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Potential Risk Factors Associated with Pest de Petites Ruminants Disease in Sudan

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ABSTRACT

The study was carried out to investigate it knowledge of towners and vetirian of ppn in sudan, the questionare was used to collect the data herd it owners.The results of the present study have identified the potential risk factors that are associated with the PPRV outbreaks occurrence in sheep in Sinnar, Gadarif, Kassala, River Nile and White Nile states of the Sudan, by using questionnaires The results of the questionnaire survey showed that Significant risk factors associated with PPRV in the univariate analysis using the chi square test were found to be species at animal level and production system, migration, animal movement, vaccination and disease history at herd level, while livestock density, climatic changes, veterinary services and wildlife were identified as risk factors at area level and all the identified risk factors noticed that they were management and animal husbandry based problems. In contrast, age, sex and breed at animal level and herd size, mixed species, housing, water, communal dipping at herd level, and elevation, livestock marketing system at area level were found not to be significantly associated with the occurrence of PPRV outbreaks.

Introduction:

Livestock are very tremendeus for livelihood of the African continent. They provide a flow of essential food products throughout the year. In some countries, like Sudan, they

are very important source of government export. They also the most source of income of many of people in rural areas. In many African countries, small ruminants play a major role in their resources (Brumby, 1990). Many health problems are encountered to put some obstacles and constraints in the front of developing productivity of small ruminants. Peste des petits ruminants (PPR) are one of the most important cause of morbidity and mortality for sheep and goats, in Africa*Paste des petits ruminants* (PPR) is an acute, highly contagious, infectious, and notifiable transboundary viral disease of domestic and wild small ruminants (FAO, 1999; Bailey *et al.,* 2005; Radostits *et al.,* 2007; Wang *et al.,* 2009; Balamurugan *et al.,* 2010; Khalafalla *et al.,* 2010; Luka *et al.,* 2011). *Peste des petits ruminant* virus (PPRV), the causative agent, belongs to the genus *Morbillivirus* of the family *Paramyxoviridae. Morbilliviruses* are known for their contagious nature and ability to cause some of the most devastating diseases worldwide (FAO, 1999; Murphy *et al*., 1999; Bailey *et al.,* 2005; Olivier *et al.,* 2011).

Infection with PPR virus in the Sudan was observed for the first time in 1972 in Al-Gedarif by Elhag Ali (1973) and by Elhag Ali and Taylor (1984) (cited by Intisar *et al.,* 2009; Khalafalla *et al.,* 2010). Since then continuous outbreaks occur in the country, affecting sheep and goats (Khalafalla *et al.,* 2010).

PPR is well known to be a constraint for animal resources development, horizontal and longitudinal herd growth and small ruminants farming in the Sudan. More importantly, PPR is reducing the export of small ruminants and their products to international markets in North Africa, the Middle East, South East Asia, and Europe.

In the Sudan, the incidence is also rising in areas where sheep and goats are raised. Furthermore, in 2004 the virus did emerge in camels in the Eastern region of the Sudan, with a case-fatality rate reaching up to 50% (516 deaths) (Khalafalla *et al.,* 2010).This rise in the prevalence and the emergence in a new species could be probably due to the virus becoming more virulent and having undergone changes in its genetic makeup. Therefore, this situation makes it very important to investigate the potential risk factors that enhance spreading of PPRV, and the knowledge and perceptions of sheep herders and owners and veterinarians on PPR in Sudan.

Material and Methods:

Study area: The aim of this study was to investigate the potential risk factors that are associated with the PPR outbreaks occurrence by sheep and goats owners and veterinarians on disease in five states: Sinnar, Gadarif, Kassala, River Nile and White Nile.

Study population: The study population was all sheep and goats herders and owners in the localities of states. Different breeds of sheep were sampled from different production systems (nomadic, semi-nomadic, sedentary, and semi-sedentary), husbandry systems and ecological conditions.

Sample size: A total of 100 owners and 20 veterinarians were questionnaire from each state using the following sample size formula for each state:

$$N = \frac{1.962\ P_{exp}\ (1 - P_{exp})}{d^2}$$

N: Required sample size

1.96: z value with confidence level 95%

P_{exp}: Expected proportions of population knowing about PPR are 50 %
d^2: Desired absolute precision (0.05)

Questionnaire for data collections:

Questions for animal owners and herders included potential risk factors at animal level included: species, age, sex and breed. Potential risk factors at animal herd included: herd size, production type, mixed species, housing, inter-herd contact grazing, watering, social exchange, communal dipping, animal movement, migration, herd structure and dynamics location of herd vaccinations and disease history. Risk factors at area level included: livestock population, density, climate: temperature, rain-fall, seasons, elevation, livestock marketing system, veterinary service provision: surveillance, control and susceptible wildlife.

Questions about potential risk factors to veterinarians included: species, age, sex and breed, farming systems, season of outbreaks and the source of PPR outbreaks.

Data management and analysis:

All collected data of individual animals and locations during sampling were entered, coded, and stored electronically in a Microsoft® Excel for Windows® 2007 data base. The Statistical Package for Social Sciences (SPSS) for Windows® version 18.0 (SPSS Inc., Chicago, Illinois) was used for all appropriate statistical analyses.

Descriptive statistics of the variables were obtained. For each variable (age, sex, breed, and locations), frequencies (number of observations within variable) were also obtained.

Hypotheses of differences of age group, breed, sex, and locations between PPR outbreak occurrence and none PPR outbreak occurrence were first tested by univariate analysis by means of the 2-tailed chi-square test. In a second step, a logistic regression model was used to assess the association between the potential risk factors sex, breed, state, and locality and the outcome PPR outbreak status. Age and potential risk factors with $p \leq 0.20$ in the univariate analysis were entered into the regression model. Associations in the logistic regression model were deemed significant when $p \leq 0.05$.

Results:

Regarding susceptible species the majority 68% (n = 340) of the owners and herders saw that both sheep and goats are the most susceptible species, 9% (n = 45) saw it is sheep, 14% (n = 70) saw it is goats while 9% (n = 45) saw it is camels, the risk factor showing significant association with odds ratio of 29.161 and *p*- value of .004. Susceptible age group, 97% (n = 485) of the owners and herders agreed that sheep ≤ 1 year are the most susceptible age group, 1.6 % (n = 8) chosed sheep 1 - 2 year and 1.4% (n = 7) had no idea concerning the most susceptible age group, the risk factor showing insignificant association with odds ratio of 4.128 and *p*- value of .845. In regards to sex and PPR, the majority, 92.6 % (n = 463) reported no difference between both sexes, but 4.4 % (n = 22) of the owners and herders considered females most susceptible to PPRV while 3 % (n = 15) were unable to identify a particular sex, the risk factor showing insignificant association with odds ratio of 4.675 and *p*- value of .792. About 88.2 % of owners and herders explained that PPRV outbreaks occurred in the local breed and 7.4 % saw that outbreaks occurred in the imported breed and 4.4 %, saw that outbreaks occurred in the cross breed, the risk factor showing insignificant association with odds ratio of 8.648 and *p*- value of .373.

Table (1) Frequencies of responses (n = 500) on the potential risk factors associated with PPR infection at animal level

Risk Factors	Number	%
Species:		
Sheep	45	9.0
Goat	70	14.0
Camel	45	9.0
Sheep, Goat	340	68.0
Age:		
≤ 1 year	485	97.0
1-2 year	8	1.6
Do not know	7	1.4
Sex:		
Males	15	3.0
Females	22	4.4
Both equally	463	92.6
Breed:		
Local	441	88.2
Imported	37	7.4
Cross	22	4.4

Chi square result:

Risk Factors	Chi square value	*p* -value
Species	29.161	.004
Age	4.128	.845
Sex	4.675	.792
Breed	8.648	.373

About 55.2 % (n = 276) of the owners and herders stated that herd size is risk factor, while 44.8 % (n = 224) of them were not, the risk factor showing insignificant association with odds ratio of 0.275 and *p*- value of .991. About 61.2 % (n = 306) of the owners and herders stated that production type is risk factor, while 38.8 % (n = 194) of them were not, the risk factor showing significant association with odds ratio of 25.470 and *p*- value of .000. About 22.2 % (n = 111) of the owners and herders stated that mixed species is risk factor, while 77.8 % (n = 389) of them were not, the risk factor showing insignificant association with odds ratio of 9.426 and *p*- value of .051. About 49 % (n = 245) of the owners and herders stated that housing is risk factor, while 51 % (n = 255) of them were not, the risk factor showing insignificant association with odds ratio of 2.561 and *p*- value of .634. About 51.6 % (n = 258) of the owners and herders stated that watering is risk factor, while 48.4 % (n = 242) of them were not, the risk factor showing insignificant association with odds ratio of 4.052 and p- value of . 399. About 24.2 % (n = 121) of the owners and herders stated that communal dipping is risk factor, while 75.8 % (n = 379) of them were not, the risk factor showing insignificant association with odds ratio of 7.240 and *p*- value of .124. About 74.8 % (n = 374) of the owners and herders stated that migration is risk factor, while 25.2 % (n = 126) of them were not, the risk factor showing significant association with odds ratio of 9.910 and *p*- value of .042. About 50.0 % (n = 250) of the owners and herders stated that animal movement is risk factor, while 50.0 % (n = 250) of them were not, the risk factor showing significant association with odds ratio of 122.640 and *p*- value of .000. About 47.2 % (n = 236) of the owners and herders stated

that vaccination is risk factor, while 52.8 % (n = 264) of them were not, the risk factor showing significant association with odds ratio of 12.070 and *p*- value of .017. About 52 % (n = 260) of the owners and herders stated that disease history is risk factor, while 48 % (n = 240) of them were not, the risk factor showing significant association with odds ratio of 26.282 and *p*- value of .000.

Table (2) Frequencies of responses (n = 500) on the potential risk factors associated with PPR infection at herd level

Risk Factors	NO	%
Herd size:		
Yes	276	55.2
No	224	44.8
Production type:		
Sedentary	306	61.2
Semi-sedentary	194	38.8
Mixed species:		
Yes	111	22.2
No	389	77.8
Housing:		
Yes	245	49.0
No	255	51.0
Watering:		
Yes	258	51.6
No	242	48.4
Communal dipping:		
Yes	121	24.2
No	379	75.8
Migration:		
Yes	374	74.8
No	126	25.2
Animal movement:		
Yes	250	50.0
No	250	50.0
Vaccinations:		
Yes	236	47.2
No	264	52.8
Disease history:		
Yes	260	52.0
No	240	48.0

Chi square result:

Risk Factors	Chi. value	*p* -value
Herd size	0.275	0.991
Production type	25.470	0.000
Mixed species	9.426	0.051
Housing	2.561	0.634
Watering	4.052	0.399
Communal dipping	7.240	0.124
Migration	9.910	0.042
Animal movement	122.640	0.000
Vaccinations	12.070	0.017
Disease history	26.282	0.000

About 84.8 % (n = 424) of the owners and herders stated that livestock density is risk factor, while 15.2 % (n = 76) of them were not, the risk factor showing significant association with odds ratio of 23.492 and *p*- value of .000. About 50.0 % (n = 250) of the owners and herders stated that climate: temperature, rain-fall, seasons is risk factor, while 50.0 % (n = 250) of them were not, the risk factor showing significant association with odds ratio of 10.560 and *p*- value of .032. Nobody of the owners and herders 100 % (n = 500) stated that elevation is risk factor. About 79.2 % (n = 396) of the owners and herders stated that livestock marketing system is risk factor, while 20.8 % (n = 104) of them were not, the risk factor showing insignificant association with odds ratio of 6.240 and *p*- value of .182. About 47.2 % (n = 263) of the owners and herders stated that veterinary service provision (surveillance, control) is risk factor, while 52.8 % (n = 264) of them were not, the risk factor showing significant association with odds ratio of 12.070 and *p*- value of .017. About 3.4 % (n = 17) of the owners and herders stated that susceptible wildlife is risk factor, while 96.6 % (n = 483) of them were not, the risk factor showing significant association with odds ratio of 70.393 and *p*- value of .000.

Table (3) Frequencies of responses (n = 500) on the potential risk factors associated with PPR infection at area level

Risk Factors	NO	%
Density:		
Yes	424	84.8
No	76	15.2
Climate: temperature, rain-fall, seasons:		
Yes	250	50.0
No	250	50.0
Elevation:		
Yes	0	0
No	500	100

Livestock marketing system:		
Yes	396	79.2
No	104	20.8
Veterinary service provision: surveillance, control:		
Yes	236	47.2
No	264	52.8
Susceptible wildlife:		
Yes	17	3.4
No	483	96.6

Chi square result:

Risk Factors	Chi. value	*p* -value
Density	23.492	0.000
Climate: temperature, rain-fall, seasons	10.560	0.032
Elevation	-	-
Livestock marketing system	6.240	0.182
Veterinary service provision: surveillance, control	12.070	0.017
Susceptible wildlife	70.393	0.000

Discussion:

Investigation of risk factor associated with PPR is important for PPR control and eradication. The climatic factors are of most importance, because knowing the seasons of infection, geographical areas with high incidences and the climate conditions in these areas will enable the veterinary authorities to implement the proper control and risk reduction measures that could eventually prevent or mitigate PPR outbreaks and its consequences.

Few studies in the Sudan have addressed risk factors associated with PPRV outbreaks (Al-Majali *et al.,* 2008); Shuaib, 2011; Huyam, (2014)). In the current study, univariate analysis using chi square, with a confidence interval of 95% and at a p-value of ≤ 0.05 was used to identify potential risk factors associated with PPRV infection in sheep in Sinnar, Gadarif, Kassala, River Nile and White Nile states of the Sudan and it showed that the occurrence of PPRV was considerably high in the five studied states.

At the individual animal level, species and having a PPR infection was significant in the univariate analysis with odds ratio of 29.161 and *p*- value of .004; it is in agreement with findings of Abd El-Rahim *et al.* (2010) and Abubakar *et al.* (2009) who found that goats is more susceptible to have PPR infection than sheep and Saeed *et al.* (2010) and Gopilo (2005) found that sheep is more susceptible to have PPR infection than goats.

Age and having a PPR infection were insignificant in the univariate analysis with odds ratio of 4.128 and *p*- value of .845; it is in disagreement with findings of Waret-Szkuta *et*

al. (2008); Al-Majali *et al.* (2008); Banyard *et al.* (2010); Abubakar *et al.* (2011) and Shuaib (2011). The insignificant association of age with PPRV infection indicates that antibodies occur in all age groups and that the virus also is in constant circulation in sheep of all ages. This can be elucidated by the fact that animals of the most vulnerable age group (lambs) do die as soon as they contract the virus and only those animals with some resistance do survive. This disagreement with Ozkul *et al.* (2002), Singh *et al.* (2004), Waret-Szkuta *et al.* (2008), Abd El-Rahim *et al.* (2010) and Shuaib (2011), who found such age dependencies.

In the combination of factors, no significant association between being PPR affected and sex was established with odds ratio of 4.675 and *p*- value of .792, this is in agreement with result of Sarker and Hemayeatul (2011), found that no difference between sexes. However, it is disagreement with results of Shuaib (2011) and Abdalla *et al* (2012), who found female more affected with PPR, considered that females are subject to more stressing factors like pregnancy and lactation; in addition, the productive life span of females is longer than that of males in addition to higher number of females in herds in comparison to males. But it disagree with Sarker and Islam (2011) who stated according to his results, that males are more affected may be due to genetic factors.

When individual risk factors are combined, associations between breeds and being PPR affected no longer exist with odds ratio of 8.648 and *p*- value of .373. Gopilo (2005) also found no association of PPR status and breeds, while in contrast, results of Abu bakar *et al.* (2011) shows that some breeds have resistance to PPRV infection.

At the herd level, the insignificant association of herd size to being PPRV affected with odds ratio of 0.275 and *p*- value of .991 could be due to the fact that all owners and herders, with small or large numbers of animals, do practice communal grazing and/or watering; therefore, all animals at these times are at similar risk to be infected with PPRV by coming in contact with infected animals.

There was a significant association between being PPR affected and the production system with odds ratio of 25.470 and *p*- value of .000. The animals owned by nomadic pastoralists were at high risk for PPR comparing to the other systems. This could be due to vulnerability of small ruminant herds in pastoralists and open grazing systems to infected herds in pastures and water points, these herds could be from other Sudan states or from a neighboring countries, in particular in state at borders like Sinnar and Gadarif, the same observation was mentioned by Kihu *et al* (2010), Huyam, 2014.

No significant association between being PPRV affected and where herds get mixed with mixed species could be established with odds ratio of 9.426 and *p*- value of .051, this agrees with Shuaib, (2011). This could be related to the fact that PPR is transmitted from infected animals to susceptible ones by contact, whether the contact happens at watering points, pastures or at both.

The analysis further showed that there was insignificant association between housing categories and PPR occurrence with odds ratio of 2.561 and *p*- value of .634; this is in disagreement with Shuaib, (2011) and Huyam, (2014) who found that housing categories have association with PPR occurrence, where animals in free grazing system were more affected followed by animals in semi_sedentary system and the low occurrence in animals kept sedentary system.

The analysis further showed that there was insignificant association between being PPR affected and water and communal dipping. This finding is in disagreement with results of Shuaib (2011) and Salih *et al.* (2014), who found increase the probability of spreading PPR through the common pastures and water sources.

The analysis further showed that there was a significant association between being PPR affected and the animal movement and migration. Stress of animal from movement, coupled with low environmental temperature, and bolstered by humidity and nutritional deficiency may contribute to the occurrence of PPR disease (Abd El-Rahim *et al.,* 2010).

Surprisely, the analysis showed an association between being affected by PPRV infection and vaccination with odds ratio of 12.070 and *p*- value of .017. Although RPV vaccine has been used for PPRV control in the Sudan for many years in the past and it is considered as the most effective way of controlling PPR (Kumar *et al.,* 2014), but the owners and herders still could not accept vaccination as method of control and this reflect their belief in it is disease causality, this is in disagreement with Huyam (2014).

There was a significant association between being affected by PPRV infection and diseases history with odds ratio of 26.282 and *p*- value of .000. Some authors suggested that a more severe disease results from mixed infection of bacteria and viruses than a single infection. Nutritional and environmental factors have important effect on the appearance of PPR disease in a flock of animals, on the other hand Saliki (1998) previously reported that poor nutrition status, stress of movement and concurrent parasitic and bacterial infections enhance the severity of clinical signs (Osman *et al,* 2009).

At the area level, this analysis showed an association between being affected by PPRV infection and density with odds ratio of 23.492 and *p*- value of .000. This is in agreement with Singh (2011) who stated that; the higher population density of animals' results in increased levels of contact between them and this helps to maintain the PPR virus within the environment.

The climatic factors were found associated with PPR occurrence with odds ratio of 10.560 and *p*- value of .032; states with high rain fall and high wind speed were found to have the highest PPR occurrence. Animals in these states were more affected significantly than those in states with low rain fall and slow wind speed. High rainfall rates lead to cold weather and that is contributing to PPR spread and this agree with Elnoman *et al* (2011), Elhassan *et al* (1994) and with Saeed *et al* (2010), Huyam (2014).

No association was found with PPR occurrence and elevation. Despite that the change of humidity and ambient temperature might have contributed to the maintenance of the outbreak (Elhassan *et al,* 1994).

The analysis further showed that there was insignificant association between being PPR affected and the livestock marketing system with odds ratio of 6.240 and *p*- value of .182, but trade of live animals is one of the important risk factors in spreading PPR in Africa as mentioned by Kaukarbayevich (2009) and Singh (2011).

The analysis showed that there was significant association between being PPR affected and the veterinary service provision (surveillance, control) with odds ratio of 12.070 and *p*- value of .017. There is no regular application for bio-security measures which considered risk that increase the disease transmission. The primary quarantine or

vaccination and inspection centers were found to be far away. Majority of primary and secondary livestock markets are lacking for separated pens (ElDirani *et al.,* 2009).

The analysis further showed that there was a significant association between being PPR affected and the wildlife with odds ratio of 70.393 and *p*- value of .000. Development of trade relations, transport, tourism and migration of wild life animals susceptible to PPR contribute to the spread of the disease beyond the boundaries of Western Africa. Also the interaction between sheep and goats in pastoralist system with wild small ruminants in pasture especially in states with high density of wild life like Sinnar could affect the PPR occurrence; as the infectivity and role of PPR transmission through wild ruminants is mentioned by Housawi *et al* (2004), Zahur *et al* (2008) and Gopilo (2005).

Conclusions:

Knowledge of risk factors associated with PPR is an important pre-requisite for the design and implementation of effective control strategies and for management programs that can lead to the control and eradication of the disease. An understanding of these risk factors and their association and contributions to the occurrence and spreading of PPRV among small ruminants populations also is a good aid for clinical diagnosis and for determining PPR's epidemiology and patterns.

Based on the results of the study, risk factors associated with PPRV outbreaks in Sinnar, Gadarif, Kassala, River Nile and White Nile states are: production system, housing, water and communal dipping; animal movement and migration, vaccination and disease history, while livestock density, climatic changes, veterinary services and wildlife were identified as risk factors at area level. In contrast, age, sex and breed at animal level and herd size, where species mixed, social exchange, and herd structure and dynamic at herd level and elevation and livestock marketing system at area level were found not to be significantly associated with the occurrence of PPRV outbreaks.

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