Recent Trends in Human Brucellosis in Israel

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ABSTRACT: **Background:** The majority of human brucellosis cases in Israel are caused by the ingestion of unpasteurized dairy foods produced from unlicensed family-owned flocks whose products are sold door-to-door at low prices. Exposure to infected farm animals is another major cause of infection.

Objectives: To determine, by examining recent incidence data and brucellosis control programs, whether a reduction in the incidence of human brucellosis in Israel can be sustained.

Methods: Case information is reported to the Health Ministry and national data are compiled and analyzed by the Division of Epidemiology. The current study focuses on data from 1998 through 2009 and discusses several of the major prevention and health education programs that have been implemented.

Results: An incidence decline of almost 70% during the period 1998–2002 was followed by a return to previously existing levels, although the incidence has remained consistently lower than in past decades. The disease is mostly limited to certain sectors of the rural Arab population. In 2009 the incidence rate per 100,000 population was 7.0 among Arabs compared with 0.2 among Jews. Between 1998 and 2009, 63% of cases were from the Beer Sheva and Acre health districts, which together comprise 15.5% of the Israeli population. Control programs – including efforts to combat brucellosis in animals and to discourage the sale of unpasteurized homemade dairy products – have met with partial success.

Conclusions: Without routine vaccination of all family-owned flocks, more effective restraints on the market for unpasteurized dairy foods and improved regional cooperation, human brucellosis will continue to be a contained, but persistent, health problem in Israel due to cultural behavior, socioeconomic factors, and the regional political environment.

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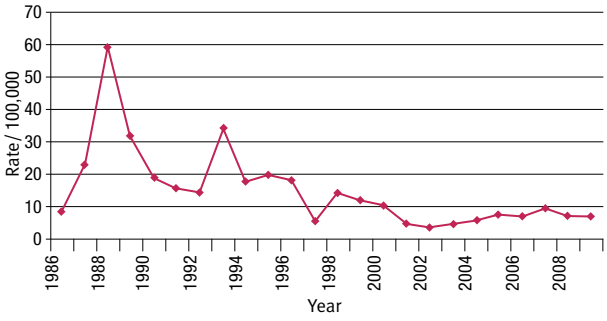
KEY WORDS: human brucellosis; small ruminants; unpasteurized dairy products; control programs

The majority of human brucellosis cases in Israel are caused by the ingestion of unpasteurized dairy products from infected animals. Occupational exposure to diseased farm animals has also been an important source of infection. A succession of disease control and prevention programs has had a positive impact on incidence rates, which have remained lower than in past decades. After a decline during the late 1990s and early 2000s, however, incidence levels began to rise again. This article discusses the recent epidemiology of human brucellosis in Israel with a focus on incidence from 1998 through 2009, the major disease-control strategies that were implemented in recent decades, and the factors that have made brucellosis a persistent public health problem among sectors of the rural Arab population.

MATERIALS AND METHODS

Human brucellosis in Israel has been notifiable by law since 1951. New cases are reported to the Health Ministry's district offices, and national data are compiled and analyzed by the Ministry's Division of Epidemiology. In approximately half of the reported cases, information has been sufficient to enable the completion of epidemiological investigations. As is common with passive surveillance systems, the extent of under-diagnosis and under-reporting is unknown. Because there have been no recent changes in reporting methods or focused efforts to improve notification, incidence data are deemed indicative of actual epidemiological trends. Case definition is based on appropriate clinical description, with either laboratory confirmation and/or epidemiological linkage to a laboratory-confirmed case. From 1998 to 2009, 64% of reported cases were corroborated serologically (by enzyme-linked immunosorbent assay) or by culture. Test results are confirmed by the national reference laboratory in the Kimron Veterinary Institute at Beit Dagan. Since the mid-1980s, *Brucella melitensis* has been the only identified causative agent of brucellosis in Israel.

Figure 1. Human brucellosis in Israel's Arab population, 1986–2009



RESULTS

Since the mid-1980s and early 1990s, when annual incidence rates per 100,000 rose to levels as high as 11 cases – and when rates in the Arab population were as high as 60 cases per 100,000 [Figure 1] – human brucellosis appears to have been contained in Israel. However, after the incidence declined between 1998 and 2002 by nearly 70%, from 181 to 56 cases annually, it began rising again and by 2007 had returned to the 1998 levels. In 2008 and 2009 the incidence was lower than in 2007 ($P = 0.003$) but higher than the annual average for the 1998–2006 period ($P = 0.0001$). The mild incidence decline after 2007 included a decrease of 39 reported cases due to ingestion of contaminated food in 2008, and a decrease of 28 reported cases due to contact with infected animals in 2009.

During the 12-year period 1998 to 2009 there were 1511 reported cases of human brucellosis in Israel. Forty-three percent of these cases resulted in hospitalization; there were no fatalities. Among the cases where the source of exposure was known, 66% were caused by ingesting contaminated food products and 34% resulted from exposure to infected farm animals. In 72% of reported cases the source of infection was not identified, but for those cases where the source of infection was known there was no significant difference in the rates of cases linked to contaminated food products versus animal contact over the 12-year period ($P = 0.15$). There were two cases of probable sexual transmission of *Brucella* from husband to wife [1] but no indications of other modes of transmission [2,3], although 22% of investigated cases were reported to be of unknown origin. As is common with zoonotic diseases in which occupational exposure is a factor, the incidence of human brucellosis was significantly higher among males (58%) than females (42%) ($P < 0.0001$). In three-fourths of the cases throughout the period the onset of illness occurred during the spring or summer months, but there was a variation in the annual spring/summer proportions ranging between 62% and 82% ($P = 0.017$).

In 2009 the incidence rate per 100,000 population was 7.0 among Arabs versus 0.2 among Jews, and from 1998 to 2009 the incidence rate was much higher in the Arab population than in the Jewish population for each age group. The highest rate among Arabs was in 10 to 14 year olds, and among Jews the highest rate was in those 65 and over [Table 1]

Table 1. Incidence rates per 100,000 by age and population group, 1998–2009 (with 95% confidence intervals)

Age group (yrs)	Total	Arabs	Jews
0–9	2.1 (1.8, 2.3)	6.5 (5.8, 7.2)	0.1 (0.0, 0.1)
10–14	3.2 (2.8, 3.7)	10.7 (9.4,12.3)	0.2 (0.1, 0.4)
15–44	1.8 (1.7, 1.9)	6.5 (5.9, 7.0)	0.3 (0.2, 0.3)
45–64	1.5 (1.3, 1.8)	8.4 (7.3, 9.7)	0.3 (0.2, 0.4)
65 +	0.8 (0.6, 1.0)	5.5 (3.9, 7.5)	0.3 (0.2, 0.5)
Total	1.9 (1.8, 2.0)	7.3 (6.9, 7.7)	0.2 (0.2, 0.3)

Regionally, incidence rates were highest in the Beer Sheva health district in the south (which encompasses the Negev desert area) primarily among Bedouins, a semi-nomadic people; and in the Northern health district, principally in rural portions of the Acre subdistrict. In the 1998–2009 period 63% of human brucellosis cases in Israel came from these two areas – 38% from Beer Sheva and 25% from Acre. (The two areas comprise 8% and 7.5%, respectively, of the total Israeli population [4].) Since the incidence rate for human brucellosis is so much higher among Arabs than among Jews we adjusted for population groups, and the adjusted incidence rates in these two areas were significantly higher than in the rest of the country ($P < 0.0001$). Recent data have shown that there have been no new foci of infection and that existing areas of infection have continued to be the source of new cases.

DISCUSSION

As in the past, human brucellosis among Israelis during the 12-year period was concentrated within segments of the Arab population, where the disease has traditionally been considered endemic [5]. From 1998 to 2009, when Arabs constituted approximately 20% of the total population [4], between 85% and 95% of human brucellosis cases occurred in this sector. Grushka [6] suggested that there is a high frequency of subclinical infection that leads to acquired immunity among Arabs. But the duration of immunity after infection is unclear [7], and infection from *B. melitensis* can result in relapse [8]. Human brucellosis in Israel continues to be a rural disease; only sporadic cases were reported in urban areas.

Infection occurs for reasons involving both occupational and dietary sources of exposure. Family-owned flocks of small ruminants (sheep and goats) are often unlicensed and not vaccinated, and sick animals transmit the infection to the humans who tend them. Also, a door-to-door market exists for the homemade unpasteurized dairy foods derived

from the produce of these flocks, which is the source of most human brucellosis cases in Israel [6,9,10].

The seasonal distribution of human brucellosis incidence, which in Israel is highest from April through September, is explained by the lactation period in dairy sheep and goats. Among small family-owned flocks in Israel, parturition occurs mainly from December through March and is followed in the spring and summer months by the production of milk and other dairy products (mainly soft cheese and yoghurt). The production of these homemade dairy products coincides with the peak brucellosis incidence and continues until the end of the milking season in August and September. Parturition, abortion and lactation commonly determine the seasonality of human brucellosis, and in most climates case incidence is highest in the spring and summer months [11].

The literature on human brucellosis in Israel and the Middle East has often focused, appropriately, on the consumption of unpasteurized dairy products as the predominant mode of exposure [5,9,12], but occupational exposure to infected farm animals is also an important cause of infection. In Israel, during the period 1998–2009, of the 63% of cases that were investigated, 52% were food-related, 22% were from unknown sources, and 26% were caused by exposure to infected animals. This occupational source of infection may help explain the higher age-group incidence rate that has prevailed in the 10 to 14 year old cohort in the Arab sector. Although reliable data on the subject are unavailable, Israeli officials involved with brucellosis control have observed that in certain rural subgroups, children at this age commonly help their families with the care of domestic animals, performing routine tasks that would significantly increase their chance of exposure to any infection that might be present.

Controlling brucellosis among animals is essentially the task of the Agriculture Ministry's Veterinary Services division. *B. abortus* has been absent from dairy cattle in Israel since 1984 and from beef cattle since 1985, when the Veterinary Services completed a 20 year disease eradication program among cattle through the test and slaughter method. But the disease continued in Israel due to the prevalence of *B. melitensis* in non-immunized small ruminants and occasionally in exposed cattle [13]. Following the high rates of human brucellosis that occurred in the late 1980s and the early 1990s, the Veterinary Services sought to control the spread of the disease in small ruminants. In a project that included mass testing, more than 30,000 sheep and goats – those infected, suspected of infection, or exposed – were slaughtered and their owners were compensated. This program, sometimes entailing the mass slaughter of entire flocks, was discontinued in 1998 due to economic constraints. Since then, efforts to control the disease among small ruminants have focused mainly on the mass vaccination of young animals with the live attenuated ocular REV-1 vaccine. Although this has contributed to a reduction in animal infection [14], vaccination without a test and slaughter program will not fully eradicate the disease in animals.

The Ministry of Health is responsible for the regulation of food products but has found it problematic to control the production and door-to-door sale of unpasteurized dairy foods, which is common practice in some sectors of the rural Arab population. In countries where markets exist for homemade food products derived from small ruminants, such regulation is notoriously difficult [11]. In Israel many case reports contain incomplete information and cannot be used in epidemiological investigations because, aside from faulty memory, there is often a reluctance to reveal the existence of homemade dairy produce obtained through the local underground economy.

There have been some successful outreach campaigns that have focused both on inoculating animals and on raising awareness of the health risks of ingesting unpasteurized dairy foods. For instance, at the beginning of 1994, following a particularly high incidence of human brucellosis in the Arab town of Taibe, the Health Ministry and the Community Pediatric Center of Taibe, in cooperation with the District Veterinary Office, established a community-based brucellosis control program. It included an intensive public health education campaign and the periodic examination and vaccination of sheep and goats. Disease incidence in Taibe declined sharply, from 175 cases per 100,000 in 1993 to 10 cases or less per 100,000 over the next 3 years [15]. Since 2001 the Health Ministry has increased its education outreach to groups at high risk, supplementing written material with oral presentations to audiences unreceptive to written information. Public health education programs stress the importance of the systematic vaccination of animals and the purchase of pasteurized dairy products from licensed producers.

More recently, prevention and health education programs have been implemented where the need presented and where the local leadership could facilitate community cooperation. From 2007 through 2009 a program was implemented in Rahat in the Beer Sheva district. The town has grown to be the country's largest Bedouin settlement, its population having made a transition from a nomadic desert lifestyle. The program was marketed as a means of "maintaining good health and improving it when moving to a permanent settlement," and its focus on health education was supplemented with brucellosis prevention initiatives. In 2009 a brucellosis prevention program was implemented for the Arab population of Lod in central Israel. The program featured the participation of key individuals in the community, a conference on brucellosis prevention techniques, and the provision of personal counseling to extended families. In 2010 a brucellosis prevention and health education program was implemented in Beit Zarzir, in the Afula subdistrict in the Lower Galilee. The program involves community leaders and residents of villages throughout the surrounding

area, and focuses on herd immunization and on the hygienic production of dairy foods.

But despite a range of such programs, human brucellosis remains a limited, though persistent, public health problem in some rural Arab communities and, as noted above, the foci of infection have remained stable over the years. Targeted health education efforts urging both the vaccination of animals and the pasteurization of dairy foods have sometimes failed to overcome the economic attractions of non-compliance. Small flock owners avoid the costs of registering and inoculating their animals and sell their unpasteurized food products at low prices via the door-to-door market. The problem is exacerbated by the smuggling into Israel of unlicensed infected animals from the Palestinian Authority, where veterinary laws are erratically enforced. In view of these factors, recent year-to-year variations in incidence are not at all surprising, despite the fact that the disease appears to be essentially under control. With incidence at generally low levels, if just two or three infected animals are added to small family-owned local flocks and their dairy produce is sold in several nearby villages, a significant percentage increase in human brucellosis cases will be the likely result.

CONCLUSION

Israel has achieved a marked reduction in human brucellosis compared with historical incidence levels, in contrast to other countries in the region where the problem has stagnated or worsened [16]. Nevertheless, the data from 1998 to 2009 indicate that the disease remains an ongoing, albeit contained, public health problem in some portions of the rural Arab population. New efforts to ensure herd immunization – modeled on selected programs that have functioned successfully in targeted areas during recent years – should focus especially on small unlicensed flocks and smuggled animals. To make these efforts feasible additional enforcement programs might be necessary.

Since no vaccine currently exists for human brucellosis, public health officials should aim at immunizing herds and flocks and minimizing human exposure to infected animals and their dairy products. In Israel, more effective control of human brucellosis will depend on overcoming difficulties posed by entrenched cultural behavior, economic expediency, and the regional political environment. Improved regional cooperation in particular – both in health education and in enforcement efforts – will remain a key priority.

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"I'm a slow walker, but I never walk back"

Abraham Lincoln (1809-1865), 16th president of the United States who led the country through a military and moral crisis, the American Civil War, ended slavery and modernized the economy

"Until he extends his circle of compassion to include all living things, man will not himself find peace"

Albert Schweitzer (1975-1965), Franco-German physician, theologian, organist, philosopher, and medical missionary who founded the Schweitzer Hospital for lepers in Lambarene (today Gabon) in West Africa. He won the Nobel Peace Prize in 1952 for his "Reverence for Life" philosophy