Research Article

Prevalence of Concurrent Infections in Broiler Population of District Chakwal, Pakistan

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Abstract | Broiler population is one of the most important segments of livestock due to its significant contribution in white meat production. Infectious disease outbreaks adversely influence the production potential and consequently cause economic losses. Epidemiological data regarding magnitude of these disease outbreaks is of fundamental importance for planning of a comprehensive control strategy. With retrospective design, this study was conducted from January 2013 through December 2017 in order to assess the disease burden on broilers reared in different open type poultry houses. Out of total 658 commercial farms with capacity of 4221800 broilers, across Chakwal, a representative sample of 70 farms with capacity of 448000 broilers was randomly selected for collection and analysis of disease data. Five years' data of these randomly selected farms revealed highest (44.64%) crude morbidity during monsoon season followed by 23.92%, 22.12% and 17.49% for winter, spring and post-monsoon seasons respectively. The highest (14.90%) prevalence was recorded for new castle disease followed by infectious bursal disease (11.79%), pullorum disease (11.17%), colibacillosis (8.71%), infectious bronchitis (7.87%), inclusion body hepatitis (7.79%), chronic respiratory disease (7.67%), necrotic enteritis (6.48%), coccidiosis (6.09%), mycotoxicosis 5.43%), fowl cholera (4.74%), infectious coryza (4.41%), fowl typhoid (4.22%), omphalitis (3.71%) and hydropericardium syndrome (0.05%). Maximum share in crude morbidity was contributed by bacterial diseases with highest proportional morbidity of 48.68% followed by viral (40.32%), parasitic (5.80%) and fungal (5.20%) diseases. This epidemiological data represents true picture of study population and is a valuable tool for planning of prevention strategy and research priorities.

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Introduction

Commercial poultry is one of the most important segments of livestock sector in Pakistan. It is acting as balancing force by keeping check on red meat prices as 31% of the total meat produced in Pakistan is from poultry sector. An investment of approximately 700 billion rupees has been reported in commercial poultry during the financial year 2016-2017 and almost 1.5 million people depend directly or indirectly on this industry for their livelihood (Hussain *et al.*, 2015).

Among major factors affecting production of commercial poultry, disease load is a potent threat affecting a considerable segment of this sector every year. The profitability in this sector can't be achieved without effective disease prevention and control as huge economic losses have been reported to be associated with different viral, bacterial fungal and parasitic diseases (Silva *et al.*, 2015). During recent years, viral diseases caused high morbidity and mortality leading to huge economic losses (Abbas *et al.*, 2015).

According to previous reports, New castle disease (ND), fowl pox, infectious bronchitis (IB), Hydropericardium syndrome (HPS), colibacillosis, Fowl typhoid, chronic respiratory disease (CRD) and coccidiosis are most important diseases which considerably affect the commercial poultry (Ahmed *et al.*, 2007).

The atmospheric and seasonal changes significantly influence the disease incidence. During extreme hot or cold weather, birds undergo stress and ability of their immune system to combat invading infectious agents is seriously affected. Humid, rainy and cold seasons favour the transmission and spread of pathogens leading to increased morbidity and mortality (Yunas *et al.*, 2009; Borah *et al.*, 2017; Umar *et al.*, 2018).

Information on epidemiological aspects of different poultry diseases is desired for planning of a comprehensive control strategy. Present retrospective study was therefore designed to assess the magnitude of problem/disease burden and it's, temporal and seasonal distribution in broiler population.

Materials and Methods

Study area and population

Being high density poultry farm region, district Chakwal, situated at longitude 72.615E° and latitude 32.8322 N° in potohar plateau in North Punjab Pakistan, with an area of 6224 square kilometres was selected as study area. Weather is dry and cold in winter with a minimum temperature of -2°C whereas hot in summer with a maximum temperature of 42C° (Parveen, 2019). A total of 658 broiler farms with capacity of 4221800 birds have been maintained throughout the district during the entire study period.

Case definition and diagnosis

Before counting the number of cases, establishment of case definition was carried out because it is an elementary step to quantify the magnitude of illness in a population. On the basis of pre-defined clinical criteria (case definition) narrating that whether an individual subject/flock under investigation has an outcome or disease of interest or not, it was decided that what actually be taken as case (Thrusfied, 2007).

Based on criteria described in published literature, clinical cases of new castle disease (Etriwati*et al.*, 2017; Haji-Abdolvahab *et al.*, 2018), infectious bronchitis (Najimudeen *et al.*, 2020; Haji-Abdolvahab *et al.*, 2018), infectious bursal disease (Orakpoghenor *et al.*, 2020), hydropericardium syndrome (Chen *et al.*, 2019), inclusion body hepatitis (Saleque, 2020), pullorum disease (Rahman *et al.*, 2004; Barrow and Neto, 2011), fowl typhoid (Rahman *et al.*, 2004; Barrow and Neto, 2011), fowl cholera (Kim *et al.*, 2011), colibacillosis (Rahman *et al.*, 2004), chronic respiratory disease (Karthik, 2018; Singh and Devi, 2021), infectious coryza (Welchman *et al.*, 2010), necrotic enteritis (Kaldhusdal *et al.*, 2016), omphalitis (Shringi*et al.*,2012; Khalifa *et al.*, 2013) and coccidiosis (Yousaf *et al.*, 2018; Fatoba and Adeleke, 2018) were selected (counted) during the outbreaks of respective infections.

Sampling

Sampling *i.e.* selection of a part of study population was carried out using multistage sampling technique in order to ensure true representation of population, so that study findings from the sample may be generalized to the population (Thrusfied, 2007).

Primary Sampling: In first stage sampling, all 658 broiler farms, across the study area, constituted the sampling frame whereas one broiler farm was taken as sampling unit.

Randomization: A total of 70 broiler farms with capacity of 448000 broilers were randomly selected at this stage.

Secondary sampling: In second stage sampling, the entire broiler population of aforementioned 70 randomly selected farms constituted the sampling frame

Table 1: *Broiler population reared in seventy randomly selected farms during the study period.*

Timeline/Season	2013	2014	2015	2016	2017
	Broiler Population	Broiler Population	Broiler Population	Broiler Population	Broiler Population
1st December	447000	445000	446730	447000	448000
28 Feburary	441000	440000	439000	443000	438000
Average for winter	444000	442500	442865	445000	443000
1st March	442830	442000	439000	443000	438000
31st May	436500	437000	434000	435000	432000
Average for Spring	439665	439500	436500	439000	435000
1st June	436000	437000	434000	435000	431500
30th September	415000	406000	411000	407000	400000
Average for Monsoon	425500	421500	422500	421000	415750
1st October	415000	406000	411000	407000	400000
30th November	402000	396000	400000	398000	395000
Average for Post monsoon	408500	401000	405500	402500	397500
1st January	442000	402000	440000	442000	444000
31st December	446600	441000	444000	432000	447000
Annual Average	444300	421500	442000	437000	445500

whereas one broiler was taken as sampling unit. Detail of these randomly selected farms with broilers reared during entire study period is presented in Table 1.

Sample size: Sample size was estimated according to recommendations of Kevin M Sullivan, using open Epi version 3, software. Desired sample size for each disease was separately accessed by specifying the values of population size (N=4221800) and absolute precision (5%). The anticipated frequency or expected prevalence of each disease was assessed by reviewing the previous recent literature (Borah *et al*., 2015; Parveej *et al*., 2016; Hassan *et al*., 2016). On the basis of anticipated values (expected prevalence) for collibacillosis (11.1%), chronic respiratory disease (10.9%), infectious bursal disease (10.59%), inclusion body hepatitis (10.4%), infectious bronchitis (9.8%), newcastle disease (7.85%), pullorum disease (7.33%), fowl typhoid (6.58%), coccidiosis (6.50%), necrotic enteritis (6.35%), mycotoxicosis (4.56%), omphalitis (2.81%), hydropericardium syndrome (1.67%), infectious coryza (1.59%) and fowl cholera (0.45%), the estimated desired sample sizes of 152, 150, 146, 144, 136, 112, 105, 95, 94, 92, 67, 42, 26, 25 and 7, respectively, were calculated for aforementioned diseases (Dean *et al*., 2016).

Data collection

Required information regarding outbreak occurance, disease diagnosed, capacity of farm, number of broilers reared, number of affected broilers and detail of diagnostic services were recorded in performa designed for present study.

Statistical analysis

Period prevalanc (annual & seasonal), crude morbidity and their 95% confidence intervals were calculated according to recommendations of Thrusfield (2007) using opne Epi vesion 3 software (Dean *et al*., 2016).

Period Prevalence (P)

$$= \frac{\text{No of new and pre existing cases over a specified period of time}}{\text{Average OR Mid interval population}} \times 10^n$$

Crude Morbidity

$$= \frac{\text{No of new and pre existing cases of all diseases over a specified period of time}}{\text{Average OR Mid interval population}} \times 10^n$$

Average population

$$= \frac{\text{Population at the begining of interval} + \text{Population at the end of interval}}{02}$$

Detail of average population for entire study period is presented in Table 1.

Results and Discussion

New castle disease (ND) appeared as most prevalent disease with highest five years average prevalence of 14.90% followed by IBD (11.79%), pullorum disease (11.17%), colibacillosis (8.71%), IB (7.87%), IBH (7.79%), CRD (7.67%), necrotic enteritis (6.48%), coccidiosis (6.09%), mycotoxicosis (5.43%), fowl cholera (4.74%), infectious coryza (4.41%), fowl typhoid (4.22%), omphalitis (3.71%) and HPS (0.05%).

Table 2: *Prevalence of different poultry diseases recorded in broiler population of District Chakwal, Pakistan during January 2013 to December 2017.*

Period prevalence with 95% confidence interval for the year															
Disease	**2013**			**2014**			**2015**			**2016**			**2017**		
	No	%	C.I	No	%	C.I	No	%	C.I	No	%	C.I	No	%	C.I
ND	80406	18.10	17.98-18.21	81532	19.34	19.22-19.46	42842	9.69	9.59-9.70	44958	10.29	10.2-10.38	76088	18.00	17.91-18.1
IBD	74356	16.74	16.63-16.85	73942	17.54	17.43-17.66	25030	5.66	9.59-9.73	32980	7.55	7.47-7.63	50982	12.07	11.98-12.17
Pullorum	44924	10.11	10.02-10.02	41880	9.94	9.85- 10.03	50322	11.4	11.3-11.5	55148	12.62	12.52-12.72	52632	11.81	11.72-11.91
Colibacillosis	50718	11.42	11.32-11.51	47248	11.21	11.11-11.31	36802	8.33	8.24-8.41	33102	7.57	7.49-7.65	22424	5.03	4.97-5.03
IB	81690	18.39	18.27-18.5	57644	13.68	13.57-13.78	10448	2.36	2.32-2.41	11190	2.56	2.51-2.61	10474	2.35	2.31-2.396
IBH	41052	9.24	9.15-9.32	38052	9.03	8.94-9.11	28928	6.54	6.47-6.62	37048	8.48	8.39-8.56	25246	5.67	5.59-5.73
CRD	40154	9.04	8.95-9.12	41940	9.95	9.86-10.04	32928	7.45	7.37-7.53	28778	6.59	6.51-6.66	23668	5.31	5.25-5.38
Necrotic enteritis	30458	6.86	6.78-6.93	31808	7.55	7.46-7.62	42894	9.70	9.62-9.79	20294	4.64	4.58-4.71	16330	3.67	3.61-3.72
Coccidiosis	25174	5.67	5.59-5.73	27482	6.52	6.44-6.59	29786	6.74	6.66-6.81	27900	6.38	6.31-6.46	22942	5.15	5.08-5.21
Mycotoxicosis	25398	5.72	5.64-5.78	19000	4.51	4.44-4.57	31066	7.03	6.95-7.10	13253	3.03	2.98-3.08	30632	6.88	6.80-6.95
Fowl cholera	21958	4.94	4.87-5.00	19418	4.61	4.54-4.67	21966	4.97	4.90-5.03	21890	5.01	4.94-5.07	18554	4.16	4.11-4.22
Infectious coryza	23952	5.39	5.32-5.46	22572	5.36	5.28-5.42	16220	3.67	3.61-3.73	17812	4.08	4.01-4.13	15820	3.55	3.49-3.60
Fowl typhoid	14486	3.26	3.21-3.31	19806	4.70	4.63-4.76	17204	3.89	3.83-3.95	22612	5.17	5.10-5.24	18060	4.05	3.99-4.11
Omphalitis	14392	3.24	3.19-3.29	15864	3.76	3.70-3.82	17720	4.01	3.95-4.07	17430	3.99	3.93-4.05	15900	3.57	3.51-3.62
HPS	310	0.07	0.06-0.08	362	0.09	0.077-0.095	310	0.07	0.06-0.08	56	0.01	0.009-0.016	85	0.02	0.015-0.023

Disease	% of 5 years
ND	14.90
IBD	11.79
Pullorum	11.17
Colibacillosis	8.71
IB	7.87
IBH	7.79
CRD	7.67
Necrotic enteritis	6.48
Coccidiosis	6.09
Mycotoxicosis	5.43
Fowl cholera	4.74
Infectious coryza	4.41
Fowl typhoid	4.22
Omphalitis	3.71
HPS	0.05

ND: *New castle disease;* **IBD:** *Infectious Bursal Disease;* **IB:** *Infectious bronchitis;* **IBH:** *Inclusion body hepatitis;* **CRD:** *Chronic respiratory disease;* **HPS:** *Hydropericardium syndrome;* **CI:** *confidence interval.*

Table 3: *Seasonal prevalence of different poultry diseases recorded in broiler population of District Chakwal, Pakistan during December 2013 to January 2017.*

Seasonal prevalence with 95% confidence interval												
	Winter season (Dec-Feb)			Spring Season (Mar-May)			Monsoon Season (June-Sept)			Post Monsoon season (Oct-Nov)		
Disease	cases	%	C.I	cases	%	C.I	cases	%	C.I	cases	%	C.I
Chronic Respiratory Disease (CRD)	72204	3.26	3.23-3.28	5120	0.23	0.23-0.24	58614	2.78	2.76-2.80	41530	2.07	2.04-2.08
Coccidiosis	39041	1.76	1.74-1.78	45942	2.10	2.08-2.11	18520	0.88	0.87-0.89	29783	1.48	1.46-1.49
Colibacillosis	25688	1.16	1.14-1.17	34046	1.55	1.54-1.57	76780	3.65	3.62-3.67	53780	2.68	2.65-2.69
Fowl cholera (Pasteurellosis)	20473	0.92	0.91-0.94	4634	0.21	0.21-0.22	71560	3.40	3.37-3.42	7119	0.35	0.35-0.36
Fowl typhoid	52901	2.39	2.36-2.40	10305	0.47	0.46-0.48	15916	0.76	0.74-0.77	13046	0.65	0.63-0.66
Hydropericardium syndrome (HPS)	134	0.01	0.005-0.007	235	0.01	0.009-0.012	357	0.02	0.01-0.02	397	0.02	0.01-0.02
Inclusion Body Hepatitis (IBH)	35719	1.61	1.59-1.63	41013	1.87	1.88-1.89	78005	3.70	3.67-3.73	15589	0.78	0.76-0.78
Infectious bronchitis (IB)	59278	2.67	2.65-2.69	21420	0.98	0.96-0.99	76120	3.61	3.59-3.64	14628	0.73	0.71-0.73
Infectious bursal disease (IBD)	33530	1.51	1.49-1.53	30410	1.39	1.37-1.40	171060	8.12	8.08-8.16	22290	1.11	1.09-1.12
Infectious coryza	20506	0.92	0.91-0.94	25598	1.17	1.15-1.18	47020	2.23	2.21-2.25	3252	0.16	0.15-0.16
Mycotoxicosis	32637	1.47	1.46-1.48	41255	1.88	1.86-1.90	21255	1.01	0.99-1.02	24202	1.20	1.18-1.21
Necrotic enteritis	31294	1.41	1.39-1.43	13814	0.63	0.62-0.64	57784	2.74	2.72-2.76	38892	1.93	1.91-1.95
New castle disease (ND)	57077	2.57	2.55-2.59	141731	6.47	6.44-6.50	96110	4.56	4.53-4.59	30908	1.54	1.52-1.55
Omphalitis	5273	0.24	0.23-0.24	25510	1.17	1.15-1.18	44792	2.13	2.10-2.15	5719	0.28	0.27-0.29
Pullorum disease	44723	2.02	1.99-2.01	43347	1.98	1.96-1.99	106410	5.05	5.02-5.08	50426	2.51	2.48-2.53
Crude morbidity	530478	23.92	23.87-23.98	484380	22.12	22.07-22.18	940303	44.64	44.58-44.71	351561	17.49	17.44-17.54

ND: *New castle disease;* **IBD:** *Infectious Bursal Disease;* **IB:** *Infectious bronchitis;* **IBH:** *Inclusion body hepatitis;* **CRD:** *Chronic respiratory disease;* **HPS:** *Hydropericardium syndrome;* **CI:** *Confidence interval.*

Year wise detailed prevalence of different diseases for entire study period is presented in Table 2.

Highest crude morbidity (44.64%) was recorded for monsoon season followed by winter (23.92%), spring (22.12%) and post monsoon (17.49%) seasons. CRD, ND, IBD and coccidiosis appeared as most prevalent diseases for winter, spring, monsoon and post monsoon seasons with highest seasonal prevalence of 3.26%, 6.47%, 8.12% and 2.68% respectively. Seasonal prevalence estimates of different diseases for entire study period are presented in Table 3.

Declining trend in crude morbidity has been recorded during the entire study period. Highest crude morbidity (62.99%) was recorded during monsoon seasons of 2014 followed by 2013 (60.4%), 2015 (35.09%), 2016 (32.28%) and 2017 (32.14%).

Season is among one of the most important extrinsic factor that significantly affects the production potential of poultry by influencing the disease incidence. Quantity and quality of poultry feeding is influenced by rainfall, humidity and temperature. Humid and cold weather stimulates the broilers for increased feeding with decreased water intake. During this season the broilers' crowd together for warmth. This situation is reversed during hot season when feed consumption is decreased with increased water intake (Abbas *et al*., 2015; Borah *et al*., 2017).

The seasonal variation and consequently induced response of broilers significantly influenced the disease outbreak occurrence and propagation. Wind speed is another important seasonal factor which instigates the disease transmission. Extreme weather conditions seriously influence the ability of bird's immune system to combat the invading pathogens by imposing stress.

The highest crude morbidity during rainy season may be attributed to elevated relative humidity levels, decreased temperature and wind speed. Rainy season facilitates the transmission and spread of pathogens (Ahad *et al*., 2015). Our findings with respect to seasonal distribution pattern of disease burden in broiler population are supported by previous reports of Abbas *et al*. (2015). The difference with respect to various bacterial, viral, parasitic and fungal diseases may be due to different study designs (Uddin *et al*., 2010).

Highest prevalence (3.26%) of CRD during winter season may be associated with low temperature which facilitates the survival of pathogens. Huddling of birds together to protect themselves from cold weather aggravates the transmission (Islam *et al*., 2009). Highest prevalence of CRD during winter season has also been reported in Lahore and surrounding areas (Yunus *et al*., 2009). Our findings with respect to seasonal distribution pattern of CRD are supported by this previous report.

ND, the most prevalent spring season disease is among severe illnesses of the commercial poultry, causing significant morbidity and mortality. Exposure to high virus concentrations may lead to human infections in the form of conjunctivitis. Persistence and transmissibility of avian paramyxo viruses is greatly influenced by multiple factors including exposure to light, humidity and temperature. Survival time of the virus in a contaminated poultry farm is 14 days in spring whereas 7 days in summer season (Rahman *et al*., 2004). The ambient humidity and temperature during spring season probably favoured the occurrence of disease during spring season leading to significant morbidity.

IBD, the prevailing infection recorded during monsoon season, has been reported to be associated with huge economic losses throughout the world. The infectious bursal disease virus (IBDV) can persist in contaminated poultry house environment for several months. Litter, feed and water from these poultry farms also remain contaminated for significant period of time (Errikson *et al*., 2018). A review of IBD history since its first report in Pakistan *i.e.* 1971, indicate highest 20.4% prevalence in broiler population during winter (November-January) season followed by 18.88%, 17.97% and 12.5% for autumn (August-October) summer (May-July) and spring (February-April) seasons respectively. The report further describes that IBD is not influenced by weather (Khan *et al*., 2017). Higher IBD incidence (36.73%) has also been reported during monsoon season as compared to winter season (Choudary *et al*., 2012). This report supports the findings of present study. These findings are in line with earlier studies with respect to morbidity but pullorum disease frequency noticed to be higher. This difference in pullorum prevalence may be as a result of poor management and less biosecurity measures (Errikson *et al*., 2018).

Coccidiosis, the commonest and most important disease for monsoon season, is reported to be associated with confined rearing. The coccidian oocysts survival and sporulation is greatly influenced by ambient temperature and high humidity. The rate and degree of oocysts sporulation affect the intensity of infection in a flock, consequently influencing the disease epidemiology. Highest prevalence of coccidiosis has also been reported in broiler population of Kashmir valley during the months of September, October and November. This increased coccidian prevalence has been attributed to ambient temperature and high humidity during this period (Ahad *et al*., 2015; Yousaf *et al*., 2018; Sultana *et al*., 2012). Findings of present study with respect to seasonal distribution pattern of coccidian infection are supported by this report.

Conclusions and Recommendations

On the basis of highest disease load in monsoon season, it may be hypothesized that rainfall and ultimate humidity, significantly influences the propagation of disease, in broiler population. October and November, however, appeared as comparatively safer period for broiler rearing.

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Novelty Statement

This type of research work with representative retrospective design, using five years disease data, has not previously been conducted in the study area. The findings may be used as an effective tool for planning of future research priorities and control programs.

Authors' Contribution

Saima Parveen and Ayesha Azad: Conducted research and drafted the manuscript.
Altaf Mahmood: Designed the study, critically reviewed and edited the manuscript.
Sajid Umar: Supervised the research.
Nosheen Shoukat and Mirza Muhammad Arsalan Azam: Collected necessary data.
Qurat-Ul-Ain and Nausheen Akhtar Malik: Assisted in data analysis.

Conflict of Interest
The authors declare that there is no conflict of interest.

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