Seroprevalence and economic impact of eradicating zoonotic brucellosis in Malaysia : A case study of Melaka state of Malaysia

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Abstract

Aim: A study was carried out to elucidate the seroprevalence of brucellosis in small and large ruminants in Melaka state of Malaysia and estimate the economic impact of zoonotic brucellosis in Malaysia using available data.

Materials and Methods: Data was collected during culling exercises by the Department of Veterinary Services of Malaysia as a result of surveillance using CFT as a confirmatory test for brucellosis.

Results: The average compensation in 4 years per district of Melaka state was RM12248.875(USD 3874.75) and the total compensation paid in 4 years was RM146,986.50(USD45,865.24) with year 2009 having the highest compensation amount of RM58,914.40(USD18,383.48). The estimated total economic losses due to brucellosis stands at about RM200,607,946.80 (USD 62,926,060.84) in a year for the whole of Malaysia. The odds of brucellosis in large ruminants (cattle/buffaloes) was significantly 1.6 times more compared to small ruminants (goats/sheep) in Melaka ($P<0.0001$; C.I. 1.41, 1.81) during the 4 year period. Average 4 year total seroprevalence for brucellosis in Melaka was significantly higher in 2010 than previous years with a rate of 7.78 % ($P<0.05$; Phi=0.025). Mass importation of livestock may be contributing in complicating the brucellosis situation.

Conclusion: Considering the economic importance of brucellosis and its epidemiological importance to public health more needs to be done to ensure successful eradication of the zoonotic disease in Malaysia.

Key words: Brucellosis, Brucella, Economic Impact, Seroprevalence, Zoonotic

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Introduction

Brucellosis is a bacterial zoonotic infection caused by members of the *Brucella* genus. Currently there are eight known species in terrestrial animals and 2 in marine animals. The species in terrestrial animals include: *B. abortus*, *B.melitensis*, *B. suis*, *B. neotomae*, *B. canis*, *B. ovis*, *B. microti* and *B. inopinata* [1,2,3,4]. The species in marine mammals include: *B. ceti* and *B. pinnipedialis* [5]. The most common domestic animals affected by brucellosis are Cattle, Buffaloes, Goats, Sheep and Pigs [4]. The economic impact of brucellosis is enormous and varies from country to country and from region to region. In Latin America annual losses are estimated at $600 million and in the U.S.A. the cost of abortion and reduced milk production in 1952 alone were put at $400 million [4,6].

Brucellosis is still endemic in most parts of the world in both humans and animals except a few countries like Australia, Canada, Cyprus, Finland, Denmark, The Netherlands, United Kingdom, Norway, Sweden and New Zealand where bovine brucellosis has been eradicated [4]. It has been reported in different countries in Asia including Pakistan [7], Sri Lanka [8], India [9], China[10], Mongolia [11] and other parts of Asia [12].There are about 500,000 new human cases of brucellosis reported annually worldwide making it the commonest zoonosis [4].

In Malaysia, Brucella was first isolated in 1950 and the government embarked upon an eradication program for brucellosis in Cattle, Buffaloes, Goats and Sheep since 1978 with full implementation and compensation scheme taking off in 1982 [13,14] Losses usually arise from the following: loss of foetus, decreased milk yield, interference with breeding system, infertility, joint infections, weakling offsprings, condemnation of infected animals, threat of reduced

Table-A. Compensation for Cattle and Buffaloes

Species	Category	Partial Compensation(RM)	Full Compensation(RM)	Means of Identification
Cattle	calves	530(USD166.25)	800(USD250.94)	No permanent incisors
	adult beef cattle	800 (USD250.94)	1600(USD501.88)	
	adult dairy cattle	1000(USD313.68)	2000(USD627.35)	
	pedigree	2000(USD627.35)	4000(USD1254.71)	Breed records
Buffaloes	calves	530(USD166.25)	800(USD250.94)	No permanent incisors
	adult	1000(USD313.68)	2000(USD627.35)	
	pedigree	2500(USD784.19)	5000(USD1568.38)	Breed records

Source: Department of Veterinary Services, Malaysia

market access, disease in man, national administrative costs of control and eradication programmes. Administrative costs for attempted eradication of bovine brucellosis 26 years ago were estimated to have costed the Malaysian government $450,000 in a single year [15].

Malaysia has about 18,270 farms already entered into the official register as of 2010 and the register is still being updated and many thousands of unregistered farms, and the total estimated population of Livestock as of 2010 is as follows: Buffaloes-126,478, Cattle-912,230, Goats-545,682, Sheep-134,408 and Swine-1,821,663 [16]. The average total seroprevalence of brucellosis in animals in Malaysia varies from 0.17% to 2.43% in goats [17] and 1.52% to 6.73% in Cattle and Buffaloes [18] in different states of the federation. Human brucellosis has also been reported in farmers, veterinary technical staff and other people who work closely with animals in Malaysia with seroprevalence ranging from 0 to 14.29% [17, 19].

Malaysia has eradication and stamping out policy for brucellosis which does not allow for vaccination of animals against brucellosis [20]. The eradication policy involves routine testing of ruminant livestock by the Department of Veterinary Services using various serological screening tests including Enzyme Linked Immuno-Sorbent Assay (ELISA), Rose Bengal Plate Test (RBPT) and the confirmatory Complement Fixation Test (CFT). All animals that test positive with the confirmatory CFT are culled and some measure of compensation is paid to the farmers affected [13, 17].

Melaka (a.ka. Malacca)(02°15'N and 102°15'E) is one of the smallest states in Malaysia with only 3 districts but is key to understanding Malaysia thereby earning the designation of historical state and the capital Melaka is called the historical city of Malaysia. It has a rich cultural diversity and a flourishing livestock industry. The human population is about 761000 out of the total population of Malaysia which is about 27,895000 [21].

This study was undertaken to elucidate the seroprevalence of brucellosis in Melaka state of Malaysia from year 2007 to 2010, the economic impact of the infection using Melaka (data for other states was not available) as a case study to estimate roughly the economic impact of this important zoonotic infection in Malaysia.

Materials and Methods

The Department of Veterinary Services of Malaysia carries out routine monitoring and surveillance by screening for brucellosis in Malaysia in different farms. About 10ml of blood was collected from the jugular veins for screening in anticoagulant bottles. The collected blood was tested for brucellosis at the Serology unit of the National Veterinary Research Institute, Ipoh, Malaysia using the confirmatory Complement Fixation Test (CFT) according to the method of Alton et al [22]. A total of 17,661 blood samples were taken from year 2007 to 2010 made up of 13,589 from small ruminants (goat and sheep) and 4,072 from large ruminants (buffaloes and cattle). Data generated was analysed using IBM SPSS version 19 and differences were considered significant at 95% confidence level [23]. Animals that were confirmed positive were culled in accordance with the eradication policy at the discretion and schedule of the Department of Veterinary Services. Positive Goats and Sheep were slaughtered and buried deep with lime in the ground and for positive Cattle and Buffaloes the offals were usually removed at slaughter and buried but the meat (muscles) are left at the discretion of the veterinary personnel. Compensation was later (period ranges from a few months to several months) paid to farmers at the official rate of RM5.60 (USD1.77) per kg for goats/sheep and for cattle/Buffaloes as shown in Table-A.

The online currency converter [24] was used for converting to United States dollars (USD) equivalents of the local currency the Malaysian Ringgit (RM). The average compensation amount for cattle and buffaloes was used for calculating for the total nationwide

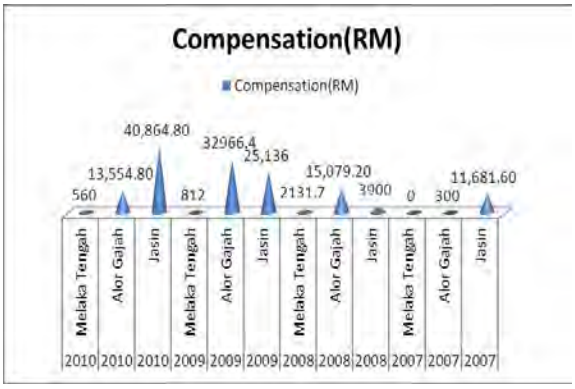

Figure-1: chart showing the amount of compensation already paid by government in the 3 districts of Melaka

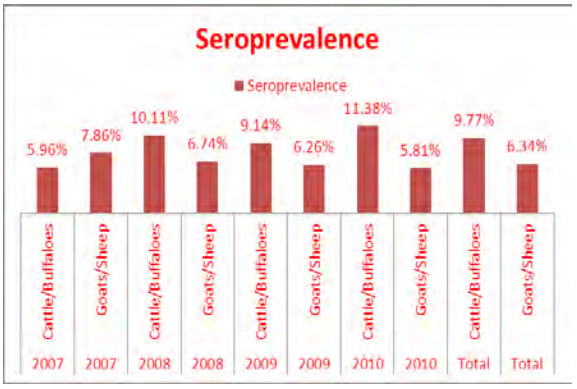

Figure-2: Seroprevalence rates for large and small ruminants in Melaka from 2007-2010

compensation. We estimated the given compensation averagely for all animals based on market trends, transport and inflation to be grossly about 60% of actual cost to the farmer for purchase. Some information were gathered from interviews and interactions with the local farmers and used in estimation. Since the weight of goats and sheep are highly variable depending on age, breed, sex and other features we fixed the average value as 30kg for the purpose of our economic impact calculations. National seroprevalence rate for brucellosis in goats was taken as 0.95% [25] and was used similarly for sheep to determine the number of goats and sheep that could be culled and compensated with the present population of sheep and goats in Malaysia. For national seroprevalence rate for bovine brucellosis, 5.0% was used for cattle and 1.6% for buffaloes [18]. The current available livestock population for 2010 (table 3) was used [16].

Results

Figure-1 shows the compensation already paid out to farmers of positive farms after confirmation of brucellosis and culling of the animals had taken place in Melaka state of Malaysia with three administrative districts. The average compensation in 4 years per district of Melaka state is RM12248.875 (USD 3874.75) and the total compensation paid in 4 years was RM146,986.50(USD45,865.24) with year 2009 having the highest compensation amount of RM 58,914.40 (USD18,383.48).

The large ruminants (cattle and buffaloes) had a significantly higher seroprevalence rate than the small ruminants (goats and sheep) during the 4 year period (figure2 and table 1). Average 4 year total seroprevalence for brucellosis in Melaka was significantly higher in 2010 with 7.78 % (figure-3 and table-2).

Table 1: Species Status Cross tabulation

Species		Status		Total
		Negative	Positive	
CATTLE/ BUFFALOES	Count	398	3674	4072
	Expected Count	290.3	3781.7	4072.0
	% within SPECIES	9.8%	90.2%	100.0%
	% within STATUS	31.6%	22.4%	23.1%
	% of Total	2.3%	20.8%	23.1%
GOATS/SHEEP	Count	861	12728	13589
	Expected Count	968.7	12620.3	13589.0
	% within SPECIES	6.3%	93.7%	100.0%
	% within STATUS	68.4%	77.6%	76.9%
	% of Total	4.9%	72.1%	76.9%
Total	Count	1259	16402	17661
	Expected Count	1259.0	16402.0	17661.0
	% within SPECIES	7.1%	92.9%	100.0%
	% within STATUS	100.0%	100.0%	100.0%
	% of Total	7.1%	92.9%	100.0%

(Odds Ratio for Species: Cattle/Buffaloes/Goats/Sheep=1.60; C.I. 1.41, 1.81; Phi=0.056) P<0.0001(Disease status is significantly dependent on species but relationship is negligible)

Table-2: Year Status Cross tabulation

Year		Status		Total
		Negative	Positive	
2007	Count	95	1321	1416
	Expected Count	100.9	1315.1	1416.0
	% within Year	6.7%	93.3%	100.0%
	% within Status	7.5%	8.1%	8.0%
	% of Total	.5%	7.5%	8.0%
2008	Count	353	4318	4671
	Expected Count	333.0	4338.0	4671.0
	% within Year	7.6%	92.4%	100.0%
	% within Status	28.0%	26.3%	26.4%
	% of Total	2.0%	24.4%	26.4%
2009	Count	400	5892	6292
	Expected Count	448.5	5843.5	6292.0
	% within Year	6.4%	93.6%	100.0%
	% within Status	31.8%	35.9%	35.6%
	% of Total	2.3%	33.4%	35.6%
2010	Count	411	4871	5282
	Expected Count	376.5	4905.5	5282.0
	% within Year	7.8%	92.2%	100.0%
	% within Status	32.6%	29.7%	29.9%
	% of Total	2.3%	27.6%	29.9%
Total	Count	1259	16402	17661
	Expected Count	1259.0	16402.0	17661.0
	% within Year	7.1%	92.9%	100.0%
	% within Status	100.0%	100.0%	100.0%
	% of Total	7.1%	92.9%	100.0%

Table-3: Malaysia: Livestock Population, 2005-2010

Livestock Type	2005	2006	2007	2008	2009	2010P
Buffalo						
Peninsula Malaysia	79,495	79,044	80,931	79,661	74,979	74,102
Sabah	44,500	40,929	42,157	43,422	44,200	44,642
Sarawak	9,237	8,965	7,687	8,146	7,973 P	7,734
Total	133,232	128,938	130,775	131,229	127,152	126,478
Cattle						
Peninsula Malaysia	723,771	716,390	772,323	779,877	786,317	802,782
Sabah	45,170	87,122	89,085	89,825 R	93,231	95,096
Sarawak	12,375	12,918	11,919	12,964	13,983 P	14,352
Total	781,316	816,430	873,327	882,666	893,531	912,230
Goat						
Peninsula Malaysia	247,460	293,871	373,319	419,720	452,467	483,268
Sabah	30,250	44,410	45,742	45,742	47,110	47,779
Sarawak	9,960	11,146	9,202	12,018	14,656 P	14,635
Total	287,670	349,427	428,263	477,480	514,233	545,682
Sheep						
Peninsula Malaysia	109,898	111,103	122,106	125,931	130,723	129,359
Sabah	1,890	1,950	1,970	1,989	2,009	2,029
Sarawak	4,134	3,334	1,912	3,338	3,553 P	3,020
Total	115,922	116,387	125,988	131,258	136,285	134,408
Swine						
Peninsula Malaysia	1,528,942	1,514,170	1,441,036	1,407,195	1,401,190	1,404,168
Sabah	120,000	91,091	82,200	105,075	83,972	77,926
Sarawak	386,705	423,858	496,881	216,037	346,146	P339,569
Total	2,035,647	2,029,119	2,020,117	1,728,307	1,831,308	1,821,663

P: Provisional, R : Revised Source: Department of Veterinary Services of Malaysia

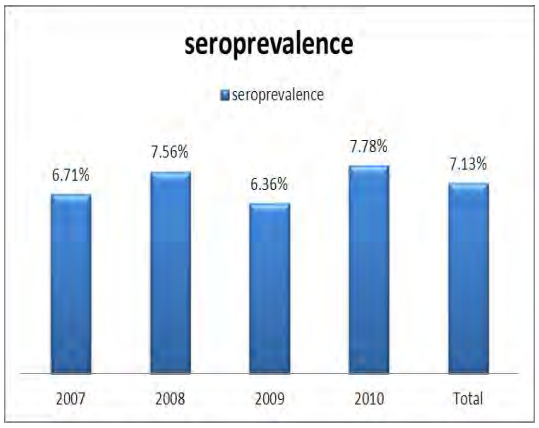

Figure-3: Yearly total Seroprevalence rates pattern for Melaka state, Malaysia from 2007-2010

National estimate: Average compensation amount for 1 cattle was estimated to be RM1, 591.25 and this multiplied by the total number of cattle to be culled using 5.0% national seroprevalence rate as of the population of cattle in 2010 (table 3) will be RM 72, 579,299.38.

Average compensation for 1 buffalo was RM 1,971.67 and computing for the total population of buffaloes with the national prevalence rate of 5.0% will be RM3, 989,966.05.

Average compensation for the goats at approved RM5.60 per kg, computing for the national seroprevalence rate of 0.95% will be RM870, 908.47.

Average compensation for sheep at approved RM5.60 per kg, computing for the national seroprevalence rate of 0.95% will be RM 214,515.17.

Total compensation expenditure by government on farmers will be: RM 72, 579,299.38(cattle) + RM3, 989,966.05(buffaloes) + RM870, 908.47(goats) + RM 214,515.17(sheep) = RM77,654,689.07 (USD24,358,475.16). This amount RM77,654,689.07 (USD24,358,475.16) covers averagely based on market values which are highly variable only about 60% of the original cost of purchase to farmers without adding the cost of production. That leaves out about 40% cost loss to farmers.

Calculating the 40% unpaid cost to farmers will be RM77, 654,689.07 × 0.4(40%) ÷ 0.6 (60%) = RM51, 769,792.71(USD16, 238,983.44).

Therefore, Compensation cost+left out compensation=actual compensation for cost of purchase of livestock. This will be: RM77,654,689.07 + RM 51,769,792.71= RM 129,424,481.8 (money actually spend by farmers to purchase animals).

Taking 5% of this as money spent on logistics and administration such as wages, allowances, transport, materials, laboratory costs, etc.by the eradication officers and allied committees: 5% of RM 129,424,481.8 will be=RM 6,471,224.09.

Based on calculations of cost of production for a typical farm we arrived at a production cost of approximately 50% of cost of purchase of the animal in a year:

Computing using the total cost of purchase of RM 129,424,481.8: 50% of RM 129,424,481.8 = RM64,712,240.90.

Total amount in a year therefore is: RM 129,424,481.8 + RM 6,471,224.09 + Rm64,712, 240.90=RM200,607,946.80 (USD 62,926,060.84).

This amount RM200,607,946.80 (USD 62, 926,060.84) represents approximately the total loss due to brucellosis in Malaysia not taking into account the economic impact if human health is endangered or there is a bioterrorist attack using *Brucella melitensis* which is estimated to cost $477.7 million per 100,000 persons exposed [26].

Discussion

The monetary compensation of farmers after culling is part of the test and slaughter policy to ameliorate the losses borne by farmers as a result of this policy which aims to eradicate brucellosis. The

compensation amount shown is not a perfect representation of the actual compensation as some farmers will have to wait for an indefinite period sometimes after verification before they are given their compensation. More money was spend on compensation in year 2009 inspite of the fact that year 2010 had the highest seroprevalence. Records (unpublished data) indicated that for the same year 2010 many positive animals were not yet culled and hence the farmers could not be compensated since the compensation record only contains farmers already compensated after verification. The year 2010 has the highest prevalence rate of 7.78% in Melaka may be due to the increase in number of animals imported into the country as that year also has the highest number of livestock (see table 3) imported into Malaysia in the continuous effort for years to improve and increase the genetic pool of livestock in Malaysia [14] many of which are from endemic countries which may contribute to the increase in prevalence of brucellosis [27]. The addition of new animals has also been identified as a risk factor for brucellosis in a previous study in Jordan [28].

The odds of brucellosis in large ruminants in our study was 1.6 times compared to the small ruminants. The disease status was significantly associated with the species of animals but the relationship was negligible using the Guilford's rule of thumb [29] and likewise the association with year. That large ruminants had a significantly higher seroprevalence than the small ruminants disagrees with the findings of El Sherbini *et al* [30] who found sheep had the highest prevalence among livestock in a study in Egypt but agrees with the findings of Omer *et al* [31] in Eritrea, who found husbandry systems have effect on the prevalence of brucellosis and large ruminants had higher prevalence than small ruminants. In another study in Zambia large ruminants were also found to have higher seroprevalence than small ruminants [32]. It is worth noting that most farmers keep goats and sheep along with large ruminants which increases the odds of testing seropositive for brucellosis among Cattle and Buffaloes 6.32 times [33]. The keeping of sheep in addition to goats has been identified as risk factor for brucellosis increasing the risk by upto 6 times compared to keeping only goats [34]. The control of the disease in humans will depend to a great extent on how much of it is controlled in livestock [35] and its presence in livestock in Malaysia raises serious public health concerns for Malaysia and the Asia Pacific region. Perhaps, instead of just applying the test and slaughter policy that is yet to eradicate brucellosis in Malaysia, the Egyptian 2 fold approach of test and slaughtering the positive animals and then vaccinating the livestock population [36] which is not being practiced in Malaysia may be a better approach.

With a GDP real growth rate of 7.2% [37] which is one of the best in Asia, Malaysia's economy would even be better without brucellosis and its potentials for greater losses to the economy. With over $62 million annually which is lost to brucellosis, a lot can be done to better the lot of Malaysians and improve the livestock and other sectors of the economy. The economic impact caused by colossal losses due to brucellosis all over Malaysia is a cause for more radical steps at eradicating the infection completely. The millions of dollars spend in compensation due to the disease will only be justified if it is completely eradicated. With the successful eradication of brucellosis money which would have been lost can be ploughed into the economy to develop the livestock industry more and ensure maximum food security for the nation and safe guard the health of the public. Strategic steps must aim at stopping all means of entry of the infection into the country especially from endemic countries when importing livestock in order to reap the fruits of the eradication policy.

Conclusion

About 30 years after the commencement of the eradication policy for brucellosis and the implementation of the compensation scheme, Malaysia is still endemic for brucellosis. The eradication policy needs to be reinforced with measures that will guard against all risk factors for brucellosis at all levels and farmers need to be more compensated for the total cost of animals lost or provided with full insurance schemes. Small ruminants seem to be more susceptible to brucellosis than the large ruminants but this needs further investigation and increasing the number of imported animals could increase the seroprevalence rate of brucellosis. Although eradication may be considered expensive but it is estimated that $7 is saved for every 1$ spend on eradication of brucellosis (Acha & Szyfres, 2003). Eradication may be costly but not eradicating is even costlier.

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Competing interests

Authors declare that they have no competing interests.

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