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Quantification of risk factors of coccidiosis in broilers by using logistic regression analysis*

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Summary: The aim of this research was to determine the most efficient risk factors on broiler coccidiosis in Turkey. The study was performed in 1110 broiler chickens housed in 817 farms located in six geographical region of Turkey between September 2006 and September 2007. Survey questionnaires were held and faecal samples were collected from broiler flocks. Survey results were combined with laboratory findings. A logistic regression analysis was used to assess variables that influenced the occurrence of Coccidiosis. Firstly, simple logistic regression was performed for each variable by using presence or absence criteria of coccidiosis. Then, variables that were associated with coccidiosis-positive flocks at P value of ≤ 0.25 were included in multivariable logistic regression. In the present study, clinical or subclinical coccidiosis ratio was determined to be 56.2% in the analysis of the faeces samples. The multivariate logistic regression model for coccidiosis was completed in 10th step by using the backward elimination procedure. Overall classification ratio of final model was determined to be 87.3%. The results showed an enhanced risk of coccidiosis due to environmental and management factors such as season, number of chick house, age of chick, type of ventilation system, roof isolation, litter materials, having a type of farmyard which is easy to clean, time between production periods, leaving litter material to a safe distance after production period, presence of vermin, climate regulation and other diseases which might facilitate introduction of the parasite.

Keywords: Broiler, coccidiosis, logistic regression analysis, odds ratio, risk factors

Broiler coccidiosis'inde risk faktörlerinin lojistik regresyon analizi ile belirlenmesi *

Özet: Bu çalışmada, Türkiye'de broiler Coccidiosis'inde etkili risk faktörlerinin belirlenmesi amaçlanmıştır. Çalışmanın gerecini, Türkiye'nin altı coğrafi bölgesinden seçilen toplam 817 çiftlikte bulunan 1110 kümes oluşturmuştur. Eylül 2006-Eylül 2007 tarihleri arasında ziyaret edilen kümeslerde anketler uygulanmış ve dışkı numuneleri toplanmıştır. Anket verileri, toplanan numunelerden elde edilen laboratuvar sonuçları ile birleştirilmiştir. Coccidiosis ile ilişkili değişkenlerin belirlenmesinde lojistik regresyon analizi kullanılmıştır. İlk olarak tüm değişkenler üzerine tek değişkenli lojistik regresyon analizi uygulanarak Coccidiosis ile ilgili değişkenler belirlenmiştir (p≤0,25). Bu değişkenler, çok değişkenli modelde kullanılmıştır. Çalışma sonucunda, Türkiye genelinde ziyaret edilen 1110 kümesten alınan dışkı örneklerinin analizi sonucunda kümeslerin % 56,2'sinde klinik veya subklinik boyutta Coccidiosis saptanmıştır. Çok değişkenli lojistik regresyon analizinde geriye doğru değişken çıkarma yöntemi kullanılmış ve 10 adımda sonlanmıştır. Final modelin Coccidiosis doğru tanı oranı %87,3 olarak belirlenmiştir. Elde edilen final modelde yer alan; "mevsim, çiftlikteki kümes sayısı, etlik pilicin yaşı, havalandırma sistemi, çatı izolasyonu, altlık materyali, iki yetiştirme dönemi arasındaki süre, altlık materyalinin güvenli bir uzaklığa atılması, kümeste giriş odasının olması, kümes çevresi veya içinde kemirgenlerin varlığı, kümes içi havanın durumu ve piliçlerin Coccidiosis dışında başka bir salgın hastalık geçirmesi veya geçirmekte olması" değişkenlerinin Coccidiosis için önemli risk faktörü olduğu belirlenmiştir.

Anahtar sözcükler: Broyler, koksidiyozis, lojistik regresyon, odds oranı, risk faktörleri

Introduction

Coccidiosis, caused by *Eimeria* species classified under the *Apicomplexa* phylum, is a protozoan disease that affects many vertebrate species mainly poultry and is known to result in serious economic loss in both worldwide and Turkey. The resistance of the causative agents to the environment as well as the easy transmission and the high prevalence of the parasites have complicated the development of an effective strategy for the solution of the problem. In view of the resultant economic loss, an effective and reliable protection and control program is required for successful combating of the disease especially with regard to poultry breeding, an industry directly linked to human health (2,7,10,15).Therefore, aim of this research was to determine the most important risk factors in poultry coccidiosis.

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Materials and Methods

The study sample consisted of 1110 broiler flocks housed in 817 farms (about 12% of all broiler farms in Turkey) located in different regions of Turkey. The study was limited by the flocks that were visited between September 2006 and September 2007.

In the present study; survey researches was held and faecal samples were collected from broiler flocks. Survey results were combined with laboratory findings. A certain flock was considered as a case when at least one bird in that flock showed microscopic presence of oocysts in faecal samples in a grow-out cycle. Other flocks were defined as controls. Finally, the risk factors, which were revealed to be effective on poultry coccidiosis, were calculated.

Logistic regression analysis was used to assess variables that influenced the occurrence of Coccidiosis. This was done by using SPSS version 14.01. Firstly, simple logistic regression was performed for each variable by using presence or absence criteria of coccidiosis. Secondly, variables that were associated with coccidiosis-positive flocks at $p \leq 0.25$ were used in multivariate logistic regression (6).

In the multivariate model, variables were excluded from the model by a backward elimination procedure. The least-significant variable based on the Wald's statistic was deleted and the model was refitted. Then the results were then compared both parameter estimates and difference in -2 log likelihood of the model with those of the previous run to check for confounding effects. With a change in parameter estimates of more than 30%, the deleted variable was considered to be a confounder and included in the model again. This resulted in a model containing variables related to the presence of coccidiosis ($p < 0.10$).

Results

Coccidiosis in broilers causes great economic losses due to high rate of morbidity, mortality, poor weight gain, and lower feed conversion.

In the present study, it was determined that the use of anticoccidials for coccidiosis did not prevent completely and it appears epidemically as subclinical infections. Clinical or subclinical coccidiosis ratio was determined as 56.2% in the analysis of the faeces samples.

While preparing survey forms, criteria related to chick house and management fabrics, breeding type, breeder, etc. that can be effective on arising and spreading of coccidiosis in broiler breeding enterprises and related farms were taken into consideration. Survey form was designed in multiple classification questioned groups. Appraised of 1110 chick houses was made according to the results of the coccidiosis as having or not having the disease. Variables were considered to be related with coccidiosis examined by using simple logistic regression analysis and then variables with frequency distribution and coccidiosis prevalence per category. Prevalence (P) is the number of flocks with the coccidiosis in a known population at a designated time. It can be expressed as follows: P=Number of flocks having coccidiosis at a particular € time/ Number of flocks the population at risk that € time. Odds ratios (OR) with 95% confidence intervals were calculated for each groups (see Table 1-7).

The results of the multivariate logistic regression for coccidiosis were presented in Table 8. The backward elimination procedure was completed in 10th step. Variables such as season, number of chick house, age of chick, type of ventilation system, roof isolation, litter materials, empty period, throw away of used litter materials, having a type of farmyard which is easy clean, presence of vermin, climate regulation and other diseases were included in the model whereas the other variables were excluded from the model in previous steps. By using the Hosmer-Lemeshow goodness of fit statistics, formed at the end of the 10th step, Chi-Square value was calculated as 3.28; related significance value as 0.916; models Pseudo R^2 (Nagelkarke R^2) value as 0.687 and model's overall classification ratio as 87.3% (Figure 1).

Table 1. Season and region variables with count, percent (%), prevalence (P) per category and odds ratios (OR) with 95% confidence interval

Tablo 1. Mevsim ve coğrafi bölge değişkenlerinin kategorilere göre sayı, yüzde(%), prevalans (P) ve %95 güven aralığında odds oranları.

Variable	Category	Count	Percent (%)	P (%)	OR	95% C.I for OR
Season	• Spring	236	21.3	51.7	Ref.	-
	• Summer	160	14.4	70.6	1.07	0.78-1.47
	• Autumn	245	22.1	63.3	2.41	1.64-3.55
	• Winter	469	42.3	49.9	1.73	1.26-2.37
Region	• Eastern Anatolia	134	12.1	56.0	Ref.	-
	• Central Anatolia	488	44.0	62.1	24.15	3.14-185.67
	• Black Sea	225	20.3	64.0	31.12	4.13-234.39
	• Marmara	125	11.3	48.8	33.79	4.44-256.98
	• Aegean	118	10.6	33.9	18.10	2.35-139.44
	• Mediterranean	20	1.8	5.0	9.74	1.26-75.44

Table 2. Explanatory variables with count, percent (%), prevalence (P) per category and odds ratios (OR) with 95% confidence interval for group of chick house and equipment.
Tablo 2. Kümes ve ekipman değişkenlerinin kategorilere göre sayı, yüzde(%), prevalans (P) ve %95 güven aralığında odds oranları.

Variable	Category	Count	Percent (%)	P (%)	OR	95% C.l for OR
Number of chick houses	• >1	633	57.0	62.6	Ref.	-
	• =1	477	43.0	47.8	1.82	1.43-2.32
House type:	• Semi-intensive	343	68.9	56.1	Ref.	-
	• Intensive	761	31.1	57.4	1.05	0.82-1.36
House age	• >10	667	62.5	55.2	Ref.	-
	• ≤10	401	37.5	56.6	0.94	0.73-1.21
House size	• >1000m^2	781	70.4	57.2	Ref.	-
	• ≤1000m^2	329	29.6	53.8	1.15	0.88-1.49
Number of broilers	• >15000	721	65.0	57.8	Ref.	-
	• ≤15000	389	35.0	53.2	1.21	0.94-1.54
Age of broilers	• Continuous	-	-	-	1.19	1.17-1.22
Genotype of broilers:	• Ross308	1078	97.0	56.3	Ref.	-
	• Isa Hubbert	32	2.9	56.2	1.00	0.49-2.03
Drinking water System	• Nipple	530	50.7	53.6	Ref.	-
	• Hanging	10	48.4	58.9	1.24	0.97-1.56
	• Cup	556	0.9	60.0	1.29	0.36-4.65
Drinking water type	• Spring water	408	62.8	57.0	Ref.	-
	• Tap water	688	37.2	54.7	0.91	0.71-1.16
Clor or acid adding to drinking water	• Yes	533	49.3	56.7	Ref.	-
	• No	548	50.7	56.9	1.01	0.79-1.28
Homogeneous distribution of equipment in chick house	• Yes	794	72.4	55.0	Ref.	-
	• No	302	27.6	59.9	1.22	0.93-1.60
Heating system	• Central heating	602	54.3	54.2	Ref.	-
	• Stove	506	45.7	58.7	1.20	0.94-1.53
Ventilation system	• Natural-Mechanical	391	35.4	44.5	Ref.	-
	• Natural	165	15.0	58.8	1.78	1.23-2.57
	• Mechanical	548	49.6	63.7	2.18	1.67-2.85
Windows and chimneys have wire isolation	• Yes	873	90.7	55.4	Ref.	-
	• No	90	9.3	71.1	1.98	1.23-3.18
Floor isolation	• Yes	1038	96.0	54.9	Ref.	-
	• No	43	4.0	76.7	2.65	1.29-5.44
Roof isolation	• Yes	901	82.6	54.4	Ref.	-
	• No	190	17.4	64.2	1.50	1.08-2.08
Litter materiel	• Wood Shavings	390	35.4	47.4	Ref.	-
	• Straw	48	4.4	60.4	1.69	0.92-3.12
	• Rice hulls	663	60.2	60.9	1.73	1.43-2.22
Type of light used for illumination	• Fluorescent	165	15.2	63.6	Ref.	-
	• Incandescent Lamp	918	84.8	54.6	1.45	1.03-2.05
Having a type of farmyard which is easy clean	• Yes	662	61.2	48.8	Ref.	-
	• No	419	38.8	67.5	2.18	1.69-2.82

Table 3. Explanatory variables with count, percent (P), prevalence (%) per category and odds ratios (OR) with 95% confidence interval for group of flock management.
Tablo 3. Sürü idaresi değişkenlerinin kategorilere göre sayı, yüzde(%), prevalans (P) ve %95 güven aralığında odds oranları.

Variable	Category	Count	Percent (%)	P (%)	OR	95% C.l for OR
Hot stress (House temperature>30 C)	• Yes	84	7.6	54.8	Ref.	-
	• No	1024	92.4	56.3	1.06	0.68-1.66
Time between production periods (Resting Period)	• >15days	1066	96.0	55.8	Ref.	-
	• ≤15 days	44	4.0	65.9	1.53	0.81-2.88
Disinfection of chick houses	• Commercial firms	145	13.1	53.8	Ref	-
	• Owner	267	24.2	51.7	1.31	0.99-1.75
	• Poultry company	694	62.7	58.5	1.08	0.72-1.63
Collection of dead broilers and suitable elimination daily	• Yes	1016	92.5	56.1	Ref.	-
	• No	82	7.5	56.1	1.00	0.63-1.57
Using special clothes and boot for houses	• Yes	406	36.6	57.6	Ref.	-
	• No	703	63.4	55.5	0.91	0.71-1.17
Presence of disinfectant on entrance of houses	• Yes	616	55.6	56.8	Ref.	-
	• No	492	44.4	55.7	0.95	0.75-1.21
Amount of litter in m^2	• > 3 kg	784	71.0	54.0	Ref.	-
	• ≤ 3 kg	320	29.0	62.5	1.42	1.09-1.85
Scattering of lime after litter change	• Yes	409	37.1	55.0	Ref.	-
	• No	692	62.9	57.4	1.10	0.86-1.41
Leaving litter materiel to a safe distance after production period	• Yes	890	81.4	54.0	Ref.	-
	• No	204	18.6	66.8	1.86	1.34-2.57

Table 4. Explanatory variables with count, percent (%), prevalence (P) per category and odds ratios (OR) with 95% confidence interval for group of flock health and Coccidiosis control methods.
Tablo 4. Sürü sağlığı ve Coccidiosis kontrol yöntemleri değişkenlerinin kategorilere göre sayı, yüzde(%), prevalans (P) ve %95 güven aralığında odds oranları.

Variable	Category	Count	Percent (%)	P (%)	OR	95% C.l for OR
Number of visits of veterinarian during flock cycle	• ≤once a week	295	26.9	48.1	Ref.	-
	• < once a week	800	73.1	59.0	1.55	1.18-2.03
Personnel who might be also working on other farms	• No	751	69.2	50.9	Ref.	-
	• Yes	334	30.8	58.9	1.38	1.06-1.79
Admittance of visitors	• Only veterinarian	209	18.8	51.7	Ref.	-
	• Veterinarian -advisor	574	51.7	53.8	1.09	0.77-1.54
	• Veterinarian-advisor-others	327	29.5	59.2	1.36	0.98-1.86
Use of medicine	• Yes	569	63.5	51.5	Ref.	-
	• No	327	36.5	52.9	1.058	0.806-1.39
In case of occurrence of coccidiosis	• Nothing	275	24.8	61.8	Ref.	-
	• Medicine application	788	71.0	54.3	0.73	0.55-0.97
	• Increasing hygiene rules	47	4.2	55.3	0.76	0.41-1.42
Other disorders	• No	964	86.8	53.2	Ref.	-
	• Yes	146	13.2	76.0	2.78	1.87-4.16

Table 5. Explanatory variables with count, percent (%), prevalence (P) per category and odds ratios (OR) with 95% confidence interval for group of environment.
Tablo 5. Çevre değişkenlerinin kategorilere göre sayı, yüzde(%), prevalans (P) ve %95 güven aralığında odds oranları.

Variable	Category	Count	Percent (%)	P (%)	OR	95% C.l for OR
Other chick house nearby	• Yes	841	78.0	54.9	Ref.	-
	• No	237	22.0	59.1	1.18	0.88-1.58
Presence of vermin	• No	244	22.2	45.5	Ref.	-
	• Yes	856	77.8	58.8	1.71	1.28-2.27
Struggle against vermin	• Yes	716	64.8	58.8	Ref.	-
	• No	389	35.2	51.2	1.36	1.063-1.74
Other poultry animals	• No	992	89.9	56.6	Ref.	-
	• Yes	111	10.1	55.0	0.93	0.63-1.39
Destruction hole for dead chicks	• No	183	16.5	59.6	Ref.	-
	• Yes	925	83.5	55.6	0.85	0.61-1.17

Table 6. Explanatory variables with count, percent (%), prevalence (P) per category and odds ratios (OR) with 95% confidence interval for group of Farmer Characteristics
Tablo 6. Yetiştirici bilgilerinin kategorilere göre sayı, yüzde(%), prevalans (P) ve %95 güven aralığında odds oranları.

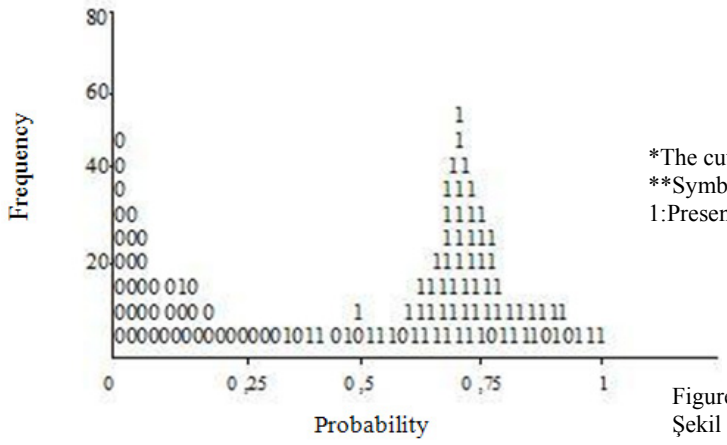
Variable	Category	Count	Percent (%)	P (%)	OR	95% C.l for OR
Personel type	• Worker	255	29.6	55.3	Ref	-
	• Owner	606	70.4	58.4	1.31	0.97-1.75
Educational level	• University	53	5.3	39.6	Ref.	-
	• Secondary school	254	25.5	57.1	2.02	1.14-3.57
	• Elementary school	688	69.2	57.0	2.03	1.11-3.71
İnformation about Coccidiosis	• Yes	164	14.8	42.7	Ref.	-
	• No	943	85.2	58.7	1.91	1.36-2.67

Table 7. Explanatory variables with count, percent (%), prevalence (P) per category and odds ratios (OR) with 95% confidence interval for group of Conditional Information
Tablo 7. Durum bilgilerinin kategorilere göre sayı, yüzde(%), prevalans (P) ve %95 güven aralığında odds oranları.

Variable	Category	Count	Percent (%)	P (%)	OR	95% C.l for OR
Presence of diarrhea	• No	499	54.8	47.7	Ref.	-
	• Yes	411	45.2	64.7	2.01	1.54-2.63
Hemorrhage in faeces	• No	520	63.3	49.0	Ref.	-
	• Yes	301	36.7	65.4	1.97	1.46-2.64
Litter condition	• Dry	300	38.8	41.3	Ref.	-
	• Moistly	374	48.4	59.6	2.09	1.32-3.32
	• Wet	99	12.8	62.3	2.34	1.72-3.20
Climate regulation in the chick house	• Good	322	30.3	45.3	Ref.	-
	• Moderate	607	57.2	58.5	1.69	1.29-2.23
	• Bad	132	12.5	67.4	2.49	1.63-3.81

Table 8. Regression coefficient of variables (β) and related standard error (SE(β)), Wald's statistic (Wald), degree of freedom (df), P significance of Wald's statistic, Odds ratios (OR) and 95 % confidence interval of multivariate logistic model.
Tablo 8. Çok değişkenli lojistik modelde değişkenlerin regresyon katsayıları (β) ve standart hataları (SE(β)), Wald istatistiği (Wald), serbestlik derecesi (df), Wald istatistiğinin önem kontrolü (p), Odds oranı (OR) ve %95 güven aralığı.

Variable	Category	β	SE(β)	Wald	df	p	OR	95% C.I for OR	
								Lower	Upper
Season				5.526	3	0.137			
	Spring(Ref.)						1.000		
	Summer	-0.241	0.397	0.369	1	0.543	0.786	0.361	1.710
	Autumn	0.806	0.412	3.835	1	0.050	2.239	0.999	5.019
	Winter	0.210	0.535	0.154	1	0.695	1.234	0.432	3.521
Number of Chick house	>1(Ref.)						1.000		
	=1	0.872	0.322	7.328	1	0.007	2.392	1.272	4.496
Age of Broilers	Continuous	0.178	0.015	136.719	1	0.001	1.195	1.160	1.231
Type of Ventilation System				13.770	2	0.001			
	Natural and mechanical (Ref.)						1.000		
	Natural	0.647	0.431	2.257	1	0.133	1.910	0.821	4.443
	Mechanical	1.492	0.406	13.509	1	<0.001	4.444	2.006	9.845
Roof isolation	Yes (Ref.)						1.000		
	No	0.827	0.432	3.664	1	0.056	2.287	0.980	5.334
Litter materiel				4.200	2	0.122			
	Wood shavings (Ref.)						1.000		
	Strow	0.696	0.620	1.257	1	0.262	2.005	0.594	6.763
	Rice hulls	0.616	0.316	3.795	1	0.051	1.852	0.996	3.442
Having a type of farmyard which is easy clean	Yes (Ref.)						1.000		
	No	0.811	0.298	7.426	1	0.006	2.250	1.256	4.031
Time between production periods (Resting Period)	>15 days(Ref.)						1.000		
	≤15 days	1.602	0.572	7.833	1	0.005	4.962	1.616	15.233
Leaving litter materiel to a safe distance after production period	Yes (Ref.)						1.000		
	No	0.699	0.373	3.503	1	0.061	2.011	0.968	4.179
Other disorders	No (Ref.)						1.000		
	Yes	2.070	0.443	21.839	1	<0.001	7.921	3.325	18.869
Presence of vermin	No (Ref.)								
	Yes	1.062	0.395	7.237	1	0.007	2.893	1.334	6.271
Climate regulation in the chick house				5.472	2	0.065			
	Good(Ref.)						1.000		
	Moderate	0.654	0.472	1.924	1	0.165	1.924	0.763	4.849
	Bad	1.256	0.562	5.005	1	0.025	3.512	1.168	10.558
Constant		-8.818	.966	83.415	1	<0.001	<0.001		



*The cut value is 0.50
**Symbols: 0: Absence
1:Presence; Each symbol represents 10 cases.

Figure 1. Observed Groups and Predicted Probabilities
Şekil 1. Gözlenen gruplar ve tahmini olasılıklar

In conclusion, this model could be used for determination of risk factors as it is not only biologically acceptable, but also gives well accurate predicted classification of cases.

Discussion and Conclusion

Infections occur more often in autumn and winter, as indicated by Braunius (1) and Graat et al. (4). Medication, additional to routine incorporation in the feed was associated with the presence of coccidiosis. In contrast to the results of Henken et al. (5), the presence of other disorders was associated with the occurrence of coccidiosis. In a study by Giambrone et al. (3) broilers became more susceptible to *Eimeria tenella* after infection with infectious bursal disease (IBDV).

Previous studies have shown interaction between *Eimeria* and *Salmonella* (9,11,13,14) reviewed the interaction with *Escherichia coli. Salmonella* viruses Marek's disease. Since coccidial species are ubiquitous, it is important to know about their relationships with other diseases, especially regarding to whether coccidial infections are predisposing for zoonoses (e.g.. *Salmonella).*

In contrast to the findings of Graat et al. (4), the presence of vermin shows an increasing (stimulatory) effect on Coccidiosis. Questionnaires asked whether there were any problems with vermin on the farm. If so, what had been done to combat it? It is possible that farmers with a high awareness of the problems of vermin carry out other kinds of management than farmers who are not as aware, and give high priority to sanitary measures.

The results showed an enhanced risk of coccidiosis due to environmental and management factors such as type of ventilation system, roof isolation, litter materials, and leaving litter material to a safe distance after production period, having a type of farmyard which is easy to clean, bad hygienic status, presence of vermin on the farm, time between production periods, climate regulation in the chick house which might facilitate introduction of the parasite or which might be related to hygienic measures. Most of these are already known risk factors for coccidiosis. However, this study has quantified the relative importance of these factors and might be useful to establish priorities for management advisory and intervention programs for the control of the disease. Crucial association that was found was the increased risk of coccidiosis when the previous time flock was infected.

Currently, emphasis is placed on developing new animal health/risk management strategies. In these strategies, risks of introduction, transmission and emission of pathogens within and between farms have to be identified and quantified. Although such programs have been developed to prevent zoonoses, they are useful for reducing occurrence of all diseases and improving animal health in general. One important fact is that, herd health is not only affected by on-farm management. All goods (e.g.feedstuffs) and services (e.g.veterinarian) purchased by the farmer are potential risks for the introduction of disease agents (8).

Finally, in a case-control study, it is difficult to demonstrate causality (12). This was obvious in this study with the following variables: association of coccidiosis with the presence of other disorders, season, type of ventilation system, roof isolation, climate regulation in the chick house litter materials and leaving litter material to a safe distance after production period. Biosecurity measures and good hygienic practice can reduce coccidiosis.

Unexplained or strange associations (e.g. healing system, windows and chimneys have wire isolation, floor isolation, type of light used for illumination, amount of litter in m^2, number of visits of veterinarian during flock cycle, personnel who might be also working on other farms, educational level of farmers and information about coccidiosis, presence of diarrhea, haemorrhagi in faeces, litter condition) might be due to random error (especially if a large number of factors was screened), confounding or imperfect biological knowledge.

This findings of the present study may help control the widely spread menace of coccidiosis and biosecurity measures and good hygienic can reduce coccidiosis.

This multivariate logistic regression model is only a sample model for these type researches. In future, new models could be fitted using different appropriate independent variables for determining risk factors for Coccidiosis.

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References

1. **Branius WW** (*1987)*: *Some aspect of epidemiology and control of coccidiosis in broilers.* Ph.D. Thesis, Faculty of Veterinary Medicine, State University of Utrecht, Utrecht, Netherlands.
2. **Davies SFM, Joyner LP, Kendal, SB** *(1963)*: *Coccidiosis.* 306-307. Oliver and Boyd, Edinburg and London.
3. **Giambrone JJ, Anderson WI. Reid WM, Eidson CS** *(1977)*: *Effect of infectious bursal disease on the severity of Eimeria tenella infections in broiler chicks.* Poult Sci, **56**, 243-246.
4. **Graat EAM, Van Der Kooij E, Frankena K, Henken AM, Smeets JFM, Hekerman MTJ** *(1998)*: *Quantifying Risk Factors of Coccidiosis in Broilers Using on Farm Data Based on a Veterinary Paractice.* Pre Vet Med, **33**, 249-308.

5. **Henken AM, Goelema JO, Neijenhuis F, Ventommen MH, Van Den Bos J, Fris C** *(1992)*: *Multivariate epidemiological approach to coccidiosis in broilers.* Poult Sci, **71**, 1849-1856.
6. **Hosmer DW, Lemeshow. S** *(2000)*: *Applied Logistic Regression.* 1-30. John Wiley and Sons Inc, Second Ed., New York.
7. **Levine ND** *(1985)*: *Veterinary Protozoology.* Iowa State University Pres, First Ed., Ames, Iowa.
8. **Noordhuizen JPTM, Welpelo HJ** *(1996)*: *Sustainable improvement of animal health care by systematic quality risk management.* Vet Q, **18,** 121-126.
9. **Qin ZR, Arakawa A, Baba E, Fukata T, Miyamoto T, Sasai K, Withanage GSK** *(1995)*: *Eimeria tenella infection induces recrudescence of previous Salmonella enteritidis infection in chickens.* Poult Sci, **74**, 1786-1792.
10. **Pellerdy L** *(1965)*: *Coccidia and Coccidiosis.* 235-287. Akademia Kiado, Budapest.
11. **Ruff. MD** *(1989)*: *Interaction of avian coccidiosis with other diseases*; a review. In: P. Yvore (ed.). Coccidia and Intestinal Coccidiomorphs, Proceedings of V.th International Coccidiosis Conference, INRA Tours, France, pp. 173-181.
12. **Rothman KJ** *(1986)*: *Modern Epidemiology*. Little Brown and Company, Boston.
13. **Takimoto H, Baba E, Fukata T, Arakawa A** *(1984)*: *Effects of infection of Eimeria tenella. E. aceruulina. and E. maxima upon Salmonella typhimurium infection in chickens*. Poult Sci, **63**, 478-484.
14. **Tellez GI, Kogut MH, Hargis BM** (1994): *Eimeria tenella or Eimeria adenoeides: induction of morphological changes and increased resistance to Salmonella enteritidis infection in Leghorn chicks*. Poult Sci, **73**, 396-401.
15. **Voeten AC** *(1987)*: *Coccidiosis: a problem in broilers.* 410-422. In: Verstegen, M.W.A., Henken AM. (eds.). Energy Metabolism in Farm Animals: Effects of Housing, Stress and Disease. Martinus Nijhoff, Dordrecht.

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