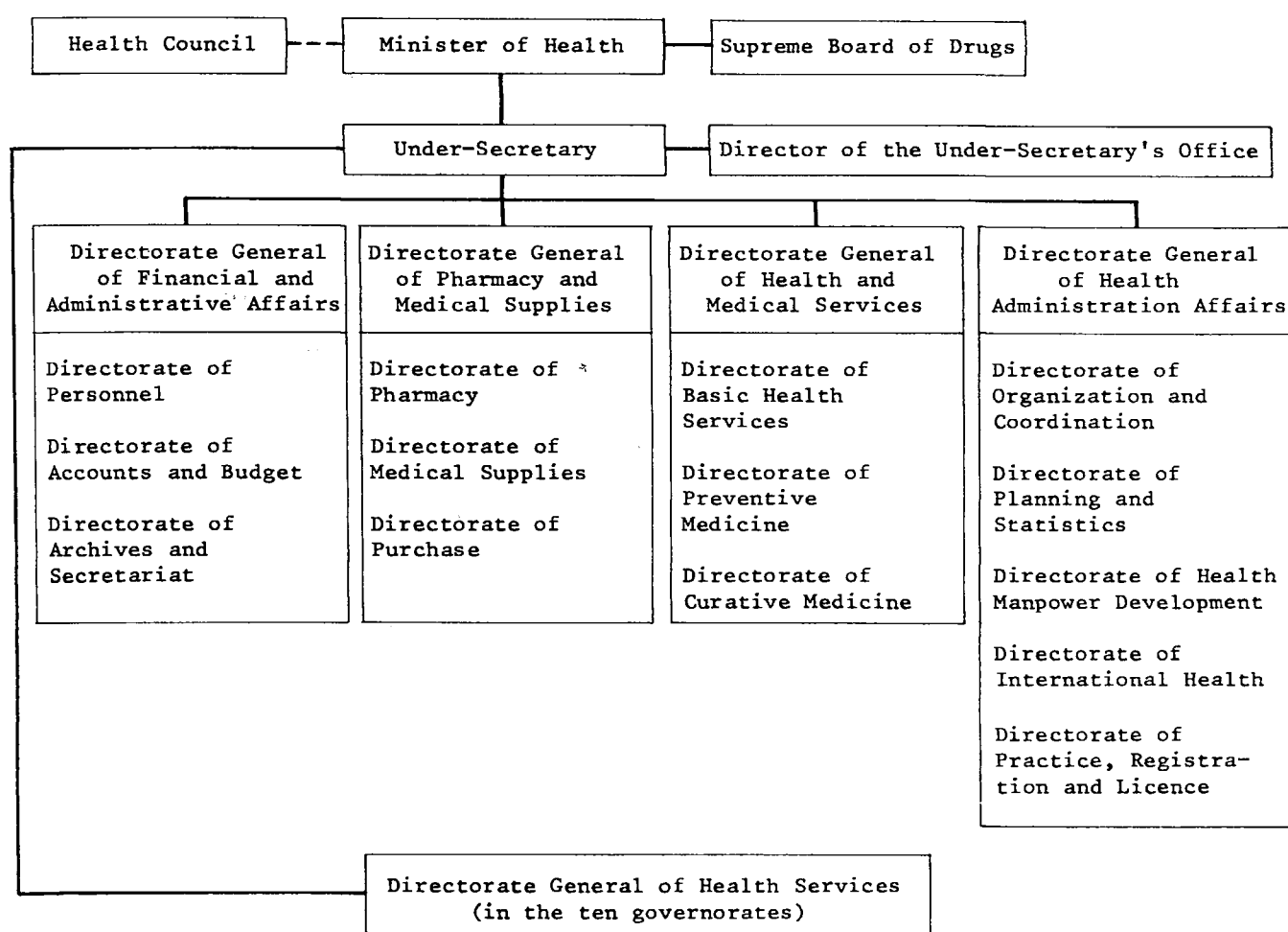
Because Marib Governorate was off limits for a governorate-wide search, some villages, schools and health centres from as wide an area as possible were selected for searches and surveys. However, travel became more restricted and so only the Governorate Health Office and four villages, two schools and one health centre in the wadi near Marib town were visited. Nine of the 10 persons seen with pockmarks, most of whom were soldiers, were infected before 1960 in other areas of the country. The one locally acquired case had occurred in 1953. The Director General of Health Services had not heard of any smallpox cases during his seven years in the Governorate.

In conclusion, despite the wide geographical coverage achieved in all programme elements - facial pockmark and vaccination scar prevalence surveys in 920 villages and 195 schools, rumour investigations, collection of 40 smallpox negative laboratory specimens, health facility enquiries, and WHO assessments - no evidence of smallpox occurring after 1969 was discovered. Surveillance was sufficiently sensitive to have detected any hidden smallpox foci, if they had been present.

Editorial Note

Since the preparation of this report all survey and assessment activities, ongoing at that time, have been completed, results have been compiled and analysis made. No new evidence contrary to that contained in the report has been discovered.

ANNEX I: ORGANIZATIONAL CHART OF THE MINISTRY OF HEALTH HEADQUARTERS



ANNEX II: LINE LISTING OF SPECIMENS TESTED IN WHO COLLABORATING CENTRES ON POXVIRUS RESEARCH 1971-1979*

No.	Name	Age	Sex	Clinical Diagnosis	Year of Collec- tion	Governorate	Laboratory Diagnosis:		
							variola	varicella	other
1	?	?	?	smallpox	1971	Beidha	negative	negative	negative
2	Abdu Razzak Yahia Al Matari	5	M	"	1972	Sana'a	"	"	"
3	Amat Al Wahab	9	F	"	1972	"	"	"	"
4	Abdu Ibrahim	22	M	"	1973	"	"	"	"
5	Abdu Ahmed Ghaleb	15	M	"	1973	"	"	"	"
6	Ahmed Abdella Al Omari	16	M	"	1973	"	"	"	"
7	M. M. Alzamari	40	M	"	1973	"	"	"	"
8	A. Malik Al Haifi	35	F	"	1973	"	"	"	"
9	Abdu Saleh Atiwah	4	M	not available	1973	Ibb	"	"	"
10	Abdella Mohd Fagi	12	M	"	1973	Sana'a	"	"	"
11	Thagora Bint Abdella Motaher Ushesh	14	F	chickenpox	1974	"	?	?	?
12	Ahmed Ali Fusaal	25	M	"	1974	"	negative	negative	negative
13	Nouria Ahmed Zeid	14	F	not available	1974	"	"	"	"
14	Taqia Ahmed Zeid Omar	8	F	"	1974	"	"	"	"
15	Ahmed Hussein Al-Khasan	6	M	chickenpox	1975	"	"	positive	"
16	Mohd Ahmed Zeid	25	M	smallpox	1975	"	"	"	"
17	Sa'ad Yahia Jabir	25	M	"	1975	"	"	"	"
18	Mohd Sabit Quaid	28	M	"	1975	Ibb	"	"	"
19	Mohsin Ali Alvi	27	M	"	1975	Beidha	"	"	"
20	Intasar Mohd Al Matweti	8	F	vaccinia	1976	Hodeidah	"	"	"
21	Kafi Ali Shamsham	12	M	"	1976	"	"	negative	"
22	Mohd Salih Aamir	16	M	not available	1977	Sana'a	"	"	"
23	Augustine Koku	adult	M	chickenpox	1977	Hodeidah	"	"	"
24	Shov'el Ahmed Al Ahdal	40	M	smallpox	1977	"	"	"	"
25	Fares Mohd Said	7	M	vaccinia	1978	Taiz	"	positive	"
26	Mona Mohd Al Radi	5	F	chickenpox	1978	Sana'a	"	negative	"
27	Fatoom Mohd Dohn	8 mo.	F	"	1978	Hodeidah	"	"	"
28	Mohd Yahia Omar	1	M	"	1978	"	"	"	"
29	Etidal Abdu Mohd	3	F	chickenpox	1978	Taiz	"	"	"
30	Gana Abdu Saleh	8	F	unknown	1978	"	"	"	"
31	Khaled Mohd Kassem	14	M	chickenpox	1978	"	"	"	"
32	Zakik Galib Garady	2	M	"	1978	"	"	"	"
33	Hail Ahmed Thabet	10	M	"	1978	"	"	"	"
34	Ali Mohsein Al Khader	13	M	"	1978	"	"	"	"
35	Ons Abdu Kalik Garson	8	F	unknown	1978	"	"	"	"
36	Sabah Said Kaleh	9 mo.	F	chickenpox	1978	"	"	"	"
37	Fachry Ahmed Abdu Rahman	6	M	"	1978	Ibb	"	"	"
38	Yasser Abdu Senan	3	M	"	1978	"	"	"	"
39	Ketam Hamood Musawa	3	F	"	1978	"	"	"	"
40	Yakya Mohd Mosleh	2	M	"	1978	"	"	"	"
41	Housiya Yahia Ahi	2	F	"	1978	"	"	"	"
42	Katiba Mohd Lakik	1	F	"	1978	"	"	"	"
43	Hadiah Saleh Murshed	3	F	unknown	1978	"	"	"	"
44	Hadiah Abdu Saled	2	F	chickenpox	1978	"	"	"	"
45	Garisa Ali Ahmed Sat	2	F	"	1978	Dhamar	"	"	"
46	Habiba Ahmed Jabari	2	F	"	1978	Ibb	"	"	"
47	Asma Ali Ismael	2	F	"	1978	Dhamar	"	"	"
48	Hefth Ali Mohd	1	F	"	1978	"	"	"	"
49	Khaled Mohd Hassan	6 mo.	M	"	1978	"	"	"	"
50	Ali Mohd	7	M	"	1978	Beidha	"	"	"
51	?	1	F	"	1978	Taiz	"	"	"
52	Naggat Mohsen	7 mo.	F	"	1978	Ibb	"	"	"
53	Rafeek Kassem	5	M	"	1978	Ibb	"	"	"
54	Mohd Ahmed Aspliny	12	M	"	1978	Beidha	"	"	"
55	Ahmed Yahia Al Jubary	4	M	unknown	1979	Hajjah	"	positive	"
56	Hiyad Ali Abdella	9	F	chickenpox	1979	Hajjah	"	negative	"
57	Jalal Abdu Habib	33	M	chickenpox	1979	Sana'a	"	positive	"
58	Mona Ahmed Nassar	6 mo.	F	smallpox	1979	Sana'a	"	negative	"
59	Josef Raleb As Sayadi	21	M	unknown	1979	Hajjah	"	pending	pending
60	Mohiba Hassar Gaidee	45	F	unknown	1979	Hajjah	"	negative	negative
61	Ali Salih Shihab	39	M	chickenpox	1979	Sana'a	"	"	"
62	Nadia Abdu Karim Al Cafari	8	F	"	1979	Sana'a	"	"	"
63	Hoda Mohd Ali Kholani	12	F	"	1979	"	"	"	"
64	Said Tassir Bamumin	35	M	"	1979	"	"	"	"
65	Semir Said Tassir Bamumin	7 mo.	M	"	1979	"	"	"	"
66	Hussein Saleh Ali Al Adahy	8	M	"	1979	"	"	"	"

* Yemenis aboard ship Al Basha, quarantined in Jeddah. Specimens collected in Saudi Arabia.

* Through March

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