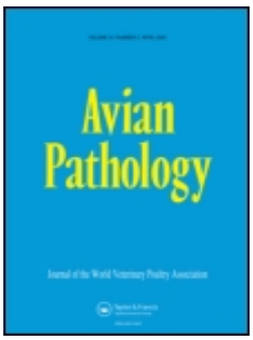

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A longitudinal study of the incidence of major endemic and epidemic diseases affecting semi-scavenging chickens reared under the Participatory Livestock Development Project areas in Bangladesh

P. K. Biswas[1]*, D. Biswas[1], S. Ahmed[1], A. Rahman[2] and N. C. Debnath[3]

[1]*Department of Microbiology, Chittagong Government Veterinary College, Pahartali, Chittagong-4202, Bangladesh,* [2]*Department of Medicine and Surgery, Chittagong Government Veterinary College, Pahartali, Chittagong-4202, Bangladesh, and* [3]*Principal, Chittagong Government Veterinary College, Pahartali, Chittagong-4202, Bangladesh*

A 17-month (from January 2002 to May 2003) longitudinal study was undertaken to elucidate the epidemiology of important endemic and epidemic diseases affecting semi-scavenging chickens reared in the Participatory Livestock Development Project area in Bangladesh. This project was implemented in 17 northern and north-central districts of Bangladesh, under which 361 839 rural poor people were assisted to undertake poultry-rearing activity as a tool of poverty reduction. Of the total beneficiaries 93% were "key rearers". A key rearer is defined as a beneficiary who generally rears 10 to 13 hens in a semi-scavenging system with little additional feed supply. Households of 650 key rearers and some chick rearers were observed. During the study period 1227 birds, which belonged to different age, breed and sex categories, were found dead as a result of disease occurrence. From every dead bird organ samples such as the liver, heart, spleen, brain lung, trachea and bursa of Fabricius were collected. The incidence rate of mortality was 0.01976 per bird-months at risk. Of the total deaths 58.44% had single or mixed type of infections. Newcastle disease had the highest proportional mortality rate (15.81%). The proportional mortality caused by fowlpox, fowl cholera, salmonellosis, colibacillosis, aspergillosis, infectious bursal disease, mixed infections and undiagnosed cases were 8.96%, 6.76%, 7.09%, 6.93%, 0.33%, 2.04%, 10.51% and 41.56%, respectively. Newcastle disease affected a significant higher proportion (18.81%) of birds older than 60 days of age ($P = 0.00$). Younger birds (age ≤ 60 days) had a higher proportional mortality due to fowlpox and infectious bursal disease than older birds ($P = 0.00$). Sonali (♂Rhode Island Red x ♀Fayoumi) birds reared under the semi-scavenging system had a higher infection rate with Newcastle disease virus compared with indigenous and Fayoumi birds ($P = 0.00$). Fowlpox was more prevalent in Fayoumi birds compared with Sonali. Surprisingly, Newcastle disease was more common in the vaccinated birds rather than the unvaccinated birds.

Introduction

Despite their low output (35 to 45 eggs per hen per year) and high mortality, village chickens still comprise the major part of the poultry industry in many developing countries (Spradbrow, 1997; Haque *et al*., 1999). In fact, 80% of the total poultry population in the world is in traditional village-based production systems, being "low input–low output" systems (Permin *et al*., 2000). In Bangladesh, 89% of the rural households are rearing poultry and the average flock size per household is 6.8 (Fattah, 1999).

Realizing that poultry could be a tool of poverty reduction and a source of employment opportunities for village people, especially the women, "The smallholder Livestock Development Programme" emerged under the Department of Livestock Services with the assistance of Donor agencies in 1984/85 (Fattah, 1999) and the programme was being implemented successfully up to 1998 (Swan, 1999). For the benefits of the wider section of people, particularly the inhabitants of northern and north-central areas (17 districts) of Bangladesh, the Danish International Development Agency and the Asian Development Bank sponsored the "Participatory Livestock Development Project" (PLDP). This PLDP was designed to link different poultry-based micro-enterprises in a production chain, including "key rearer" (rears 10 to 13 hens in a semi-scavenging system), "chick rearer", "model breeder" (rears 25 to 30 Fayoumi hens and three to four Rhode Island Red cocks in an intensive system), "pullet rearer", "mini hatchery owner", "poultry worker", "feed seller" and "egg collector". Key rearers comprised 93% of the total beneficiaries who are rearing chickens.

*To whom correspondence should be addressed. Tel: +88 31 659093. Fax: +88 31 659492 105. E-mail: biswaspk2000@yahoo.com
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At the end of January 2002 a total of 361 839 beneficiaries had been enrolled under the poultry production chain of the PLDP. The main objective of the programme was to help the resource-poor coming out of the vicious cycle of poverty by engaging them any of poultry-related activities. It has been reported that a successful key rearer and a chick rearer in this programme may secure income TK.1139 and TK.1500 per month, respectively (Ahamed, 2002) (Taka [TK] is the currency of Bangladesh; 1 US$ = 60 Taka). However, there are some constraints regarding the productivity and profitability of the production chain with consequences for growers and credit suppliers. Poor poultry growers can become extremely helpless when all their birds die of epidemic diseases, leaving them no longer in a position to repay loans. There is some published information on the constraints to smallholder poultry production (Permin, 2003). One-half of the recorded mortality is caused by infectious diseases, of which Newcastle disease (ND) has the predominant role (Alexander, 1988a; Kitalyi, 1998; Alders, 2000; Mtambo, 2000). However, very little is known on disease information affecting semi-scavenging chickens reared in Bangladesh (Christensen, 1999). The present study was carried out to identify infectious diseases affecting semi-scavenging chickens reared under the PLDP areas in Bangladesh.

Materials and Methods

Duration of the study and areas under surveillance. The duration of the project was 17 months from January 2002 until May 2003. Active surveillance was confined to six upazilas (administrative unit of Bangladesh) of PLDP areas: Palashbari, Gaibandha sador of Gaibanoha district, Sirajgong sadar and Raigong of Sirajgong district, Mohangonj of Netrokono district and Jhinaigati of Sherpar district. The districts were selected randomly in different geographical locations of the PLDP areas: Gaibanda in the Northern part, Sirajgonj in the Jamuna basin region, and the other two districts Sherpur and Netrokona in the North-East part of Bangladesh having a common border with India with a hilly influence.

Study population. In an upazila, the list of all types of beneficiaries was maintained by a non-government organization. This non-government organization was responsible for the supply of credits to the beneficiaries to run poultry-rearing activities. The listed beneficiaries were "key rearer", "chick rearer", "model breeder", "pullet rearer", "mini hatchery owner", "poultry worker", "feed seller" and "egg collector". Using this list of beneficiaries as a sampling frame, 100 key rearer flocks were selected randomly in each study unit. In its administrative formation, there are three strata of an upazila: "upazila centre", "unions" and "villages". The upazila centre is the first stratum, which is surrounded by several unions, and a union is composed of several villages—the third stratum. Chick rearers flocks (250 to 300 chicks in a flock $\leq$60 days age), which were near or at the vicinity of an upazila centre, were also investigated based on their availability and sustainability.

Calculation of the study population size, sample size, measures of estimation of disease occurrence. The size of the study population was estimated based on the total number of birds recorded at the beginning and the end of 16 consecutive months. The required sample size for each variable studied was 96 based on the formula $n = Z^2\ PQ/L^2$ (Kitalyi, 1998), where n is the sample size, P is the expected prevalence, $Q = 1 - P$, and L is the required precision. As the prevalence was not known, 50% ($P = 0.5$) was considered in this calculation; a precision of 10% was considered ($L = 0.10$) with the confidence level 95% (i.e. $Z = 2$). There were two measures applied to estimate disease occurrence: incidence rate of mortality and proportional mortality rate. The incidence rate of mortality was estimated using the number of birds found dead during this period as the numerator and the total number of bird months at risk as the denominator. The proportional mortality rate was calculated as the number of deaths caused by a specific disease divided by the total number of deaths recorded (Thrusfield, 1986).

Collection of organ samples from dead chickens. The field technicians recruited for the study areas were responsible for the collection of organ samples from dead birds including liver, spleen, heart, lung, trachea, and bursa of Fabricius. They had a monetary incentive at the rate of TK.30 per dead bird to collect all of the dead birds from beneficiaries. Each organ sample collected from a dead bird was placed separately in a polythene bag and all samples taken from a single dead bird were kept together in a polythene bag. Each bag was tagged to identify samples from a particular bird. All samples collected in a particular upazila were kept frozen in a refrigerator at the "Upazila livestock office" until collected fortnightly from the Department of Microbiology, Chittagong Government Veterinary College, Pahartali, Chittagong, Bangladesh.

Collection of additional disease data. Every field sample had a sample submission form completed by the field technicians with information including breed, sex, age of birds, medication history, detailed vaccination history, postmortem examination findings and tentative diagnoses made by the field technicians based on clinical history and postmortem examination findings.

Diagnosis of chicken diseases

Newcastle disease. ND was diagnosed on the basis of isolation of the virus in 9-day-old to 11-day-old chicken embryos, the inoculum being from pooled organ samples (lungs, trachea, spleen and brain). The virus was identified based on haemagglutination followed by a haemagglutination inhibition test. For the haemagglutination test, 1% red blood cells suspension was prepared by taking blood from 2-week-old to 4-week-old village chickens that had not been primed with ND vaccine. And, locally raised Newcastle disease virus (NDV) immune sera with haemagglutination inhibition titres ranging from 2^{12} to 2^{14} were used to confirm that the haemagglutinating virus was NDV. Uninfected allantoic fluid was used as a negative control and the Muketswar strain was used as a positive control. The virulence of the NDV isolates was assessed by means of the "mean death time" (h) for chicken embryos infected with 0.1 ml inoculum.

Infectious bursal disease. This was diagnosed tentatively by recording changes in the bursa of Fabricius and haemorrhage in thigh or pectoral muscles. Confirmation was obtained by positive result in an agar gel precipitation test using bursal homogenate as a crude source of antigen. Infectious bursal disease (IBD) virus reference serum produced by Biocheck (the Netherlands) was used for this test, and specific pathogen free chicken serum produced by the Veterinary Laboratories Agency (Weybridge, UK) was used for the negative control.

Fowlpox. This was initially identified by finding characteristic pox lesions in the head region. Confirmation was obtained by inoculating skin lesion material onto the chorioallantoic membrane of 9-day-old to 12-day-old embryos, and finding pock lesions on the chorioallantoic membrane at 5 to 7 days post inoculation.

Salmonellosis. This was diagnosed on the basis of isolation of the causative agent onto McConkey agar followed by typical biochemical characteristics shown in triple sugar iron agar slants and in Moeller (Difeco) medium for the lysine decarboxylase test.

Colibacillosis. This was diagnosed by isolating the organism on McConkey agar followed by identification based on typical biochemical properties shown by the organism.

Fowl cholera. This was diagnosed by finding the characteristic bi-polar organism in liver imprints stained by Giemsa (Richard & Glisson, 1997).

Aspergillosis. This was deduced after observing the characteristic colony produced on Sabourand's dextrose agar after inoculation of granulomatous small nodules taken from lung tissue. The initial diagnosis was confirmed by examining colony growth containing a reproductive structure with a drop of lacto phenol cotton blue under the microscope.

When only a single pathogen was identified, the infection was termed "single" infection. When a bird was identified as harbouring more than one pathogen; the infection was considered as a "mixed" one.

Data analysis. All disease and epidemiological data were entered into a spreadsheet programme (Excel 2000; Microsoft Corporation) and transferred to STATA-7 (STATA Corporation) statistical software, and were used for data management and analysis. Causal association of different factors such as breed, age, sex and vaccination was assessed by calculation of the odds ratio (both point and 95% confidence interval) or using a χ^2 test.

Results

Occurrence of major diseases in the chickens reared under the PLDP areas. Due to the monetary incentives given to the beneficiaries, it was presumed that all of the birds that died from disease were collected. An overview of the duration of active surveillance and total birds recorded in each month is presented in Table 1. Overall, 61 675 birds were recorded at the beginning of 17 months. A total of 1227 birds died over the study period, with 732 in the first year (From January 2002 to December, 2002) and a further 495 birds in the following 5 months of observation in the second year. Organ samples were collected from all dead birds during the entire period of surveillance. There were seven major diseases recorded affecting the semi-scavenging chickens reared in the PLDP areas; ND, fowlpox (FP), IBD, fowl cholera (FC), salmonellosis, colibacillosis and aspergillosis. A total of 129 birds were isolated with two or more pathogens, 62 of which were diagnosed as having ND-mixed infections and the rest without any involvement of ND. The occurrence of ND alone (194 cases) predominated over other disease cases. All the NDV isolates (194) caused death of chicken embryos within 60 h of inoculation. Proportional mortality rates caused by different diseases, including mixed infections, are shown in Figure 1. Almost identical proportional mortality was recorded due to occurrence of three bacterial diseases: fowl cholera, salmonellosis and colibacillosis with 6.76, 7.09 and 6.93%, respectively. Very low mortality was observed due to the occurrence of IBD and aspergillosis.

The incidence rate of mortality for the study period was 0.01976 deaths per bird-months at risk (i.e. 19.76 deaths per 1000 bird-months at risk). The incidence rates of mortality for the winter season (December to February), summer (March to May), rainy (June to August) and autumn (September to November) were 0.01430, 0.02911, 0.03225 and 0.01323, respectively.

Mixed infections/diseases. The temporal distribution of different combinations of mixed infections is presented in Table 2. As many as 13 combinations were recorded, of which only one resulted from infection by three pathogens. The other 12 cases were found with different combinations of two pathogens. In the mixed infection category, ND (62 cases) was involved with at least six different combinations of concomitant diseases, of which the highest proportion was found with salmonellosis (18.60%). Almost the same numbers of cases (64) were recognized as mixed-disease conditions resulted from the synergistic effects of the causative agent of FC (*Pasteurella multocida*) with other pathogens except NDV. Of all the combinations of mixed infections, the "fowl cholera + salmonellosis" category represented the highest proportion (27.13%), followed by "fowl cholera + colibacillosis" (20.93%).

Temporal distribution of diseases based on proportional mortality (monthly) rates. Figure 2 illustrates the monthly proportional mortality rates in chickens caused by major diseases with single form infections for each case. The temporal dynamics of mixed infections and undiagnosed cases are also shown. Higher proportional rates of mortality in May and August caused by ND indicated two epidemics of the disease. The worst

Table 1. *An overview on the study population and diseases observed*

Period of observation	Number of birds recorded on visit day	Total number of deaths	Distribution of diseases							Total undiagnosed	Mixed infections
			ND	FP	FC	Sal	Coli	Asp	IBD		
January 2002	1490	14	2	0	0	0	0	0	5	5	2
February 2002	1497	68	10	4	3	3	8	1	2	33	4
March 2002	868	95	7	7	8	3	6	1	2	59	2
April 2002	4782	33	3	3	1	1	1	2	3	17	2
May 2002	4480	65	17	7	0	3	3	0	0	27	8
June 2002	3010	67	12	9	8	1	8	0	2	19	8
July 2002	4872	93	22	4	11	11	4	0	3	29	9
August 2002	846	84	20	1	7	8	14	0	0	16	18
September 2002	684	61	9	1	1	5	1	0	1	42	1
October 2002	1333	51	17	0	4	7	4	0	0	15	4
November 2002	3043	26	7	1	0	0	0	0	3	12	3
December 2002	11418	75	18	6	6	5	3	0	0	27	10
January 2003	5951	122	14	15	0	14	14	0	0	49	16
February 2003	13600	132	15	0	6	12	6	0	4	72	17
March 2003	1595	112	7	6	17	6	1	0	0	51	24
April 2003	1684	101	10	43	7	4	12	0	0	24	1
May 2003	522	28	4	3	4	4	0	0	0	13	0
Total (17 months)	61 675	1227	194	110	83	87	85	4	25	510	129

ND, Newcastle disease; FP, fowlpox; FC, fowl cholera; Sal, salmonellosis; Coli, colibacillosis; Asp, aspergillosis; IBD, infectious bursal disease.

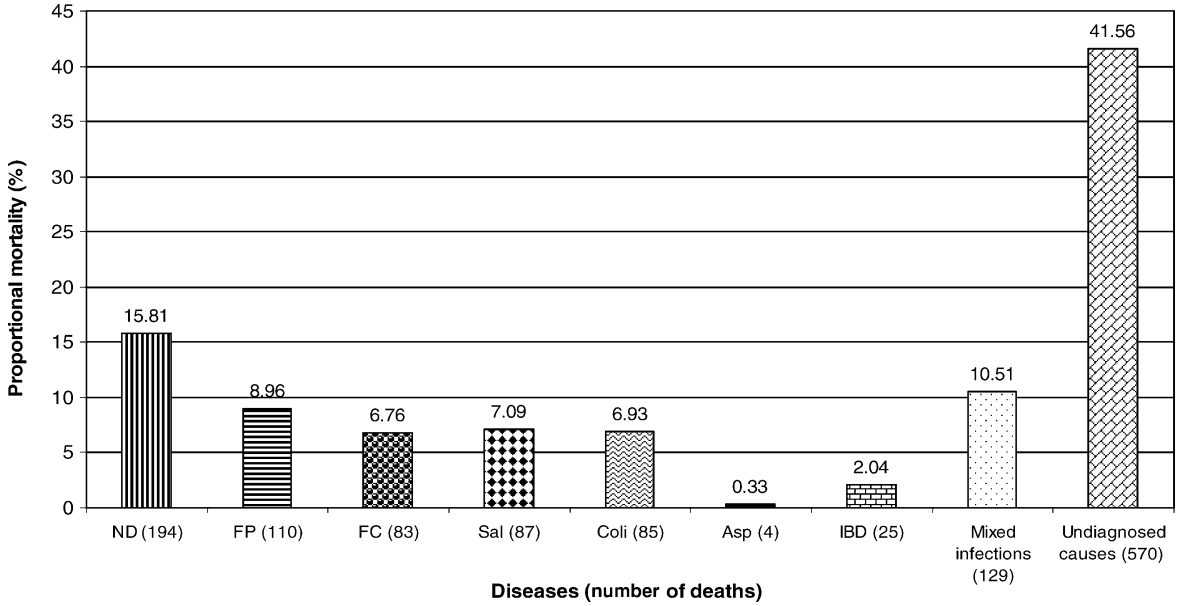

Figure 1. *Proportional mortality rates of common endemic and epidemic disease affecting chickens reared in the PLDP area of Bangladesh.*

epidemic continued for more than 3 months from October 2002 until January 2003. The highest proportional mortality caused by FP was recorded in April 2003, at 42.57% (Figure 2). IBD caused the highest proportional mortality in January 2002. Salmonellosis, FC and colibacillosis occurred in typical endemic fashion in the semi-scavenging chickens reared in the PLDP areas.

Distribution of disease in chickens aged below and above age 2 months. The distribution of seven major diseases in groups of chickens below and over 2 months of age is presented in Table 3. ND was found with a significantly higher proportion ($P < 0.001$) in birds above 2 months of age compared with the younger birds. In contrast, FP was mainly contained in the latter group of younger birds ($P < 0.001$). FC, salmonellosis and colibacillosis were more probably equally distributed between the two age groups as statistically no significant difference at $P < 0.05$ was observed. However, IBD was mainly in birds below 2 months of age ($P < 0.001$).

Breed association of diseases. Table 4 presents the distribution of diseases in four different breeds of chickens investigated; Sonali, Deshi (Indigenous), Fayoumi and Rhode Island Red. Based on the proportional mortality rate Sonali birds appeared to be more susceptible to ND in semi-scavenging rearing system compared with Deshi and Fayoumi chickens ($P < 0.001$). In contrast, Fayoumi birds were found with FP to be more frequently infected ($P < 0.001$) compared with Sonali birds. Unlike ND and FP, no significant difference ($P > 0.05$) was established on the distribution of FC, salmonellosis, and colibacillosis in birds of different genetic make-up. These diseases appeared to be equally distributed in all four breeds observed in the field condition. However, Fayoumi birds were affected with a significantly higher trend ($P = 0.01$) with IBD compared with Sonali birds.

Sex variation on occurrence of diseases. Results of diseases in male and female birds are presented in Table 5. ND affected both sexes equally ($P > 0.05$), but female birds reared under semi-scavenging condition were more likely to be affected with FP ($P = 0.01$).

Occurrence of ND in vaccinated and unvaccinated birds. Table 6 presents the occurrence of ND in the vaccinated and unvaccinated birds. According to data provided by the beneficiaries, 445 of 1227 dead birds investigated were reported to have been vaccinated against ND, 36.27% of total birds collected. Therefore a majority of birds (63.73%) remained susceptible to ND. The occurrence of ND was found significantly higher in the vaccinated birds compared with unvaccinated birds ($P = 0.00$).

Discussion

In the present study, it was impossible to investigate the same population covering the entire surveillance period due to continued culling or introduction of new birds in the endeavour of the beneficiaries' own interests. It was beyond the control of the scope of this study to interfere with the normal activities run by the beneficiaries. Not only that, there were situations emerging when some flocks were removed due to salvage selling because of proportional disease threats or natural calamities like floods. These are the reasons for finding large variations among the number of birds observed at the beginning of each month. Human interventions for limiting the number of birds in each month had influence on the natural incidence rates of mortality caused by endemic and epidemic diseases. This is the reason for finding higher rates of incidence of mortality in the months of March, August and September 2002, when the monthly population size was lower. However, the incidence rate of mortality in this study disagrees with that reported by Fattah (1999), who reported that the yearly mortality rate of poultry fell from 21.3% to 7.6% in the PLDP project area. This variation might be due to the reason

Table 2. *Temporal distribution of cases of mixed infection*

Month	Mixed infection categories													
	ND+FC	ND+FP	ND+IBD	ND+Sal	ND+Coli	Sal+IBD	Coli+IBD	FC+Asp	FC+FP	FC+Sal	FC+Coli	Sal+Coli	FC+Coli+ND	Total
January 2002	–	–	–	–	1	–	1	–	–	–	–	–	–	2
February 2002	–	–	1	1	1	–	–	–	–	–	1	–	–	4
March 2002	–	1	–	1	–	–	–	–	–	–	–	–	–	2
April 2002	–	1	–	–	–	–	–	1	–	–	–	–	–	2
May 2002	–	–	–	6	–	–	–	–	1	1	–	–	–	8
June 2002	–	1	–	3	2	1	–	–	–	1	–	–	–	8
July 2002	3	–	–	–	–	–	–	–	–	4	2	–	–	9
August 2002	1	–	–	1	4	–	–	–	–	7	5	–	–	18
September 2002		–	–	1	–	–	–	–	–	–	–	–	–	1
October 2002		–	–	–	–	–	–	–	–	2	2	–	–	4
November 2002	1	–	–	1	–	–	–	–	–	1	–	–	–	3
December 2002	2	–	–	4	4	–	–	–	–	–	–	–	–	10
January 2003	1	–	–	2	3	–	–	–	–	2	6	1	1	16
February 2003	3	–	–	3	1	–	–	–	–	5	5	–	–	17
March 2003	4	–	–	1	1	–	–	–	–	12	6	–	–	24
April 2003	1	–	–	–	–	–	–	–	–	–	–	–	–	1
May 2003	–	–	–	–	–	–	–	–	–	–	–	–	–	0
Total	16	3	1	24	17	1	1	1	1	35	27	1	1	129
Proportional distribution (%)	12.40	2.33	0.78	18.60	13.18	0.78	0.78	0.78	0.78	27.13	20.93	0.78	0.78	100

ND, Newcastle disease; FP, fowlpox; FC, fowl cholera; Sal, salmonellosis; Coli, colibacillosis; Asp, aspergillosis; IBD, infectious bursal disease.

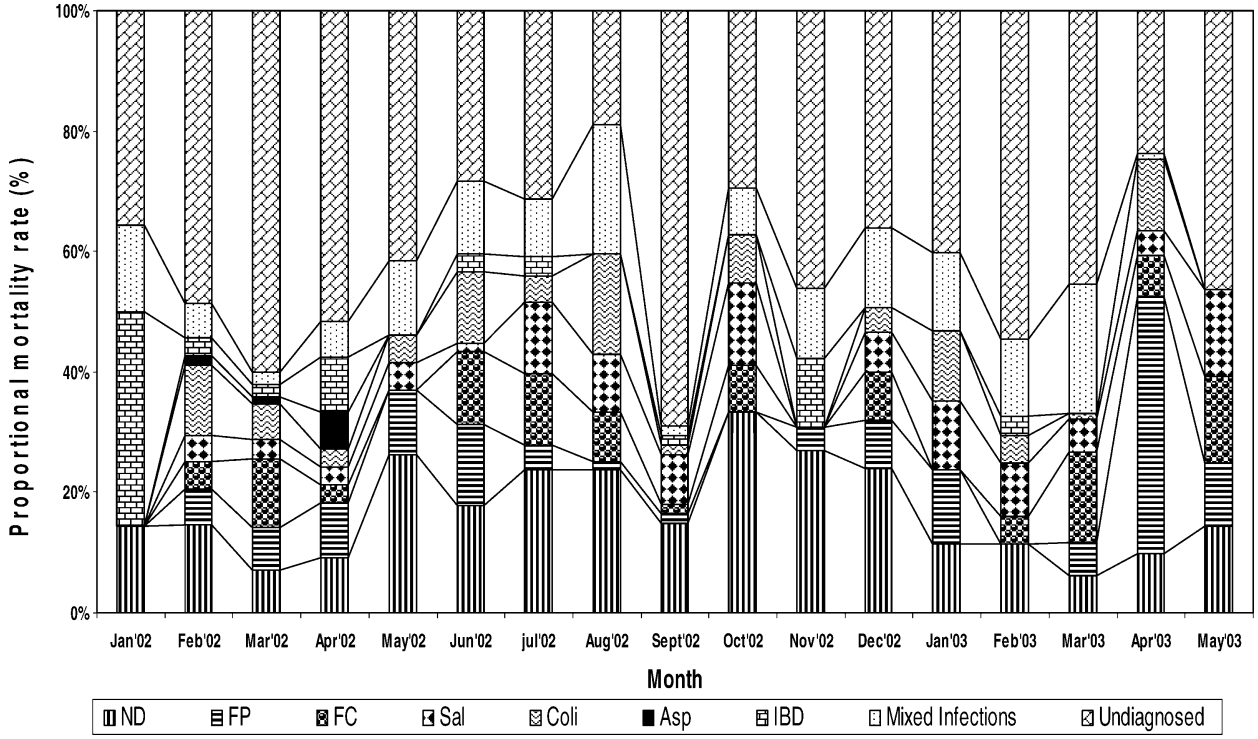

Figure 2. *Proportional mortality dynamics of semi-scavenging chickens in Bangladesh caused by endemic and epidemic diseases.*

that previous reports were based on a conventional passive reporting system from field Veterinary Extension services or a cross-sectional survey made by non-government organizations involved in running the programme. The disease data incorporated in those reporting systems came from beneficiaries' information, not by producing appropriate diagnoses-based surveillance. The incidence of mortality found through a 17-month active surveillance might have been more scientific. The high mortality of birds has to be reduced by taking necessary action.

This study dealt with the deaths of birds and resulted from the occurrence of major diseases of poultry caused by viral, bacterial and fungal pathogens. There was a proportion of birds killed by predators that was not included in calculating the incidence rate of mortality. Some birds were also slaughtered by the beneficiaries to consume meat, which were also excluded.

Under the scope of the study the contributory causes of mortality of a substantial number of birds were not known and were summarized as belonging to the "undiagnosed" group—birds that died of other infectious, nutritional or parasitic diseases that were not screened under the present investigation. As a consequence the present study failed to unveil the holistic factors with respective magnitude to cause mortality of semi-scavenging chickens reared in Bangladesh.

There was another group of diseases collectively categorized as diseases resulting from mixed infections. The birds, which were found dead harbouring any of the combinations of mixed infections, seemed to have died owing to synchronized infections of the pathogens concerned or by synergistic cooperation between or among them. The exact role played by a concurrent organism was not well understood at field investigation and their roles can only be illustrated in case–control studies. However, the majority of such disease combinations actually occurred by the association of either NDV or *Pasteurella multocida*. Isolation and identification of NDV from a dead chicken in ND-mixed disease could indicate that death was mainly attributable to ND, as most of the cases of the velogenic strains of NDV (58 isolates) were involved in the mixed infection category since those field isolates killed chicken embryos within 60 h. But in the other 64 cases of mixed infections where *Pasteurella multocida* was the common organism, the role of companion pathogen(s) cannot be estimated and deaths in those cases actually happened as a result of synergistic cooperation between or among the pathogens.

There was no significant difference observed in the present study on the occurrence of ND in the male and female birds, in agreement with Barmon (2002). The present study also revealed a higher occurrence of ND in adult birds. Ezeokoli *et al*. (1984) obtained similar results, and concluded that a higher occurrence of ND in the backyard chicken aged between 16 and 24 weeks is observed. Sonali birds were found to be significantly susceptible to ND compared with other birds in the field. No such observation has yet been made in Bangladesh on the higher susceptibility of Sonali birds to ND. However, the fact can only be elucidated in a case–control situation, as there were so many uncontrolled factors involved in the field to find more positive cases of ND in Sonali birds.

Fayoumi birds were found with higher prevalence of IBD, a finding in agreement with Chowdhury *et al*. (1996). In the present study IBD was mostly contained in birds below 2 months age but the mortality rate appeared to be far below that reported by Ahad (2002) observing a flock at Mirpur Central Poultry Farm and six other rural poultry units in Madargonj (North-East area). IBD, at present, in Bangladesh is considered one of the constraints to making intensive chicken farming sustainable and lucrative. But the findings of the present study revealed that the disease was found with a very low magnitude, if not absent, in the village chicken.

Table 3. *Occurrence of major diseases in birds aged below and above 60 days*

Age	*n*	Diseases: total positive cases (%)								
		ND	FP	FC	Salmonellosis	Colibacillosis	IBD	Aspergillosis	Mixed	Undiagnosed deaths
≤60 days	315	30 (9.52)	71 (22.54)	13 (4.13)	18 (5.71)	14 (4.44)	13 (4.13)	4 (1.27)	36 (11.43)	116 (36.83)
>60 days	856	161 (18.81)	34 (3.97)	65 (7.59)	65 (7.59)	65 (7.59)	11 (1.29)	–	84 (9.81)	371 (43.34)
Difference in occurrence	1171	$P=0.00$	$P=0.00$	$P=0.04$	$P=0.27$	$P=0.06$	$P=0.00$	–	$P=0.42$	–

Fifty-six samples missed to have age information.

Table 4. *Occurrence of diseases in the four breeds investigated*

Breed	Diseases: total positive cases (%)								
	ND	FP	FC	Salmonellosis	Colibacillosis	Aspergillosis	IBD	Mixed	Undiagnosed
Sonali ($n=112$) (♂Rhode Island Red + ♀Fayoumi)	31 (27.68)	4 (3.57)	6 (5.36)	6 (5.36)	3 (2.68)	1 (0.89)	2 (1.79)	21 (18.75)	38 (33.93)
Deshi ($n=933$) (non-descriptive)	140 (15.01)	80 (8.57)	63 (6.75)	70 (7.50)	64 (6.86)	0 (0)	7 (0.75)	84 (9.00)	425 (45.55)
Rhode Island Red ($n=20$)	2 (10.00)	4 (20.00)	2 (10.00)	0 (0)	2 (10.00)	0 (0)	1 (5.00)	1 (5.00)	8 (40.00)
Fayoumi ($n=158$)	21 (13.29)	22 (13.92)	11 (6.96)	11 (6.96)	16 (10.13)	3 (1.90)	15 (9.49)	21 (13.29)	38 (24.05)
Overall difference	$P=0.00$	$P=0.01$	$P=0.81$	–	$P=0.08$	–	$P=0.00$	$P=0.01$	–
Comparative occurrence									
Sonali versus Deshi	$P=0.00$	$P=0.07$	–	–	–	–	$P=0.26$	$P=0.00$	
Sonali versus Rhode Island Red	$P=0.09$	$P=0.01$	–	–	–	–	$P=0.37$	$P=0.13$	
Sonali versus Fayoumi	$P=0.00$	$P=0.00$	–	–	–	–	$P=0.01$	$P=0.22$	
Deshi versus Rhode Island Red	$P=0.53$	$P=0.08$	–	–	–	–	$P=0.04$	$P=0.53$	
Deshi versus Fayoumi	$P=0.57$	$P=0.03$	–	–	–	–	$P=0.00$	$P=0.09$	
Fayoumi versus Rhode Island Red	$P=0.68$	$P=0.47$	–	–	–	–	$P=0.51$	$P=0.13$	

Table 5. *Occurrence of diseases in male and female birds*

Sex type	Diseases: total positive cases (%)								
	ND	FP	FC	Salmonellosis	Colibacillosis	Aspergillosis	IBD	Mixed	Undiagnosed
Male ($n=235$)	37 (15.74)	10 (4.26)	16 (6.81)	26 (12.06)	15 (6.38)	0 (0.0)	3 (1.28)	4 (1.70)	124 (52.77)
Female ($n=987$)	157 (15.91)	100 (10.13)	66 (6.69)	61 (6.18)	70 (7.09))	4 (0.41)	21 (2.13)	123 (12.46)	385 (39.01)
Differences (P)	0.95	0.01	0.95	0.01	0.70	0.33	0.40	0.00	–

The mortality rate of chickens caused by FC in the PLDP area was found higher than the rate (3.3%) observed previously (Barmon, 2002) in backyard chickens. Salmonellosis in this present study was considered as resulting from infection caused by *Salmonella gallinarum* and *Salmonella pullorum*. Unlike FC, salmonellosis can be transmitted through the egg by transovarian infection, and carrier birds are assumed to be the most important means of perpetuation and spread of the organism. For salmonellosis, Sonali birds represented the highest proportion of positive cases compared with Deshi and Fayoumi. The deaths that were apparently caused by colibacillosis might have been influenced by predisposing factors, enabling this malady to develop. Interactions between infectious bronchitis virus and *Escherichia coli* have been studied extensively (Nakamura *et al*., 1992). In the present study colibacillosis was found evenly in both groups of birds below and over 2 months, a finding that differs from the observation of Huq (2002) who reported that the disease was more prevalent in the young of Fayoumi birds below 4 months old. Like colibacillosis, brooder pneumonia (aspergillosis) occurs when the causative organism is present in sufficient quantities and the bird's resistance is impaired by factors such as environmental stresses, immunosuppressive compounds or inadequate nutrition. The major two agents causing aspergillosis of poultry are *Aspergillus fumigatus* and *Aspergillus flavus* (Ghori & Edgar, 1979). Of the four positive cases of aspergillosis recorded in the present study one was found to cause by dual invasions of *A. fumigatus* and *Aspergillus Niger*, which has rarely been reported.

ND seems to be the major threat to village chickens reared under the PLDP area. The proportional mortality rate caused by ND (single+mixed infections) in the present study was in agreement with Barmon (2002), who reported the rate could be 21.6% in the village chickens that had never been vaccinated against ND. A higher mortality rate (40% to 60%) has also been reported (Chowdhury *et al*., 1982). The country has been producing two live vaccine: Baby Chick Ranikhet Disease Vaccine—BCRDV (F strain of NDV) and Ranikhet Disease Vaccine—RDV (Muketswar strain). Despite having the introduction of the vaccine, ND still remains one of the major problems to the village chickens in Bangladesh, like other parts of the world (Spradbrow, 1988; Werner, 1994; Kama *et al*., 2000; Tu, 2000). Results of the present study further illustrate that ND could be found with significantly higher trend in the vaccinated birds under the PLDP area than in the unvaccinated birds. The results categorically differ from those of Barmon (2002), who reported significant lower mortality rate in the vaccinated village chickens compared with those that remained unvaccinated.

There are many reasons why there was a higher occurrence of ND in the vaccinated birds reared in the PLDP area. First, the vaccination data that were being provided by the beneficiaries might not be sufficiently valid, as most of them did not mention the exact date of vaccine given. They could only appreciate whether or not the birds had been vaccinated, not the date of vaccination. Second, it is probable that the birds would have been vaccinated when they already incubated the virus or the vaccines were given 6 months previously, resulting in low or non-protective titres at the time of infection. Third, one crucial point has never been assessed—the role of "poultry health workers" in the "village poultry production network". They have little idea of how to handle ND vaccine hygienically. In the villages, adult birds are generally vaccinated with RDV, which is supplied in 100-dose vials. This vaccine is administered parenterally. The poultry health workers could vaccinate birds incubating the virus and healthy ones using the same needle and syringe. This practice may disseminate the lethal viruses from diseased to healthy birds. In addition, they move from one village to another to carry on their services, which may further spread ND. The greatest potential for the spread of NDV by humans and their equipment with contaminated feed, water and vaccines had been observed by Alexander (1988b), and the role of vaccination crews moving from one farm to another in the spread of NDV was reported by Beard *et al*. (1970). Unfortunately, although the "poultry health worker" is considered a key component for the preservation of chicken health, their contribution, perhaps, has been assessed on how much they can earn delivering their services. To what extent they are causing harm indirectly to the beneficiaries has never been evaluated. It is, therefore, high time to investigate whether poultry health workers play roles in disseminating ND in the village chickens rather than containing it.

Table 6. *Occurrence of ND in vaccinated and unvaccinated birds*

Immune status	ND occurrence (%)		Total birds observed	Odds ratio (95% confidence interval)	χ^2 value	P value
	Positive	Negative				
Vaccinated	101 (single)+31 (mixed) =132 (29.66)	313	445	2.24 (1.66–3.02)	32.74	0.00
Unvaccinated	93 (single)+31 (mixed) =124 (18.84)	658	782			
	Total =256	971	1227			

In this regard of high occurrence of ND in the vaccinated birds, one more vital point has to be addressed; the quality of vaccines and their dependency on being kept cool. Both vaccines produced in Bangladesh are thermolabile and to retain their potency they rely on a proper cooling system. However, Christensen (1999) strongly recommended establishing quality control for vaccines produced in Bangladesh. Moreover, vaccine has to be transported over long distances to the PLDP. Cooling systems are often interrupted by power failure or absence of freezers. Furthermore, supply is not sustainable or synchronized with the field demands. Considering these limitations of heat sensitivity of RDV and BCRDV, a scope for alternative thermostable vaccine against Newcastle disease could be considered for the village chicken. Such a type of vaccine could be very effective for the village chicken as this type of vaccine is not entirely dependent on the cooling system (Spradbrow, 2000). In fact, there are many developing countries in Africa and Asia already practicing thermostable vaccines in place of conventional heat-sensitive vaccines, with a great deal of success (Alders, 2000; Bell, 2000; Tu, 2000).

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Translations of the abstract in French, German and Spanish are available on the *Avian Pathology* website.

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Non-English Abstracts

A longitudinal study of the incidence of major endemic and epidemic diseases affecting semi-scavenging chickens reared under the Participatory Livestock Development Project areas in Bangladesh

P. K. Biswas[1]*, D. Biswas[1], S. Ahmed[1], A. Rahman[2] and N. C. Debnath[3]

[1]*Department of Microbiology, Chittagong Government Veterinary College, Pahartali, Chittagong-4202, Bangladesh,* [2]*Department of Medicine and Surgery, Chittagong Government Veterinary College, Pahartali, Chittagong-4202, Bangladesh, and* [3]*Principal, Chittagong Government Veterinary College, Pahartali, Chittagong-4202, Bangladesh*

Etude longitudinale de l'incidence des maladies épidémiques et endémiques affectant les poulets se nourrissant partiellement de détritus, élevés au Bengladesh dans des zones sous le PLDP (Projet de participation au développement du cheptel)

Une étude longitudinale de 17 mois (janvier 2002 à mai 2003) a été entreprise pour élucider l'épidémiologie des maladies importantes épidémiques et endémiques affectant les poulets se nourrissant partiellement de détritus, élevés au Bengladesh dans des zones sous le PLDP (Projet de participation au développement du cheptel). Ce projet a été mis en place dans 17 districts du Nord et centre Nord du Bengladesh où 361.839 habitants très pauvres, vivants à la campagne sont aidés pour entreprendre une activité d'élevage de volailles comme un moyen de réduction de la pauvreté. Parmi les bénéficiaires 93% étaient des "éleveurs clefs". L'éleveur clef est défini comme un bénéficiaire qui généralement élève 10 à 13 poules qui se nourrissent partiellement de détritus et qui reçoivent un peu d'aliment en complément. Les élevages de 650 éleveurs clefs et quelques éleveurs de poulets ont été suivis. Durant l'étude, 1227 animaux sont morts de maladie, ils étaient de souches, d'âges et de sexes différentes. A partir des morts des prélèvements d'organes ont été réalisés, il s'agissait du foie, du cœur, de la rate, du cerveau, des poumons, de la trachée, et de la bourse de Fabricius. Le taux de mortalité a été de 0,01967 oiseaux par mois. Parmi les morts, 58,44% présentaient une infection simple ou mixte. La maladie de Newcastle (ND) a été responsable du taux de mortalité le plus élevé 15,81%. Les taux de mortalité due à la variole aviaire, au choléra aviaire, à la salmonellose, la colibacillose, l'aspergillose, la bursite infectieuse, aux infections mixtes et aux cas non diagnostiqués ont été respectivement de 8,96, 6,76, 7,09, 6,93, 0,33, 2,04, 10,51% et de 41,56%. La maladie de Newcastle a affecté une proportion significativement plus élevée (18,81%) d'animaux âgés de plus de 60 jours ($P = 0{,}00$). Les animaux plus jeunes (âge $\leq$60 jours) ont présenté une mortalité supérieure due à la variole aviaire et à la bursite infectieuse que les animaux plus âgés ($P = 0{,}00$). Les animaux de souche Sonali (♂ Rhode Island Red X ♀ Fayoumi) élevés dans les conditions décrites supra ont présenté un taux plus élevé d'infection due au virus de la maladie de Newcastle comparés à ceux de souche Fayoumi ($P = 0{,}00$). La variole aviaire a été plus prévalente chez les Fayoumi comparés aux Sonali. De façon surprenante, la ND a été diagnostiquée plus souvent chez les animaux vaccinés que chez les non vaccinés.

Langzeitstudie zur Inzidenz von bedeutsamen endemischen und epidemischen Erkrankungen bei den im Rahmen der PLDP (Participatory Livestock Development Project)-Bezirke in Bangladesh in einem halb-offenen System gehaltenen Hühnern

Es wurde eine 17-monatige Langzeitstudie (von Januar 2002-Mai 2003) durchgeführt, um die Epidemiologie wichtiger endemischer und epidemischer Erkrankungen bei den teilversorgten Hühnern zu untersuchen, die in Bangladesch in den Bezirken des, Participatory Livestock Development Project (PLDP)' aufgezogen worden. Dieses Projekt wurde in 17 nördlichen und nordzentralen Distrikten von Bangladesch in Gang gesetzt, wobei 361.839 zur armen Landbevölkerung zählenden Menschen darin unterstützt wurden, Geflügelaufzucht als ein Mittel zur Reduzierung ihrer Armut durchzuführen. 93% der Begünstigten waren sog. 'Key Rearers' (Hauptzüchter). Ein 'key rearer' ist ein Begünstigter, der meistens10-13 Hennen in einem halb-offenen System mit geringer Zufütterung hält. Die Haltungen von 650 'key rearer' und von einigen Kükenaufzüchtern wurden beobachtet. Während des Beobachtungszeitraums verendeten 1227 Hühner

*To whom correspondence should be addressed. Tel: +88 31 659093. Fax: +88 31 659492 105. E-mail: biswaspk2000@yahoo.com
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verschiedener Alters-, Zucht – und Geschlechtsgruppen als Folge von Erkrankungsfällen. Von jedem dieser gestorbenen Tiere wurden Organproben wie Leber, Herz, Milz, Gehirn, Lunge, Trachea und Bursa Fabricii entnommen. Die Inzidenz der Todesrate betrug 0,01976 pro Monat. 58,44% der toten Tiere wiesen eine Einzel- oder Mischinfektion auf. Die Newcastle-Krankheit hatte die höchste proportionale Todesrate, 15,81%. Die proportionale Mortälität verursacht durch Geflügelpocken, Geflügelcholera, Salmonellose, Colibazillose, Aspergillose, infektiöse Bursitis, Mischinfektionen und ungeklärten Ätiologien betrug 8,96%, 6,76%, 7,09%, 6,93%,033%, 2,04%, 10,51% bzw. 41,56%. Die Newcastle-Krankheit befiel einen signifikant höheren Anteil von Hühnern, die älter als 60 Tage waren ($p = 0{,}00$). Jüngere Tiere (Alter $\leq$ 60 Tage) hatten eine höhere Sterblichkeitsrate aufgrund von Geflügelpocken und infektiöser Bursitis als ältere Tiere ($p = 0.00$). Sonali (männl. Rhodeländer X weibl. Fayoumi)-Hühner, die in dem halb-offenen System gehalten wurden, zeigten im Vergleich zu der einheimischen und der Fayouni-Rasse eine höhere Infektionsrate mit dem Virus der Newcastle-Krankheit ($p = 0{,}00$). Verglichen mit den Sonali-Hühnern hatten Fayouni-Hühner öfter Gelügelpocken. Erstaunlicherweise war die Newcastle-Krankheit bei den geimpften Tieren stärker verbreitet als bei den ungeimpften.

Estudio longitudinal sobre la incidencia de las enfermedades epidémicas y endémicas más importantes que afectan pollos semi-carroñeros producidos en las áreas que participant en el PLDP (*Participatory Livestock Development project*) en Bangladesh

Se llevó a cabo un estudio longitudinal que duró 17 meses (de enero 2002 a mayo 2003) para determinar la incidencia de las enfermedades epidémicas y endémicas más importantes que afectan pollos semi-carroñeros producidos en las áreas que participant en el PLDP (*Participatory Livestock Development project*) en Bangladesh. Este proyecto se implementó en 17 distritos del área norte y centro-norte de Bangladesh en la cual 361,839 personas pobres de ambiente rural fueron asistidas para llevar a cabo engorde de pollos como herramienta para luchar contra la pobreza. Del total de beneficiarios, el 93% fueron 'productores clave.' Un productor clave se define como un beneficiario que produce unas 10-13 gallinas en un sistema de semi-carroñeo con poco alimento adicional. Se tuvieron en cuenta hogares de 650 productores clave y algunos productores de pollos. Durante el periodo de estudio, 1227 aves, que pertenecían a diferentes grupos de edad, raza o sexo fueron encontradas muertas como resultado de una enfermedad. De cada ave muerta se tomaron muestras de hígado, corazón, bazo, encéfalo, pulmón, tráquea y bolsa de Fabricio. La proporción de incidencia de mortalidad fue del 0.01976 por ave-mes a riesgo. Del total de muertos, 58.44% estaban infectados con uno o más microorganismos. La enfermedad de Newcastle presentó la parte proporcional de mortalidad más elevada, 15.81%. La mortalidad proporcional causada por viruela aviar, cólera aviar, salmonelosis, colibacilosis, aspergilosis, bursitis infecciosa, infecciones mixtas y casos no diagnosticados fue del 8.96, 6.76, 7.09, 6.93, 0.33, 2.04, 10.51% y 41.56%, respectivamente. La enfermedad de Newcastle afectó a una proporción significativamente alta (18.81%) de aves mayores de 60 días de edad ($P = 0.00$). Las aves más jóvenes (edad $\leq$ 60 días) presentaron una mortalidad proporcional debido a la viruela aviar y a la bursitis infecciosa que las aves más viejas ($P = 0.00$). Las aves Sonali (♂ Rhode Island Red X ♀ Fayoumi) producidas en un sistema de semi-carroñeo presentaron una proporción de infección con virus de la enfermedad de Newcastle más elevada en comparación con las aves indígenas Fayoumi ($P = 0.00$). La viruela aviar presentó una prevalencia más elevada en aves Fayoumi en comparación con aves Sonali. Sorprendentemente, ND fue más común en las aves vacunadas en comparación con las no vacunadas.