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Bluetongue disease in small ruminants in Palestine: Epidemiological study of the period 2005-2019

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Abstract: Small ruminant's livestock industry provides for a major source of livelihood for many people worldwide, particularly the rural poor in developing countries. Bluetongue (BT) is a reportable infectious non-contagious disease of the small ruminant that has a considerable socioeconomic importance in the small ruminants in Palestine. The objective of this study was to investigate the epidemiological analysis of Bluetongue disease within small ruminants in Palestine over 14 years 2005 – 2019. The study indicated that BT is enzootic in Palestine, reported started from 2009-2019. A total of 273 outbreaks, 1628 cases, and 351 deaths were reported. The average incidence rate was 5.5%, and the average mortality rate of 1.6%. The case fatality rate ranged from 0.0- 39.29 with an average of 20.2%. No vaccination practice was applied in Palestine. Temporal analysis obtained that BT is more endemic in the low-temperature season between September and December, with a higher peak in November, displaying `overwintering` of BTV in Palestine. At least five BTV serotypes (BTV-2, BTV-4, BTV-5, BTV-6, and BTV-8) were continuously present in Palestine. Multiple serotypes were recorded in the same outbreak period increases the risk for re-assortment of individual BTV gene segments. The appropriate data recording, improving owner awareness, use of the BTV, and a systematic disease monitoring program are required to control the spread of the disease.
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Keywords: Epidemiology; Bluetongue disease; Palestine; Serotypes.

Introduction

Small ruminants have great socioeconomic importance. A large proportion of the Palestinian population depends on small ruminants' livestock products as a source of income (Sinjilawie and Nori 2005). Bluetongue (BT, other names: Sore muzzle and Ovine catarrhal fever) is a World Organisation for Animal Health (OIE) reportable, infectious, non-contagious disease of the ruminants (Maclachlan 2011). The disease is a non-zoonotic insect-borne viral disease that affects ruminants mainly sheep, causing a great economic loss as a result of reducing the international trade, high morbidity, and mortality rates (Rushton and Lyons 2015, Rojas, Rodriguez-Martin et al. 2019). The clinical signs of the disease range from subclinical to a fatal outcome, depending on the animal species, the virus serotype, the nutritional and immune status of the affected animal, and the environmental conditions. The severity of the disease is mild to subclinical in goats, cattle, and wild ruminants. However, these animals can act as a reservoir for BTV circulation and genetic re-assortment (Van den Bergh, Coetzee et al. 2018).

BT is caused by bluetongue virus (BTV), which consists of double-stranded RNA (dsRNA), that belongs to the *Orbivirus* genus within the *Reoviridea* family (Roy 2008). The genome consists of ten segments (Seg1-Seg 10), encoding structural viral proteins VP3, VP7, and VP2 and VP5, respectively. Currently, BTV has been listed in 28 different serotypes distributed around the world based on Seg 2 sequence (Bumbarov, Golender et al. 2020). The virus is transmitted by a vector known as *Culicoides* biting midges (Sperlova and Zendulkova 2009) as well as transplacental transmission resulting in severe congenital malformations (van der Sluijs, de Smit et al. 2016).

The disease occurs worldwide, commonly located in the developing country particularly Asia, the Middle East, and Africa (Taylor, Sellers et al. 1985, Mogajane 2004, Maclachlan 2011), where veterinary services and resources are inadequate to control or eradicate. Information on the occurrence, prevalence, and serotype characterization of BT disease is available from many countries in which the disease has been reported. The pattern of BT disease in Palestine has not been investigated before. Therefore, the current study was performed to provide retrospectives of BT epidemiology in Palestine for 14 years. This information would be necessary to understand the disease dynamics, mortality, incidence, and temporal distribution and other factors responsible for the persistence of infection in Palestine. Also, it will help assess the risks, of the disease to formulate the appropriate preventative and reactive measures to decrease the infection or to eradicate the disease.

Methodology

BT annual and temporal trends

The quantitative data on BT outbreaks, cases, and deaths were collected for the period 2005 to 2019. Data were based on reports of the World Organization for Animal Health (http://www.oie.int/), submitted by Palestinian governmental veterinary services between 2005 to 2019.

Analysis

The present study considers the frequency of the outbreaks, incidence rate , mortality rate, and case fatality rate of BT diseases in each month of the year according to standard methods (Thrusfield, Christley et al. 2018). These epidemiological parameters were calculated according to the following formulae:

- Incidence rate = number of cases per year/ number of susceptible animals during the outbreaks in the same year X 100
- Mortality rate = number of deaths /number of susceptible animals during the outbreaks at the same year X100
- Case fatality rate = number of deaths /number of cases

Data analyses were performed using GraphPad Prism 5 software (GraphPad Software Inc., San Diego, US).

Results

Cumulative profiles

The retrospective data of Bluetongue disease for the past 14 years in Palestine are shown in table 1 included the following information:

- A total of 273 outbreaks, 1628 cases, and 351 deaths.
- The average incidence rate of 5.5%.
- The average mortality rate of 1.6%.
- The average case fatality rate of 20.2%.
- No vaccination history was recorded in Palestine.

No data for the BT was published in 2005-2008 from OIE.

BTV serotypes.

Outbreaks of bluetongue disease have occurred in Palestine in each year from 2009-2019. The following BTV serotypes were recorded: 2, 4, 5, 6, and 8 (Table 1). Multiple serotypes were recorded in 2013 (2, 4), 2015 (2, 4), and 2016 (2, 4, 5, 8). The serotypes in outbreaks in the years 2011, 2012, and 2018 were not determined.

BT Annual trends

The present study finding showed that outbreaks occurred from 2009-2019 (Figure 1), with the highest number occurring in 2012 (n=100), followed by 2013 (n=42). The lowest outbreaks number reported in 2015 (n=2) (Figure 1).

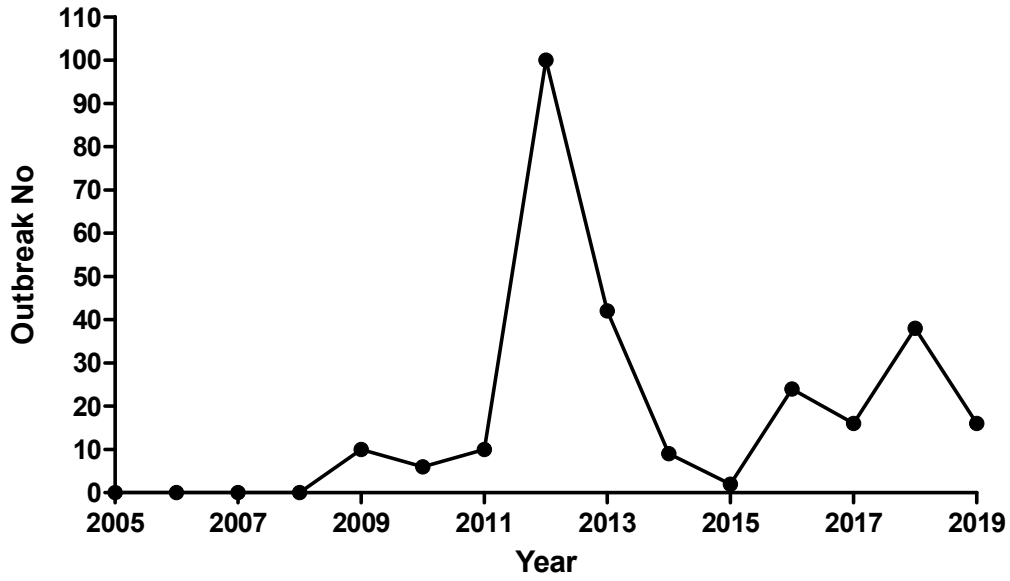

Figure 1: Numbers of BT outbreaks in sheep and goat in Palestine during 2005-2019.

The highest incidence rate was observed in 2019 (15.23 %), followed by 2010 (14.55%) and 2017 (10.77 %). The lowest incidence rate occurred in 2015 (0.05 %). The highest mortality rate was reported in 2013 (4.96%), followed by 2012 (3.94%). Upon the two outbreaks reported in 2015, there is no death (Table 1). The highest case fatality occurred in 2009 (39.29%) followed by 2017 (32.99%), and the lowest occurred in 2015.

Table 1: Annual statistics of BT in sheep and goat in Palestine (2005-2019).

Year	No. Outbreak	No. Susceptible	No. Cases	No. Deaths	Incidence rate (%)	Mortality rate (%)	Case Fatality (%)	Serotype
2005	NA	NA	NA	NA	NA	NA	NA	NA
2006	NA	NA	NA	NA	NA	NA	NA	NA
2007	NA	NA	NA	NA	NA	NA	NA	NA
2008	NA	NA	NA	NA	NA	NA	NA	NA
2009	10	402	28	11	6.97	2.74	39.29	8
2010	6	797	116	23	14.55	2.89	19.83	8
2011	10	1362	53	2	3.89	0.15	3.77	ND
2012	100	3970	262	79	6.60	1.99	30.15	ND
2013	42	4600	254	40	5.52	0.87	15.75	2,4
2014	9	330	17	6	5.15	1.82	35.29	2
2015	2	11003	5	0	0.05	0.00	0.00	2,4
2016	24	1958	140	28	7.15	1.43	20.00	2,4,5,8
2017	16	2731	294	97	10.77	3.55	32.99	6
2018	38	4038	297	53	7.36	1.31	17.85	ND
2019	16	1064	162	12	15.23	1.13	7.41	4

NA: Not available, ND: Not determined

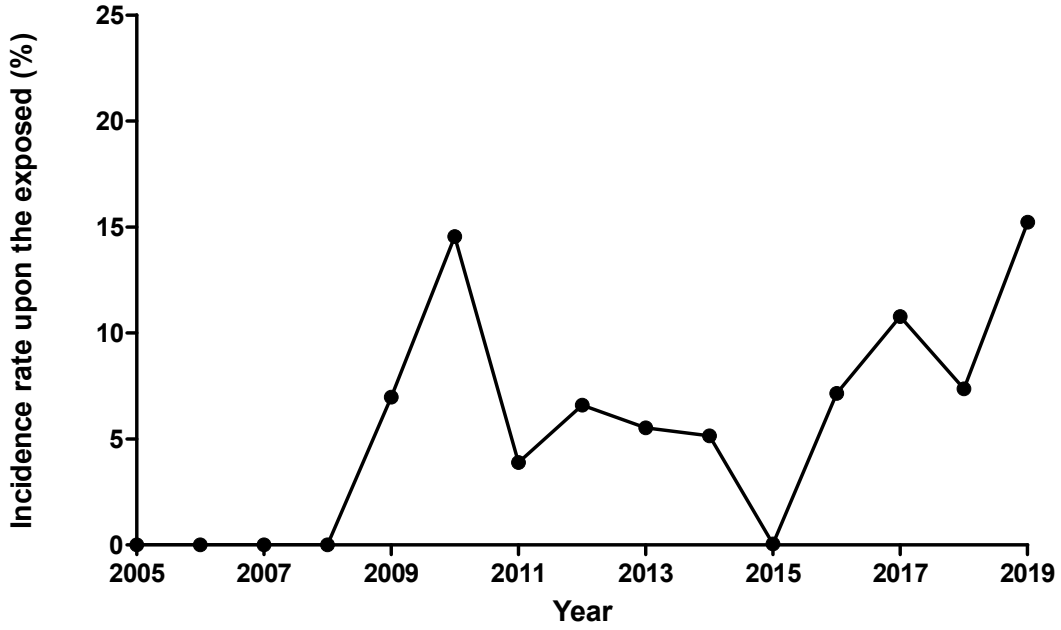

Figure 2: Incidence rate of BT upon the susceptible animals in Palestine (2005-2019)

Temporal distribution

Data for various parameters were collated by month for the period January 2005 to December 2019. During this period, the disease occurred in all months of the year, but the highest number of outbreaks occurred in November (see table 2, figure 3). Most of the reported outbreaks occurred in the autumn and winter seasons between September and December (see figure 3). The lowest outbreaks, lowest incidence, and mortality reported in the spring and summer season (May-June). The highest mortality and case fatality rate occurred in August. The disease trend tends to be more severe in April, September October, and November with the highest case fatality rate (Table 2).

Table 2: Seasonality of BT in Palestine (January 2009 to December 2019)

Month	No. Outbreak	No. Susceptible	No. Cases	No. Deaths	Mortality rate (%)	Case fatality (%)
Jan	16	1680	135	17	1.01	12.6
Feb	24	2739	135	17	0.62	12.6
Mar	5	240	23	23	9.58	100.0
Apr	5	615	51	5	0.81	9.8
May	1	100	9	0	0.00	0.0
Jun	5	297	31	4	1.35	12.9
Jul	3	598	109	25	4.18	22.9
Aug	6	872	128	48	5.50	37.5
Sep	29	2739	237	51	1.86	21.5
Oct	53	4441	338	88	1.98	26.0
Nov	80	5610	341	89	1.59	26.1
Dec	50	1328	127	15	1.13	11.8

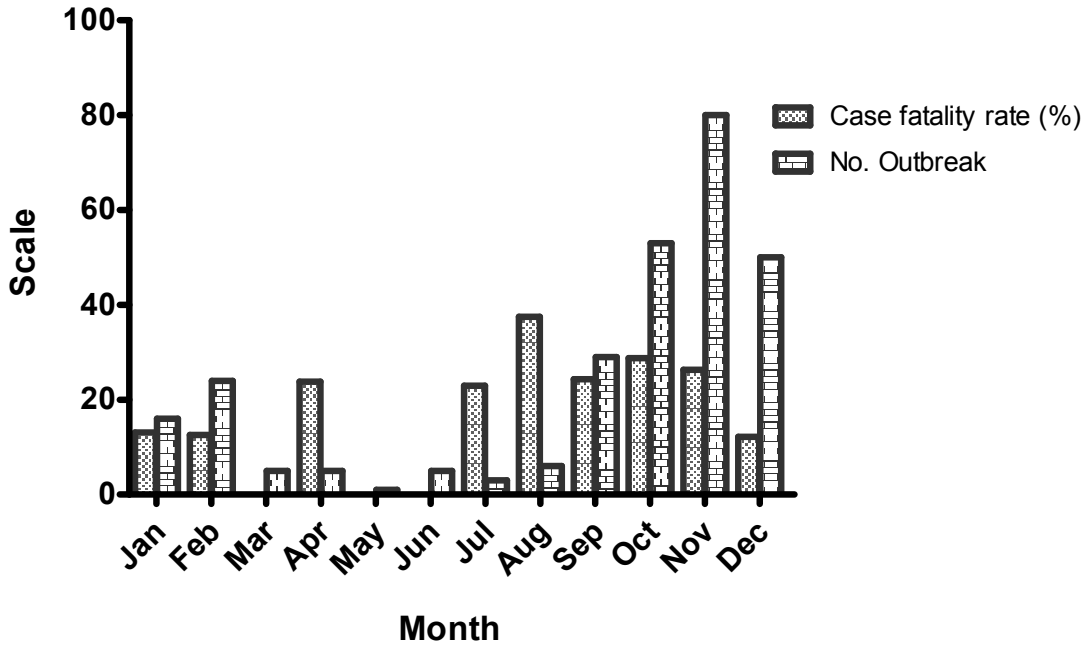

Figure 3: Seasonality of BT in sheep and goat in Palestine (January 2009 to December 2019)

Discussion

Bluetongue (BT) is a reportable infectious non-contagious disease of the small ruminant. The disease has socioeconomic importance in the small ruminants in Palestine. In the present study, the epidemiological characteristic of BT in Palestine was discussed and the circulating serotypes were mentioned for the first time.

BT was first observed in the country in 1944 (Shimshony 2004). Till 2009, data regarding the occurring of the disease and circulating serotypes in Palestine was not available. In 2009, numbers of outbreaks have occurred and documented, these documentations were based on the confirmation of the World Organization for Animal Health (OIE). Enzyme-linked immune assay (ELISA) and real-time reverse transcriptase-polymerase chain reaction (Real-Time RT-PCR) were used for diagnosis and serotype detection. During the investigated period, BT was enzootics in Palestine, the incidence rate ranged from 0.05-15.23%, mortality rate of 0.0-3.55%, and case fatality was 0.0-39.29%. The morbidity, mortality, and case-fatality rates recorded in Palestine during the present study are close to those in other countries (Conraths, Gethmann et al. 2009, Katsoulos, Giadinis et al. 2016). Certainly, other outbreaks, cases, and deaths, based on clinical observations were not accurately recorded due to

inadequate animal disease diagnosis, reporting, and surveillance systems.

In most years, only one serotype has been encountered in clinically affected sheep. However, this study showed the presence of multiple BTV infections in the same susceptible animals in the same year. The identification of multiple co-infecting (or co-circulating) BTV serotypes increases the likelihood of genome re-assortment, which could potentially lead to the formation of increased virulent strains (Brenner, Oura et al. 2010). BTV serotypes recorded in Palestine are: 2, 4, 5, 6, and 8 (Table 1). Multiple serotypes were recorded in 2013 (2, 4), 2015 (2, 4), and 2016 (2, 4, 5, 8) in the same outbreak. Serotypes 2, 4, 6, and 8 are originated and distributed in Europe and Mediterranean Basin (Mellor, Carpenter et al. 2008), while serotype 5 has an Eastern Asia origin (Yang, Xiao et al. 2017) and serotype 6 has a Middle East origin (Maclachlan 2011). Other recorded serotypes in the Middle East are serotypes 1, 2, 4, 6, 8, 10, 16, and 24 (Shimshony 2004, El Hage, Lorusso et al. 2013). However, the interpretation of the BT status and BTV serotypes in the developing countries of Africa and the Middle East is complicated by the lack of adequate surveillance in many areas.

BTV is an arbovirus, and its transmission, the incidence is related to the insect *Culicoides* midges as a vector of the virus. The insect's activities are highly related to the seasonal changes in temperature, availability of water, and other climatic variables (Purse, Mellor et al. 2005). Palestine has a temperate, Mediterranean climate, with a rainy season between November and April (Shahin 2007). Our findings showed that the temporal distribution of BT in Palestine showed activities peaked during the autumn to the winter (September to December). This is a period of low temperature and expects to reduce the insect activity comparing to the spring and summer season. The persistence of BTV in the cold weather is well documented and known as 'overwintering' of BTV in endemic temperate regions (Mayo, Mullens et al. 2016). The detection of BTV in pools of productive female midges during the warm period, with a long lifespan, represents most likely the mechanism of BTV overwintering. The female midges infected during the prior seasonal period of virus transmission. It is further likely that these infected productive midges were less active in the fall and re-emerged in midwinter during a transient period of higher temperature (Maclachlan and Mayo 2013). Besides, for the female midges, the transmission from warm to a cold period typically requires 6 months period in temperate regions (Maclachlan and Mayo 2013). Besides, adult *Culicoides* may also be sheltered from the worst conditions of winter to a resting place in the farm and animal shelter (Wilson, Darpel et al. 2008). The transmission of the virus increased with low temperature and enhance its spread with the occurrence of wind (Wittmann and Baylis 2000). These facts can explain the extent of higher indices in the cold weather in Palestine. Our findings are in agreement with other reported in India (Sreenivasulu, Subba Rao et al. 2004), In Italy (De Liberato, Purse et al. 2003), and Germany(Conraths, Gethmann et al. 2009) describing the overwintering of BTV. Regarding case fatality, the highest rate indicates the severity of the disease observed during the endings of summer and autumn season. The fatality rate ranging from 0.00 to 37.5. Our finding is similar to other studies of the epidemiology of the disease in India where the fatality rate was ranged from 2.37 to 38.14 (Sreenivasulu, Subba Rao et al. 2004) and Germany(Conraths, Gethmann et al. 2009), lower than case fatality caused by BTV serotype 8 in sheep in Netherlands (Elbers, Backx et al. 2008).

In conclusion, BT during the past 14 years is enzootic in Palestine, revealed a considerable number of outbreaks and death. Multiple serotypes circulation all over the year implying that BT is considered a serious problem. Although the observations regarding the morbidity/mortality of BT in Palestine, research publications reporting these findings are not available. Despite the economic impact of the disease in Palestine, no vaccination or eradication measures were adopted.

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