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RETROSPECTIVE ENDEMICITY OF FOOT AND MOUTH DISEASE AFFECTING CATTLE IN EGYPT FROM 2006 TO 2018

By

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ABSTRACT

Infectious diseases of livestock are a major threat for global animal health and welfare**.** Foot and Mouth Disease (FMD) is on the A list of infectious diseases of animals that attacked the Egyptian cattle farms during the last years and resulted in high mortality rate in both young and adult cattle. The present work was conducted to evaluate the current status of most common endemic diseases affecting Cattle in Egypt (FMD) and to find out the causes of its endemicity and risk factors associated with the disease in Egypt in the period starting from 2006 to 2018.

A structured questionnaire was established for collecting primary data through a field survey of cattle farms throughout Egypt in 21 government. Primary data were collected through examining 1197cattle during the period December- January, 2017 in a previously designed questionnaire which revealed that only 215 cattle representing 18% of total cattle number only manifested clinical signs. The highest prevalence rate 52.3% was recorded in Gharbia, Luxor 50%, Al Bahareh 48%, Al qalyubiyah (31.2%). The most isolated serotype O represented high percentage in Al Bahareh, Ad Daqahliya, Bani suif, and Kafr-el-shaykh also Serotype O predominated with recorded higher number of the three circulating FMD serotypes in investigated (21) governorates, (238 out of 531). The isolated serotypes (44.82%). The highest Prevalence rate of FMD in investigated 21 governorates was recorded in spring 93.3%, while the lowest was in winter (14.5%.) Egypt owned 273 animal markets, not a systematic distributed all over the country. Results showed that animal markets close to the farms increased clinically manifested FMD cases significantly (P ≤0.01), also when farmers' visited animal markets FMD cases were significantly impacted (P ≤ 0.003*) Prevalence rate 96%. The possible sources of disease transmission (markets,) increases FMD cases significantly ((P ≤ 0.03*) up to Prevalence 74%. Farmers kept their animals outside the farms in the open-air all over the day increased significantly Prevalence rate (P0.03*) 77.2%.

Moreover, using tap water and non-grazing increased significantly FMD prevalence. Mixed food and rearing spp.Did not significantly affected disease prevalence .The absence of animal isolation, sharing instruments, absence of personnel hygiene and farm periodic cleaning, improper carcasses disposing of were significantly increased FMD prevalence in smallholder farms as well as two farms with large numbers of animals. Lack of awareness about vaccination increased Prevalence rate significantly. Non-significant differences were recorded in Prevalence rate within ages (less than 2 years and more than two years as well, in different types of production (dairy and fattening). Secondary study the total positive FMD notified outbreaks by (Wahis OIE) during 2006-2018 reached 531**.** In 2006 notification reached 30 outbreaks followed by 6 years of low numbers of notifications. The highest total Prevalence rate of 45% was for serotype O during the study period and predominated during 2014- 2017. Serotype A was the lowest total Prevalence rate 18%. Serotype SAT2 emerged in 2012 and prevalent in 2012, 2014, and 2018. Delta region showed the highest 337 confirmed epidemiological unit out of 531 (83.47%). The highest recorded outbreaks were in spring 213 followed by winter 203 and the lowest was in summer 46.

Keywords:

Biosecurity, Endemicity, Epidemiological unit, FMD, Prevalence, Risk factors.

INTRODUCTION

The Egyptian cattle farms have been still attacked by several outbreaks of FMDV during the last years resulted in a high mortality rates in both young and adults. Although Vaccinations regime is regularly adopted by veterinary authorities; the Egyptian farms have been attacked by several outbreaks of FMDV during the last few years. Foot-and-mouth disease virus (FMDV) serotypes A, O and South African Territories (SAT2) are endemic in Egypt **(Alexandersen and Mowat 2005)**. Between 1964 and 2011, only FMD serotype O was reported in Egypt, except for years 1972 and 2006, where serotype A emerged due to importation of animals from African countries and resulted in the loss of one-third of Egyptian animal wealth (**Knowles *et al.*,2007**). The epidemiology of FMD in North Africa is complicated by the co-circulation of endemic FMD viruses (FMDV), as well as sporadic incursions of exotic viral strains from the Middle East and Sub-Saharan Africa via animal movements across international borders **(Ahmed *et al.*, 2012; Abdul Hamid *et al.*, 2011).** (FMDV) has seven serotypes recognized as O, A, C, SAT-1, SAT-2, SAT-3, and Asia 1 (**Depa *et al*., 2012)**. FMDV serotypes O, A, and the South African Territories (SATs) are the most circulated serotypes in the continent. Serotype O is the most widely distributed in eastern and western Africa followed by A, while SAT's virus is mostly found in the southern region **(Brito *et al.,* 2015).** Massive FMD outbreaks were reported in February 2012 due to the appearance of the SAT2 serotype in Egypt, these were the first FMD outbreaks due to this serotype in Egypt since 1950 **(Valdazo-González *et al.*., 2015).** Serotypes A and O of FMDV were the most prevalent serotypes circulating in Egypt in addition to the SAT2 serotype **(Abd El-Moneim *et al.,* 2016).**

The emergence of new serotypes or topotypes has been associated with the importation of animals from endemic countries. The use of incompletely matching vaccines made the animals prone to infections with antigenically atypical strains of FMDV **(FAO, 2016)**. There is a paucity of the investigation of risk factors associated with FMD in Egypt. Recognition of the potential risk factors associated with FMD-infected cases offers a novel approach to construct the best preventive measures. **(Elgioushy *et al.,* 2018).** Foot and mouth disease is considered to be one of the world's most important livestock diseases, and is a highly contagious transboundary disease of cloven-hoofed animals, including livestock and wildlife **(Sansamur *et al.,* 2020).** From 2012 to 2018, FMD outbreaks have struck cattle and buffaloes in different localities of Egypt exerting severe economic losses to livestock industries **(Abdel-Rahman, 2020)**. Although FMD has a low mortality figure, its high morbidity and contagiousness can lead to enormous economic consequences on bovine production and trading because of its transboundary nature of transmission .as well infection with one serotype does not confer immunity against another **(Guzman *et al.,* 2008; OIE, 2009).**The outbreaks of this contagious disease can seriously affect the economy of the country in terms of production loss, export bans, vaccination costs, and losses from tourism in exposed regions **(Birhanu, 2014)**.

Applicable control measures for FMD involve animal movement restrictions, a vaccination program, animal quarantine, environmental sanitary controls, outbreak investigation, serological surveillance,and slaughtering of sick animals **(Chaosuancharoen, 2012).**

Vaccination is a major tool for FMD control to mitigate the impact of clinical disease or to reduce and eventually eliminate virus circulation as outlined in the Progressive Control Pathway for FMD **(FAO, 2011 and Dar *et al.,* 2013)**. In Africa, despite its US$2.32 billion impacts (from direct production losses and vaccination only), control of the disease is not yet prioritized. Standard vaccination regimens are too costly, its economic impact is underestimated and its epidemiology is not clearly understood **(Miriam *et al.*, 2018).** Immunity development by animals to one FMDV serotype does not protect them from other serotypes, and protection from other strains within a serotype varies with their antigenic similarity. Animal species, breed, immunity status, and virus infection dose are some of the factors that affect the FMD infection rate **(Anna and James, 2019)**. Understanding the outbreak dynamics, endemic serotypes, and lineage profiles of FMD is very critical in designing control and prevention programs. For this, detailed information on outbreak dynamics in Ethiopia needs to be understood **(Wubshet *et al.*, 2019).**

MATERIALS AND METHODS

Data Collection:

1-Survey Implementation.

Primary data of the survey was conducted between January and December 2017, a total of 1197 cattle were checked from 60 villages in 21 governorates of Egypt. The owners were interviewed as their animals showing clinical signs of FMD (mouth lesion, feet lameness, and drooling) as described by **OIE (2013)** by using a structured questionnaire (SQ).

A-Questionnaire design

Basic information:

The questionnaire included both closed and open-ended questions during the outbreak with FMD **(Young *et al.*, 2016**). The questionnaire contained basic data as (governorate, village, and date of visit, the total number of animals and the number of animals showed clinical signs).

Identifying risk practices of smallholder cattle farmers and large scale farms

Using the primary transmission routes as defined by **(OIE, 2013),** we developed a risk practice table to identify risk factors like husbandry system (a type of housing, type of drinking and grazing, isolation sick animals, markets distances).

Smallholder farmer knowledge, attitude and practice (KAP) survey

Collecting smallholder farmer responses to general information, knowledge, attitudes and practices as (visits of markets and owner movement and vaccination of animals) **(Young *et al.*, 2016).**

2. Secondary obtained Data.

Data obtained from (Wahis OIE) international site which is the country's passive surveillance system (PSS).The Survey village was the epidemiological unit where the animals suspected FMD were diagnosed via authorized referee laboratories and identified serotypes (A, O, and SAT2) then notified on site every 6 months.

Data were collected through 2006-2018 and analyzed spatial distribution into 4 regions (Upper Egypt, Delta, Desert and Suez).Upper Egypt (Giza, Cairo, Al fayyum, Bani suif, Al minya, Suhaj, Asyut, Qena,Luxor,Aswan) .Delta (Al qalyubiyah, Al minufiyah, Alsharkya, Al gharbiyah, Ad Daqahliya , Dumyat, Kaferelshikh, Alexandria and Al Buhayrah) . Canal (Suez, Portsaid, and Ismailia.) Desert (Red Seas, New Valley, and Matrouh). As well, temporal distribution of FMD in different seasons (spring, autumn, summer, and winter).

Data Management and Analysis:

A relational database was created in Microsoft Office Access 2010, to manage data. For statistical analysis, data were exported to Microsoft Office Excel 2010 and SPSS v18.0 for Windows (SPSS Inc., Chicago IL, USA. The outcome variable of interest was ‘farmer-diagnosed FMD in Egypt and the predictor variables were the RFs that were most likely associated with the outcome variable .Univariable analysis, using 2x2 tests, were used to identify the factors associated with farmer-diagnosed FMD. Odds ratios and their 95% CI were used to measure the strength of association between RFs and disease. Fisher’s exact test was used to report statistical significance **(Dukpa *et al.*, 2011).** Prevalence% calculated according to the total number of diseased animals. Prevalence rate percentage = No. of infected /total no. of animals * 100. *= highly significant differences ($P \leq 0.01$) .Insignificant differences ($P \geq 0.05$) by using T. test and F. test.

RESULTS AND DISCUSSION

Primary data were collected from January.-December.2017 in a designed questionnaire (Table 1), shows the prevalence of FMD in 21 governorates. From a total of 1197 examined cattle, 215 showing clinical signs Pr.18%. The highest Prevalence rate 52.3% recorded in Al gharbiyah, Luxor 50%, Al Buhayrah 48%, Al qalyubiyah 31.2%, Al minufiyah 22.2% regarding the number of examined animal despite 100% of low numbered animal in Banisuif. Delta region geographical nature considers as one block (no borders between governorates). It has a high census of animals and famous for agriculture activities. The Upper Egypt census of animals is lower than Delta as published by (FAO, 2012) in the SAT2 crises. In Banisuif and

Al fayyum which considers the upper region gate, the animals are transporting from Delta to the rest of the upper governorates through animal trade. Due to the low animal census in Desert and Canal regions, the number of clinical cases is very low and also due to the big distance between houses.

FMD temporal distribution,the winter season is favorable for FMD, but in Egypt, the situation is different as shown in (Tables 2).The highest Prevalence rate of FMD in investigated 21 governorates were recorded in spring 93.3%, while the lowest was in winter 14.5%. Spring season recorded more FMD cases which may relate to many factors like animals give birth in winter as previously reported by **(Kalthoum *et al.*, 2018)**, so young animal had maternally derived antibodies (MDA) from the authorized vaccinated dam during the national vaccination campaign before the winter season which stands for 3-4 months. In Delta, winter is hard, rainy, and not suitable for animals and farmers' movements .When temperature slightly raises in spring with the movement of animals and possible attracting of infection with consequent increase of notifications numbers as noticed. Winter and spring are favorite conditions for the spreading of FMD in Egypt.

Market location and owner movement activities considered of risky points as shown in (Table 3). Egypt owned 273 animal markets, not a systematic distributed all over the country. Some of the markets act as collecting points or connected two regions or more. Markets closet to farms increased Prevalence rate of clinically manifested FMD cases significantly ($P \leq 0.01$). Farmers' visited animal markets either in the village or directorates with significant impact ($P \leq 0.003$*) Prevalence rate 96% of FMD cases. The animals are transporting from Delta to the rest of the upper governorates through animal trade without any restriction or veterinary inspection (risk factor), this finding was coincided with **(Green *et al.*, 2006).**The possible sources of disease transmission (markets,) significantly (($P \leq 0.03$*). affected disease Prevalence rate 74% compared with type of rearing and presence of infected neighbors as possible sources. (**Elnekave *et al.*, 2016)** reported higher FMD seropervellance with the location of up to 3 km from FMD outbreaks in multiple farms.

Livestock husbandry associated with FMD infected farms were recorded in (Table 4). Farmers kept their animals outside the house in the open-air allover day increased Prevalence rate 77.2% significantly ($P \leq 0.03$*), this may expose animals to contaminated feed and soil. Housing cattle in sheds reduced the opportunity for animals to mix with other animals within villages, and therefore reduced disease transmission among the animals within villages**.(Dukpa *et al.*, 2011)**. As a result of keeping animals at home the tap water used and Prevalence rate reached 99% in all investigated farms. Non-grazing significantly (P ≤0.06*) affected Prevalence rate 67%. Mixed feed (green and formulated one) was commonly used allover year did not significantly (P ≤0.1) affect Prevalence rate 41.5%, Rearing may be mixed cow and buffalo or with other species like sheep, cow only increased Prevalence rate 52% of smallholders, Mixed rearing did not influence Prevalence rate (P ≤0.1).

Biosecurity procedures showed in (Table 5). The absence of animal isolation in examined farms increased significantly (P ≤0.01**). Prevalence rate 97%. Sharing instruments significantly (P ≤0.04*) impacted Prevalence rate 75.6%. All of the farmers didn't allocate fixed clothes for dealing with their own animals with Prevalence rate 100%. Most of farmers did not regularly clean and remove wastes. The absence of daily and periodic cleaning significantly (P ≤0.0.08*) increased Prevalence rate 89%. None of the farmers disposing of carcasses hygienically (throw them either in the near canal or near desert) which increased Prevalence rate 100% significantly. Lack of awareness about vaccination increased significantly (P ≤0.0.04*) Prevalence rate 84% significantly. Due to lack of awareness, the number of vaccinated animals is relatively low (risk factor) associated with FMD endemicity in Egypt. Lack of vaccination increased significantly (P≤0.02*) Prevalence rate 81%. However, vaccination is the cheapest and effective method of disease control and limiting the spread of FMD **(Depa *et al.*, 2012)** and regular vaccination of cattle and buffalo against FMD in Egypt, has become an important input to maintain animal productivity and to reduce economic losses **(knight-Johnes *et al.*, 2015)**.

Applied hygienic measures in the three large scales visited farms were illustrated in (Table 6). The large number dairy farms no.1,2 revealed low Prevalence rates (4, 2 %). Despite the first one applied good biosecurity measures but missed regular vaccination compared with the second farm. The farm no.3 fattening Frisian vaccinated regularly but with absence of biosecurity measures had the highest Prevalence rate 11%. Improper biosecurity measures in investigated large number farms and irregular vaccination increased Prevalence rate and potentiated FMD endemicity in Egypt. Despite the exerted efforts by the Egyptian government to control FMD, the shortage in proper quarantining facilities, boarder-based slaughterhouses, and the breakdown in security forces puts the country at high-risk of continuous disease introduction. In endemic countries, culling is not usually considered a viable control option due to the associated costs and stakeholder resistance **(Abdel Rahman *et al.*, 2020)**.

Age and type of production impact on FMD Prevalence rate were clarified in (Table 7). Non-significant differences were recorded in Prevalence rate in all ages (less than 2 years and more than two years. It has been recorded that a significant increase in FMD infection in animals with age > 1 year than in animals with age < 1 year **(Orabi *et al.*, 2017)**. In contrast to **(Elgioshy *et al.*, 2018)**, where it has been recorded that a significant increase in FMD infection in animals with age > 1 year than in animals with age < 1 year. Non-significant differences were recorded in Prevalence rate with type of production, dairy and fattening cattle. . This result did not coincide with what happened in the Netherlands outbreaks in 2001 wherefrom field observations in 2001 and experimental work with the field strain it was noticed that veal calves did not show clear signs of FMD, whereas dairy cows did **(Orsel and Bouma 2009)**.

Secondary study data obtained from **(Wahis OIE)** was clarified in (Table 8), the total positive FMD notified outbreaks by **(Wahis OIE)** according to the investigated epidemiological unit during 2006-2018 reached 531. In 2006 notification reached 30 outbreaks followed by 6 years of low numbers of notifications. In 2006 Serotype A incursion in Egypt affected >7,500 animals and 411 cattle (mainly calves) reportedly died **(Knowles *et al.*, 2007)**. Meanwhile, the SAT2 serotype epidemic in 2012 was firstly notified in the SAT2 crises. **(FAO 2012)** reported that the Ministry of Agriculture in Egypt announced that the number of suspected FMD cases was estimated to be over 40,000 cattle and buffalo, and 4,658 animals, mostly calves, have already died. Current results confirmed increased numbers of outbreaks from 2012 to 2017 reached 116 outbreaks.

Cumulative annual seropervellance of the 3 serotypes of FMD circulating in Egypt (A, O, SAT2) during 2012-2018 was illustrated in (Table 9 a), the highest total Prevalence rate of 45% was for Serotype O during study period , where it was predominant during 2014- 2017 with percent 50, 65, 77, and 94 respectively. Current findings were agreed with the results of **(Ghoneim *et al.*, 2010)** where, Serotype O has been the predominant one, while type A has been controlled by vaccination. Results revealed serotype A was the lowest total Prevalence rate 18% with a maximum recorded 90, 35 % in 2013, 2015 respectively. Serotype SAT2 emerged in 2012 with a Prevalence rate of 78% and in 2018 was 90%. SAT2 serotype was prevalent in 2012, 2014, 2018 with percent (78, 30, and 90 respectively) with total Prevalence rate 37%. The distribution of reported circulating serotypes investigated in 21 governorates were illustrated in (Table 9,b) and revealed that Serotype A reported higher numbers in both AL Dakahlya and AlBuhayra 11 out of a total of 95 (11.57%) Versus the rest of governorates. Serotype O reported a high number in Buhayra, Dakahlya, Bani-swef, and Kafr Elsheik in descending order (34,31,24 , and 12) out of a total 238 (14.29, 13.03, 5.04% respectively). This serotype predominated with recording a higher number of the three circulating FMD serotypes investigated in 21 governorates, 238 out of a total 531 (44.82%). Serotype SAT 2 reported a high number in ALdakahlya, Alminufya, Kar-Elsheikh, and Al Buhayra (30, 22, 16, 15) out of a total 198 (15.15, 11.11.8.08, 7.58% respectively).

The obtained results previously recorded by **(Brito *et al.*, 2015)**, FMDV serotypes O, A, and the South African Territories (SATs) are the most circulated serotypes in the continent. Serotype O is the most widely distributed in eastern and western Africa followed by A, while SAT's virus is mostly found in the southern region. These attacks with different serotypes during the study period and reported outbreaks by Wahis OIE was confirmed also by **(Abdel-Rahman, 2020)**, they mentioned that, from 2012 to 2018, FMD outbreaks have struck cattle and buffaloes in different localities of Egypt exerting severe economic losses to livestock industries. The spatial distribution of the FMD in Egypt (Upper Egypt, Delta, Suez Canal, and Desert regions) was illustrated in (Table 10). Delta region showed the highest 337 confirmed epidemiological unit out of 531 (83.47%). This result was coincided with **(Ahmed *et al.*, 2012)** where, during 2012, there has been a dramatic upsurge in FMD SAT 2 outbreaks in Egypt. Initial cases were recognized in the Delta Governorates (Gharbia and Sharkia).

The upper region showed lower notifications number than Delta as only reported through 2014-2016 (23, 34, and 23 respectively). Suez recorded 42 epidemiological unit, while the lowest number recorded in the desert 26 epidemiological unit.The highest spatial distributions recorded in the Delta region for 6 continue years 2012-2018. However, understanding the outbreak dynamics, endemic serotypes, and lineage profiles of FMD is very critical in designing control and prevention programs. **(Wubshet *et al.*, 2019)**.

Temporal distribution of FMD clarified in (Table 11), the highest recorded outbreaks were in spring 213 followed by winter 203 and the lowest was in summer 46. The disease spread in winter during 2013-2018 with the highest number 75 in 2017. In autumn disease spread during 2014, 2015, and 2018 with the highest 21 in 2018. During summer disease spread 10 only through 2015. During spring, disease distributed in 2012, 2014-2018 with highest number 49 in 2012 from mentioned results it's noticed that more spatial distribution was recorded in spring 213 epidemiological unit despite the highest epidemiological unit in all sessions was recorded in winter 75 in 2017.

CONCLUSION

the identified causes and risk factors associated with the FMD endemicity in Egypt was vaccination of cattle, low level of biosecurity, lack of farmer's awareness about disease vaccination necessity, uncontrolled markets, and movement, geographic distribution, season impact mainly spring. .

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Conflict of interest:

The authors declare that they have no competing interests.

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Table (1): Prevalence rate of FMD in different Egyptian governorates (January- December 2017)

Governorate	No. of examined cattle	FMD clinically manifested cases		Odds ratios (95% CI)
		No.	Prevalence rate %	
Aswan	**84**	**9**	**11**	**1.04 (0.8-2.8)**
Assuit	**8**	**2**	**25**	**1.0**
Bani-swef	**5**	**3**	**60**	**1.0**
Beheyra	**23**	**11**	**48**	**6.3 (0.8-12)**
Dakahlia	**33**	**7**	**21.2**	**19.1 (15.5-22.5)**
Domyat	**6**	**2**	**33.3**	**1.0**
El-wadi El-gedeed	**11**	**2**	**18**	**1.0**
Fayom	**327**	**38**	**12**	**8.9 (1.3-16.5)**
Gharbia	**21**	**11**	**52.3**	**19 (13.5-24.5)**
Giza	**30**	**8**	**27**	**38 (34-42)**
Ismalia	**3**	**1**	**33.3**	**1.0**
Kafr el-sheikh	**128**	**24**	**19**	**1.5 (1.5-4.5)**
Kalyobia	**64**	**20**	**31.2**	**2.7 (1.2-6.7)**
Louxer	**10**	**5**	**50**	**1.4 (0.2-3.1)**
Menofia	**54**	**12**	**22.2**	**2.6 (0.4-5.5)**
Menya	**13**	**3**	**23**	**1.0**
Port-said	**177**	**35**	**20**	**13 (4.5-22)**
Quena	**4**	**2**	**50**	**1.0**
Sharquia	**59**	**16**	**27**	**2 (1-5.4)**
Sohag	**3**	**1**	**33.3**	**1.0**
Suez	**134**	**3**	**2.2**	**1.0**
Total	**1197**	**215**	**18**	**4.9 (5.3-15.1)**

Table (2): Prevalence % of (FMD) In Egypt during Different Seasons In 2017.

Season	No. of examined Cattle	FMD clinically manifested cases		Odds ratios (95%CI)
		No.	Prevalence %	
Winter	980	143	14.5	1.4 (2.4-5.3)
Spring	15	14	93.3	11.7 (7-16.4)
Summer	86	23	26.7	2.1 (1.1-5.5)
Autumn	116	35	30	1.1 (1.6-3.8)

Variables	Status	FMD clinically manifested cases		Odds ratios (95%CI)	P value
		No.	Prevalence rate %		
Market	Near	189	88	1.2 (2.8-5.1)	0.01*
	Away	26	12	1 (1.2-3.1)	
Owner last days Market visiting	Visit	206	96	1 (2.6-4.6)	0.003**
	Not Visit	9	4	5 (2-8)	

Table (3): Effect of market location and owner movement activities on the diagnosed cattle with (FMD) in different governorates (n=215).

Possible source of transmission	**Market**	**159**	**74**	**1.3 (2.4-5.3)**	**0.03***
	Rearing	**29**	**13.4**	**2 (3.6-5.6)**	
	Neighbor	**27**	**12.5**	**1.4 (1.3-4.1)**	

***= highly significant differences (P≤0.01)**

****= insignificant differences (P≥0.05) by using T. test and F. factor**

Variable	Status	FMD positive cases		(95%CL)	P value
		No.	%		
Housing	**Open system**	**166**	**77.2**	**1.2(2.5-5)**	**0.03***
	Closed system	**39**	**18**	**0.8(1.7-3.4)**	
Grazing	**Yes**	**78**	**36**	**0.9(2-3.7)**	**0.06***
	No	**144**	**67**	**1.6(4.2-5.8)**	
Drinking	**Tap water**	**213**	**99**	**1(2.6-4.6)**	**-**
	Water canals	**2**	**1**	**1.0**	
Type of nutrition	**Barseem**	**69**	**32**	**1.1(2.1-4.2)**	**0.1**
	Concentrates	**57**	**26.5**	**2.5(1.3-6.3)**	
	Mixed	**89**	**41**	**1.8(5.7-2)**	
Mixed rearing	**Cow only**	**111**	**52**	**1.4(5-2.1)**	**0.1**
	Cows+ buffaloes	**83**	**38.6**	**1.7(1.9-5.3)**	
	Cows+ sheep	**21**	**9.7**	**2.3(1.2-5.7)**	

Variable	Status	FMD positive cases		(95%CL)	P value
		No.	%•		
Sharing instruments	**No**	**53**	**24.6**	**4.1(1.2-9.4)**	**0.04 ***
	Yes	**162**	**75**	**0.8(2.4-4.1)**	
Cleaning	**No**	**192**	**89**	**1(2.4-4.4)**	**0.08***
	Yes	**23**	**11**	**4.8(1-10.5)**	
Isolation of diseased animal	**No**	**208**	**97**	**1(2.6-4.7)**	**0.01****
	Yes	**7**	**3**	**1.4(0.9-3.8)**	
Awareness about the disease	**No**	**181**	**84**	**0.8(2.4-4)**	**0.04***
	Yes	**34**	**16**	**17.6(6-29)**	
Personal hygiene	**No**	**215**	**100**	**0.9(2.6-4.5)**	**--**
	Yes	**0**	**-**	**-**	
Carcass disposal	**Throw**	**215**	**100**	**0.9(2.6-4.5)**	**--**
	Burry	**0**	**-**	**-**	
Vaccination	**No**	**175**	**81**	**1.2(2.5-4.8)**	**0.02***

Table (4): Livestock Husbandry and Rearing Procedures Associated With the Diagnosed Cattle for (FMD) In Different Governorates (n=215)

Table (5): Biosecurity procedures adopted in the infected farms with FMD.

Table (6): Breeds, Number of Animals, and vaccination in Large Scale Diagnosed Farms

Farm No.	Total # Animal	No .Of Diseased	Type Of Production	Vaccination	Breed	Prevalence %
1	2000	98	Dairy	Not regular	Frisian	4
2	1700	35	Dairy	Regular		2
3	450	50	Fatting	Regular		11

Table (7): Effect of age and type of production on prevalence rate of FMD in different governorates (n=215).

Variable	Status	FMD positive cases		Odd ratio (95%CL)	P value
		No.	Prevalence %		
Age	Less than 2 years	127	59	1.5 (3.6-5.2)	0.1
	More than 2 years	88	41	1 (2.6-4.6)	
Type of production	Dairy	123	57	0.7 (2.6-4)	0.1
	Fattening	92	43	2.3 (1.6-6.3)	

Table (8) : Total FMD Outbreaks Recorded During 2006-2018 in Epi. Units

Year	FMD outbreaks
2006	30
2008	1
2009	8
2012	67
2013	40
2014	69
2015	73
2016	53
2017	116
2018	74
Total	531

Table (9 a): Annual FMD Serotypes Prevalence during 2012-2018

Year	Prevalence% of Serotype (A)	Prevalence % of Serotype (O)	Prevalence % of Serotype (Sat2)
2012	7	15	78
2013	90	10	0
2014	17	54	30
2015	35	65	0
2016	14	77	9
2017	0	94	6
2018	8	2	90
Total	18	45	37

Prevalence %= (Total number serotype / Total detected serotypes) × 100