Preslaughter Mortality in Broiler Chickens, Turkeys, and Spent Hens Under Commercial Slaughtering

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ABSTRACT The incidence of dead on arrival (DOA) birds was surveyed over 33 broiler, 11 turkey, and 19 spent hen abattoirs representing the majority (around 70%) of the Italian poultry slaughter plants. Data were recorded monthly during a 4-yr period (August 2001 to July 2005), considering a total of 1,266 million chicken broilers, 118 million turkeys, and 54 million spent hens, which represent 67.7, 84.0, and 28.4% of the national production, respectively. The overall average incidence of DOA was found to be 0.35, 0.38, and 1.22% in broilers, turkeys, and spent hens, respectively. The season significantly ($P \leq 0.01$) influenced the mortality of all considered poultry categories, with higher incidence being observed during the summer (0.47, 0.52, and 1.62% for broilers, turkeys, and spent layers, respectively). The incidence of DOA broilers was found to be lower in small slaughter plants compared with medium and large slaughter plants (0.28 vs. 0.38 and 0.35%, $P \leq 0.01$). The data obtained in this study might be used for establishing limit values of DOA as a welfare indicator during the preslaughter time of birds, including catching, loading, transportation, and lairage.

Key words: preslaughter transportation, dead on arrival, broiler, turkey, spent hen

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INTRODUCTION

The preslaughter transportation of poultry constitutes the largest commercial translocation of a single class of livestock in Italy. In 2004, the number of slaughtered broiler chickens was approximately 450 million, whereas the corresponding figures for turkeys and spent hens were 35 and 46 million, respectively (Food and Agriculture Organization of the United Nations, 2005). All these birds, before slaughter, are caught, loaded into cages or coops, transported to an abattoir that may be located either close or far from the farm, and laired in a holding area. Many problems may occur at these stages that potentially increase the rate of mortality.

Broilers and turkeys that are dead on arrival (**DOA**) at the plant represent a complete loss of economic value and range up to 0.5% (Bingham, 1986; Bayliss and Hinton, 1990; Gregory and Austin, 1992; Warriss et al., 1992; Ekstrand, 1998; Nijdam et al., 2004). The mortality for spent hens is generally higher and more variable. Occasionally, very high mortalities have been reported (Warriss et al., 1999). In addition to the economic loss due to DOA, the welfare of poultry during preslaughter time is receiving more and more attention in Europe, resulting in pressure to improve conditions to safeguard animal welfare. Mortality rate is also considered as a parameter to evaluate animal welfare during transport (European Food Safety Authority, 2004). The recent Council Regulation 2005/1/EC (European Union, 2005a) has established that suitable food and water shall be available in adequate quantities in the case of a journey lasting more than 12 h. The European Union proposal of Council Directive 2005/99/CNS (European Union, 2005b) lays down minimum rules for the protection of chickens kept for meat production and includes the mortality during transport (<0.5%) as a parameter to allow stocking density during rearing periods exceeding 30 kg of live weight per square meter.

The birds may be exposed to a variety of potential stressors during transit, including the thermal demands of transport microenvironments, acceleration, vibration, motion, impacts, fasting, withdrawal of water, social disruption, and noise (Mitchell and Kettlewell, 1998). These factors cause adverse effects on the birds that may range from mild discomfort to death (Knowles and Broom, 1990; Nicol and Scott, 1990; Weeks and Nicol, 2000). More careful bird handling to reduce trauma has been reported as a crucial factor to reduce mortality and carcass defects, such as hemorrhages, bruises, and broken bones (Warriss et al., 1992; Barbut, 2002; Nijdam et al., 2004). Spent hens are transported to processing plants when they are at the end of the laying period. There are several particular concerns

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Table 1. Incidence of dead on arrival (%) broilers, turkeys, and spent hens

Descriptive statistics	Broilers	Turkeys	Spent hens
Mean	0.35	0.38	1.22
SEM	0.043	0.025	0.121
Variation interval (minimum-maximum)	0.04 – 2.00	0.04 – 1.23	0.00 – 6.60

about this; they are mostly attributable to injuries formed during cage removal and crating, because osteoporosis in laying hens leads to loss of structural bone and increased incidence of fracture at various skeletal sites by the end of the laying period (Whitehead and Fleming, 2000). The spent hens also have a low monetary value; thus, there is little economic incentive to encourage careful handling and good welfare. For example, in the United Kingdom each year, about 36 million laying hens are slaughtered, and by the time they are killed, about 30% have suffered 1 or more broken bones (Gregory and Wilkins, 1989).

A further crucial factor is that close environmental control in the crates or modules on the vehicle is difficult, mainly because on most vehicles, ventilation is passive and is impeded by the close stacking of adjacent crates. The high probability of thermal stress being suffered by at least some birds in transit has been well documented (Bayliss and Hinton, 1990; Mitchell and Kettlewell, 1998; Warriss et al., 1999). Particularly, when hot weather is expected, it is important to reduce stocking density to control the buildup of heat and humidity. This was illustrated by Warriss et al. (1992). In this study, mortality was reduced from 0.22 to 0.16% from March to August in 1 UK plant, despite the increasing ambient temperature, by reducing stocking density progressively from, on average, 17.3 to 15.8 birds per transport crate. In European Mediterranean countries such as Italy, the average air temperature and RH are higher than 25°C and 70%, respectively, during the summer months (June, July, August); these environmental conditions during antemortem time of birds can induce heat stress and, subsequently, increase the DOA rate of birds. It has been previously evidenced that environmental conditions and duration of lairage at the slaughter plant affect preslaughter mortality rates significantly (Bayliss and Hinton, 1990; Nijdam et al., 2004).

Moreover, mortality is higher in consignments of broilers transported for a longer amount of time (Warriss et al., 1992). Warriss et al. (1992) found that for journeys lasting less than 4 h, the prevalence of dead birds was 0.156%, whereas for longer journeys (up to 9 h), it was 0.283%, an increase of about 80%. In a similar study, Petracci et al. (2005) found that a shorter journey time (<3.5 h) exhibited a lower mortality rate (0.24%) of birds in respect with longer time (>5 h; 0.45%).

Even if several factors have been reported to affect the preslaughter mortality, it can be important to evaluate the average value of DOA under commercial conditions and taking into account the majority of national poultry production. These data could also be used to establish limit values of DOA to evaluate the welfare of poultry during antimortem time as foreseen in the ongoing European Union legislation. The aim of the present study was to determine the incidence of broiler chickens, turkeys, and spent hens that are DOA at the abattoir in the majority of Italian slaughtering plants.

MATERIALS AND METHODS

The incidence of DOA birds was surveyed over 33 broiler, 11 turkey, and 19 spent hen abattoirs representing the majority of Italian poultry slaughtering plants. Data were recorded monthly during a 4-yr period (August 2001 to July 2005), considering a total of 1,266 million chicken broilers, 118 million turkeys, and 54 million of spent hens, which represented 67.7, 84.0, and 28.4% of the national production, respectively, according to the Food and Agriculture Organization of the United Nations (2005). In all abattoirs, the monthly incidence of DOA birds was collected with the help of official veterinarian services; this measurement is actually mandatory in Italy. The monthly rate of DOA was calculated as a percentage, with the total number of dead birds per month counted at the moment of hanging from shackles on the slaughter line as the numerator and the total number of transported broilers per month as the denominator.

Data on DOA prevalence were processed by computing overall descriptive statistics (mean, SEM, minimum and maximum). Additionally, 1-way ANOVA was performed to test the effect of season (summer, June to August; autumn, September to November; winter, December to February; spring, March to May) on DOA birds in each considered poultry category (broilers, turkeys, and spent hens;

Table 2. Effect of season on dead on arrival incidence in broilers, turkeys, and spent hens

Bird	Summer (Jun–Aug)	Autumn (Sep–Nov)	Winter (Dec–Feb)	Spring (Mar–May)	Pooled SEM
Broilers	0.47^{A}	0.28^{D}	0.35^{B}	0.32^{C}	0.006
Turkeys	0.52^{A}	0.29^{B}	0.29^{B}	0.32^{B}	0.010
Spent hens	1.62^{A}	1.16^{B}	1.06^{B}	1.13^{B}	0.048

$^{A–D}$Means within a row followed by different superscript letters differ significantly ($P \leq 0.01$).

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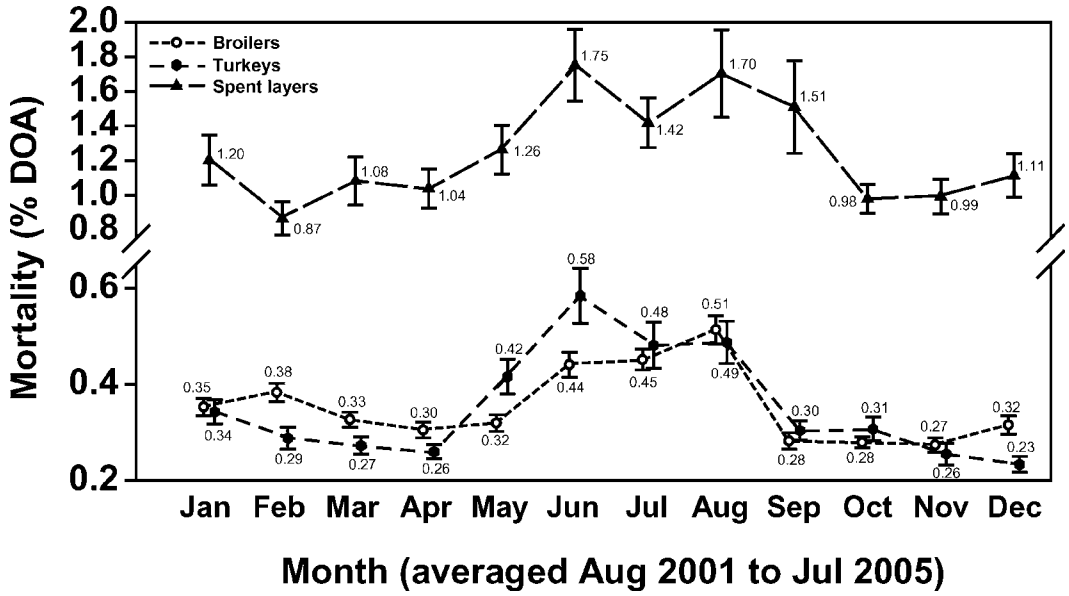

Figure 1. Average monthly dead on arrival (DOA) percentage in broilers, turkeys, and spent hens (mean ± SEM)

SAS Institute, 1988). Furthermore, in broilers only, the effect of abattoir size was tested by classifying the broiler abattoirs as follows: small (<1 million slaughtered birds/yr), medium (1 to 10 million slaughtered birds/yr), and large (≥10 million slaughtered birds/yr). Data processing was conducted by considering the means multiplied by the respective number of birds slaughtered by each abattoir.

RESULTS

Overall mean, SEM, and variation interval of the incidence of DOA birds in broilers, turkeys, and spent hens are presented in Table 1.

Broilers exhibited an average monthly DOA percentage of 0.35%, with ranges from 0.04 to 2.00%. In turkeys, the DOA incidence showed a similar mean value of 0.38%, and the overall range varied from 0.04 to 1.23%. As expected, a higher DOA mean value was found in spent hens (1.22%), with a very wide variation interval from 0.00 to 6.60%.

The season of slaughtering significantly ($P \leq 0.01$) influenced the preslaughter mortality rate in broilers, turkeys, and spent hens, as shown in Table 2. The average monthly DOA percentage in broilers, turkeys, and spent hens is shown in Figure 1. The differences among the years seemed to be less important (Figure 2).

Concerning the broilers, a significantly ($P \leq 0.01$) higher DOA percentage was observed in the summer (0.47%), whereas the lowest was found in autumn (0.28%). Winter and spring presented intermediate mortality rates (0.35 and 0.32%) during preslaughter time. Also, DOA prevalence was significantly ($P \leq 0.01$) higher in turkeys in the summer (0.52%) than in autumn, winter, and spring, which did not differ from one another (0.29, 0.29, and 0.32%, respectively). In addition, the same trend ($P \leq 0.01$) was observed in spent hens (1.62 vs. 1.16% and 1.06 and 1.13%, in summer, autumn, winter, and spring, respectively). Also, in spent hens the higher DOA percentage ($P \leq 0.01$) was observed in summer (1.62%) compared with other seasons (1.16, 1.06, and 1.13% in autumn, winter, and spring, respectively).

In Italy, the turkey abattoirs process almost the same number of birds per year, whereas broiler plants process a variable number of birds per year; it was interesting to study the effect of abattoir size on the mortality rate. It was observed that DOA prevalence was significantly ($P \leq 0.01$) lower in small abattoirs (<1 million birds/yr; 0.28%) than in medium (1 to 10 million birds/yr; 0.38%) and large abattoirs (≥10 million birds/yr; 0.35%; Figure 3).

DISCUSSION

The data on preslaughter mortality found in our study are similar to those reported by Warriss et al. (1999), who indicated that DOA prevalence in the United Kingdom ranged from 0.2 to 0.5%, depending on environmental conditions and journey time. More recently, Nijdam et al. (2004), considering 1,907 Dutch and German broiler flocks slaughtered in 2000 and 2001 at a Dutch processing plant, found a 0.46 average DOA percentage. Weeks and Nicol (2000) also suggested a conservative figure of 0.3% for overall average mortality of broilers. It was also confirmed that preslaughter mortality in spent hens is very critical. This is mostly attributable to injuries formed during cage removal and crating, because osteoporosis in laying hens leads to loss of structural bone and increased incidence of fracture at various skeletal sites by the end of the laying period (Whitehead and Fleming, 2000). Gregory et al. (1994) found that 10.2% of birds had old and healed breakages (principally, the furculum, ulna, and humerus), and 16.5% of breakages occurred during depopulation and transport (most frequently the pubis and the keel). At this stage, Gregory and Wilkins (1989) observed that 31.4% of

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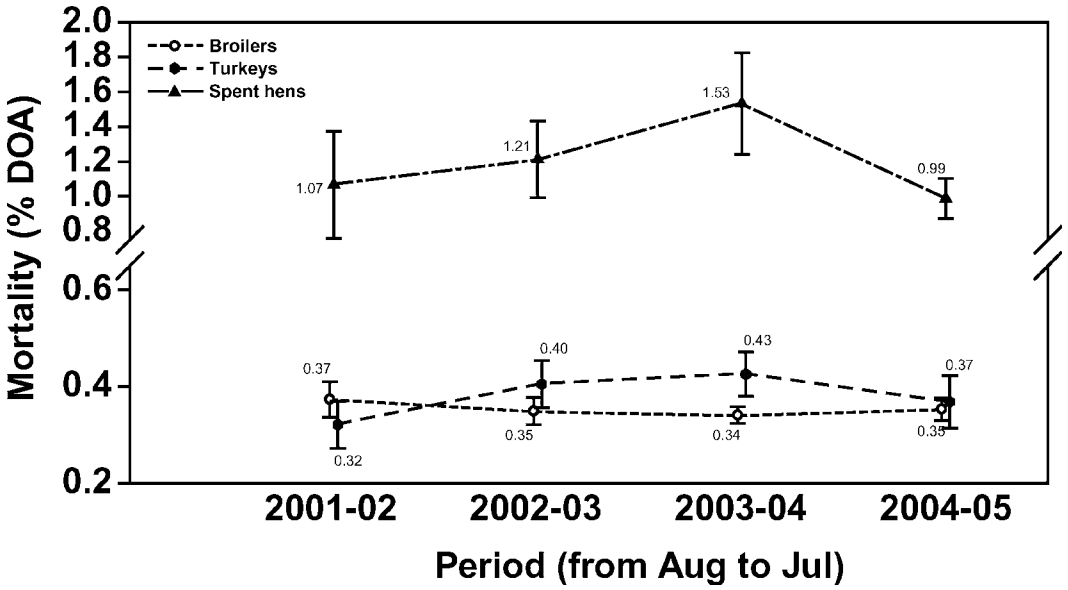

Figure 2. Average yearly dead on arrival (DOA) percentage in broilers, turkeys, and spent hens (mean ± SEM)

birds had broken bones, rising to 45.3% after removal from transport crates and hanging on shackles before stunning.

In the present study, the season significantly affected the DOA incidence in all considered poultry categories. Moreover, if the preslaughter mortality differences among autumn, winter, and spring were statistically significant only in broilers, preslaughter mortality in the summer was found to be dramatically higher in broilers (+43%), turkeys (+59%), and spent hens (+42%) than the respective averaged mortality observed in autumn, winter, and spring. These results could be explained by the high environmental temperatures and RH normally observed in Italy during the summer months compared to the other seasons of the year. For instance, in the weather station in Vicenza (Metereological Service of Military Italian Aeronautics), which is close to the main area of poultry processing in Italy, the average air minimum–maximum temperature and RH observed during the summertime (from June to August) is 16.3 to 27.7°C and 72.7%, respectively.

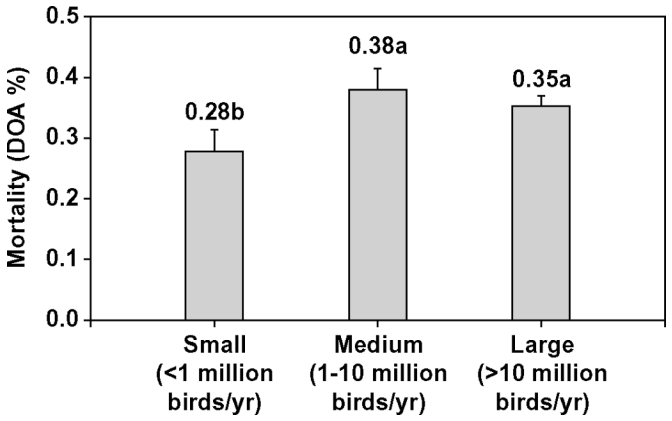

Figure 3. Effect of abattoir size on dead on arrival (DOA) incidence (mean ± SEM) in broilers. Means with different letters differ significantly ($P \leq 0.05$).

These results confirm that heat stress due to high environmental temperature and RH can be a major factor in the death of birds during preslaughter time, whereas low ambient temperatures appear to be less important, even if broilers seem to be more prone to have higher mortality during winter compared with turkeys. Some postmortem inspections conducted by veterinarian personnel in one of the larger abattoirs revealed that a main cause of death in birds that are DOA at the plant is acute and congestive heart failure (P. Gaspari, personal communication). This suggests that DOA is caused more by antemortem stress than preexistent pathologies, and it is consistent with a previous study (Barontini et al., 1999), which found that the causes of preslaughter mortality are acute (14%) and congestive (37%) heart failure, followed by trauma (32%). This agrees with Bremner and Johnston (1996), who indicated that heart failure explained 47% of the deaths. Both environmental temperature and humidity are important factors affecting metabolic exhaustion and dehydration, which can cause heart failure (Elrom, 2001). An important method of losing heat in poultry at high temperatures is by evaporative cooling from the respiratory tract. The birds pant to facilitate this. In high humidity, evaporative mechanisms become less effective, or ineffective (Mitchell and Kettlewell, 1998; Barbut, 2002). High temperatures and humidity during preslaughter time (in the broiler house during catching and loading, on the vehicle during transport, and in the lairage area at the abattoir) may be a part of the explanation for greater mortality during the summer (Nijdam et al., 2004).

In regard to the effect of abattoir size, the lower broiler preslaughter mortality rates found in small abattoirs can be attributed to the fact that intermediate and large abattoirs usually process flocks with larger amount of birds. Larger flocks mean an increased catching time that can affect the catching team's ability to exercise care during catching, as discussed by Nijdam et al. (2004), who found that the

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percentage of DOA birds significantly increased with increasing flock size. The importance of reducing trauma in controlling mortality is demonstrated by the findings of Gregory and Austin (1992). Handling of broilers is usually by the legs, and operatives may carry up to 5 birds, each held by 1 leg, in each hand. The potential for trauma is, therefore, considerable. In particular, it may lead to dislocations of the femur at the hip joint (Gregory and Austin, 1992). Also, in turkeys, it has been evidenced that during loading, birds may suffer death, bruising, broken bones, torn skin, and other physiological stress (Prescott et al., 2000).

The present study found that mortality during preslaughter time in the Italian slaughtering system is, on average, 0.35, 0.38, and 1.22% in broilers, turkeys, and spent hens, respectively. Mortality of spent hens was found to be very critical for bird welfare. Higher DOA incidence was found in all poultry categories in the summer, confirming the importance of heat stress in determining the death of birds during preslaughter phases. Furthermore, abattoir size was found to have an effect on DOA; DOA was found to be lower in small abattoirs compared to medium and large abattoirs.

In conclusion, the data obtained in this study might be used for establishing limit values of DOA as welfare indicators during preslaughter time of birds. In fact, the term "welfare" is relevant only when an animal is alive, but death during handling and transport is preceded by a period of poor welfare (European Food Safety Authority, 2004). The official veterinarian should check to see if the DOA percentage exceeds some established limit values, and the owner or keeper of the abattoir should be notified by the competent authority to improve catching and loading operations and conditions during transport and holding at the abattoir, as indicated in the recent EU proposal of Council Directive 2005/99/CNS (European Union, 2005b).

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