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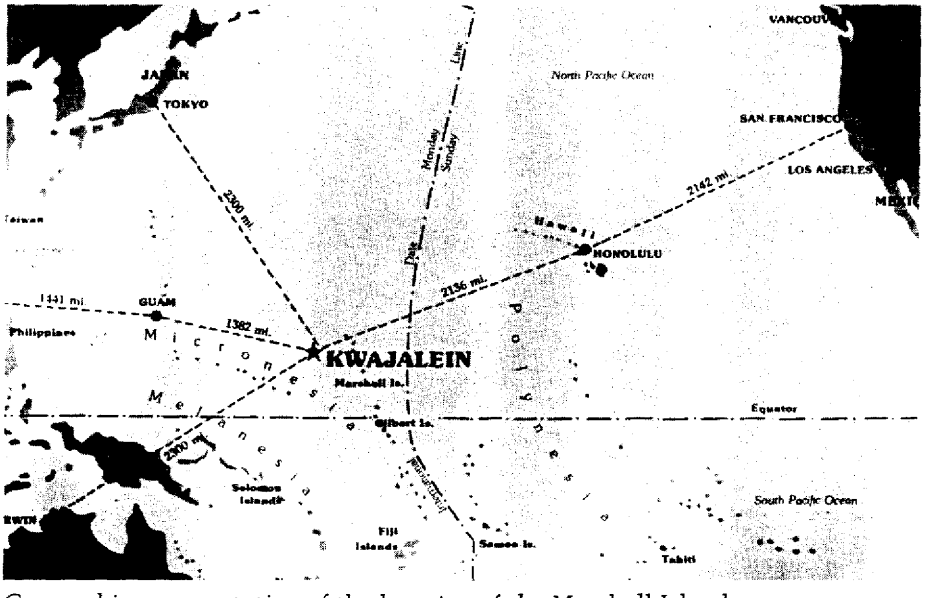
Hearing Loss and Middle-Ear Abnormalities in a Group of Marshallese Children

By MARC LERNER, SHARON FUJIKAWA, & WILLIAM H. ADAMS

Under contract to the United States Department of Energy, medical teams directed by New York's Brookhaven National Laboratory have conducted an observation, in a unique fashion, of the health of a group of children in the Republic of the Marshall Islands. Previous publications have noted a large number of ear problems among children from Micronesia,[1,2] but no study to date had used audiometry and impedance measurements to document that information. As a part of a visit to the Republic of the Marshall Islands, a medical team from Brookhaven National Laboratory tested the hearing and eardrum impedance of a group of project children. With the growing recognition of the importance of hearing to the development of language skills and learning capacity, such testing was seen as important in understanding the possible vulnerability of those children.

The Republic of the Marshall Islands consists of 29 coral atolls and five mountain-top islands located in the Pacific Ocean approximately 2500 miles southwest of Hawaii. The small islands total a mere 70 square miles of land scattered over 300,000 square miles of ocean. There are 35,000 inhabitants of the Marshalls. A primary population concentration—some 8000 persons—is on the island of Ebeye, a part of the Kwajalein atoll. Another 15,000 live on the Majuro atoll. The Marshall Islands, the Caroline, and the Mariana Islands make up the Pacific archipelago of Micronesia.

Currently, medical care on most atolls is administered by resident health aides who are provided by the Government of the Republic of the Marshall Islands Health Services. A combination of mobile and stationary units house the healthcare facilities. More in-depth medical care for children on some atolls is provided by physicians of the Brookhaven National Laboratory and the government of the Marshall Islands via stationary sites and a medically equipped ship.



Geographic representation of the location of the Marshall Islands.

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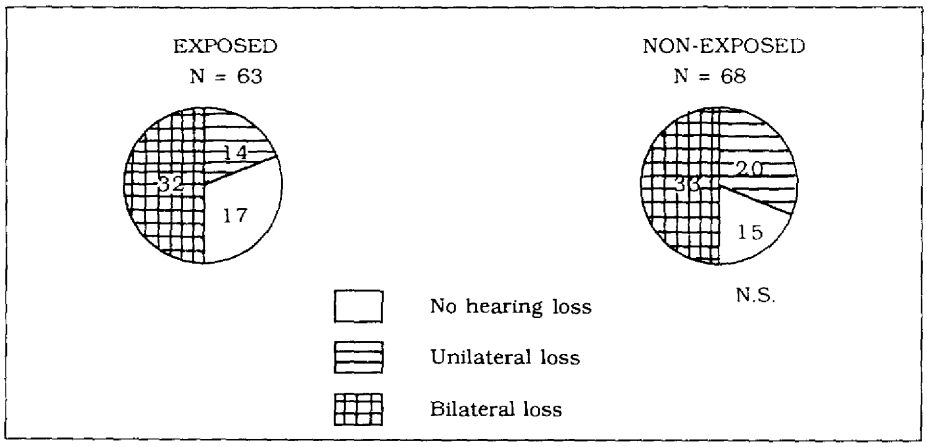


Figure 1. Occurrence of unilateral and bilateral hearing loss in children of radioactive-fallout-exposed and nonexposed parents.

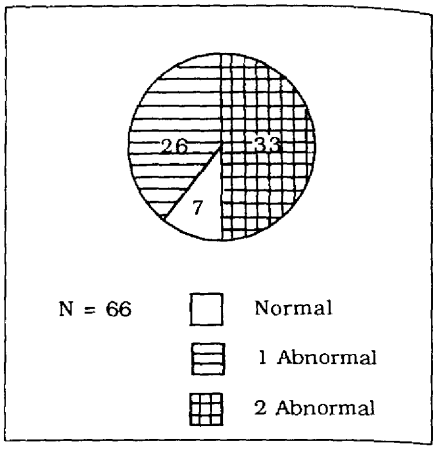


Figure 2. Tympanogram results for children with hearing loss.

PROJECT FOCUSES ON RADIATION-EXPOSURE VICTIMS

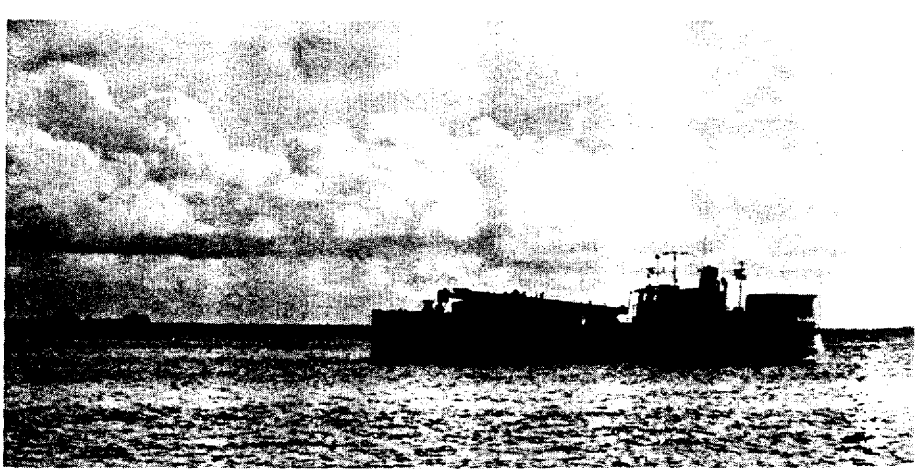
The mandate of the Brookhaven medical project is to diagnose and treat radiation-related illnesses in a group of Marshallese living on Rongelap and Utirik atolls who were accidentally exposed to radioactive fallout of the Bravo nuclear bomb test at Bikini atoll on March 1, 1954. Total body exposure was estimated at 190 rads of absorbed external gamma radiation at Rongelap, 110 rads at Ailingnae, and 11 rads on Utirik.[3] The original group included residents of those islands. The project examines and treats 1200 to 1400 persons each year. Voluntary examinations have been given by the Brookhaven medical team over a 30-year span.

A second group of Marshallese that had not been exposed to the fallout has been observed as a control group to help identify any unforeseen risks resulting from the fallout. In addition, examinations and medical care are offered to many other persons not in those two groups, on the basis of humanitarian need; and each year some 400 to 500 children of both exposed and nonexposed parents are seen. Previous studies documented elements of increased medical risk, primarily to the thyroid, for the exposed population.[4] Social disruption, changes in nutritional and feeding practices, and other factors with potential impact on health might contribute to undue risk for some or all of these Marshallese children.

The study reported here offers data about monaural and binaural hearing loss and middle-ear status among children of the Marshall Islands as documented by audiometry and tympanometry. It also presents an analysis of the contribution of demographic variables. One study focus was the possibility of increased risk for ear/hearing problems among children with a family history of nuclear exposure versus those without.

METHODS

In all, 131 project children were examined, both on the island of Ebeye and on the medical ship during its stay in Majuro. The team performed otoscopic examination of the ears, removed obstructive cerumen, and tested hearing acuity and middle-ear function using an MD-1 microprocessor impedance analyzer/pure-tone audiometer (Singer Medical Products, Inc.). In the impedance mode, the MD-1 produces a probe tone of 226 Hz at 85 dB SPL. The compliance range is from 0.00 cc to 5.00 cc, with an air pressure range of +200 mm to −400 mm H_2O via an automatic pump. The results are displayed digitally. In the audiometer mode, the MD-1 can produce pure tones of 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz and 6000 Hz with an intensity range of 0 dB to 100 dB HL at all frequencies except 6000 Hz, at which the range is 0 dB to 90 dB HL. In both the impedance and audiometer modes, the instrument has an automatic calibration check upon initiation; it will correct automatically for environmental pressure and temperature changes in the impedance mode, and for variations in the attenuator setting in the audiometer mode.



The Litanur II medical ship in transit to an outer-island screening visit.

The hearing-acuity testing was performed in such a fashion as to provide a modified screening of hearing. This maximized efficiency, to allow for inclusion of the largest number of children, but also gave a sense of the severity of any hearing loss observed, because the actual thresholds were obtained at 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz. If a child showed any abnormalities in hearing, at any frequency, then impedance testing was also performed. In a group session the pediatric nurse practitioner instructed and encouraged all the children in their native language to undergo the hearing test. For hearing acuity testing, the children wore earphones and raised their hands or dropped objects into a cup to signify each time that they heard the stimulus tone. For impedance audiometry, the children were required to sit still, as for a regular ear examination.

Abnormalities were defined as: (1) tympanograms with pressure peaks that fell in the negative range beyond – 100 mm H_2O, (2) flat tympanograms, and (3) hearing thresholds of 30 dB or greater in one or two ears. Hearing thresholds at 500 Hz were eliminated from this study, because abnormally elevated thresholds there were obtained in 56% of the children, and it was often the only abnormal frequency—suggesting that environmental-noise contamination, not impaired hearing among those children, caused those abnormal results.

FINDINGS

Of the 131 children—66 boys, 65 girls—who ranged in age from 3 years to 18 years (mean = 9.3 years), 63 were offspring of parents who had been exposed to radiation, while 68 were the children of nonexposed parents.

Of those 131, 65 had hearing within the normal range. Hearing loss in one or two ears was observed in 66 (50.4%) of the children. Of those children with hearing loss, losses for 48 were classified in the mild-hearing-loss range; 12 children had hearing thresholds in the worse ear ranging from 40 dB to 55 dB (moderate loss); 4 had moderate-to-severe losses; and 2 had thresholds poorer than 70 dB in the worse ear. Abnormal tympanograms were observed in one or both ears for 59 (89%) of the children with hearing loss (Figure 1). Summaries of abnormalities in hearing and tympanometry, relative to the ages of the children tested, are shown in Tables 1 and 2, respectively.

A comparison was made of data obtained for the children born to parents who had been exposed to radiation, and the children born to nonexposed parents. Of those with normal hearing, 32 were children of parents who had been exposed to radiation, while 33 were children of nonexposed parents. Unilateral hearing loss was observed in 14 of the exposed group, and in 20 of the nonexposed group. Bilateral hearing losses were recorded in 17 children of the exposed group, and in 15 of the nonexposed (Figure 2). Chi square revealed no significant interactions relative to the exposed and nonexposed groups for either unilateral or bilateral hearing losses. Of those children with abnormal tympanograms, 29 were from the exposed group and 30 were from the nonexposed group. The test of chi square revealed independence of the two groups.

DISCUSSION

Our evaluation of the hearing and tympanometric testing of 131 Marshallese children revealed a high rate of abnormalities. In 1982, Dungy et al. noted ear/hearing abnormalities in 11.4% of 513 Marshallese children examined.[2] They described acute and chronic purulent and serous otitis media and ear-canal foreign bodies, and they postulated an increased risk attributable to the large amount of time the children spent swimming in the warm tropical lagoons.

That study lends support to our concerns about hearing and middle-ear function among this group of children. We found 50.4% of the children in our study to have unilateral or bilateral hearing

Table 1. Audiometric hearing findings (by age) for 131 Marshallese children.

	Age in Years				
	3–6	7–9	10–12	13+	(Total)
Children with abnormal findings in 1 ear	9	9	8	8	(34)
Children with abnormal findings in 2 ears	2	18	9	3	(32)
Total	11	27	17	11	(66)

Table 2. Tympanometric findings (by age) for 66 Marshallese children with hearing loss.

	Age in Years				
	3–6	7–9	10–12	13+	(Total)
Children with abnormal findings in 1 ear	5	10	7	4	(26)
Children with abnormal findings in 2 ears	3	17	8	5	(33)
Total	8	27	15	9	(59)

loss, as compared to a sample of children in the United States among whom the prevalence of hearing loss was 15.3% to 23.8%.[5] Likewise, 45% of the 131 Marshallese children had abnormal middle-ear function, as compared to an occurrence of 20% to 30% abnormal ears among children in North America during warm weather months, as reported by Casselbrant et al.[6] It is also significant that in our study the distribution of abnormalities was relatively unchanged across all the ages tested through adolescence, while most North American research shows a decline in occurrence of middle-ear abnormalities after the age of 6 to 7 years.[5]

The risk of children having or developing hearing/ear problems is influenced by many factors, including ethnic or genetic predisposition, exposure to respiratory infections, type of milk (breast of formula), and an infant's position during feeding. Among Marshall Island children, such other factors as crowded housing, suboptimal nutrition, limited access to health care, and limited knowledge of treatments for ear problems interact to increase their vulnerability for hearing loss. The high prevalence of ear problems in this study might have been attributable in part to the way in which the children were chosen. Participation in the annual pediatric health screening is voluntary, which probably resulted in a selection bias toward the inclusion of youngsters with active health problems. However, the audiometric service was not available from previous health teams and was not announced to the community until the end of the children's screening program. At that time a general screening was made available to the public at large at the local hospital on the Island of Majuro. However, data gathered on the children tested in that general program were excluded from our study.

A pediatric nurse practitioner and her patient demonstrate a hearing screening to a group of Marshallese children.

As we noted, one issue of interest to the health team was the possiblity of a difference in risk for audiologic problems between the two groups of children—those with a family history of exposure to the Bravo nuclear explosion, and those in the "nonexposed" control group. Because those children did not have direct exposure to the 1954 fallout, we believed that the social disruption and dietary changes resuting from American aid programs were more likely to be possible contributors to altered risk. In fact, we found that the prevalence of hearing loss was high overall, but was not significantly different for either group.

CONCLUSIONS

In the first five years of life, critical language learning may be affected by even mild hearing loss. It has also been suggested that among school-age children, fluctuating hearing loss, which often results from otitis media with effusion,[6] might result in delayed educational achievement.

Other investigators have promoted a more cautious view toward the link between otitis, hearing loss, and language/cognitive impairment.[7] Certainly, the otologic problems identified for the Marshallese children pose a challenge for the health resources of their government.

Although it is difficult to identify simple factors that might offer increased protection for these children, important public health goals should include recognition of the importance of draining and painful ears, and the availability of antibiotic treatment. Successful treatment of middle-ear effusion is difficult without surgical intervention, and on balance might be of lower priority. Sir John Wilson, in his discussion of deafness in developing countries, noted that the unmet needs of third-world countries are not so much technologic as they are insufficient awareness and lack of practical delivery of otologic services.[8] Recommendations have been made to the Marshallese Health Ministry for establishing audiologic resources and a risk registry for hearing-impaired persons who might benefit from more intensive services. Further, it has been suggested that programs supporting the general health needs for all Marshallese children would offer hope for improvement of the issues raised by this preliminary study.

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Health Survey of the Trust Territory of the Pacific Islands

ALICE M. HETZEL, B.S.

IN THE SUMMER of 1948 the U.S.S. *Whidbey* began the voyage from island to island that, before its completion, was to take it through the Caroline Islands, the Marshall Islands, and the Northern Mariana Islands. Under the auspices of the United States Navy, a survey staff aboard the *Whidbey* was undertaking a survey of health and sanitary conditions. The ultimate goal of the survey was a physical examination of every inhabitant.

These islands, with the exception of Guam in the Marianas, then designated as the Trust Territory of the Pacific Islands (fig. 1), were the former Japanese mandated islands. Invaded and occupied by American military forces during World War II, responsibility for civil administration of the islands was placed with the Navy, pending the enactment of legislation by Congress designating the permanent governing authority. Under direction of the Secretary of the Navy, the Commander in Chief of the Pacific Fleet served as High Commissioner of the trust territory.

The trusteeship agreement of the United Nations directed the United States to care for and improve the health of the inhabitants. It was recognized immediately that a broad general health-service policy must be established to meet the need for improvement of the health and hygiene in the islands. As a result of the war the natives were in a state of emotional shock. They had been displaced from their homes, their food had been confiscated, trade and industry had been abandoned, and schools were nonexistent. Medical needs had long been neglected. The islanders, a primitive people who had been exposed to the diseases of civilization against which they had no racial immunity, were unable to support doctors, dentists, and nurses in private practice or to maintain hospitals, dispensaries, or departments of public health.[1]

From Medical Statistics Division, Bureau of Medicine and Surgery, Department of the Navy, Washington, D.C.

One of the main difficulties encountered in developing a public-health program for the trust territory was the lack of reliable information concerning health and sanitation conditions. The most reliable reports came from the naval dispensaries where natives living in the immediate vicinity were given medical care and treatment. There was definite indication from these reports that certain diseases were affecting the health of the islanders and that sanitation in general was on a very low level. Without a comprehensive survey, however, a correct appraisal of disease prevalence, morbidity, and sanitation problems could not be made.

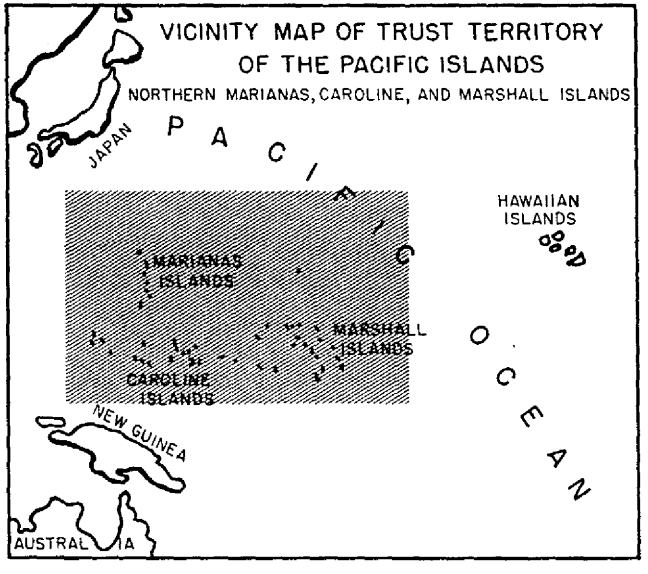

Figure 1. The Trust Territory of the Pacific Islands.

Motivated by these considerations, the Navy undertook a health survey of the trust territory to determine the public-health problems of the indigenous population. The U.S.S. *Whidbey*, converted especially for this survey, was a twin-screw diesel-driven 177-foot vessel displacing 935 tons. The *Whidbey* was equipped with a photofluorographic unit and facilities for complete physical and dental examinations. The survey was begun in the Marshall Islands area on 1 August 1948. Four officers and 21 enlisted men made up the ship's company. The survey staff was comprised of the following personnel: 2 Medical Corps officers, 1 Dental Corps and 1 Medical Service Corps officer, and 9 hospital corpsmen serving in laboratory, x-ray, dental, epidemiologic, and clerical activities.

Traveling from island to island the survey group examined every native present and investigated and evaluated the food, water, sewage, and garbage facilities, as well as the general living conditions and native habits and customs that had a bearing on the subject of health and sanitation. Among other things the survey included a physical examination, photofluorographic examination of the chest, Kahn test, tuberculin skin test, and stool examination. This report concerns those islands surveyed by the U.S.S. *Whidbey* during the period from August 1948 through June 1950. Three of the trust territory civil administrative districts, those of Palau, Saipan, and the Marshall Islands, are represented. All of the western Caroline Islands, the northern Mariana Islands (except Alamagan and Agrihan Islands), and the eastern islands of the Marshall Islands group are included.

Subsequent to June 1950 the U.S.S. *Whidbey* also surveyed the Truk and Ponape districts. However, data for these districts corresponding to those for the three districts mentioned before are relatively incomplete. As a consequence, it is impossible to present a comprehensive description of the health status of the population in the trust territory as a whole. The fragmentary data available for Truk and Ponape, while not included in this article, are contained in a detailed study in the Bishop Museum, Honolulu, Hawaii, and the Bureau of Medicine and Surgery, Department of the Navy.

POPULATION CHARACTERISTICS

The total native population of the trust territory was placed at approximately 54,300 in 1950. About 28,600 of these were in the three districts of Palau, Saipan, and the Marshall Islands. The population figures presented in the accompanying tables, totaling 22,146 for these three districts, are based upon the number of identification cards distributed during the survey. One card was distributed to each inhabitant present on the island at the time of the visit of the U.S.S. *Whidbey*. Although it was intended that every inhabitant be included, the length of time involved in making a survey of this nature, coupled with the fact that there was a great deal of interisland visiting, resulted in some individuals being examined at places away from their home island and others not receiving any examination at all. The area of the island, the scattering of the population; the terrain, and the amount of control exercised over their people by the local chiefs or administrative heads were all factors affecting the extent to which the population was brought into the survey.

Density. Population density varied from island to island. Out of 39 islands or atolls, 5 had a population of less than 100, 24 had a

population between 100 and 499, and 10 had a population of 500 or more. In this latter group were Saipan, Babelthuap, Yap, Koror, Majuro, and Kwajalein, all with over 1,000 inhabitants.

Area was no indication of population. In terms of size, some of the larger islands were very sparsely populated. Tinian and Rota, for instance, while nearly as large as Saipan, had much smaller populations. On some of the tiny islands with an area of less than 1 square mile, the population density was far greater than on the larger islands. Population density in terms of over-all area was misleading in numerous instances for, on many of the larger islands, only a very small area was inhabitable. This was especially true on the volcanic islands where much of the island was too rocky to be inhabited. The result was a concentration of population in a very small area with an extremely high population density, while the rest of the island had few or no inhabitants at all.[2]

Table 1 shows by district the number of females visibly pregnant at the time of the health survey. Estimated annual birth rates based on these figures are also shown. For comparative purposes, in the United States in 1949 birth rates per 1,000 estimated female population, between the ages of 15 to 44, were as follows: all races, 105.2; white, 102.6; and nonwhite, 126.4.[3]

Age distribution. The median age for the three districts combined was 23.0. Over one third of the population was under 15 years of

Table 1. ***Females 15 to 44 years of age visibly pregnant on day of survey***

Population examined	Total	Saipan district	Palau district	Marshall Islands district
	Number			
Total	22,146	4,999	10,575	6,572
Females 15 to 44 years of age	4,138	1,036	2,416	686
Females pregnant on day of survey	406	119	152	135
	Annual birth rate per 1,000*			
Total	24.4	31.7	19.2	27.3
Females 15 to 44 years of age	130.8	153.2	83.9	262.4

*Estimated on basis that all pregnancies will terminate in live births. Rates computed by relating total pregnancies on day of survey to population and multiplying by 4/3.

age, and approximately one fifth was 45 years of age or over. It should be borne in mind that most ages were estimated by an interpreter, as very few natives knew their own age.

The age distribution in the Saipan district presented the most youthful pattern of population found in the territory. The median age was 17.3 as compared with 25.5 for the Palau district and 23.6 for the Marshall Islands district. Only part of the Marshall Islands district is included in this study. Statistics were available for about two thirds of the inhabited islands of the district, accounting for over 70 percent of the population.

Age distributions for the islands or atolls of the Marshall Islands and Saipan districts were relatively consistent. In the Palau district, however, there was considerable variation. Merir, Sonsorol, and Tobi had the highest proportion of old people. There was a strong tendency on the part of the young people of these islands to leave for homes elsewhere while the older people remained. Of Merir's 11 inhabitants, only 3 were under 45 years of age. Approximately 70 percent of Sonsorol's population of 111 was 45 years of age and over, and almost one third of the total had reached or passed the 65-year mark. On Tobi, 60 percent of the 128 inhabitants had reached or passed 45 years of age. At the other extreme were Koror, Eauripik, and Rota, each of which has only 10 percent in the 45-year-and-over age group.

The median age of 22.8 years for Tinian Island appeared high as compared with Saipan and Rota in the same district. There were two groups of inhabitants on Tinian, the Yap-Chamorros and the patients at the leprosarium. The latter group was composed mainly of middle-aged and old people. There were no small children at the colony. Infants born at the leprosarium were sent to Saipan immediately and cared for at the hospital until they were adopted. The median age for the leprosarium patient was 35.4 years, while that for the Yap-Chamorros was 16.6 years, the second lowest in these districts.

An unusual situation existed on Pulo Anna. Fourteen of the sixteen inhabitants were members of one family: the chief; his mother; two brothers; two sisters; two young Indonesian girls, the wives of his two brothers; and six children.

Marital status. The traditional marriage customs with their large gatherings, feasts, and exchanges of property were still practiced throughout the territory. Missionary influence had made its imprint on marriage customs and many marriages were being performed with church sanction.

Earlier marriages for women than for men resulted in a much higher proportion of married females than males in the 15- to 19-year age group, 30.2 percent for females as compared with 4.7 percent for males. In all age groups up to 45 years of age, with the exception of Palau's 35- to 44-year age group, there were proportionately more married females than males. The reverse was true without exception for those 45 years of age and over.

Height and weight. The inhabitants of the trust territory were of medium stature and weight. In the adult age groups the average height ranged from 5 feet 2 inches to 5 feet 6 inches for males and from 4 feet 11 inches to 5 feet 1 inch for females. The average weight for males was from 133 to 145 pounds and for females from 112 to 135 pounds.

Height and weight varied by district. For a given height the inhabitants of Saipan and Palau were heavier than those in the Marshall Islands, with Saipan having a slight edge over Palau in this respect (table 2). The difference was more marked for females than for males. It may be noted in table 3 that the inhabitants of Saipan were slightly taller than those of the other two districts. In Palau males were noticeably shorter than in Saipan and the Marshall Islands.

Blood-pressure readings. Blood-pressure readings were taken for over 60 percent of the population. Only one reading was taken for each individual and all readings were taken routinely during the course of the examination.

Table 2. ***Average weight, by height and sex, of 44-year age group***

Height (inches) and sex	Saipan district	Palau district	Marshall Islands district
	Average weight (pounds)		
60 to 62			
Male	130.6	128.5	122.4
Female	134.4	126.2	123.5
63 to 65			
Male	137.9	137.7	135.3
Female	149.3	135.9	133.1
66 to 68			
Male	150.0	147.6	142.9
Female	(*)	(*)	(*)
69 to 71			
Male	164.4	159.2	160.9
Female	(*)	(*)	(*)

*No females over 65 inches in height.

Table 3. ***Average height by age group and sex***

Age group (years)	Saipan district		Palau district		Marshall Islands district	
	Male	Female	Male	Female	Male	Female
10 to 14	53.4	54.7	52.4	53.3	54.8	54.9
15 to 19	63.4	61.1	61.8	59.5	63.1	59.1
20 to 24	65.8	61.2	64.4	60.2	65.4	59.8
25 to 34	65.4	60.9	64.7	60.1	65.8	59.6
35 to 44	65.6	60.8	64.2	59.9	65.1	60.0
45 to 64	64.8	60.4	63.6	59.2	64.6	59.8
65 and over	63.1	59.1	62.2	57.9	63.5	58.7

No generalizations may be made for the trust territory as a whole with respect to variations in median blood-pressure readings. Variations followed no consistent pattern in the districts. As normally expected, median blood-pressure readings increased with age. This increase was most rapid in the Saipan district. The median systolic and diastolic readings were generally higher for males than for females, with the smallest difference between sexes occurring in the Marshall Islands (table 4).

Table 4. ***Median systolic and diastolic blood pressure by age group and sex***

District and sex	15 to 24 age group (years)		25 to 44 age group (years)		45 and over age group (years)	
	Systolic	Diastolic	Systolic	Diastolic	Systolic	Diastolic
Saipan						
Male	119	69	124	76	135	80
Female	113	70	115	73	132	79
Palau						
Male	118	70	122	74	125	75
Female	117	69	119	70	122	73
Marshall Islands						
Male	116	76	118	77	125	78
Female	113	74	117	76	130	79

DISEASE PREVALENCE

American occupation forces found the health of the islanders generally poor and their needs for medical and surgical care extremely pressing. The conditions under which the native population had been forced to live during World War II, wartime diets of low calorie content, and the inadequacy of medical treatment received prior to and during the war had all left their mark.

By the time the health survey was launched, however, health conditions were much improved. The islanders had received medical care on an emergency basis immediately following American occupation in 1945, until July 1947 when the territory passed from military government to civil administration. In 1947 the health service policy of the Navy for the Trust Territory of the Pacific Islands, outlining a health program for the trust territory, was adopted for the purpose of controlling preventable disease and rendering medical and dental care. By 1 August 1948, the date the health survey started, this program was in full operation and rapid strides had been made in the control of preventable disease. Measures to correct sanitary practices of the islanders were being enforced; treatments, inoculations, and vaccinations had been administered; and the food supply had been improved to the extent that malnutrition no longer existed except in a few areas. Diseases that were previously the most serious threats had been brought under control. In many respects the health survey served as a means of evaluating the health program.

A marked reduction in the prevalence of intestinal parasites was accomplished in the interval prior to the health survey. It is believed that at the time of the American occupation nearly 100 percent of the indigenous population was infested with hookworm. Ascaris and Trichuris were also extremely prevalent. As a result of a mass deworming program, the control of flies, and education regarding health habits, sanitation and particularly the use of sanitary latrines, the prevalence of intestinal parasites had been noticeably reduced throughout the trust territory.

Yaws is another disease that was brought under control with effective treatment. The large number of inhabitants exhibiting multiple scars and the high proportion of positive Kahn tests bear testimony to the widespread prevalence of yaws. Very few primary lesions were noted during this survey, however, as these had been virtually eradicated by extensive treatment with penicillin administered by Navy medical officers on field trips prior to the survey.

The findings of the health survey revealed, however, that certain sanitation problems still remained. Most islands had community latrines that, in general, were clean and in good repair. It was evident, however, that use of the beaches was still a common practice throughout the islands. In many places, leaves and coconut fiber used in lieu of toilet paper were thrown about promiscuously. Maloelap Atoll was the only place where no latrines were available but many islands had clean and well-constructed latrines that were seldom used. Even on Saipan Island, where virtually every household had its own

latrine, use of the beach was evident. Garbage was usually buried in pits but on some islands it was burned or carried out to sea and dumped. The most inadequate methods of garbage disposal were noted on Utirik Atoll and Namorik Atoll where the garbage was allowed to accumulate over long periods of time.

In general, the fresh-water supply for the islands was furnished by rainfall. This was supplemented by wells wherever possible and, on the high islands, springs, streams, ponds, and reservoirs were also utilized. Rainwater was collected in old oil drums by means of spouts and drains on houses and coconut trees. The water was then stored in the drums, often without covers or other safeguards against debris. There were indications that the water supply on the following islands or atolls was contaminated: Babelthuap, Elato, Lamotrek, Yap, Tabal, Ebon, Kwajalein, Majuro, Mili, Maloelap, Namorik, and Ormed. Most wells were contaminated and the natives were warned to boil water before using it. On Saipan Island all water was chlorinated.

FINDINGS OF HEALTH SURVEY

Stool examinations. Stool examinations were made for 2,252 inhabitants of the Saipan district, 4,584 of the Palau district, and 3,495 of the Marshall Islands district, approximately 45 percent of the combined population. As shown in table 5, 52.4 percent of all stools examined were positive for intestinal parasites. One out of every five positive stools showed evidence of multiple species. The highest proportion of positives occurred among children from 5 to 14 years of age.

Comparison of the three districts reveals that Saipan had the highest proportion of positive examinations, 79.3 percent as com-

Table 5. ***Percentage of stools positive for intestinal parasites by age group and sex***

Age group (years)	Percentage positive			
	Total	Saipan district	Palau district	Marshall Islands district
All ages	52.4	79.3	64.5	19.3
Male	53.5	79.5	64.9	18.9
Female	51.4	79.1	64.2	19.6
Under 5	47.7	74.6	51.6	20.9
5 to 14	60.3	88.7	68.8	23.6
15 to 24	48.8	76.4	65.3	16.1
25 to 44	51.4	77.2	64.9	16.0
45 and over	51.5	74.4	65.7	21.4

pared with 64.5 percent for Palau and a much lower percentage of 19.3 for the Marshall Islands. On the following islands or atolls less than 5 percent of the stool examinations were positive: Ngulu, Lib, Aur, Mejit, Likiep, Utirik, Tabal, and Kwajalein. Over 75 percent of the stool examinations were positive on Eauripik, Namorik, Saipan, Elato, Tinian, Kayangel, Faraulep, Woleai, Satawal, Ifalik, and Lamotrek (table 6).

Table 6. ***Distribution of islands by percent of stools positive for intestinal parasites***

Percent of positive stools	Total number of islands	Saipan district	Palau district	Marshall Islands district
Under 5	8	-	2	6
5 to 9	4	-	-	4
10 to 24	4	-	1	3
25 to 49	5	1	4	-
50 to 74	7	-	5	2
75 and over	11	2	8	1

The most prevalent intestinal parasites were hookworm, Trichuris or whipworm, and Ascaris or roundworm. Hookworm was found in 23.1 percent of the stools, Trichuris in 22.3 percent, and Ascaris in 17.2 percent. The relative importance of the three species varied from district to district. In the Saipan district Ascaris had the greatest prevalence, with Trichuris ranking second and hookworm third. The rank order in the Palau district was just the reverse, while in the Marshall Islands district Trichuris was the most prevalent, hookworm ranked second, and Ascaris was practically nonexistent (table 7).

Table 7. ***Percentage of positive stools by parasitic infestation***

Parasitic infestation	Percent positive			
	Total	Saipan district	Palau district	Marshall Islands district
All parasites	52.4	79.3	64.5	19.3
Hookworm	23.1	26.2	34.0	6.8
Trichuris	22.3	40.6	22.0	11.0
Ascaris	17.2	44.2	16.8	.3
Other	2.8	5.6	1.4	2.9

Variations of prevalence rates by age and sex were slightly different for each species. Hookworm and Ascaris show opposite tendencies with respect to age. The former increased with age while the latter decreased. Trichuris showed little change by age. Hookworm was more prevalent among males, while Trichuris and Ascaris had slightly higher rates among females.

The actual procedure of obtaining the sample of stool specimens resulted in a haphazard rather than a representative cross section of the population. Each individual examined was given a stool box and requested to submit a fecal specimen. The number of specimens obtained varied greatly. After the specimens were received, some had to be rejected because of contamination from the specimen wrappings and others because of inadequacy of the specimen. The remaining specimens were examined for ova of the helminth or platyhelminth group. On some of the specimens, examinations were made for protozoa. Stools were examined by the simple flotation technic with a concentrated sugar solution used for ova of helminths and flukes. Direct normal saline smears were used to determine the presence of protozoan cysts. When protozoan cysts were indicated by the smears, iron-hematoxylin stains were made for positive identification.

Kahn tests. Kahn tests were given to 16,320 inhabitants, nearly three fourths of the population of the Saipan, Palau, and Marshall Islands districts The Kahn-test technic was not uniform throughout the portion of the survey reported here. Originally, the three-tube test was utilized. Later, using this same Kahn antigen, only the second dilution was used. Approximately 50 percent of the Kahn tests were positive, with little difference between the sexes (tables 8 and 9). The Palau district had by far the highest proportion of positives—65.4 percent as compared with 38.1 percent for the Marshall Islands district and 30.4 percent for the Saipan district.

Wide variation occurred among the islands, paralleling the variation between the districts. Tabal Island in the Marshall Islands

Table 8. ***Distribution of islands by percent of positive Kahn reactions***

Percent of positive Kahns	Total number of islands	Saipan district	Palau district	Marshall Islands district
Under 25	2	1	-	1
25 to 49	17	-	6	11
50 to 74	13	2	7	4
75 and over	7	-	7	-

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Table 9. ***Percentage distribution of examined population with positive Kahn reactions by age group***

Age group (years)	Percent positive			
	Total	Saipan district	Palau district	Marshall Islands district
All ages	50.1	30.4	65.4	38.1
Under 5	37.6	41.0	61.3	18.9
5 to 14	42.9	18.3	65.0	25.9
15 to 24	49.5	33.7	66.4	37.4
25 to 44	53.8	36.7	66.3	43.0
45 and over	52.9	32.0	63.9	44.0

district had the lowest percentage of all, only 3.6 percent positive. The next lowest was Saipan Island, with 22.8 percent. At the other extreme was Elato Atoll in the Palau district, the only place where every individual tested had a positive reaction. Other islands or atolls where over 75 percent of the population had positive reactions were Kayangel (95.4), Satawal (92.9), Woleai (89.1), Peleliu (87.0), Lamotrek (84.2), and Faraulep (77.3), all in the Palau district.

Generally speaking, the proportion of positive reactions increased with age up to the age group of 45 and over, where a slight decline was noted. The same rate of increase from age group to age group, however, was not observed in each district. In the Saipan district a marked increase occurred between the 5- to 14- and 15- to 24-year age groups, with little change in the age groups thereafter. The conspicuously high rate for Saipan's under-5-years-of-age population, however, is based on only 39 tests. Very little variation is observed between the age groups in the Palau district. On the other hand, the Marshall Islands district exhibits definite increases with each age group.

In this survey a positive Kahn test was considered likely evidence of the presence of yaws infection. It is recognized that the Kahn test is far from being an infallible index for the prevalence of yaws, for a positive reaction to the test may result from many diseases and conditions. Because malaria was not noted in this area and because syphilis, leprosy, and infectious mononucleosis seldom occurred in proportion to the number of positive Kahn tests, it would appear to be a reliable guide in this instance.

Yaws is not, as commonly believed, a venereal disease, but is a contagious disease that may be transmitted from person to person by

direct contact or carried by flies. The spirochete causing yaws, *Treponema pertenue*, enters through open lesions such as scratches and minor cuts. The primary lesions appear most frequently on the lower extremities and may last from 3 months to 3 years. It is not unusual for old healed-over lesions to break down. Tertiary-stage lesions often cause severe scarring and, in the form of gangosa, sometimes completely destroy the features.

Many inhabitants had multiple scars as evidence of a history of yaws. Very few diagnoses of active yaws were established during the course of the health survey. As shown in table 10, most of these cases were found in the Marshall Islands district. Numerous cases of active yaws were suspected, but dark-field examinations of the lesions were negative, possibly due to local treatment of ulcerative lesions with merthiolate and mercuric ointments by the native health aides.

Table 10. ***Results of survey for active yaws, Saipan,* Palau, and Marshall Islands districts***

District and island or atoll	Number of cases	District and island or atoll	Number of cases
Total	73	Marshall Islands.	
		Mejit Island	8
Palau	2	Majuro Atoll	7
		Ailuk Atoll	4
Babelthuap Island	1	Aur Island	3
Elato Atoll	1	Likiep Atoll	3
		Wotje Atoll	3
Marshall Islands	71	Kwajalein Atoll	2
		Namorik Island	2
Ine Island	12	Tabal Island	2
Ebon Atoll	11	Utirik Atoll	2
Maloelap Atoll	11	Lib Island	1

*No active cases of yaws reported for the Saipan district.

During the survey (table 11) urogenital examinations were made only of the male population, as the women were reluctant to permit examination. Little or no acute urethritis from gonococcus was noted but, although cases were not reported on the health record, medical officers at some of the hospitals stated that among the women there were many cases of "salpingitis, gonococcic" and "cervicitis, acute, due to gonococcus." The presenting symptoms of the reportedly widespread gonococcal infection among the men were those of a nongonococcic urethritis. Syphilis was almost nonexistent, a condition found to parallel the prevalence of yaws. Very few cases of primary chancre were found and secondary skin manifestations oc-

Table 11. *Results of survey for syphilis and gonorrhea, Saipan,* Palau, and Marshall Islands districts*

District and island or atoll	Syphilis	Gonorrhea
Total number of cases	6	12
Palau	-	2
Koror Island	-	1
Yap Island	-	1
Marshall Islands	6	10
Ailuk Atoll	-	1
Arno Island	1	1
Ebon Atoll	1	-
Kwajalein Atoll	-	3
Majuro Atoll	4	4
Namorik Island	-	1

*No cases of syphilis or gonorrhea reported for the Saipan district.

curred infrequently among both men and women. Several cases of syphilis and gonorrhea were reported from the Majuro and Kwajalein Atolls but only an occasional case was reported from any of the other islands or atolls.

Chest x-ray examinations. Chest roentgenograms were made of approximately 82 percent of the population of the Saipan, Palau, and Marshall Islands districts (tables 12 and 13). Many of those not

Table 12. *Results of chest x-ray examinations*

X-ray findings	Total		Saipan district		Palau district		Marshall Islands district	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
X-ray examinations	18,094	100.0	4,226	100.0	8,733	100.0	5,135	100.0
All chest defects	817	4.5	230	5.4	388	4.4	199	3.9
Tuberculosis, pulmonary	267	1.5	85	2.0	141	1.6	41	.8
Moderately and far-advanced	94	.5	24	.6	53	.6	17	.3
Other active	147	.8	44	1.0	81	.9	22	.4
Arrested	26	.1	17	.4	7	.1	2	.0
Chest tumor	31	.2	7	.2	17	.2	7	.1
Cardiovascular abnormality	48	.3	11	.3	11	.1	26	.5
Bone deformity	32	.2	3	.1	2	.0	27	.5
Other	439	2.4	124	2.9	217	2.5	98	2.0

Table 13. *Results of chest x-ray survey for active pulmonary tuberculosis by age group*

Age group (years)	Active by x-ray							
	Total		Saipan district		Palau district		Marshall Islands district	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
All ages	241	1.3	68	1.6	134	1.5	39	0.7
Under 5	5	.5	3	.8		0	2	.6
5 to 14	15	.3	5	.4	8	.4	2	.2
15 to 24	39	1.1	16	2.0	17	1.1	6	.5
25 to 44	67	1.2	17	1.5	43	1.5	7	.5
45 and over	115	3.2	27	4.4	66	3.5	22	2.0

x-rayed were aged and infirm. The initial examination consisted of a 35-mm photofluorographic roentgenogram that, if the x-ray shadows were suspiciously abnormal, was followed by a 14- by 17-inch chest roentgenogram. The findings reported in this survey were made from the 14- by 17-inch films without further clinical study.

On the basis of these examinations 4.5 percent of those x-rayed were found to have chest defects, and 1.3 percent were suspected of having active pulmonary tuberculosis. The number of chest tumors, cardiovascular abnormalities, and bone deformities was negligible, none being over 0.3 percent of the total x-rayed.

The prevalence rates for active pulmonary tuberculosis increase with age, showing but little variation by sex. The proportion of active-pulmonary-tuberculosis suspects among those x-rayed is greatest for those 45 years of age and over, 3.2 percent as compared with the next highest rate of 1.2 percent for the 25- to 44-year age group. Only slight differences were noted between rates for both sexes, the overall rate for females exceeding that for males by 0.1 percent.

Of the three districts Saipan has the highest percentage of chest defects, with Palau ranking second and the Marshall Islands lowest of all, 5.4, 4.4, and 3.9 percent, respectively. Of the persons x-rayed only 0.7 percent in the Marshall Islands, 1.5 percent in Palau, and 1.6 percent in Saipan were recorded as being suspected of having active pulmonary tuberculosis.

On the basis of the chest roentgenograms performed (table 14), 10 islands had no active pulmonary tuberculosis. On the other islands the percentage of positive films for the x-rayed population ranged from Kwajalein's 0.1 to Faraulep's 6.8. On six of these islands or

Table 14. *Percentage of chest x-rays indicative of active pulmonary tuberculosis by rank order on selected islands or atolls, Saipan, Palau, and Marshall Islands districts*

Island or atoll and district	Percent active	Island or atoll and district	Percent active
Faraulep Atoll*	6.8	Wotje Atoll**	1.2
Elato Atoll*	3.8	Majuro Atoll**	.9
Sonsorol Island*	3.6	Mejit Island**	.7
Lamotrek Atoll*	3.5	Babelthuap Island*	.6
Tabal Island**	3.4	Satawal Island*	.6
Ine Island**	3.1	Ebon Atoll**	.4
Mili Atoll**	2.9	Ailuk Atoll**	.3
Fais Island*	2.8	Namorik Island**	.3
Yap Islands*	2.8	Kwajalein Atoll**	.1
Aur Island**	2.4	Angaur Island*	0
Koror Island*	2.4	Eauripik Atoll*	0
Maloelap Atoll**	2.2	Lib Island**	0
Kayangel Atoll*	2.1	Likiep Atoll**	0
Ngulu Atoll*	2.1	Merir Island*	0
Tinian Island***	1.8	Peleliu Island*	0
Ifalik Atoll*	1.7	Pulo Anna Island*	0
Saipan Island***	1.6	Tobi Island*	0
Woleai Atoll*	1.3	Ulithi Atoll*	0
Arno Island**	1.2	Utirik Atoll**	0
Rota Island***	1.2		

*Palau district.
**Marshall Islands district.
***Saipan district.

atolls, Ine, Tabal, Lamotrek, Sonsorol, Elato, and Faraulep, over 3 percent of the x-rayed population had active pulmonary tuberculosis.

An interesting experience was reported from Tabal Island. The U.S.S. *Whidbey* visited this island in November 1948 but, because heavy seas rendered the x-ray machine inoperable, the ship was forced to return at a later date to complete the examinations. During the initial visit one 39-year-old woman on the island showed clinical evidence of pulmonary tuberculosis and had positive sputum for tubercle bacilli. At that time nine people were living in the same house with this active case of pulmonary tuberculosis. Eighteen months later when the survey ship returned the woman had died of tuberculosis. The chest roentgenograms for the other nine members of the household were still negative for tuberculosis.

Table 15 shows the diagnoses of tuberculosis that occurred among inhabitants who were not x-rayed. These diagnoses had been established prior to the health survey and, in some cases, the individuals were receiving treatment for the disease.

Nearly 90 percent of the population were tuberculin-tested. Table 16 shows the distribution of islands by percent of positive tuberculin

Table 15. *Diagnoses of tuberculosis for natives not x-rayed*

District and island or atoll	Total cases	Tuberculosis						
		Pulmonary		Skin	Lymph nodes	Male genitalia	Bronchus	Other
		Active	Arrested					
Total	44	9	3	6	14	1	1	10
Saipan: Saipan Island	6	1	-	2	1	-	-	2
Palau	33	4	3	3	13	1	1	8
Babelthuap Island	4	1	-	1	1	-	-	1
Fais Island	1	-	-	-	-	-	-	1
Koror Island	4	-	-	-	3	-	-	1
Ngulu Atoll	1	-	-	-	-	1	-	-
Peleliu Island	2	-	-	-	-	-	-	2
Satawal Island	1	-	-	-	1	-	-	-
Sonsorol Island	1	1	-	-	-	-	-	-
Yap Islands	19	2	3	2	8	-	1	3
Marshall Islands	5	4	-	1	-	-	-	-
Ailuk Atoll	2	1	-	1	-	-	-	-
Kwajalein Atoll	1	1	-	-	-	-	-	-
Majuro Atoll	1	1	-	-	-	-	-	-
Tabal Island	1	1	-	-	-	-	-	-

tests. Two test-strength dosages of tuberculin, 0.0001 mg PPD and 0.00002 mg PPD, were used for the tests, the latter dosage being used early in the program and occasionally when the 0.0001 mg PPD dosage was not available. On most of the islands in the Marshall Islands district the 0.0001 mg PPD dosage was used, while primarily the 0.00002 mg dosage was used in the Palau district. Both dosages were used in the Saipan district. From Babelthuap Island, where the 0.0001 mg PPD tuberculin dosage was used on about one half of the tested population and the 0.00002 mg PPD tuberculin dosage was

Table 16. *Distribution of islands by percent of positive tuberculin tests*

Percent of positive tuberculin tests	Total	Saipan district	Palau district	Marshall Islands district
Under 9	3	-	1	2
10 to 19	6	-	-	6
20 to 29	7	-	3	4
30 to 39	8	1	3	4
40 to 49	3	1	2	-
50 to 59	6	1	5	-
60 to 69	4	-	4	-
70 to 79	1	-	1	-
80 and over	1	-	1	-

used on the remainder of the population, it was reported that there was no significant variance between the number of positive reactors to the two dosages.

The findings for the Yap Islands presented in this article are all based on dosages of 0.00002 mg PPD tuberculin. In 6 of the 10 districts of Yap, however, all natives with negative reactions to these first tests were given a second test of 0.005 mg PPD tuberculin. Out of 304 tests there were 251 positive reactions. In other words, of the negative reactors to 0.00002 mg PPD test-strength tuberculin, who were retested with 0.005 mg PPD test-strength tuberculin, approximately 83 percent reacted positively. The practice of employing second test-strength dosages of tuberculin was discontinued. It was found that most individuals reacted to the second dose and the reactions were regularly so severe that they were alarming the natives.

Of the tuberculin-tested population 46.5 percent were positive reactors. The Marshall Islands district had much the lowest percent positive, 19.2 percent as compared with 54.6 percent for the Saipan district and 60.0 percent for the Palau district.

There is wide variation among islands in the proportion of positive reactors (table 17). The widest range occurs in the Palau district,

Table 17. ***Percentage of positive tuberculin tests by rank order, selected islands or atolls***

Island or atoll and district	Percent positive	Island or atoll and district	Percent positive
Yap Islands*	84.5	Lib Island***	34.0
Fais Island*	79.0	Tabal Island***	32.9
Tobi Island*	66.4	Aur Island***	30.0
Koror Island*	63.8	Eauripik Atoll*	28.9
Merir Island*	63.6	Mili Atoll***	27.9
Peleliu Island*	62.4	Namorik Island***	27.5
Angaur Island*	59.7	Majuro Atoll***	25.6
Saipan Island**	58.4	Pulo Anna Island*	23.1
Sonsorol Island*	57.9	Kwajalein Atoll***	22.8
Ngulu Atoll*	56.5	Satawal Island*	20.0
Woleai Atoll*	54.6	Wotje Atoll***	19.2
Ulithi Atoll*	52.5	Mejit Island***	18.0
Babelthuap Island*	47.8	Maloelap Atoll***	16.4
Rota Island**	42.1	Ailuk Atoll***	13.3
Kayangel Atoll*	40.2	Utirik Atoll***	12.6
Lamotrek Atoll*	38.6	Likiep Atoll***	10.1
Ifalik Atoll*	38.5	Elato Atoll*	6.1
Tinian Island**	36.4	Arno Island***	4.3
Ine Island***	36.0	Ebon Atoll***	3.2
Faraulep Atoll*	34.5		

*Palau district.
**Saipan district.
***Marshall Islands district.

from 6.1 percent for Elato Island to 84.5 percent for the Yap Islands. All of the islands in the Marshall Islands district had less than 40 percent positive reactors. The two lowest percentages in this district were those for Ebon Atoll and Arno Island, 3.2 percent and 4.3 percent, respectively. Most consistency was shown in the Saipan district, where the percent positive was 36.4 percent for Tinian Island, 42.1 percent for Rota Island, and 58.4 percent for Saipan Island.

The proportion of positive reactors progresses steadily with age (table 18). The only exception is the Saipan district where the peak is reached in the 15-to-24-year age group and a slight decline occurs after the age of 44. The percentages for both sexes in each district are very close. Where substantial differences exist the higher percentage is for males.

Table 18. ***Percentage of positive reactions among tuberculin-tested population by age group and sex***

Age group (years)	Percent positive			
	Total	Saipan district	Palau district	Marshall Islands district
All ages	46.5	54.6	60.0	19.2
Male	47.6	54.4	61.2	22.1
Female	45.3	54.8	58.8	16.2
Under 5	9.1	8.0	16.3	1.7
5 to 14	32.7	44.3	40.1	6.9
15 to 24	53.3	78.7	65.4	20.9
25 to 44	60.3	73.0	73.5	27.7
45 and over	58.9	71.1	76.2	27.7

Skin diseases. Skin diseases are prevalent throughout the territory. The low standards of hygiene among the islanders and the humid, hot climate of the area are all conducive to these conditions.

Dermatophytosis is the most common skin disease. The prevalence rate for the three districts combined was 298.5 per 1,000 inhabitants. The Saipan district had the highest rate for this disease, 379.9 as compared with 308.7 for the Marshall Islands and 253.7 for Palau. Over one-half the population of Tabal, Aur, Faraulep, Satawal, Rota, Wotje, Lamotrek, and Maloelap had dermatophytosis. In this class tinea versicolor is in such common occurrence that it is ignored by the natives. Tinea cruris and tinea circinata are also prevalent.

The prevalence rate for diseases of skin and cellular tissue was 149.2 per 1,000 persons. This group of diseases includes a high proportion of local skin infections. These include ecthyma, which is especially

prevalent in this area, and such conditions as diseases of the sweat glands, dermatitis seborrheica, and molluscum contagiosum. Rates were much higher in the Saipan and Marshall Islands districts than in the Palau district—246.2 and 214.2 per 1,000 inhabitants as compared with 62.9, respectively.

MISCELLANEOUS DISEASES

Prevalence rates for diseases which occurred with greatest frequency are presented by district in table 19. These diseases were diagnosed from the general physical examinations rather than from special tests and examinations.

Table 19. ***Morbidity for selected diagnoses***

(Prevalence rates per 1,000 examinations)

Selected diagnosis	Total		Saipan district		Palau district		Marshall Islands district	
	Number	Rate	Number	Rate	Number	Rate	Number	Rate
Examinations	22,146	(*)	4,999	(*)	10,575	(*)	6,572	(*)
Dermatophytosis	6,611	298.5	1,899	379.9	2,683	253.7	2,029	308.7
Chronic tonsillitis and nasopharyngitis	3,326	150.2	1,433	286.6	555	52.5	1,338	203.6
Diseases of the skin and cellular tissue	3,304	149.2	1,231	246.2	665	62.9	1,408	214.2
Pterygium	2,087	94.2	449	89.8	675	63.8	963	146.5
Degenerative joint disease	1,563	70.6	262	52.4	900	85.1	401	61.0
Conjunctivitis	909	41.0	273	54.6	443	41.9	193	29.4
Cataract	784	35.4	87	17.4	519	49.1	178	27.1
Acute respiratory infections	632	28.5	426	85.2	123	11.6	83	12.6
Neoplastic diseases	325	14.7	60	12.0	74	7.0	191	29.1
Inflammatory diseases of ear	217	9.8	132	26.4	10	.9	75	11.4
Opacity of cornea	211	9.5	82	16.4	86	8.1	43	6.5
Vitamin deficiency	195	8.8	101	20.2	28	2.6	66	10.0
Anemia	185	8.4	64	12.8	4	.4	117	17.8

*Not applicable.

The most prevalent diseases in the Saipan, Palau, and Marshall Islands districts were skin diseases, diseases of the eye, and respiratory diseases. Leprosy was also of major importance. Other diseases of wide prevalence were degenerative joint disease, neoplastic diseases, rickets and vitamin deficiency, anemia, and inflammatory diseases of the ear. Diseases carried by mosquitoes and other arthropods do not assume the importance in the trust territory that is usual in other tropical areas. Malaria is not an indigenous disease at the present

time because of the absence of anopheline mosquitoes. None of the rickettsioses were present. Although dengue, typhoid fever, and amebic dysentery were formerly regarded as widespread in the territory, no cases were reported present in these three districts during the survey. Several cases of filariasis were reported from the Palau district and one case from the Saipan district.

It should be borne in mind that some of the variations occurring among the islands may be due to the fact that examinations on the various islands were performed during different seasons of the year and by different personnel.

Diseases of the eye. Over 4,000 cases of diseases of the eye and adnexa oculi were reported from this area; the prevalence rate was 198.4 per 1,000. Pterygium, conjunctivitis, and cataract were greatest in occurrence. The intense sunlight, fine coral sands blowing about, the use of open fires, and frequent submersion in salt water are considered factors possibly contributing to the wide prevalence of pterygium and conjunctivitis. Cataracts were mostly of the senile type. Eighty-five cases of blindness were reported; 17 of these were bilateral and 68 were unilateral. It is believed that most of these were either congenital or resulted from physical injury.

In comparison with the other districts, the Marshall Islands had a strikingly high rate for pterygium, 146.5 per 1,000 persons as compared with 89.8 for Saipan and 63.8 for Palau. Conjunctivitis was most prevalent in the Saipan district, while cataracts occurred most frequently in the Palau district.

Acute respiratory infections. Acute respiratory infections were in common occurrence throughout the three districts. The over-all prevalence rate was 28.5 per 1,000 persons. This rate was much higher in the Saipan district than in the Marshall Islands and Palau districts, 85.2 per 1,000 persons as compared with 12.6 and 11.6 respectively. The changeable humid climate, crowded living conditions, sleeping on floors, low levels of nutrition, and poor standards of sanitation were undoubtedly factors contributing to these diseases. Saipan Island had an unusually large number of acute respiratory infections for its examined population. Chronic tonsillitis and nasopharyngitis were widespread in this area. The prevalence rate for the 3 districts combined was 150.2 per 1,000 persons. The rate for the Palau district, 52.5, was far below those for Saipan and the Marshall Islands, 286.6 and 203.6, respectively.

Leprosy. Eighty-six lepers from various parts of the trust territory were under treatment at the leprosarium on Tinian Island at the time of the health survey. Of these cases, 25 were thought to be lep-

romatous, 59 tuberculoid, and 2 mixed. As shown in table 20, 83 additional cases clinically suspicious for leprosy were found in the Saipan and Palau districts during the course of the survey. None were reported from the Marshall Islands district.

Table 20. ***Results of survey for clinically suspicious cases of leprosy, Saipan, Palau, and Marshall Islands* Districts***

District and island or atoll	No. of cases	District and island or atoll	No. of cases
Total	83	Palau—Continued	
		Yap Islands	3
Saipan: Saipan Island	65	Koror Island	2
		Satawal Island	2
Palau	18	Woleai Atoll	2
Lamotrek Atoll	4	Elato Atoll	1
Babelthuap Island	3	Fais Island	1

* No clinically suspicious cases of leprosy for Marshall Islands district.

The fact that the true macular lesion is not readily recognized by other than specialists in the field may have reduced the discovery rate for leprosy in this survey. Recognition of leprosy was especially difficult because of the prevalence of tinea versicolor and traumatic contracture, both of which required differentiation from the disease. Personnel conducting the survey were reluctant to make a diagnosis of leprosy where there was any question of its certainty.

Diseases of ear. Inflammatory diseases of the ear occurred at the rate of 9.8 per 1,000 inhabitants. The majority of cases were in the Saipan district where the rate was 26.4 per 1,000 persons. The rate in the Marshall Islands district was 11.4 and only 0.9 in the Palau district.

The most prevalent disease of the ear was "infection, diffuse, external auditory meatus." It is an interesting fact that of the 161 cases reported, 101 were on Saipan Island. It is not known whether personnel conducting the survey were more thorough in making examinations on this island than they were elsewhere or whether an epidemic was in occurrence at the time of the survey.

Other conditions. Degenerative joint disease was rather prevalent, showing a rate of 70.6 per 1,000 inhabitants in the three districts combined. Rates were highest in the Palau district and lowest in the Saipan district. This disease was most prevalent among the aged.

A total of 325 neoplastic diseases was reported, establishing a prevalence rate of 14.7 per 1,000. Only 11 neoplasms were proved malignant, although other malignancies were suspected. The malignant neoplasms were distributed among the islands or atolls as follows: Saipan, 3; Babelthuap, 2; and 1 each on Tinian, Ulithi, Woleai, Yap, Kwajalein, and Wotje. Among the 312 benign neoplasms there were 114 melanomas of skin, 63 lipomas, and 29 hemangiomas and lymphangiomas. The bulk of these were on Majuro, Ebon, Saipan, Yap, Babelthuap, Maloelap, and Mili.

The prevalence rate for vitamin deficiency was 8.8 per 1,000 inhabitants. Of the 195 cases reported, 98 were on Saipan Island where the prevalence rate was 24.2. Other islands where the rate was high were Ine, 72.8; Arno, 57.6; and Mili, 28.2.

Anemia, with a prevalence rate of 8.4 per 1,000 persons, was reported in substantial numbers from Saipan, Majuro, Ebon, and Mili. According to reports of this survey anemia was practically nonexistent in the Palau district.

It was reported that a large number of cases of leukoplakia buccalis were seen on Saipan and Babelthuap Islands. These occurred principally among betel-nut chewers. A comparatively small number of cases were reported on the health record cards used in this study for tabulation purposes. In the summary reports accompanying the cards, however, it was estimated that on Saipan alone over 200 cases of leukoplakia buccalis were observed. Many of these were verified by biopsy. It was further pointed out in the reports that, although betel-nut chewing was also a common practice on the Yap Islands, leukoplakia buccalis was not prevalent there. It was suggested that this might have resulted from the oral mud packs used on Yap to hide the staining effect of the betel nut. The mud packs were not used on Babelthuap. The reports from Saipan did not state whether mud packs were used there.

SUMMARY

In the summer of 1948 a survey staff aboard the U.S.S. *Whidbey* began a health survey of the Trust Territory of the Pacific Islands. its objective being a physical examination of every inhabitant of the area. This report covers the civil administrative districts of the Saipan, Palau, and Marshall Islands. Fifty-two percent of all stools examined were positive for intestinal parasites. The most prevalent intestinal parasites were hookworm, Trichuris, and Ascaris. Approximately 50 percent of the Kahn tests were positive. This was judged to be evidence of the yaws infection on the islands. Of those receiving chest x-ray examinations, 4.5 percent were found to have chest defects and 1.3 percent were suspected of having active pulmonary tuberculosis. The number of chest tumors, cardiovascular

abnormalities, and bone deformities was negligible. The incidence was 0.3 percent or less of the total number of inhabitants x-rayed.

The general physical examinations disclosed that the most prevalent diseases were skin diseases, diseases of the eye, and respiratory diseases. Leprosy was also of major importance. Other diseases of wide prevalence were degenerative joint disease, neoplastic diseases, rickets and vitamin deficiencies, anemia, and inflammatory diseases of the ear.

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PROGRESS IN DIABETES

Diabetes continues to maintain an unchallenged position in the study of clinical conditions chiefly because it represents all aspects of medicine. The number of diabetic patients increases each year, not because it is as such on the increase, but rather because the thousands of undiscovered cases are now being discovered. . . . The future of diabetes is brighter now than ever in the past. Research may bring about fewer complications, oral management and even eventual cure, but our present knowledge, when applied, makes the future more hopeful. Early diagnosis, better management, control of disabling conditions and efforts in the prevention of diabetes are all important steps toward the goal we are all striving for, namely, make the two million known diabetic patients and the one and one-half million undiscovered cases a valued part of everyday living because they are quite like their nondiabetic neighbor.—I. W. WILKENS: The Future of Diabetes. *The Journal of the Indiana State Medical Association*, October 1958.

Case Reports

Localization of Spinal Cord Injury in a Deep Sea Diver

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THIS CASE REPORT illustrates the occurrence and persistence of a specific localized lesion of the spinal cord following inadequate decompression of a diver. The fact that delayed recompression appears to have been of some benefit is noteworthy.

Behnke[1] has estimated that up to 5 percent of decompression injuries in deep-sea diving and about 2 percent in caisson workers give rise to symptoms referable to the presence of intravascular or extravascular nascent gas bubbles. The most common type of injury is the peripheral cramplike pain known as bends. Occasionally, the nervous system is involved: this serious type of injury has received careful evaluation in an excellent monograph by Haymaker and Johnson.[2]

CASE REPORT

On 24 March 1957, a 29-year-old commercial diver made two dives to depths of about 135 feet. The ascent from the first dive was rapid, with no stage decompression. The ascent from the second dive was controlled and there was an 8-minute stop at a depth of 10 feet. Each dive was about 20 minutes long, with an interval between dives of about 1 hour. Immediately after coming to the surface following the second dive, the patient experienced dizziness, nausea, generalized aching, weakness of the left arm and leg, and numbness of the right side. He went to bed, and after a sound sleep awoke free of symptoms except for persistent numbness on the right side of his body and muscular weakness of the left side. In addition, he felt a slight stiffness and tenderness at the base of his neck. There were no bladder symptoms.

The patient was first examined 2 days after the injury. Physical findings were not remarkable except for the neurologic examination. There was localized

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