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**Anisa Qadir Janwari**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

**Masood Saleem Mir**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

**Umar Amin**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

**Showkat Ahmad Shah**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

**Majid Shafi**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

**Hilal Musadiq Khan**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

**Shayaib Ahmad Kamil**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

**Mohammad Maqbool Darzi**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

**Correspondence**
**Anisa Qadir Janwari**
Division of Veterinary Pathology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shuhama, Alusteng, Srinagar, Kashmir, (J&K) India

# Prevalence and epidemiology of pulmonary hypertension syndrome in broiler chicken reared under temperate climatic conditions of Northern Himalayas

**Anisa Qadir Janwari, Masood Saleem Mir, Umar Amin, Showkat Ahmad Shah, Majid Shafi, Hilal Musadiq Khan, Shayaib Ahmad Kamil and Mohammad Maqbool Darzi**

**Abstract**
Present study was aimed to investigate the prevalence and associated epidemiological factors of Pulmonary Hypertension Syndrome (Ascites) in commercial broiler chickens. Samples comprised of mortalities from various poultry farms operating in Srinagar, Ganderbal, and Budgam, Districts along with their adjoining areas during April 2014 to June 2015. The outbreaks suspected for *Pulmonary hypertension syndrome* in broiler chicken were identified on the basis of presence of ascites or right ventricular hypertrophy i.e. right ventricle vs total ventricular weight ratio >0.3. Case prevalence of uncomplicated and complicated PHS; and proportionate mortalities were worked out as a function of the total number of necropsies performed and PHS cases, respectively, for a given age group in a particular season, for a given age group, and for a given season. Effect of housing, biosecurity, commercial feed brands and chick strain was also investigated. The overall case prevalence of PHS was 8.70% with 71.71% uncomplicated and 28.29% complicated including concurrent colibacillosis (12.35%), IBD (14.99%) and coccidiosis (0.95%). Farm level incidence in the spring was 1.52 ± 0.216% (0.00-6.00%). Occurrence varied significantly between age groups and seasons but not with the commercial chick strains or feed brands. Poor ventilation and farm-level biosecurity were major epidemiological factors for diseases and PHS.

**Keywords:** Broiler chicken, prevalence, pulmonary hypertension syndrome

## 1. Introduction
Clinical ascites in broiler chickens represent the terminal consequence of pulmonary arterial hypertension (PAH), and hence referred either as PAH, pulmonary hypertension syndrome (PHS), or ascites syndrome [1]. It is characterized by accumulation of serous fluid in coelomic cavities associated with hypoxaemia, increased tension on the cardiopulmonary system, central venous congestion, the right ventricular hypertrophy and a flaccid heart leading to death [1-4]. The condition simulates congestive heart failure in cirrhotic human patients in transudation of plasma fluids due to pulmonary hypertension and central venous congestion as composition of ascitic fluid is fairly similar to that of plasma in osmolarity, total protein and albumin concentration [2, 5, 6]. It constitutes one of the economically important syndromes prevalent worldwide in fast growing broiler chicken causing severe losses to grower and finisher broilers [7]. The syndrome is multifactorial involving complete epidemiological triad. Researchers had suggested various factors as agents of ascites incidence; high altitude, rapid growth rate, energy rations and pelleted diets; poor ventilation; the presence of respiratory disease, high sodium and low dietary phosphorus levels; hepatotoxins, mycotoxins and furazolidone in the feed; vitamin E and selenium deficiencies; and stress [8-10]. Numerous reviews have summarized the extensive literature related to nutritional, management, environmental, and genetic influences on the pathogenesis of PAH [8, 11]. Further, in fast growing broiler chicken lines lower thyroid activity has been associated with impaired lung development elevating the risk of ascites incidence [12-14]. Cold exposure and reduced oxygen tension are two important factors favouring development and progression of the disease condition [12, 15]. In fast growing broilers at high altitudes, the hypobaric hypoxia causes pulmonary vasoconstriction leading to pulmonary hypertension [16]. An exposure to hypobaric hypoxic conditions has been extensively used for development of experimental PHS models [17-20]. Embryonic hypoxia immediately prior to hatching has been associated with increased incidence of ascites [21, 22].

Prolonged embryonic hypoxia at high altitude has been found to impair pulmonary surfactant maturation [23]. Owing to high altitude and temperate climate in Kashmir valley, the birds in closed houses frequently encounter the conditions like cold and reduced oxygen tension, and hence are prone to develop ascites. However, many intrinsic and extrinsic factors have been incriminated, warranting detailed studies in given environmental conditions [24]. Hence, present study was aimed as investigating prevalence and associated epidemiological factors of Pulmonary Hypertension Syndrome in broiler chicken.

## 2. Materials and Methods

### 2.1 Study Design

Samples comprised of mortalities from various poultry farms operating in Srinagar, Ganderbal, and Budgam, Districts along with their adjoining areas brought to Division of Veterinary Pathology, Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir, for post-mortem examination during April 2014 to June 2015. Diagnosis involved systematic approach. Tentative diagnosis was arrived at based on the history, clinical signs and lesions, after following a thorough post mortem examination of birds. The outbreaks suspected for *Pulmonary hypertension syndrome* in broiler chicken were identified on the basis of presence of ascites or right ventricular hypertrophy i.e. right ventricle vs total ventricular weight ratio >0.3.

### 2.2 Occurrence of pulmonary hypertension syndrome

Overall **c**ase prevalence of uncomplicated and complicated PHS was worked out as a function of the total number of carcasses necropsied. Proportionate mortalities were calculated as a function of the total number of PHS cases. Also, case prevalence and proportionate mortalities of PHS were calculated as a function of the total number of necropsies performed and PHS cases, respectively, for a given age group in a particular season, for a given age group, and for a given season.

### 2.3 Incidence of Pulmonary Hypertension Syndrome

Information on flock strength, weekly mortality, weekly mortality due to PHS/ascites syndrome, chick type and feed brand was collected from 48 flocks reared at 24 commercial farms (2 flocks each) during spring 2015. Overall and weekly mean mortality and mean incidence of PHS were calculated as a function of number of birds reared in the flocks under investigation. Weekly mean proportionate mortalities for PHS were worked out as a function of the mortality in a given week. Also, mean mortality, the mean incidence of PHS / ascites and mean proportionate mortality was worked out for nine different commercial broiler chick strains. Effect of feed type on mortality and mortality due to PHS was investigated in 26 flocks maintained on five different commercial feed brands. Also, feed samples were collected from each flock and analysed for proximate composition as per standard procedure given by AOAC, 2012.

### 2.4 Statistical Analysis

Data regarding mortalities including case prevalence and proportionate mortalities was presented as *per cent*. For incidence studies descriptive statistics was used for calculation of means and standard error. For comparing PHS incidence with respect to chick strain, and feed brands; and proximate composition of feed brands data were analysed by one-way ANOVA followed by Duncan's test as post hoc, using SPSS20 software as per Snedecor and Cochran [25].

## 3. Results

### 3.1 Case prevalence and proportionate mortality

Out of a total number of 16935 carcasses necropsied PHS/ ascites was observed in 1474 cases giving a case prevalence of 8.70%. The occurrence of grossly uncomplicated ascites was significantly higher than complicated with case prevalence 6.24% vs 2.46% and proportionate mortality of 71.71% vs 28.29%. The complications included concurrent colibacillosis, and IBD infections whose case prevalences (1.07% vs 1.30%) and proportionate mortalities (12.35% vs 14.99%) were comparable, but significantly higher than concurrent coccidiosis (0.08% and 0.95%, respectively) (Table 1).

### 3.2 Seasonal and Age-wise Case Prevalence

The seasonal case prevalence of ascites calculated on the basis of total number of necropsies performed for a given age group in a particular season is given in Table 2. Ascites was observed in broiler chicken after 15 days age. Highest case prevalence was recorded in age group >28 days (24.08%), followed by 22-28 days (23.13%) and least in the age group 15-21 days (3.68%). Seasonal evaluations revealed highest case prevalence of 9.95% in spring, followed by 9.42% in autumn, 8.68% in winter and 6.15% in summer. In the age group 15-21 days case prevalence was comparable in autumn (5.95%) and winter (5.49%), which was greater than spring (2.93%). In the age group 22-28 days case prevalence was highest in autumn (26.41%) followed by spring (24.20%), winter (22.57%) and summer (16.07%). In age group >28 days, case prevalence was highest in spring (32.31%), followed by winter (31.07%), autumn (20.55%) and summer (20.03%).

Evaluation of case prevalence as a function of the total number of necropsies in a given age group is presented in Table 3. Highest overall case prevalence of 3.88% was observed in autumn, followed by 2.48% in spring, 1.45% in summer and 0.89% in winter. Similar trend was observed in all age groups.

Evaluation of case prevalence as a function of the total number of necropsies in a given season revealed highest case prevalence in spring (9.95%), followed by autumn (9.42%), winter (8.68%) and summer (6.15%). In general highest case prevalence of 4.34% was observed in the age group 22-28 days, followed by 3.65% in age group >28 days, and 0.71% in age group 15-21 days. Similar trend was observed in autumn and winter, whereas in spring and summer highest case prevalence was observed in age group >28 days followed by 22-28 days and 15-21 days (Table 4).

### 3.3 Seasonal and Age-wise Proportionate Mortality Distribution

Proportionate mortality distribution with respect to the seasons and age groups is presented in Table 5. The overall season wise proportionate mortality was highest in autumn (44.57%), followed by spring (28.49%), summer (16.69%) and winter (10.24%). Similar distribution pattern was observed for age groups 22-28 days and >28 days with proportionate mortalities of 48.44%, 26.80%, 15.92% and 8.84%, and 36.57%, 32.20%, 20.87% and 10.36%, respectively in autumn, spring, summer and winter. In age group 15-21 days, proportionate mortality was highest in autumn (61.98%), whereas it was comparable in spring (19.83%) and winter (18.18%).

Age-wise proportionate mortalities in winter and spring were comparable in age groups 22-28 days (43.05% and 46.90% respectively) and >28 days (42.38% and 47.38% respectively) which were significantly higher than in the age group 15-21 days (18.18% and 19.83%, respectively). During summer proportionate mortality was higher in age group >28 days (52.44%) than 22-28 days (47.56%); and during autumn it was highest in the age group 22-28 days (54.19%) followed by >28 days (36.57%) and 15-21 days (11.42%).

### 3.4 Incidence of Pulmonary Hypertension Syndrome

Information was collected on total mortality and mortality due to PHS/ascites syndrome from 48 flocks reared at 24 commercial farms with flock strength ranging from 1000 to 12000 (Avg. 3463.96 ± 339.824) during spring 2015. The overall mean mortality recorded was 6.48 ± 0.474% (1.25-15.33%). the overall incidence and proportionate mortality for ascites were 1.52 ± 0.216% (0.00-6.00%) and 21.27 ± 1.973% (0.00-55.56%) respectively.

The weekly mortality pattern revealed highest mortality 2.05 ± 0.211% (0.40-7.13%) during the first week, followed by 1.25 ± 0.133% (0.19-3.71%) in 4th week, 1.12 ± 0.142% (0.13-5.20%) in 5th week, 1.06 ± 0.093% (0.11-2.50) in the 3rd week and 1.00 ± 0.090% (0.13-2.87%) in 2nd week, in that order. Mortality due to ascites was highest during the 4th week followed by 5th and 3rd week with a respective incidence of 0.70 ± 0.098% (0.00-2.90%), 0.59 ± 0.086% (0.00-1.83%) and 0.23 ± 0.054% (0.00-1.50%); and and proportionate mortalities 54.46 ± 4.262% (0.00-120.00%), 52.95 ± 4.661% (0.00-100.00), and 15.35 ± 2.919% (0.00-75.00) (Table 6)

### 3.5 Incidence of Pulmonary Hypertension Syndrome in Different Commercial Broiler Strains

Mortality evaluation of nine different strains of commercial broiler chicken revealed that the mean mortalities and the incidence of ascites were comparable between the chick strains. However, Proportionate mortality was significantly higher in Type I, III and IX where as it was significantly lower in Type VIII (Table 7).

### 3.6 Effect of Feed Type on Mortality Due to Pulmonary Hypertension Syndrome (Ascites)

The proximate composition of five different commercial broiler feed brands showed significant differences in mean moisture, crude fibre, ash, and ether extract. The mean crude protein and NFE values were comparable (Table 8).

The mortality due to PHS/ ascites in 26 flocks of 1000 to 3300 chicken (2203.84 ± 122.942) ranged from 1.11 to 6.00% with mean mortality 2.62 ± 0.212. The mortality due to PHS / ascites in flocks given feed brand I to V was 2.82 ± 0.643 (1.21 – 4.31), 2.63 ± 0.363 (1.96 – 3.70), 2.65 ± 0.348 (1.65 – 3.53), 2.47 ± 1.187 (1.87 – 3.05), and 2.54 ± 0.709 (1.11 – 6.00) *per cent* respectively. The means did not differ significantly between feed brands (Table 9).

## 4. Discussion

Pulmonary Hypertension Syndrome has been reported worldwide in fast growing broiler chicken [7]. In a World Broiler Ascites Survey, information on 18 countries from four continents showed 4.7% incidence for ascites in live broilers [26]. However, varying prevalence/Incidence rates have been reported from different parts of the word from time to time ranging from 4% to 10% from China, Bangladesh, Iran and India [27-29]. Occasionally very high mortality due to PHS have been reported. Buragohain and Kalita [30] reported 34.3% mortality due to PHS from Mizoram (India). Bhat [31] reported that occurrence of ascites was 11.72% among broilers reared in Kashmir. Itoo [32] reported 4.00% to 16.66% mortality due to ascites in 12 of 186 broiler flocks screened in Kashmir. In Kashmir various epidemiological factors including altitude and housing system seem conducive for development of PHS. The complications observed in the present study may be attributed to stress factor predisposing the birds to prevalent infections due to compromised immunity [11, 33]. This also correlates well with the histopathological findings in the lymphoid organs.

The observed case prevalence and farm level incidence of PHS were higher in the 4th and 5th week followed by the 3rd week. Ascites has been recognized as an important cause of mortality from 3rd week of rearing because of increased metabolic stress [30, 34, 35]. It has been propounded that provision of continuous light during the starter period promotes continuous feeding and higher weight gain in fast growing broilers leading to metabolic stress and ascites during the grower stage.

Higher prevalence during colder periods of the year may be attributed to early exposures to low ambient temperature and closed housing with improper ventilation management [36, 37]. Exposure to lower ambient temperature has been implicated as a trigger for incidence of PHS in broiler chicken and has been used for development of experimental PHS [10, 12, 15, 38]. Subthermoneutral environmental temperatures, especially when supplemented with hypobaric hypoxia, has been reported to induce release of stress hormones and increase cardiac output leading to PHS [11, 33]. Stress induced release of epinephrine and norepinephrine or their administration has been reported to cause immediate pulmonary vasoconstriction leading to pulmonary hypertension [17, 39, 40]. However, prevalence of the condition round the year may be attributed partially to the high altitude of the investigation area. At high altitude, the hypobaric hypoxia has been found to cause vasoconstriction in fast growing broilers leading to pulmonary hypertension and has been used extensively for the development of experimental PHS models [16-19]. Further, the day old chicks are imported from hatcheries at markedly lower altitude which does not provide the opportunity for compensatory cardiovascular and pulmonary modulations during embryonic development [12, 21, 41-45].

The mean mortalities and incidence of ascites were comparable between the chick strains. However, Proportionate mortality due to PHS was significantly lower in Type VIII. Genetic susceptibility plays a critical role in development of PHS/PAH [19, 46, 47]. Heritability for this syndrome has been estimated moderate to high, ranging from 0.11 to 0.57 [48, 49]. The commercial strains investigated, being fast growing, seem to be equally susceptible to ascites [50]. Increased growth rate is accompanied by a severe incidence of ascites in the commercial broiler industry throughout the world [3, 7, 12, 51-52]. Fast growing broilers have very high metabolic rate with high oxygen demand and hence are prone to development of PHS/ascites [24, 33, 53]. Further, in fast growing broiler chicken lines lower thyroid activity has been associated with impaired lung development elevating the risk of ascites incidence [12-14] which correlates well with our histopathological observations. The differences observed in proportionate mortalities may be attributed to other management factors [8, 10, 24].

Various dietary factors including high nutrient density rations, high feed intake, pellet feedand poultry by-product meal have been implicated for inducing PHS in broilers [54-59]. Non-

significant difference observed in mortality due to PHS in chicken maintained on five different commercial feed brands may be attributed to the fact that the feed brands were comparable in proximate analysis.

Investigation into housing and management revealed ventilation management as critical and challenging task. Besides other factors unsatisfactory ventilation has been incriminated as an important factor in respiratory diseases and PHS [8, 10, 24]. Unsuitable ventilation has been found to cause a higher incidence of PHS/ascites in broiler chicken [37]. Poor ventilation associated with higher oxygen demands during second half of the rearing period make the fast growing broiler strains susceptible to PHS [24, 29]. Hypoxia has been considered as a key factor in pathogenesis of ascites [60].

**Table 1:** Case prevalence of Pulmonary Hypertension Syndrome / Ascites among broiler chickens

| Nature | | Mortality due to PHS/Ascites | | |
|---|---|---|---|---|
| | | No. | Case Prevalence | Proportionate Mortality |
| | | | N=16935* | N=1474** |
| **Uncomplicated PHS/ Ascites** | | 1057 | 6.24$^{A}$ | 71.71 |
| Complicated PHS / Ascites | Total complicated PHS | 417 | 2.46$^{B}$ | 28.29 |
| | PHS with Colibacillosis | 182 | 1.07$^{a}$ | 12.35 |
| | PHS with IBD | 221 | 1.30$^{a}$ | 14.99 |
| | PHS with Coccidiosis | 14 | 0.08$^{b}$ | 0.95 |
| Total PHS | | 1474 | 8.70 | |
| *N=Total Number of Necropsies Performed<br>**N=Total number of PHS cases | | | | |

**Table 2:** Case prevalence of Pulmonary Hypertension Syndrome / Ascites in broiler chickens as a function of total number of necropsies performed for a given age group in a particular season

| Season | 0-7 Day | | 8-14 Day | | 15-21 Day | | 22-28 Day | | >28 Day | | Overall | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mortality (N) | PHS/ Ascites | Mortality (N) | PHS/Ascites | Mortality (N) | PHS/ Ascites | Mortality (N) | PHS/Ascites | Mortality (N) | PHS/ Ascites | Mortality (N) | PHS/ Ascites |
| **Winter** | 446 | 0 (0.00) | 398 | 0 (0.00) | 401 | 22 (5.49) | 288 | 65 (22.57) | 206 | 64 (31.07) | 1739 | 151 (8.68) |
| **Spring** | 1194 | 0 (0.00) | 779 | 0 (0.00) | 819 | 24 (2.93) | 814 | 197 (24.20) | 616 | 199 (32.31) | 4222 | 420 (9.95) |
| **Summer** | 1014 | 0 (0.00) | 805 | 0 (0.00) | 811 | 0 (0.00) | 728 | 117 (16.07) | 644 | 129 (20.03) | 4002 | 246 (6.15) |
| **Autumn** | 1679 | 0 (0.00) | 1585 | 0 (0.00) | 1260 | 75 (5.95) | 1348 | 356 (26.41) | 1100 | 226 (20.55) | 6972 | 657 (9.42) |
| **Total** | 4333 | 0 (0.00) | 3567 | 0 (0.00) | 3291 | 121 (3.68) | 3178 | 735 (23.13) | 2566 | 618 (24.08) | 16935 | 1474 (8.70) |
| Figures in braces represent *per cent* values | | | | | | | | | | | | |

**Table 3:** Season wise case prevalence of Pulmonary Hypertension Syndrome / Ascites as a function of total no of carcasses necropsied in a given age group

| Season | Mortality due to PHS/ Ascites | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0-7 Day | | 8-14 Day | | 15-21 Day | | 22-28 Day | | >28 Day | | Overall | |
| | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| **Total Birds Necropsied (N)** | 4333 | | 3567 | | 3291 | | 3178 | | 2566 | | 16935 | |
| Winter | 0 | 0.00 | 0 | 0.00 | 22 | 0.67 | 65 | 2.05 | 64 | 2.49 | 151 | 0.89 |
| Spring | 0 | 0.00 | 0 | 0.00 | 24 | 0.73 | 197 | 6.20 | 199 | 7.76 | 420 | 2.48 |
| Summer | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 117 | 3.68 | 129 | 5.03 | 246 | 1.45 |
| Autumn | 0 | 0.00 | 0 | 0.00 | 75 | 2.28 | 356 | 11.20 | 226 | 8.81 | 657 | 3.88 |
| Total | 0 | 0.00 | 0 | 0.00 | 121 | 3.68 | 735 | 23.13 | 618 | 24.08 | 1474 | 8.70 |

**Table 4:** Age wise case prevalence of Pulmonary Hypertension Syndrome / Ascites as a function of total no of carcasses necropsied in a given season

| Season | Total Birds Necropsied (N) | Mortality due to PHS/ Ascites | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-7 Day | | 8-14 Day | | 15-21 Day | | 22-28 Day | | >28 Day | | Overall | |
| | | No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| Winter | 1739 | 0 | 0.00 | 0 | 0.00 | 22 | 1.27 | 65 | 3.74 | 64 | 3.68 | 151 | 8.68 |
| Spring | 4222 | 0 | 0.00 | 0 | 0.00 | 24 | 0.57 | 197 | 4.67 | 199 | 4.71 | 420 | 9.95 |
| Summer | 4002 | 0 | 0.00 | 0 | 0.00 | 0 | 0.00 | 117 | 2.92 | 129 | 3.22 | 246 | 6.15 |
| Autumn | 6972 | 0 | 0.00 | 0 | 0.00 | 75 | 1.08 | 356 | 5.11 | 226 | 3.24 | 657 | 9.42 |
| Overall | 16935 | 0 | 0.00 | 0 | 0.00 | 121 | 0.71 | 735 | 4.34 | 618 | 3.65 | 1474 | 8.70 |

**Table 5:** Proportionate distribution of mortality due to Pulmonary Hypertension Syndrome / Ascires in broiler chickens

| Season | Total Mortality due to Ascites (N) | Proportionate mortalities due to PHS / Ascites | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-7 Day | | | 8-14 Day | | | 15-21 Day | | | 22-28 Day | | | >28 Day | | | Overall | |
| | | No. | PMS | PMA | No. | PMS | PMA | No. | PMS | PMA | No. | PMS | PMA | No. | PMS | PMA | No. | PMS |
| Winter | 151 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 22 | 18.18 | 14.57 | 65 | 8.84 | 43.05 | 64 | 10.36 | 42.38 | 151 | 10.24 |
| Spring | 420 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 24 | 19.83 | 5.71 | 197 | 26.80 | 46.90 | 199 | 32.20 | 47.38 | 420 | 28.49 |
| Summer | 246 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 117 | 15.92 | 47.56 | 129 | 20.87 | 52.44 | 246 | 16.69 |
| Autumn | 657 | 0 | 0.00 | 0.00 | 0 | 0.00 | 0.00 | 75 | 61.98 | 11.42 | 356 | 48.44 | 54.19 | 226 | 36.57 | 34.40 | 657 | 44.57 |
| Overall | 1474 | **0** | 0.00 | 0.00 | **0** | 0.00 | 0.00 | 121 | | 8.21 | **735** | | 49.86 | **618** | | 41.93 | **1474** | |
| PMS: Proportionate mortality between seasons within age group; PMA: Proportionate mortality between age groups within a season | | | | | | | | | | | | | | | | | | |

**Table 6:** Weekly incidence and proportionate mortality of Pulmonary Hypertension Syndrome / Ascires in broiler chickens (Mean ± SE)

| Period | | 1st week | 2nd week | 3rd week | 4th week | 5th week | Overall |
|---|---|---|---|---|---|---|---|
| Flock Strength | | 3463.96 ± 339.824 (1000 - 12000) | | | | | |
| Mean Mortality | No. | 65.77 ± 10.082 (10-300) | 25.60 ± 1.740 (10-62) | 27.38 ± 1.874 (5-71) | 30.50 ± 2.185 (12-70) | 26.81 ± 2.288 (4-85) | 176.06 ± 12.707 (80-502) |
| | % | 2.05 ± 0.211 (0.40-7.13) | 1.00 ± 0.090 (0.13-2.87) | 1.06 ± 0.093 (0.11-2.50) | 1.25 ± 0.133 (0.19-3.71) | 1.12 ± 0.142 (0.13-5.20) | 6.48 ± 0.474 (1.25-15.33) |
| Mean Mortality due to Ascites | No. | 0.00 ± 0.000 (0) | 0.00 ± 0.000 (0) | 4.58 ± 1.021 (0-30) | 16.94 ± 1.775 (0-58) | 14.19 ± 1.666 (0-45) | 35.71 ± 3.612 (0-120) |
| | % | 0.00 ± 0.000 (0.00-0.00) | 0.00 ± 0.000 (0.00-0.00) | 0.23 ± 0.054 (0.00-1.50) | 0.70 ± 0.098 (0.00-2.90) | 0.59 ± 0.086 (0.00-1.83) | 1.52 ± 0.216 (0.00-6.00) |
| Proportionate Mortality due to Ascites | | 0.00 ± 0.000 (0.00-0.00) | 0.00 ± 0.000 (0.00-0.00) | 15.35 ± 2.919 (0.00-75.00) | 54.46 ± 4.262 (0.00-120.00) | 52.95 ± 4.661 (0.00-100.00) | 21.27 ± 1.973 (0.00-55.56) |
| Number of Farms = 24; Number of Flocks = 48; Total Number of Birds = 166270; Values in braces are range. | | | | | | | |

**Table 7:** Incidence and proportionate mortality of Pulmonary Hypertension Syndrome / Ascites in different commercial strains of broiler chickens (Mean ± SE)

| Chick Type | No. of Flocks | Mean Flock Strength | Mortality | | Mortality due to Ascites | | Proportionate Mortality due to Ascites |
|---|---|---|---|---|---|---|---|
| | | | No. | % | No. | % | % |
| I | 7 | 3910.00 ± 1485.887 (1000 --12000) | 192.43 ± 25.370 (109-274) | 7.93 ± 1.849 (2.28-15.33) | 55.00 ± 13.230 (16-120) | 2.53 ± 0.826 (0.53-6.00) | 28.46 ± 5.441[a] (11.51-55.56) |
| II | 5 | 4000.00 ± 1635.542 (1500-10000) | 282.20 ± 70.780 (167-502) | 8.83 ± 1.197 (5.02-11.53) | 41.40 ± 7.553 (21-67) | 1.55 ± 0.439 (0.67-3.00) | 16.85 ± 3.434[ab] (8.50-26.01) |
| III | 6 | 3433.33 ± 971.825 (1500-7500) | 199.00 ± 32.904 (135-356) | 7.57 ± 1.348 (1.80-11.13) | 49.67 ± 8.781 (12-69) | 2.35 ± 0.683 (0.16-4.31) | 26.91 ± 5.550[a] (8.89-38.76) |
| IV | 4 | 4125.00 ± 1505.199 (1500-8000) | 195.00 ± 67.607 (100-395) | 6.39 ± 1.725 (1.25-8.67) | 30.25 ± 10.036 (7-48) | 1.18 ± 0.689 (0.25-3.20) | 18.27 ± 6.976[ab] (4.52-36.92) |
| V | 5 | 3040.00 ± 668.281 (1500-5000) | 149.60 ± 18.117 (122-219) | 5.89 ± 1.226 (2.58-8.94) | 31.00 ± 9.396 (0-56) | 1.53 ± 0.639 (0.00-3.29) | 23.18 ± 6.597[ab] (0.00-36.84) |
| VI | 4 | 3375.00 ± 746.519 (1500-5000) | 121.75 ± 14.744 (92-150) | 4.29 ± 1.038 (1.84-6.73) | 26.00 ± 14.118 (0-66) | 0.76 ± 0.490 (0.00-2.20) | 19.76 ± 9.443[ab] (0.00-44.00) |
| VII | 8 | 3575.00 ± 675.264 (1500-6000) | 163.12 ± 23.972 (90-306) | 5.90 ± 1.280 (1.88-11.50) | 34.50 ± 7.892 (0-74) | 1.37 ± 0.548 (0.00-4.11) | 22.36 ± 4.885[ab] (0.00-35.75) |
| VIII | 5 | 3000.00 ± 474.341 (1500-4500) | 134.00 ± 16.652 (99-194) | 4.98 ± 0.899 (2.20-7.33) | 7.20 ± 3.337 (0-17) | 0.20 ± 0.087 (0.00-0.40) | 5.66 ± 3.141[b] (0.00-17.17) |
| IX | 4 | 2375.00 ± 375.000 (1500-3000) | 127.25 ± 20.511 (80-169) | 5.47 ± 0.651 (4.00-7.13) | 33.00 ± 8.669 (12-53) | 1.47 ± 0.448 (0.60-2.60) | 25.28 ± 5.132[a] (15.00-36.45) |

Values in braces are range

**Table 8:** Proximate analysis of different brands of commercial poultry feed (Mean ± SE)

| | I (N=5) | II (N=5) | III (N=5) | IV (N=5) | V (N=6) |
|---|---|---|---|---|---|
| **Moisture** | 11.05±0.453$^{ab}$ (9.74-12.17) | 10.79±0.236$^{a}$ (9.90-11.20) | 11.71±0.527$^{ab}$ (10.30-12.93) | 13.23±0.631$^{bc}$ (12.34-15.62) | 14.12±1.203$^{c}$ (12.31-19.87) |
| CF | 4.74 ± 0.175$^{ab}$ (4.31-5.14) | 4.53± 0.117$^{a}$ (4.25-4.86) | 4.47 ± 0.103$^{a}$ (4.27-4.79) | 4.58 ± 0.134$^{a}$ (4.23-4.89) | 5.18 ± 0.201$^{b}$ (4.22-5.62) |
| CP | 23.10 ± 0.911 (20.01-25.35) | 22.98 ± 0.345 (22.00-24.12) | 24.05 ± 0.508 (22.45-25.24) | 23.47 ± 0.752 (21.23-25.73) | 23.16 ± 0.579 (21.23-25.45) |
| Ash | 1.40 ± 0.183$^{a}$ (1.00-1.98) | 1.48 ± 0.135$^{ab}$ (1.23-2.00) | 1.51 ± 0.111$^{ab}$ (1.23-1.81) | 1.57 ± 0.143$^{ab}$ (1.34-2.12) | 1.88 ± 0.107$^{b}$ (1.43-2.15) |
| EE | 3.74 ± 0.147$^{a}$ (3.41-4.23) | 3.53 ± 0.049$^{a}$ (3.42-3.70) | 3.70 ± 0.293$^{a}$ (2.78-4.60) | 3.47 ± 0.120$^{a}$ (3.12-3.87) | 2.78 ± 0.149$^{b}$ (2.45-3.45) |
| NFE | 67.01 ± 1.066 (64.37-70.74) | 67.46 ± 0.593 (65.49-68.96) | 66.25 ± 0.768 (64.00-68.00) | 66.88 ± 0.725 (64.37-68.64) | 66.99 ± 0.911 (64.00-70.67) |
| Values in braces represent range | | | | | |

**Table 9:** Mortality due to Pulmonary Hypertension Syndrome / Ascites in broiler chickens maintained on different brands of commercial feed (Mean ± SE)

| Feed Brand | N | Flock Strength | Mortality due to Ascites | |
|---|---|---|---|---|
| | | | No. | % |
| I | 5 | 2060.00 ± 282.134 (1500 – 3000) | 52,40 ± 8.364 (29 – 74) | 2.82 ± 0.643 (1.21 – 4.31) |
| II | 5 | 2160.00 ± 352.987 (1000 – 3200) | 53.20 ± 7.391 (37 – 76) | 2.63 ± 0.363 (1.96 – 3.70) |
| III | 5 | 1810.00 ± 132.664 (1500 – 2300) | 46.40 ± 3.722 (38 – 56) | 2.65 ± 0.348 (1.65 – 3.53) |
| IV | 5 | 2880.00 ± 231.084 (2000 – 3300) | 70.00 ± 5.108 (56 – 82) | 2.47 ± 1.187 (1.87 – 3.05) |
| V | 6 | 2125.00 ± 192.245 (1750 – 3000) | 53.83 ± 14.531 (21 ± 120) | 2.54 ± 0.709 (1.11 – 6.00) |
| Overall | 26 | 2203.84 ± 122.942 (1000 – 3300) | 55.11 ± 4.147 (21 – 120) | 2.62 ± 0.212 (1.11 – 6.00) |
| Values in braces represent range | | | | |

## 5. Conclusion

PHS frequently affects broiler chickens reared in Kashmir from 3rd week onwards and constitutes a significant proportion of mortality. Commercial chick strains or feed brands screened seemed to be comparable. Chick age, low temperature (season), poor ventilation and poor farm-level biosecurity appeared to be the major epidemiological factors for occurrence of PHS and its complications.

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