

INFECTIOUS AND TROPICAL DISEASES IN OMAN: A REVIEW

EUAN M. SCRIMGEOUR, FIRDOSI R. MEHTA, AND ALI JAFFER MOHAMMED SULEIMAN

Department of Medicine, Sultan Qaboos University, Al-Khod, Muscat, Sultanate of Oman; Department of Surveillance and Disease Control, Ministry of Health, Muscat, Sultanate of Oman

Abstract. Oman is generally hot and dry, but the Salalah region in southern Dhofar province is relatively cool and rainy during the summer monsoon, and has a distinctive pattern of infection. Important, notifiable infections in Oman include tuberculosis, brucellosis (endemic in Dhofar), acute gastroenteritis, and viral hepatitis: 4.9% of the adults are seropositive for hepatitis B surface antigen and approximately 1.2% for hepatitis C virus. Infection with human immunodeficiency virus is uncommon, and leprosy, rabies, and Crimean-Congo hemorrhagic fever are rare. Between 1990 and 1998, the incidence of malaria, (>70% due to *Plasmodium falciparum*) decreased from 32,700 to 882 cases. Cutaneous and visceral leishmaniasis (caused by *Leishmania tropica* and *L. infantum*, respectively) and Bancroftian filariasis occur sporadically. Intestinal parasitism ranges from 17% to 42% in different populations. A solitary focus of schistosomiasis mansoni in Dhofar has been eradicated. There are major programs for the elimination of tuberculosis, leprosy, and malaria, and to control brucellosis, leishmaniasis, sexually transmitted diseases, trachoma, acute respiratory infection in children, and diarrheal diseases. The Expanded Program on Immunization was introduced in 1981: diphtheria, neonatal tetanus, and probably poliomyelitis have been eliminated.

Much has been written about infectious and tropical diseases in Oman during the past 3 decades. This data has been published in regional journals, including the *Medical Newsletter of Oman* (1982–1994), its successor, the *Oman Medical Journal* (1994 to the present), other medical journals, and in Ministry of Health publications, especially the quarterly *Community Health and Disease Surveillance Newsletter*. (The *Oman Medical Journal* is a bi-monthly, peer-reviewed journal.) In addition, Oman has been mentioned in reviews of communicable diseases in the Middle East.^{1–3} However, most of this information is inaccessible to the general reader. In this review, we summarize epidemiologic data from these sources and provide references. It follows the format of a similar review in Saudi Arabia published in 1995.⁴

OMAN: THE COUNTRY AND THE PEOPLE

Although Oman is generally hot and dry, the Salalah region in southern Dhofar Province (Figure 1) is relatively cool and rainy during the summer southwestern monsoon (July to September), e.g., in July, mean daily temperature = 28°C, (24°C at night), mean rainfall = 27 mm. No other part of the Arabian Peninsula is affected by the monsoon. These conditions encourage certain conditions, e.g., intestinal helminthiasis. Oman lies between the Afro-Tropical, Palaearctic, and Indo-Oriental zoogeographic zones, and this is reflected in its remarkable diversity of flora and fauna (which includes certain arthropods involved in disease transmission).

The population of Oman is 2.09 million; 1.5 million are Omanis and most of the remaining population are expatriates from the Indian sub-continent. Thousands of Omanis were born in east Africa, particularly Zanzibar (which was administered by Oman until 1964). Most Omanis are employed in agriculture, animal husbandry (farming goats, sheep, cattle, and camels), or fishing.

THE HEALTH SERVICES

Oman has a broad-based health service with country-wide primary health care, and district, regional, and tertiary re-

ferral hospitals. The Expanded Program on Immunization (EPI) was introduced in 1981, and in March 1991, a National Communicable Diseases Surveillance System was established. The Ministry of Health has major programs for controlling brucellosis, leishmaniasis, sexually transmitted diseases, trachoma, acute respiratory infection in children, and diarrheal diseases and for eliminating (or eradicating) malaria, leprosy, and tuberculosis. The success of some of these programs is shown in Table 1.

INFECTIOUS AND TROPICAL DISEASES

Important bacterial, viral, and parasitic diseases are discussed briefly in alphabetical order. Table 1 documents changes in gross incidences and incidence rates/100,000 population of some important reportable communicable diseases between 1992 and 1998.

Bacterial infections. *Brucellosis.* This disease is prevalent in Oman (Table 1), particularly in Dhofar, where semi-nomadic Bedouin communities live with their flocks.^{5–8} In 1993, 1% of healthy residents of Dhofar (mainly children) had serologic evidence of exposure.⁸ Bacteriologic culture (*Brucella melitensis* is invariably isolated) is available only in major hospitals; elsewhere, diagnosis is confirmed by a standard agglutination test. Since a single, relatively low antibody titer $\geq 1:80$ – $1:160$ is often accepted as diagnostic, the true incidence may be less than that reported. (In Saudi Arabia, titers $\geq 1:320$ – $1:640$ are usually preferred to support a diagnosis.⁹) Mass vaccination of livestock has yet to be undertaken.

Chlamydial infection. Trachoma (*Chlamydia trachomatis*) is endemic and produces significant morbidity.^{10–12} Control of trachoma, with an emphasis on public education, has been a priority of the Ministry of Health,¹³ and Table 1 shows the substantial progress in this field. Data from genitourinary and gynecology clinics indicates that sexually acquired chlamydial infection is uncommon.

(*Acute*) gastroenteritis, diarrhoea, and shigellosis.¹⁴ These are important public health problems, but the effects of improved water supplies and public education are reflected in

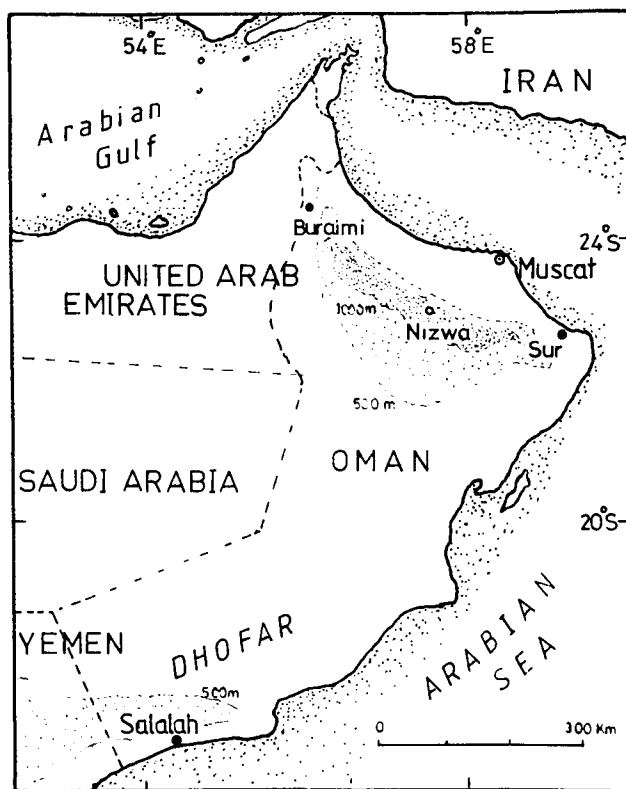


FIGURE 1. Map of Oman, showing its location in the Middle East, and the principal towns mentioned in this review.

substantial improvements in incidence rates since 1992 (Table 1).

Leprosy. The incidence of leprosy has not changed significantly since 1992 (Table 1). In 1998, of 39 cases, 12 were Omani adults and 9 had multibacillary disease; the 27 expatriates infected were mostly from the Indian subcontinent. Leprosy is targeted for eradication by the Ministry of Health by 2000.¹⁵

Sexually transmitted diseases (STDs). Between 1992 and 1995, the percentages of different STDs encountered in Salalah in Dhofar Province were as follows: syphilis = 28.5%, gonorrhoea = 19.5%, non-specific urethritis = 11%, and herpes simplex virus infection = 5.5%. Condyloma acuminatum, chancroid, trichomoniasis, granuloma inguinale, and lymphogranuloma venereum were less frequent.¹⁶ Table 1 shows the decrease in incidence rates for syphilis and gonorrhoea from 1992 to 1998. These reflect the impact of the STD control program. Under-reporting is likely because many patients with STDs seek private treatment.

Tuberculosis. The incidence of tuberculosis has decreased significantly since 1992 (Table 1), especially the incidence of sputum-positive, pulmonary tuberculosis (PTB), but the rate for extra-pulmonary disease has not changed significantly. In 1998, among Omanis, 109 cases of sputum-positive PTB (prevalence = 5.2 per 100,000) were reported, with an additional 26 cases diagnosed by radiology, and 77 cases of extra-PTB (48% lymphatic and 8.4% bones and joints). There were an additional 75 expatriate cases, including 47 sputum-positive patients. The directly observed treatment, short course policy is now standard for sputum-positive cas-

TABLE 1

Changes in gross incidences and incidence rates per 100,000 population (values in parentheses), of important, notifiable communicable diseases in Oman 1992–1998*

Condition†	Incidence in 1992	Incidence in 1998	χ^2 P‡
Brucellosis	371 (21.0)	307 (14.7)	<0.001
Gastroenteritis and diarrhea	193,709 (10,944.0)	96,908 (2,432.9)	<0.001
Gonorrhoea	639 (36.1)	247 (11.0)	<0.001
Leprosy	36 (2.0)	39 (1.8)	NS
Malaria	14,827 (872.0)	882 (42.2)	<0.001
Mumps	10,655 (601.9)	5,951 (263.8)	<0.001
Typhoid fever	124 (7.0)	105 (5.0)	<0.01
Shigellosis	1,680 (94.9)	1,381 (61.2)	<0.001
Syphilis	377 (20.9)	199 (9.5)	<0.001
Trachoma	10,142 (572.9)	2,279 (101.0)	<0.001
Tuberculosis	348 (19.7)	287 (13.7)	<0.001
Viral hepatitis B (HBsAg +)	368 (20.8)	313 (13.9)	<0.001

* 1992 population = 1.77 million; 1998 = 2.09 million

† HBsAg = hepatitis B surface antigen.

‡ NS = not significant.

es. The annual risk of infection (AARI) was 0.5–1%, which is within the moderate prevalence range (World Health Organization, 1994, unpublished data), but in 1995, a survey of school children revealed that this had decreased to 0.2%, which is in the low prevalence range (AARI < 0.5%). Bacille Calmette-Guérin vaccination is given to all infants at birth.

Typhoid (enteric) fever. There has been no significant change in the incidence of typhoid fever (which includes infection with *Salmonella typhi* and *S. paratyphi*) since 1992 (Table 1). Since a single Widal serologic test result is often accepted as diagnostic, some over-diagnosis is likely. Chloramphenicol resistance is commonplace.¹⁷

Whooping cough (pertussis). In 1998, 484 cases (clinical diagnosis only) were reported (21.5 per 100,000 population). Some of these cases may have been caused by respiratory viruses and other pathogens. Pertussis vaccination was included in the EPI in 1981.

The following bacterial diseases are infrequent or rarely reported: actinomycosis,¹⁸ Lyme disease (*Ixodes* ticks are endemic¹⁹), meningococcal infection (World Health Organization, 1987, unpublished data), tetanus, tick-borne relapsing fever (*Ornithodoros* ticks are endemic²⁰), and tropical pyomyositis.²¹ Diphtheria (last case in 1992), and neonatal tetanus (last case in 1995) have been eradicated. The following diseases have not been reported: anthrax, bejel, leptospirosis, melioidosis, plague, tularemia, and yaws. Cholera has only been reported once in an expatriate.²²

Rickettsial diseases. Rickettsial infection has not been reported, although potential tick vectors for tick typhus (e.g., *Rhipicephalus sanguineus*), and Q fever (*Amblyomma* spp.) are indigenous.²⁰ It is surprising that Q fever has not been reported because Q fever occurs in Saudi Arabia, particularly in the Eastern Province.⁴

Viral diseases. Arbovirus infections. Arbovirus studies have been confined to animals.²³ Dengue, sandfly fever, and Hantaan fever have not been reported (although the first 2 have occurred in Saudi Arabia).^{4,24} There have been 7 cases of Crimean Congo hemorrhagic fever (CCHF) since 1995, and all were associated with exposure to fresh animal blood

or ticks^{25,26} (various *Hyalomma* ticks, the principal vectors of the virus, are widely prevalent.^{27,28}) A recent countrywide survey showed that 26% of 283 individuals in contact with live or slaughtered livestock and 27% of 501 animals (camels, goats, sheep, and cattle), were seropositive for CCHF virus (Khan AS, unpublished data). A viral hemorrhagic fever policy is now standard in Oman hospitals.²⁹

Cytomegalovirus (CMV). Infection with this virus is prevalent in Oman; a study of antenatal patients showed that 95.5% had IgG antibodies to CMV.³⁰ It is likely that infection with Epstein-Barr virus (EBV) has a similar prevalence. Burkitt's lymphoma, (which is associated with EBV infection and malaria), occurs occasionally in Oman.³¹

Human immunodeficiency virus (HIV). This infection is uncommon and apparently has been introduced only recently; in 1996, no cases were found in a seroepidemiologic survey of antenatal patients.³² However, by June 1998, 165 cases of acquired immunodeficiency syndrome (AIDS) had been recorded (cumulative since 1996). The majority (78%) of these case were males, and the source of infection was heterosexual contact in 48%, homosexual contact in 11%, infected blood products (contracted prior to 1989) in 30%, and vertical transmission from mother to baby in 11%. No cases were attributed to intravenous drug abuse.³³ Current population prevalence rates are not available. Control of HIV is part of the STD control program.^{34,35} Infection with human T cell leukemia virus has not been reported in Omanis.³⁶

Other viruses. Epidemics of influenza occur during most winters. In 1998, 4,914 cases (most attributed to influenza A) were reported. Measles vaccine was included in the EPI in 1981, but epidemics continued until recently.³⁷ Measles is targeted for elimination,³⁸ and 98% of the children are currently immunized. In 1998, 5,951 cases of mumps (clinical diagnosis only) were reported (Table 1). Mumps, measles, and rubella (MMR) vaccine was included in the EPI in 1997.

Poliomyelitis. The incidence of poliomyelitis decreased after the introduction of vaccine in the EPI in 1981, although outbreaks continued until 1992.³⁹⁻⁴³ More than 95% of the children are now vaccinated, and the Ministry of Health conducts National Immunization Days for children less than 6 years of age to promote the target of poliomyelitis eradication by the year 2000. (It seems likely that this goal has already been achieved.)

Rabies. This was apparently introduced by foxes from the United Arab Emirates in 1990, when the first human case occurred.⁴⁴ Within a year, rabies had spread among red foxes (*Vulpes vulpes*) countrywide,^{45,46} and human cases occurred in 1991 (wolf bite), 1992 (fox bite),⁴⁷ and 1997 (fox bite). The latter occurred despite post-exposure prophylaxis. Animal bites surveillance was introduced in 1990; from 1990 to 1997, 1,195 bites were reported: 45% caused by dogs and 4% by foxes. During this period, rabies affected 163 foxes, 25 cattle, 11 camels, and 11 dogs examined at the government veterinary laboratory. In 1997, only 11 foxes (no dogs) were found to be rabid (Ministry of Agriculture and Fisheries, unpublished data).

Rubella. Surveys in antenatal patients have revealed an IgG seropositivity of 92% for rubella.³² In 1994, measles rubella (MR) vaccine, administered at 15 months of age, was included in the EPI.⁴⁸ Between 1992 and 1994, 60 congenital

rubella syndrome cases were notified, but in 1998, there were only 8 cases.

Viral hepatitis. This disease is a major problem, and in 1998, there were 1,219 reports of acute infection. Infection with hepatitis A virus is endemic, and most individuals probably become seropositive in childhood. With regard to hepatitis B virus (HBV), a survey of women attending antenatal clinics showed that 8.9% were positive for hepatitis B surface antigen (HBsAg) and 38.5% had anti-s antibodies.⁴⁹ Unpublished data from blood banks indicates that currently among donors, the prevalence of HBsAg varies from 3.2% to 4.9%. Vertical transmission with persisting, nonreplicative HBsAg seropositivity continues to be common among young Omanis.

The prevalence of hepatitis δ virus (HDV) has been studied in renal dialysis patients,⁴⁹ but not in the general community. Infection with hepatitis C virus (HCV) is prevalent in renal dialysis patients⁵⁰ and among blood donors; presently, approximately 1.2% are seropositive. Morbidity from chronic HBV and HCV infection (e.g., cirrhosis, portal hypertension, esophageal varices, and hepatoma) is frequent in hospital patients. Vaccination for hepatitis B at birth was incorporated in the EPI in 1990. Table 1 shows the decrease in HBsAg seropositivity from 1992 to 1998.

Prion diseases. *Creutzfeldt-Jakob disease (CJD)*. Two typical sporadic cases of CJD have been reported.⁵¹

Bovine spongiform encephalopathy. This occurred in 2 cattle imported from the United Kingdom in 1990.^{52,53} When variant CJD (vCJD) syndrome was reported in the United Kingdom in 1996,⁵⁴ the importation of British beef was banned, and a vCJD Surveillance Unit was established.

Systemic fungal diseases. *Mycetoma.* This disease, which is caused by actinomycetoma and eumycetoma is prevalent, although culture identification is rare.⁵⁵⁻⁵⁷ Systemic fungal infection occurs particularly in AIDS patients, but histoplasmosis has not been recorded.

Parasitic diseases. *Leishmaniasis.* Although various sand flies, including *Phlebotomus alexandri*, *P. sergenti*, and *P. papatasi* occur in Oman, the vectors responsible for leishmaniasis are unknown.⁵⁸⁻⁶⁰ In a study of cutaneous leishmaniasis in Dhofar between 1984 and 1995, *Leishmania tropica* was suspected to be the usual cause, but culture and identification was not performed (Ali MAM, unpublished data). After culture methods were introduced in 1996, *L. tropica* was isolated from a Pakistani resident of Oman.⁶¹ In 1998, 25 cases of cutaneous leishmaniasis were reported.

Visceral leishmaniasis (VL) is confined principally to children in the mountains of northern Oman,^{62,63} and Dhofar.⁶⁴ Between 1992 and 1995, the annual incidence rate of VL in Oman varied from 14 to 40 cases, but in 1998, only 5 cases were reported. (Many children treated empirically for kala azar are not reported.) The first successful culture of *Leishmania* in Oman was achieved in 1998 when *L. infantum* was isolated from an AIDS patient.⁶⁵ Post-kala-azar dermal leishmaniasis was observed in a child whose parents did not allow a full course of treatment and follow-up care at the University Hospital in 1996. She presented approximately 6 months later with typical post-kala-azar dermal leishmaniasis that resolved following further treatment.

Malaria. This disease is caused by *Plasmodium falciparum* (>70% of the cases) and *P. vivax* in Oman. The vectors

Anopheles stephensi and *A. culifacies* are present in Muscat and the northern provinces, *A. fluviatus* in the central mountains, and *A. custiani* (which is a day-biting mosquito) in Dhofar. (Despite the favorable climate, malaria is uncommon in Dhofar.) In 1990, there were 32,720 cases of malaria, but subsequent to the implementation of the malaria control program in 1992, the incidence decreased to 880 cases in 1998 (Table 1). Falciparum malaria may be introduced by visitors or migrants from east Africa or elsewhere, and inevitably, chloroquine resistance has become prevalent.⁶⁶⁻⁶⁹ The high rate of protective erythrocyte anomalies in Oman suggests long historical exposure to malaria.^{70,71} The mean prevalence rates are sickle cell trait = 6%, β -thalassemia = 2%, and glucose-6-phosphate dehydrogenase deficiency = 18% (male:female ratio = 2.5:1). (Al-Riyami A, unpublished data).

Toxoplasmosis. This disease is endemic in Oman: 42.3% of antenatal patients in 1 survey were seropositive for IgG antibody,³⁰ and in Dhofar 59% of the population were seropositive.⁷² Cats are common in metropolitan areas, and widespread population exposure is inevitable.

Trypanosomiasis. This disease is not found in Oman (although non-pathogenic *Trypanosoma evansi* affects horses).

Helminths. In 1997, Oman was declared free of dracunculiasis by the World Health Organization (WHO), the last recorded case being in an expatriate patient in 1992. Echinococcosis (hydatid disease) is encountered mainly in shepherds in Dhofar.^{73,74} Dogs are rarely kept by Omanis (the animal is considered unclean).

Filariasis. The WHO regards Oman as being endemic for filariasis, presumably because of a report in 1953 (Hawking F, unpublished data), but cases have never been reported. However, from 1996 to 1999, several patients, including Omanis born in east Africa, have been diagnosed to have amicrofilaremic filariasis based on clinical and serologic grounds and response to treatment (Scrimgeour EM, unpublished data). Culicine mosquitoes including *Culex fatigans* are indigenous.

Onchocerciasis. This disease does not occur, although indigenous blackflies (Simuliidae), occur in many locations.^{75,76} (Onchocerciasis occurs in the mountains of Yemen and southern Saudi Arabia.⁴)

Intestinal parasitoses (protozoa and helminths). The prevalence of intestinal parasites has been studied in many regions, especially in Dhofar.^{77,78} In a 1994 study of 5% of the Dhofar population, including adults and children, 25% had parasites. These included hookworm (*Necator americanus*) (23%), *Giardia lamblia* (3.4%), *Entamoeba histolytica* (0.5%), and less frequently *Trichuris trichiura*, *Hymenolepis nana*, *Strongyloides stercoralis*, *Enterobius vermicularis*, and *Ascaris lumbricoides*.⁷⁹ The highest prevalence was in those 6-13 years old. Infections were mild and were not associated with anemia. Studies of hospital patients in the Musandem Province⁸⁰ and of school children in Muscat⁸¹ and Nizwa⁸² have shown parasite rates of 42%, 27.5%, and 33.3%, respectively. Further studies have been recently reported from Sur⁸³ and the Nizwa district.⁸⁴ Non-Omanis have different rates of parasitism. Of 6,000 food-handling recruits, (mostly from the Indian sub-continent), 12.7% had parasites. These included *A. lumbricoides* (4.8%), *T. trichuris* (4%), and *A. duodenale* (3.8%), and 1 had a *Taenia saginata* in-

fection.⁸⁵ Cutaneous larva migrans is prevalent in Dhofar, especially during the monsoon. From 1990 to 1994, 389 cases were observed, principally in children.⁸⁶

Schistosomiasis. Schistosomiasis mansoni was first identified on a farm at Salalah, Dhofar in 1979, and the vector snail was *Biomphalaria arabica*.⁸⁷ The disease may have been introduced by Egyptian and Sudanese laborers. In 1989, 28% of 47 farmworkers, 12% of 99 adults, and 1% of 389 children attending Salalah clinics had serologic evidence of exposure, and a snail survey conducted simultaneously revealed for the first time that *Bulinus wrighti*, a potential host for *S. haematobium*, was present in the district, although urinary schistosomiasis was absent.⁸⁸ The control program was reactivated, and by 1994, the incidence of schistosomiasis had fallen to zero. The sequelae of chronic schistosomiasis in Omanis from Salalah and east Africa, and in expatriates from Egypt and Sudan continue to cause morbidity.⁸⁹ Surveillance continues to ensure that the disease is not reintroduced, and this includes evaluation of Salalah residents who present with serologic evidence of residual infection.

Taeniasis. Infection with *Taenia saginata*,⁸⁵ but not *T. solium*, has been reported (the keeping of pigs is forbidden in Oman). Cysticercosis is confined to an occasional expatriate.

Toxocariasis. This disease has not been reported. A study of children with eosinophilia at the Sultan Qaboos University Hospital from 1995 to 1997 failed to identify any subject with positive serology suggesting occult toxocariasis (Scrimgeour EM, unpublished data).

Myiasis and ectoparasites. **Myiasis.** Various diptera, e.g., *Chrysomya bezziana*, the Old World screw worm fly, occur in veterinary practice.⁹⁰ Ectoparasites (apart from head, body lice, and scabies) are infrequently encountered; however, an animal scabies epidemic affected 50% of the population of the Khasab district in Musandem in 1996 (Naidu TY, unpublished data). Scabies is relatively common in rural children from impoverished districts.

CONCLUSION

The spectrum of infectious and tropical diseases in Oman is wide, but apart from a few conditions, incidence and prevalence rates are low. During recent decades, the Ministry of Health has initiated many control programs for major communicable diseases to promote the goal of Health for All by the year 2000. Substantial improvements have been achieved in many areas (e.g., in malaria, tuberculosis, and trachoma control), and some infections, including schistosomiasis, diphtheria, neonatal tetanus, and probably poliomyelitis, have been eliminated.

Financial support: This work was supported by SmithKline Beecham.

Authors' addresses: Euan M. Scrimgeour, Department of Medicine, Sultan Qaboos University, PO Box 35, Al-Khod, Muscat 123, Sultanate of Oman. Firdosi R. Mehta and Ali Jaffer Mohammed Suleiman, Department of Surveillance and Disease Control, Ministry of Health, Muscat, Sultanate of Oman.

REFERENCES

- Quin NE, 1982. The impact of diseases on military operations in the Persian Gulf. *Mil Med* 147: 728–734.
- Oldfield III EC, Wallace MR, Hyams KC, Yousif AA, Lewis DE, Bourgeois AL, 1991. Endemic infectious diseases of the Middle East. *Rev Infect Dis* 13 (suppl 3): S199–S217.
- Baker MS, Strunk HK, 1991. Medical aspects of Persian Gulf operations: serious infectious and communicable diseases of the Persian Gulf and Saudi Arabian Peninsula. *Mil Med* 156: 385–400.
- Scrimgeour EM, 1995. Communicable diseases in Saudi Arabia: an epidemiological review. *Trop Dis Bull* 92: R79–R95.
- Ismaily SI, Harby HA, Nicoletti P, 1988. Prevalence of *Brucella* antibodies in four species in the Sultanate of Oman. *Trop Anim Health Prod* 20: 269–270.
- Mehta FR, El-Maully KN, 1990. Is brucellosis a public health problem in Oman? *Med Newsletter Oman* 6: 11–14.
- Varghese TP, 1987. Study of bone and joint brucellosis in southern region (Dhofar), Oman. *Med Newsletter Oman* 4: 25–29.
- Idris MA, Maiwald M, El-Maully KN, Ruppel A, 1993. Human brucellosis in Dhofar, Sultanate of Oman. *J Trop Med Hyg* 96: 46–50.
- Cooper CW, 1991. The epidemiology of human brucellosis in a well-defined urban population in Saudi Arabia. *J Trop Med Hyg* 94: 416–422.
- Reacher MH, Munoz B, Alghassany A, Daar AS, Elbualy M, Taylor HR, 1992. A controlled trial of surgery for trachomatous trichiasis of the upper lid. *Arch Ophthalmol* 110: 667–674.
- El-Madany M, 1989. Prevalence of trachoma among school children in North Batna region. *Med Newsletter Oman* 6: 29–32.
- White AG, Bogh J, Leheny W, Kuchipudi P, Varghese M, Al-Riyami M, Al-Hashmi S, Daar AS, 1997. HLA antigens in Omanis with blinding trachoma: markers for disease susceptibility and resistance. *Br J Ophthalmol* 81: 431–434.
- Graz B, 1993. Trachoma: possibilities of prevention. A study in the Sultanate of Oman. *Eur J Ophthalmol* 3: 127–131.
- Elshafie SS, Rafay AM, 1993. Antimicrobial resistance of *Shigella* isolates in the Sultanate of Oman. *Oman Med J* 9: 5–8.
- Venkataram MN, Al Suwaid AR, 1997. Leprosy in Oman. *Oman Med J* 13: 30–33.
- Rao KD, 1996. A study of sexually-transmitted diseases in Dhofar. *Oman Med J* 12: 16–20.
- Elshafie SS, Rafay AM, 1992. Chloramphenicol-resistant typhoid fever: an emerging problem in Oman. *Scan J Infect Dis* 24: 819–820.
- Lad SJ, Chandy MJ, 1991. Craniofacial actinomycosis. *Br J Neurosurg* 5: 361–370.
- Scrimgeour EM, 1996. Does Lyme disease exist in the Middle East (letter)? *Emirates Med J* 14: 68.
- Hoogstraal H, 1980. Ticks (Ixodidea) from Oman. *J Oman Studies (Special Report No. 2)*: 265–272.
- Nayar PM, Freeman NV, 1992. Pyomyositis and psoas abscess in relation to the acute abdomen in children. *Oman Med J* 8: 5–8.
- Kamath BR, Rolfe M, 1995. *Vibrio cholerae* non-O1 septicaemia. *Oman Med J* 12: 29–30.
- Al-Busaidy SM, Mellor PS, 1991. Isolation and identification of arboviruses from the Sultanate of Oman. *Epidemiol Infect* 106: 403–413.
- Tesh RB, Saidi S, Gajdamovic SJ, Rodhain F, Vesenjck-Hirjan J, 1976. Serological studies on the epidemiology of sandfly fever in the Old World. *Bull World Health Organ* 54: 663–674.
- Schwartz TF, Nitschko H, Jager G, Nsanze H, Longson M, Pugh RNH, Abraham AK, 1995. Crimean-Congo haemorrhagic fever in Oman. *Lancet* 346: 1230.
- Scrimgeour EM, Zaki A, Mehta FR, Abraham AK, Al-Busaidy S, El-Khatim H, Al-Rawas SFS, Kamal AM, Mohammed AJ, 1996. Crimean-Congo haemorrhagic fever in Oman. *Trans R Soc Trop Med Hyg* 90: 290–291.
- Hoogstraal H, 1979. The epidemiology of tick-borne Crimean-Congo haemorrhagic fever in Asia, Europe, and Africa. *J Med Entomol* 15: 307–417.
- Scrimgeour EM, 1996. Crimean-Congo haemorrhagic fever in Oman. *Lancet* 347: 692.
- Scrimgeour EM, El-Azazy OME, 1998. Viral haemorrhagic fever: admission policy for hospitals in the Arabian Peninsula (letter). *Ann Saudi Med* 18: 273–274.
- Elbualy MS, Kolhatkar A, Al-Dharhy SHS, 1996. Seroprevalence of rubella, cytomegalovirus, measles and toxoplasmosis among pregnant women in Oman. *Oman Med J* 12: 6–10.
- Al-Lamki A, Elbanna N, Unnikrishnan M, Saha A, Elbualy MS, 1994. Malignant tumours in Omani children. *Ann Trop Paediatr* 14: 313–320.
- Elbualy MS, Kolhatkar A, Al-Dharhy SHS, 1996. Prevalence of hepatitis B and human immunodeficiency virus infection among pregnant women in Oman. *Oman Med J* 12: 11–14.
- Anonymous, 1998. Global AIDS Surveillance, Part I and II. *Wkly Epidemiol Rec* 73: 373–380 and 381–388.
- Al-Baqllaan SAS, Al-Buwaidy SM, Paul G, Al-Awaidy ST, 1997. Decline of anti-HIV1 antibodies to undetectable levels in a terminally-ill acquired immunodeficiency (AIDS) patient. *Oman Med J* 14: 6–8.
- Scrimgeour EM, 1997. Do-it-yourself information notes for AIDS counseling in developing countries. *Trop Doct* 27: 83–84.
- Knox-Macauley H, McDonald R, al-Busaidy A, Ali N, 1997. HTLV-1 seroprevalence in the Sultanate of Oman. *Scand J Infect Dis* 29: 217–218.
- Anonymous, 1993. Measles outbreak in Dhofar. *Wkly Epidemiol Rec* 68: 41–48.
- Anonymous, 1998. EPI: measles elimination in Oman. *Wkly Epidemiol Rec* 73: 121–125.
- Sutter RW, Patriarca PA, Brogan S, Malankar PG, Pallansch MA, Kew OM, Bass AG, Cochi SL, Alexander JP, Hall DB, Suleiman AJM, Al-Ghassany AAK, El-Bualy MS, 1991. Outbreak of paralytic poliomyelitis in Oman: evidence for widespread transmission among fully-vaccinated children. *Lancet* 338: 715–720.
- Robertson SE, Suleiman AJM, Mehta FR, Al-Dharhy SH, El-Bualy MS, 1994. Poliomyelitis in Oman: acute flaccid paralysis surveillance leading to early detection and rapid response to a type 3 outbreak. *Bull World Health Organ* 72: 907–914.
- Anonymous, 1994. Poliomyelitis in Oman: update. *Community Health Dis Surveill Newsletter, Ministry of Health, Oman* 1: 4.
- Sutter RW, Patriarca PA, Suleiman AJ, Brogan S, Malankar PG, Cochi SL, Al-Ghassani AA, Elbualy MS, 1992. Attributable risk of DTP (diphtheria and tetanus toxoids and pertussis vaccine) injection provoking paralytic poliomyelitis during a large outbreak in Oman. *J Infect Dis* 165: 444–449.
- Elbualy MS, Al-Dharhy SHS, 1995. Prevalence of polio antibodies among healthy adults in Oman. *Oman Med J* 12: 5–10.
- Novelli VM, Marquez B, Malankar P, 1990. Rabies in Oman. *Med Newsletter Oman* 7: 19–21.
- Novelli VM, Malankar P, 1991. Epizootic of fox rabies in the Sultanate of Oman. *Trans R Soc Trop Med Hyg* 85: 543.
- Anonymous, 1992. Wildlife rabies in Oman and the United Arab Emirates. *Wkly Epidemiol Rec* 67: 65–68.
- Ata FA, Tageldin MH, Al-Sumry HS, Al-Ismaily SI, 1993. Rabies in the Sultanate of Oman. *Vet Rec* 132: 68–69.
- Anonymous, 1994. Expanded program on immunization. Rubella outbreak. *Wkly Epidemiol Rec* 69: 333–337.
- Al-Dharhy SHS, Aghanashinikar PN, Marhuby, Buhl MR, Daar AS, Al-Hasani MK, 1994. Hepatitis B, delta, and human immunodeficiency virus infections in Oman patients with renal diseases: a seroprevalence study. *Ann Saudi Med* 14: 312–315.
- Al-Dharhy SH, Aghanashinikar PN, Al-Hasani MK, Buhl MR, Daar AS, 1993. Prevalence of antibodies to hepatitis C virus among Omani patients with renal disease. *Infection* 21: 164–167.
- Scrimgeour EM, Chand PR, Kenny K, Brown P, 1996. Creutzfeldt-Jacob disease in Oman: report of two cases. *J Neurol Sci* 142: 148–150.

52. Carolan DJ, Wells GA, Wilesmith JW, 1990. BSE in Oman (letter). *Vet Rec* 126: 92.
53. Kimberlin RH, Wilesmith JW, 1994. Bovine spongiform encephalopathy. Epidemiology, low dose exposure and risks. *Ann NY Acad Sci* 724: 210–220.
54. Wills RG, Ironside JW, Zeidler M, Cousens SN, Estibeirok K, Alperovitch A, Poser S, Pocchiari M, Hofman A, Smith PG, 1996. A new variant of Creutzfeldt-Jakob disease in the UK. *Lancet* 347: 921–925.
55. Devi KRL, 1987. Mycetoma; a study of 17 cases. *Med Newsletter Oman* 3: 19–24.
56. Mahzoon S, Anbar A, 1990. Cranial and intracranial mycetoma due to *Streptomyces somaliensis*. *Emirates Med J* 8: 153–158.
57. Buhl MR, Joseph TP, Snelling BE, Buhl L, 1992. Temperofacial zygomycosis in a pregnant woman. *Infection* 20: 230–232.
58. Roberts DM, 1996. Circadian flight activity of Arabian sandflies (Diptera: Psychodidae) using a vehicle-mounted net. *Bull Entomol Res* 86: 61–66.
59. Belazzoug D, 1988. Visceral leishmaniasis in North Africa and the Middle East. *Postgrad Doct Middle East* 11: 324–330.
60. Roberts DM, 1994. Arabian sandflies (Diptera: Psychodidae) prefer the hottest nights? *Med Vet Entomol* 9: 194–198.
61. Scrimgeour EM, Windsor JJ, Shetty MK, Banodkar DD, Lambson B, Barker DC, Idris MA, McCann SHE, Al-Suwaid AR, 1999. *Leishmania tropica* as a probable cause of cutaneous leishmaniasis in Oman, in a Pakistani resident: case report. *Trans R Soc Trop Med Hyg* 93: 233–234.
62. John KI, 1986. Kala azar in Oman. *Med Newsletter Oman* 3: 22–30.
63. Padmanabhan A, Nair R, 1995. Leishmaniasis in North Sharqiya region. *Oman Med J* 12: 11–12.
64. George L, Gunwardana SS, 1994. Visceral leishmaniasis in the Dhofar region of Oman. *Oman Med J* 11: 5–6.
65. Scrimgeour EM, Barker DC, Al-Waily A, Idris M, Lambson B, Nirmala V, Windsor JJ, 1998. First identification of a *Leishmania* species causing visceral leishmaniasis in the Sultanate of Oman, in a patient with AIDS. *Trans R Soc Trop Med Hyg* 92: 356–357.
66. Aysa MH, Varghese M, Venkataramani K, Deshmokh M, Khan PIA, Al-Shafae MA, 1995. Sensitivity of *Plasmodium falciparum* malaria to chloroquine + primaquine and quinine + sulfadoxine/pyrimethamine. *Oman Med J* 11: 7–13.
67. Buhl P, 1995. Malaria in Oman: the emergence of chloroquine-resistance. *Emirates Med J* 13: 56–59.
68. Sheth M, Prabhakar NA, Marhuby H, 1996. Chloroquine-resistant severe falciparum malaria. *Oman Med J* 12: 55–57.
69. Dar FK, Bayoumi R, Al-Karmi T, Shalabi A, Beidas F, Hussein MM, 1993. Status of imported malaria in a control zone of the United Arab Emirates bordering an area of unstable malaria. *Trans R Soc Trop Med Hyg* 87: 617–619.
70. White JM, Christie BS, Nam O, Daar A, 1993. Frequency and clinical significance of erythrocyte genetic abnormalities in Omanis. *J Med Genet* 30: 396–400.
71. Rajab A, Patton MA, 1997. Major factors determining the frequencies of haemoglobinopathy in Oman (letter). *Am J Med Genet* 71: 240–242.
72. Idris MA, Ruppel A, 1994. Prevalence of IgG antibodies against *Toxoplasma gondii* in human sera from Dhofar, Oman. *Ann Trop Med Parasitol* 88: 89–91.
73. Vaid AK, Rizk K, 1988. Pelvic hydatid cyst. *Med Newsletter Oman* 5: 43–45.
74. Bhuyan BC, Freeman NV, 1994. Primary costal echinococcosis: a case report. *Oman Med J* 10: 47–48.
75. Crosskey RW, Buttiker W, 1988. First records of black flies from Oman and Dubai (Diptera: Simuliidae). *J Oman Studies (Special Report No. 3)*: 373–375.
76. Crosskey RW, Büttiker W, Roberts DM, 1994. Further data on blackflies (Diptera: Simuliidae) of the Arabian Peninsula, including description of a new species of the *Simulium* subgenus *Wilhelmia* from the Sultanate of Oman. *Fauna Saudi Arabia* 14: 137–144.
77. Idris MA, Ruppel A, Shaban MAA, Shandi MS, 1992. Hookworms and other human intestinal parasites in Dhofar. *Oman Med J* 9: 5–10.
78. Idris MA, Ruppel A, De Careri I, Shaban MA, Al-Awfy SA, Jayawardene CR, Savioli L, 1993. High prevalence and intensity of hookworm infection in Dhofar Governorate, Oman. *Ann Trop Med Parasitol* 87: 421–424.
79. Anonymous, 1995. *Community Health Dis Surveill Newsletter, Ministry of Health, Oman* 4: 1–4.
80. Florendo ER, 1989. A study of the prevalence of human intestinal parasites found in Khasab, Musandem Province. *Med Newsletter Oman* 6: 39–49.
81. Idris MA, Al-Awfy SAM, 1991. A survey of intestinal parasitic infections among school children in Muscat, Sultanate of Oman. *Med Newsletter Oman* 7: 16–18.
82. Idris MA, Al-Awfy SAM, 1991. Intestinal parasitic infections among school children (9–14 years old) in Nizwa, Sultanate of Oman. *Med Newsletter Oman* 7: 8–10.
83. Florendo ER, 1997. Pathogenic human intestinal parasites prevalent in Sur, South Sharqiya region: a six-year study. *Oman Med J* 13: 43–51.
84. Al-Shishtawy MM, Nanay AM, 1998. Intestinal parasitic infections, anaemia and underweight among 6-years old school children in Al Hamra Wilyat. *Oman Med J* 14: 14–19.
85. Idris MA, Al-Awfy SAM, 1990. Parasitic infections in a pre-screening of food handlers in the Sultanate of Oman. *Med Newsletter Oman* 6: 20–23.
86. Rao KD, 1996. Cutaneous larva migrans: a clinical study. *Oman Med J* 12: 22–27.
87. Shaban MMA, 1995. Role of organisational cooperation in schistosomiasis eradication in Dhofar Governorate. *Oman Med J* 12: 17–19.
88. Idris MA, Ruppel A, Numrich P, Eschilbeck A, Shaban MA, Diesfeld HJ, 1994. Schistosomiasis in the southern region of Oman: vector snails and serological identification of patients in several locations. *J Trop Med Hyg* 97: 205–210.
89. Huseinbhoj S, Zubaidi G, 1990. Two years of experience of sclerotherapy at the Royal Hospital. *Med Newsletter Oman* 7: 6–9.
90. Spradbery JP, Khanfar KA, Harpham D, 1992. Myiasis in the Sultanate of Oman. *Vet Rec* 131: 76–77.