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# Seroprevalence of Sheep and Goat Pox Virus Infection in Small Ruminants in Three Egyptian Governorates

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**Abstract**

SHEEP and goat pox virus (SGP) is a contagious virus that infects sheep and goats and can lead to trade restrictions and large financial losses. A cross-sectional study was done to investigate the seroprevalence of SGP virus infection and its related risk factors in sheep and goats. A total of 810 serum samples (400 sheep and 410 goats) were collected from Kafr ElSheikh, Qalyubi and Gharbia governorates during January to December 2023and examined using virus neutralization test (VNT). The overall seroprevalence of SGP virus infection was 15.3%, with 13.8% in sheep and 16.8% in goats. The highest seroprevalence was observed in Kafr Elsheikh (17.1%) and the lowest seroprevalence was reported in Qalyubia governorate (13.5%). In addition, the seroprevalence of SGP virus infections was significantly associated with sex, age and flock size. Multivariate logistic regression analysis revealed that the odds of seroprevalence of SGP in Kafr ElSheikh and females were two times higher than in other areas and males. Moreover, the odds of seropositivity for SGP virus in young animals below one year and animals raising large flocks were three times higher than in other age groups and small flocks. The study confirms the distribution of the SGP virus among Egyptian sheep and goats. Hence, implementing an efficient mass vaccination program can effectively manage sheep and goat pox disease in studied areas and across the country.

**Keywords:** Sheep pox, Goat pox, Risk factors, Virus neutralization test, Egypt.

## Introduction

Sheep and goat pox (SGP) is a highly contagious viral disease that affects sheep and goats. The causative agent of the disease is sheep and goat pox virus, belonging to the *Poxoviaride* family and genus *Capripoxvirus* [1, 2]. The sheep and goat pox virus mostly affects sheep and goats and is closely related to the lumpy skin disease virus (LSDV) in cattle [3, 4]. Certain viral isolates exhibit transitional host specificity by causing mild to severe illness in both species [5].

Although indirect contact with contaminated objects and mechanical insects can also spread disease, direct contact is the most common method of transmission [6, 7]. The sheep and goat pox virus can also be transmitted by aerosol and nasal secretions [8]. SGP is a severe fetal systemic disease that causes death in sheep and goats. It is characterized by fever, internal lesions in the upper respiratory tract and gastrointestinal mucosa, papules or nodules on non-wool skin, and generalized vesicles [9, 10]

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SGP is endemic throughout Turkey, Africa (except southern Africa) and the Middle East, Asia, while sporadic outbreaks occurred in eastern Europe and Greece [1]. The substantial financial damage is attributable to these viruses. Especially young animals are mostly susceptible. Pneumonia caused fatality rates that varied from 50% to 70% [11].

The economic consequences of sheep and goat pox are typically attributed to their high rates of sickness and mortality, reduced productivity, deterioration of skin quality, and other production losses [12, 13].

Laboratory diagnosis is required to confirm the disease. Serological tests include serum neutralization tests (gold standard) but it is labor intensive and require a long time to give the result, indirect fluorescent antibody tests (IFAT), enzyme-linked immunosorbent assays (ELISA), and agar gel immunodiffusion assays (AGID) [14-16]. Viral isolation is essential to determine the agent's infectivity. Thus, primary cell lines can be used to distinguish sheep pox virus (SPPV) from Goat pox virus (GTPV) [17]. Furthermore, PCR is an easy-to-use method for identifying CaPV genomes in tissue samples [18], however, it is unable to distinguish between GTPV and SPPV.

Nonetheless, these viruses were identified through sequencing of the GpCR and P32 genes [19, 20]. Furthermore, the differential analysis of GTPV and SPPV was conducted using a unique and sensitive duplex PCR approach, especially in endemic areas with low resources [21]

In Egypt, several outbreaks of SGP have been reported in upper Egypt (Minia governorate) and northern governorates like Dumiate, Menofia and Kafr ElSheikh [22]. However, the risk factors associated with SGP infection were not studied.

Therefore, this study aimed to investigate the prevalence of SGP in three governorates within the Nile Delta region of Egypt and find out the risk factors associated with this infection.

## Material and Methods

*Ethical statement*

The study was conducted following the guidelines and regulations set forth by the ethical committee of the Faculty of Veterinary Medicine, Benha University. Furthermore, the study's methodology and techniques received formal approval from the same ethical committee.

*Study area*

The study was conducted across three governorates in the Nile Delta region of Egypt—Kafr El-Sheikh, Qalyubia, and Gharbia in Egypt—during the period from January to December 2023.

Kafr El-Sheikh experiences a subtropical desert climate (BWh classification) and is located at an elevation of 9.14 meters above sea level. The governorate records an average annual temperature of 23.78°C and receives approximately 4.42 millimeters of precipitation annually. In Qalyubia, summer is lengthy, hot, humid, arid, and clear, while winters are chilly, dry, and mainly clear. In addition, Gharbia has a subtropical desert climate (Classification: BWh), with an elevation of 8.49 meters above sea level. The annual temperature of the governorate is lower than the average for Egypt, at 24.55ºC and 3.1 millimeters (0.12 inches) of precipitation fall on Gharbia each year. The chosen study area is located between two branches of the Nile in Egypt, and agriculture and animal breeding are the primary activities in these areas.

*Sample size and sampling*

The sample size was calculated using the formula provided by Thrusfield [23].

$$n = Z^2 P(1 - P)/d^2$$

where n is the calculated sample size, Z is confidence interval 95%, and P is the expected prevalence which depends on the previous prevalence (16.2%) reported by [24], and d is absolute error 5%.

A total of 400 and 410 blood samples were randomly collected from sheep and goats raised by individual farmers. From each examined animal, 5 mL of blood was drawn from the jugular vein using a sterile tube without anticoagulant and transported on ice to the Veterinary Diagnostic Laboratory, Faculty of Veterinary Medicine, Benha University. The serum was separated by centrifuging each sample at 3500x g for 10 minutes and stored at -20°C until serological analysis.

*Data and Laboratory analysis*

Additionally, data for each animal was collected during sampling through a questionnaire. The survey included comprehensive information on the animal's location, species, sex, age, flock size, and vaccination history. Serum samples were examined for sheep and goat pox antibodies using the virus neutralization test (VNT), following the protocols outlined by Boshra, Truong, Babiuk and Hemida [25] . Since VNT cannot discriminate between sheep pox and GP antibodies, the serological result is referred to as sheep and goat pox antibodies.

*Statistical analysis*

Data from the questionnaire surveys were recorded and coded using Microsoft Excel 2016 before being imported into SPSS version 24 (IBM SPSS, USA) for analysis. A univariate analysis was conducted to evaluate the association between SGP seropositivity and various risk factors, including locality, species, sex, age, flock size, and vaccination

history. Variables with P-values ≤0.2 from the univariate analysis were further analyzed using a multivariate logistic regression model. Odds ratios (ORs) and 95% confidence intervals (95% CIs) were calculated to assess the strength of association between different factors and seropositivity [26-30].

## Results

A total of 810 serum samples were examined for antibodies against SGPV in sheep and goats in three Egyptian governorates using VNT. The total seroprevalence rate of SGP was 15.3% (95 CI: 12.99-17.95), with 13.8% in sheep and 16.8% in goats. However, the difference in antibody prevalence between sheep and goats was not significant ($P > 0.05$). Furthermore, the seroprevalence of SGP was significantly varied between studied governorates ($P < 0.05$), Kafr ElSheikh reported the highest seroprevalence rate (17.1%), while Qalyubia recorded the lowest rate (13.5%), shown in Table 1.

Furthermore, there were significant differences in the seroprevalence rate of SGP between age groups and between males and females. The highest seroprevalence rate was found in females (17.2%) and young age group less than one year (23.7%). The findings of the present study revealed that the large flock is significantly associated with higher seroprevalence (25.4%) for SGP in comparison with the small flock.

Table 2 showed the result of the multivariate logistic regression model, where the odds of seroprevalence of SGP in Kafr ElSheikh and females were 1.3 and 1.7 times higher than in other localities and males. In addition, the risk of SGP seropositivity was three times higher in young animals (OR= 2.8, 95%CI: 1.7-4.6; p >0.0001) and large flocks (OR=2.9, 95%CI: 1.9-4.3; p >0.0001) than older and small flocks.

In addition, the collinearity of independent variables was assessed, and the variance inflation factor (VIF) was 1.009, 1.009, 1004 and 1.003 for the locality, sex, age and flock size, which indicates a moderate correlation between variables.

## Discussion

In this study, SGP is a highly infectious viral pathogen, that reduces sheep and goat productivity in Egypt. The disease is endemic and causing significant economic losses in Egypt [31].

The overall seroprevalence of SGP using VNT in the studied area was 15.3%, with 13.8% in sheep and 16.8% in goats. This finding is consistent with prior findings of 15.5% in the Western Amhara region [32] and 15.36% in the Afar region of Ethiopia [33]. However, the study's findings were lower than those reported in Sudan (63.55%) [34] and Pakistan (17.24%) [35]. The variance in seroprevalence of SGP among these studies may be attributable to changes in animal movement and the introduction of newly infected animals into the flock [25, 33, 36, 37].

Furthermore, the seroprevalence of SGP was non-significantly different between sheep and goats, and the seroprevalence was greater in goats than sheep, corresponding with the observation of Dubie, Dagnew, Hamid, Bizuayehu and Fentahun [33]. In contrast, other studies reported a higher prevalence of SGP among sheep than goats [32, 38].

Regarding to sex, the seroprevalence of SGP in this study comes in accordance with Fentie, Fenta, Leta, Molla, Ayele, Teshome, Nigatu and Assefa [32], where the greater seroprevalence was reported among females in comparison with males. Other researchers reported similar findings [34, 35]. These results could be explained by lowered immunity in females as a result of physiological changes during lambing. Moreover, the seroprevalence increased significantly in young animals below one year in comparison to other age groups. This finding was consistent with previous observation in Sudan, Pakistan and Ethiopia [32, 34, 35, 39]. This might be due to maternal immunity lasting only for up to 3 months and young unvaccinated animals more susceptible to malignant forms of SGP disease [6, 16, 40-42]. However, Domenech, Lubroth, Eddi, Martin and Roger [43] reported that recovered animals from the SGP virus developed long-life immunity.

The results of this study tie well in line with the previous study of Kassa, Fesseha, Mathewos, Getachew, Hundessa, Aliye and Kebede [38], where the risk of SGP seropositivity increased significantly in large flocks than in small flocks. This could be explained by the SGP virus can persist stable for long periods in the environment and transmitted mechanically between susceptible animals [33]. The present study revealed that the seropositivity for the SGP virus was a non-significant increase in non-vaccinated animals in comparison with vaccinated animals. However, a governmental mass vaccination program with live attenuated vaccine was applied in Egypt for sheep and goats. Contrary to these findings, Kardjadj [44] reported that absence of vaccination is a significant risk factor for increasing the SGP virus infection in sheep and goats.

## Conclusion

The results concluded that that despite an annual vaccination campaign, SGP virus infection is widespread and endemic in Egyptian sheep and goat populations. The risk factors associated with disease distribution among small ruminants were locality, sex, age and flock size. Additionally, in order to enhance animal welfare and decrease the financial losses brought by epidemic episodes, the vaccination must be covered all of the entire population of small ruminants.

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*Conflict of interest.*

The authors declare that there is no conflict of interest.

*Ethical of approval*

This study follows the ethics guidelines of the Faculty of Veterinary Medicine, Benha University, Egypt

**TABLE 1. Seroprevalence of Sheep and goat pox virus in small ruminants**

| Variable | Total examined animals | No of positive | No of negative | % of positive | 95% CI | Statistic |
|---|---|---|---|---|---|---|
| **Locality** | | | | | | |
| Kafr ElSheikh | 280 | 48 | 232 | 17.1 | 13.18-22.19 | $\chi2$=33.211 df=3 P<0.0001* |
| Qalyubia | 260 | 35 | 225 | 13.5 | 9.84-18.14 | |
| Gharbia | 270 | 41 | 229 | 15.2 | 11.4-19.96 | |
| **Species** | | | | | | |
| Sheep | 400 | 55 | 345 | 13.8 | 10.72-17.47 | $\chi2$=0.043 df=1 P=0.836 |
| Goats | 410 | 69 | 341 | 16.8 | 13.52-20.76 | |
| **Sex** | | | | | | |
| Male | 210 | 21 | 189 | 10.0 | 6.63-14.8 | $\chi2$=16.178 df=1 P<0.0001* |
| Female | 600 | 103 | 497 | 17.2 | 14.36-20.39 | |
| **Age** | | | | | | |
| <1 | 270 | 64 | 206 | 23.7 | 19.02-29.12 | |
| 1-2 | 250 | 31 | 219 | 12.4 | 8.87-17.06 | $\chi2$=8.614 df=2 P=0.013* |
| >2 | 290 | 29 | 261 | 10.0 | 7.05-13.99 | |
| **Flock size** | | | | | | |
| Small | 550 | 58 | 492 | 10.5 | 8.25-13.4 | $\chi2$=48.203 df=1 P<0.0001* |
| Large | 260 | 66 | 194 | 25.4 | 20.48-31 | |
| **History of vaccination** | | | | | | |
| Yes | 380 | 29 | 351 | 7.6 | 5.36-10.74 | $\chi2$=0.908 df=1 P=0.341 |
| No | 430 | 95 | 335 | 22.1 | 18.43-26.25 | |
| Total | 810 | 124 | 686 | 15.3 | 12.99-17.95 | |

*P<0.05 indicates that the result is significant.

**TABLE 2. Risk factors associated with Sheep and goats pox infection in small ruminants**

| Variable | B | S.E. | OR | 95% CI for OR | | P value |
|---|---|---|---|---|---|---|
| | | | | Lower | Upper | |
| **Locality** | | | | | | |
| KafrElSheikh | 0.294 | 0.251 | 1.3 | 0.8 | 2.2 | 0.024 |
| Gharbia | 0.147 | 0.258 | 1.2 | 0.7 | 1.9 | 0.036 |
| **Sex** | | | | | | |
| Female | 0.542 | 0.262 | 1.7 | 1.0 | 2.9 | 0.033 |
| **Age** | | | | | | |
| <1 | 1.042 | 0.249 | 2.8 | 1.7 | 4.6 | <0.0001 |
| 1-2 | 0.311 | 0.280 | 1.4 | 0.8 | 2.4 | 0.0246 |
| **Flock Size** | | | | | | |
| Large | 1.064 | 0.204 | 2.9 | 1.9 | 4.3 | <0.0001 |

B: Logistic regression coefficient, SE: Standard error, OR: Odds ratio, CI: Confidence interval

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# الانتشار المصلي لعدوى فيروس جدري الأغنام والماعز في المجترات الصغيرة في ثلاث محافظات مصرية

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**الملخص**

إن فيروس جدري الأغنام والماعز هو عدوى فيروسية معدية تصيب الأغنام والماعز وتسبب خسائر اقتصادية كبيرة وقيوداً محتملة على التجارة. أجريت دراسة مقطعية لتحديد الانتشار المصلي لعدوى فيروس جدري الأغنام والماعز وعوامل الخطر المرتبطة به في الأغنام والماعز. تم جمع ما مجموعه 810 عينات من المصل (400 من الأغنام و410 من الماعز) وفحصها باستخدام اختبار تحييد الفيروس (VNT). كان معدل الانتشار المصلي العام لعدوى فيروس SGP 15.3٪، مع 13.8٪ في الأغنام و16.8٪ في الماعز. ولوحظ أعلى انتشار مصلي في محافظة كفر الشيخ (17.1%) وأقل انتشار مصلي في محافظة القليوبية (13.5%). بالإضافة إلى ذلك، ارتبط الانتشار المصلي لعدوى فيروس SGP بشكل كبير بالجنس والعمر وحجم القطيع. كانت احتمالات الانتشار المصلي لفيروس SGP في كفر الشيخ والإناث أعلى بمرتين من المناطق الأخرى والذكور. وعلاوة على ذلك، كانت احتمالات الإيجابية المصلية لفيروس SGP في الحيوانات الصغيرة أقل من سنة واحدة والحيوانات التي تربي قطعانًا كبيرة أعلى بثلاث مرات من الفئات العمرية الأخرى والقطيع الصغير. تؤكد الدراسة انتشار فيروس SGP بين الأغنام والماعز المصرية. ومن ثم، فإن تنفيذ برنامج تطعيم جماعي فعال يمكن أن يدير بفعالية مرض جدري الأغنام والماعز في المنطقة المدروسة وفي جميع أنحاء البلاد.

**الكلمات الدالة:** جدري الأغنام، جدري الماعز، عوامل التنبؤ، اختبار تحييد الفيروسات، مصر