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Effects of Air-borne Hazards on the Physical and Psychological Health of Nigerian Poultry Workers

Pius A. Okiki[1]*, Anthony O. Ogbimi [2] and Wilson E. Edafiadhe [3]
[1]Department of Microbiology, Faculty of Sciences, Afe Babalola University, Ado Ekiti, Nigeria.
[2]Department of Microbiology, Faculty of Life Sciences,University of Benin, Benin City, Nigeria.
[2] Department of Mental Health/Psychiatry, Faculty of Clinical Sciences, College of Medical Sciences, Delta State University, Abraka, Delta State, Nigeria.
*E-mail: piusokiki@yahoo.com

Abstract
Industrialized agriculture has resulted in a public health crisis for farmers, farm workers and their families. This study, which involved measurement of the concentrations of air-borne dust and ammonia in poultry buildings using active samplers and assessing the physical and psychological health status of poultry workers via questionnaire, was conducted in some poultry farms in Lagos and Ogun States of Nigeria. Ammonia concentrations in poultry houses, 52.53 $\pm$ 23.56 parts per million (ppm), were found to be much higher than allowable value of 25ppm. Poultry working environment was found to be dustier than human indoors. Poultry workers experienced significantly higher frequency of symptoms of physical ill-health than the control populace ($P < 0.001$). Depression indices were low in all the two groups studied without significant difference in the frequency of occurrence of depression symptoms. Poultry workers with anxiety index of 0.23 were found to be moderately anxious while control populace showed no anxiety. The symptoms of anxiety were significantly higher among poultry workers than control ($P < 0.001$). Female poultry workers experienced significantly higher symptoms of physical ill health, anxiety and depression than their male counterparts ($P < 0.001$, in all cases). The results indicated that the poultry air has high load of respirable dust, noxious gases and other agents that may be acting in synergy to produce deleterious effects on both the physical and psychological health of poultry workers.
Key words: Ammonia, anxiety, depression, poultry dust, poultry workers, physical ill health.

1.0. Introduction

Modern poultry farming involves breeders' management, hatchery operation, egg processing and distribution, broiler processing, turkey production and feed mill operation (Miller, 1983). The tasks performed by poultry workers which include: feeding, cleaning of feed and water trough, transportation of birds, removal of dead and injured birds, vaccination, collection of blood samples from birds and maintenance of litter or bedding, expose them to a variety of air-borne hazards (Olson and Bark, 1996). Exposure of poultry workers to live birds in poultry confinements results in potential respiratory insult from various infectious, toxic, allergic and immunogenic agents (SNBOSH, 1994; Olson and Bark, 1996; Tellier, 2006). Prolonged inhalation of organic dust containing faecal materials and feather has been reported to cause hypersensitivity lung diseases (extrinsic allergic alveolitis) and symptoms such as coughing, wheezing and respiratory distress have been noted (Reynolds *et al.,* 1993; SNBOSH, 1994; Olson and Bark, 1996; Seedorf' 2004; Tellier, 2006).
Gases in poultry confinements are produced by the bio-degradation of droppings, animal respiration and building operations. Each of these gases may affect the respiratory health and the general well-being of humans (Leistikow *et al.*, 1989; Schiffman, 1998; Cole *et al.*, 2000). Complaints of odour nuisance have been more frequent in the environment of high concentration of livestock. Studies have suggested that eye, nose and throat irritation, headache and drowsiness are common complaints of health symptoms of those exposed to odours such as poultry odour (Shusterman, 1992). The human health effects may also include innate odour aversive conditioning phenomena and stress induced illness. Deleterious psychological health effects such as mood disorders resulting from a combination of physical agents and physiological responses to swine odour have been reported (Schiffman, 1995; Thu *et al.*, 1997).
Most studies on exposure to allergens and irritants in animal husbandry have taken place in temperate regions, where animals are kept in closed confinement buildings the whole year round for climatic reasons (Iversen, 1997). In the tropics, however, chickens are only housed in closed confinements during brooding at young age, but live the rest of their lives in side-netted unenclosed confinement buildings. Recent studies reported high prevalence in Nigerian poultry dust, of multidrug resistant bacteria, toxic chemicals and heavy metals (Okiki *et al.,*2011), as well as mycotoxins and various toxigenic and pathogenic fungi (Okiki and Ogbimi,2011). This study was carried out with the aim of assessing the air contaminants in the poultry-working environment and their possible effects on the physical and psychological health of Nigerian poultry workers.

2.0. Materials & Methods

2.1. Exposure Measurements

Airborne dust of aerodynamic diameter less than 10 microns were measured in 25 poultry pens and 15 feed mills with the aid of an active sampler (WHO, 2000), Haz Dust (Environmental Device Cooperation, US). The measurements were carried out during the dry season (January to April) and the wet season (May to October) in the year 2008. Ammonia levels in the air of 25 poultry buildings made up of 11 flocks in battery cages with manure accumulating in pits and 14 flocks in deep litter system, were determined using a direct reading active sampler, Crowcon (Environmental Device Cooperation, US).

2.2. Questionnaire

Questionnaire was developed to elicit data on socio-demographic, and the physical and psychological health status of the groups studied. The questionnaire, which was adapted from the work of Thu *et al.* (1997), was made up of 4 sections: -

a) The first section provided information on socio-demographics,
b) The second section were symptoms of physical ill health,
c) The third sector was a depression scale based on the work of Zung (1965),
d) The fourth was an anxiety scale based on the Beck anxiety Inventory (Steer *et al.*, 1993).

The properties of questionnaires with respect to the symptoms of physical ill-health, depression and anxiety are as contained on the horizontal axes of Figures 1, 2 & 3. The questionnaires were approved by the ethical committee of the Faculty of Life Sciences, University of Benin before they were used for this work. The questionnaire was administered to 275 poultry workers in commercial poultry farms and 110 control subjects between November 2008 and February 2010 in some parts of Lagos and Ogun states of Nigeria. The control subjects were healthy individuals that were neither occupationally nor environmentally exposed to poultry or organic dust. Individuals with pre-existing medical or psychiatric history were completely excluded.

2.3. *Data analysis*

The following were used for comparison of frequency of occurrence of symptoms of ill health: -

a) Physical health: never =0, rarely =1, occasionally =2, often =3, very often=4;
b) Depression: never =0, some of the time =1, good part of the time =2, most of the time =3;
c) Anxiety: not at all =0, sometimes =1, frequently =2, almost constantly =3 (Thu *et al.*, 1997).

Group mean was calculated per symptom of ill health. Anxiety and depression indices in each study group were obtained by totalling the raw scores of participants and dividing it by the total possible score (Zung, 1965; Thu *et al.*, 1997). Paired *t*-test was used to determine the significant difference of mean scores of symptoms of physical and psychological ill health between the groups studied. Dust concentrations during wet and dry seasons were tested for significance using paired t-test. Model selection loglinear analysis was used to test the association of socio-demographic variables with one another and with the physical and psychological health statuses of the poultry workers. All statistical analyses were carried out using SSPS 15.0 for windows. Only two-tailed test was used in determining significance in all cases. A minimum value of $P < 0.05$ was considered significant.

4.0. Results

Air-borne dust concentrations of respirable size (<10μm), at breathing zone of poultry and feed mill working environments, were found to be much higher than the human indoor control (Table 1). Values in the range of 0.27-1.60mg/m^3 and 0.78 -3.56mg/m^3 were obtained in pens with birds in battery cages and with bids on deep litters, respectively. The results also showed significantly higher air borne dust concentrations during the dry season than the raining season ($t = 2.838$, $P = 0.047$). Air concentration of ammonia at breathing zone in poultry confinements were found in the range of 24 - 103 (52.5 $\pm$ 23.56) parts per million.

The socio-demographics of groups studied are presented in Table 2. There were no significant differences between the poultry workers and control in their socio-demographic statuses. The symptoms of physical ill health were significantly higher among poultry than the control subjects ($P < 0.001$; Figure 1).

Clusters of symptoms of both lower and upper respiratory illnesses were found to be significantly higher among poultry than control. Poultry workers experienced significantly higher symptoms of psychogenic sickness than controls (Table 3). Female poultry workers experienced higher physical ill-health symptoms than their male counterparts ($P = 0.001$). There was no significant difference in physical health statuses between on-farm and off-farm residence poultry farm workers ($p = 0.943$), Table 4. Both tobacco smoking and alcohol consumption were found to be significantly associated with physical ill health ($\chi^2 = 6.281$; $P = 0.043$ and $\chi^2 = 7.329$; $P = 0.026$ respectively), and a strong association between tobacco smoking and alcohol consumption ($P = 0.007$) was obtained. There was strong association between education, marital status and gender among the poultry workers studied ($P = 0.004$); gender and marital status combined were significantly associated with physical ill-health ($P = 0.002$); the combination of education and gender equally produced a significant association with physical ill health ($P = 0.024$); however, the combination of gender and marital status produced a significant association with

physical ill-health (P = 0.002), Table 4.
The depression indices for poultry workers and control subjects were 0.48 and 0.46 respectively. There was no statistical significant difference in depression symptoms among the two groups studied (Figure 2). The female poultry workers and their male counterparts had depression indices of 0.54 and 0.45 respectively, and the frequencies of the depression symptoms they experienced were significantly different (P < 0.001).
Anxiety indices for poultry workers and control subjects were respectively 0.23 and 0.12. Symptoms of anxiety were significantly higher among poultry workers than control populace (P < 0.001; Figure 3). Female poultry workers and their male counterparts had anxiety index scores of 0.28 and 0.19, respectively. Frequency of symptoms of anxiety was significantly higher among female poultry workers than their male counterparts (P < 0.001). Anxiety was found to be significantly associated with on/off farm residence (P = 0.012; Table 5), with higher symptoms of anxiety reported by on-farm residence workers. The section/types of birds managed was also found to be associated with anxiety (P = 0.004), with highest symptoms reported by workers in pens housing birds in battery cages with accumulation of manure in pits (Table 5).
The associations of symptoms of physical ill health, depression and anxiety are presented in Table 6. There was significant association between physical ill health and depression ($\chi^2 = 17.625$, P = 0.001), as well as between anxiety and depression ($\chi^2 = 20.340$, P < 0.001). There was however, no significant association between physical ill health and anxiety (P = 0.399).

5.0. Discussion
Indoor atmospheres in animal dwellings have been found to contain gases and particles at many times the concentration of outdoor atmospheres and that of human dwellings (Pickrel, 1991). Ammonia measurement in this study was used as an indicator for the presence of toxic gases and odours, which have been found to have deleterious effects on human health (Shusterman, 1992; Schiffman, 1998).

The ammonia in poultry confinement buildings reported in this study, 52.53 ± 23.56 (23 –103) ppm, was higher than the allowable value of 25ppm (Pickrel, 1991). The ammonia immediate dangerous to life and health (IDLH) value (a US National Institute for Occupational Safety and Health parameter) is 300ppm, representing the maximum concentration of ammonia one can withstand for 30 minutes (Michaels, 1999). Haber's rule (an approximation in toxicology) states that the product of the dose and duration of exposure to a particular toxic substance equals a constant (Pederson and Selig, 1989; Michaels, 1999). Following this rule, exposure to ammonia concentration of 50ppm for 180minutes will produce almost the same health hazard effects that the IDLH value of 300ppm NH_3 will produce for 30min. By implication the values of ammonia concentrations obtained in this study are dangerous to health, especially in poultry confinements with manure accumulating in pits where values as high as 72 – 103ppm NH_3 were obtained. Ammonia is a water- soluble, toxic and irritant gas. Ammonia can cause irritation of the eyes, gastrointestinal and respiratory tracts potentiating infectious respiratory diseases. Clinically, pulmonary oedema has been associated with high dose and acute exposure to ammonia in animal buildings (Blood and Radostits, 1989; Pickrel, 1991).

In this study, the concentrations of air-borne dust in air of poultry working environments in this study were much higher than human indoor airs. Higher concentrations of respirable dust were obtained during the dry season than the rainy seasons in all the environments studied. The poultry workers experiencing significantly higher symptoms of physical ill health than the control, could be due to the fact that the poultry workers are continuously exposed to dust containing faecal materials, feathers, allergens, high load of microbes and their by-products such as endotoxins in an air with high concentrations of toxic gases and irritating odours (Pickrel, 1991; SNBOSH, 1994; Olson and Bark, 1996). Airborne dust in a livestock confinement containing 3.9ppm of ammonia has been reported and that dust has been implicated as a vehicle for deep lung deposition of ammonia (Pickrel, 1991). Inhalation of such dust could be of grave respiratory health consequence.
The cluster of symptoms of psychogenic illness which was found to be significantly higher among the poultry workers than and control populace, in this study (Table 3), could be attributed to poultry odour. The ambient odour has been found to play a significant role in precipitating this illness (Shusterman, 1992; Thu *et al.*, 1997). Chronic exposure to odour over a long time can modify a person's perceptional world and this account to the fact that persons who work with livestock cannot fully understand the complaints from neighbours who only receive odours intermittently (Shusterman, 1992; Schiffman, 1995).
Zung's clinically admitted population of depressed patients had depression index of 0.74 and his control or "normal" population had an index of 0.33 (Zung, 1965; Thu *et al.*, 1997). When compared to Zung's indices, the poultry workers and the control populace, in this study, with indices of 0.48 and 0.46 respectively could be considered to have mild depression. However, Thu *et al.* (1997) indices of 0.40 for control and 0.37 for people residing in the vicinity of a large swine operation were said to have mild depression.
The control populace with anxiety index of 0.12 could be considered not suffering from anxiety. Thu and co-workers reported an index of 0.11 for both control and case study and the two groups were considered normal.

Steer *et al.* (1993) obtained an index score of 0.29 in a population of 250 clinically admitted patients categorized as "moderately anxious". The poultry workers in this study with an index of 0.23 could be considered as moderately anxious. Noxious odours and gases have been noted to play an important role in precipitating anxiety (Shusterman, 1992; Schiffman, 1995).

Female poultry workers in this study reported significantly higher symptoms of physical ill health, depression and anxiety than their male counterparts. These statistical differences obtained along sex may be due to the effects of poultry odour exposure. According to Shusterman (1992), odourant chemicals may trigger hormonal or reflex behavioral responses.

In conclusion, the ambient air in the poultry confinements contains noxious and odourous gases and air-borne particles rich in various infectious, allergenic and toxic agents; which individually or collectively in a synergy can affect negatively the physical and psychological health of poultry workers. The occupational health hazard reported in this study is of high significance because, Nigeria in Sub-Saharan Africa, a region with high endemicity of malaria and human immunodeficiency virus (HIV) infection, cannot afford such occupational health risk that can compromise health. It becomes imperative that should be legislation that ensures poultry farms and feed milling outfits comply with industrial safety rules, by providing (and enforcing the usage of) protective materials for their workers, as well as being environmental friendly.

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Table 1: Ambient dust concentration of aerodynamic diameter of 10 microns

Environment	Wet season	Dry season
Human indoor (control)	0.04 ± 0.01	0.13 ± 0.03
Birds in battery cages	0.48 ± 0.35	1.07 ± 0.42
Birds on deep liters	1.84 ± 0.38	2.68 ± 0.73

Values are Mean ±SD (mg/m^3)

Table 2: Sociodemographics of poultry workers and control populace.

	Poultry workers		Control		
Characteristics	No	%	No	%	Significance
Total number	275	100	110	100	
Gender					
Male	183	66.55	68	68.82	
Female	92	33.45	42	38.18	p = 0.215
Education					
No formal education	0	0	6	5.45	
Primary education	29	10.55	17	15.45	
Secondary education	144	52.36	53	48.18	
Tertiary education	102	37.09	34	30.91	p = 0.354
Age in years					
21-25	38	13.82	16	14.55	
26-30	119	43.27	43	39.09	
31-35	75	27.27	27	24.55	
36-40	27	9.82	14	12.73	
40-45	16	5.82	10	9.09	p = 0.999
Smoking habit					
Smoker	27	9.82	13	11.82	
Non Smoker	248	90.18	97	88.18	p = 1.000
Years of involvement in poultry					
1-3	43	15.64			
4-6	113	41.09			
7-9	86	31.27			
10-12	22	8.00			
13-15	11	4.00			
Average	6.31±2.94				
Residence					
On farm	92	33.45			
Off farm	183	66.55			

Table 3: Comparison of average scores of clusters of related physical ill-health symptoms among poultry workers and control populace.

Physical symptoms clusters	*Poultry*	*Control*
i. All symptoms combined	1.26±0.84[a]	0.64±0.42[b]
ii. Cluster 1: Symptoms of chronic bronchitis and hyper-reactive airways	0.81±0.38[a]	0.52±0.35[b]
iii. Cluster 2: Symptoms of mucous membrane irritation	1.09±0.51[a]	0.54±0.33[b]
iv. Cluster 3: Symptoms of psychogenic illness	1.47±1.10[a]	0.54±0.60[b]
v. Cluster 4: Symptoms of chronic sinusitis	1.63±1.12[a]	0.85±0.66[a]
vi. Cluster 5: Others	1.58±1.17[a]	0.87±0.34[a]

[a-c] mean values in the same row for each parameter with different superscript are significantly different, $P < 0.05$; paired *t*-test.

Cluster 1: Cough, sputum, shortness of breadth, tightness in chest, wheezing
Cluster 2: Running nose, scratchy throat burning/watering eyes
Cluster 3: Weakness, nausea/vomiting, dizziness, fainting/blackout
Cluster 4: Headache, plugged/irritating ears.
Cluster 5: Fever, muscle ache/pain, skin rash, hearing problem.

Table 4: Association of socio-demographic variables with one another and with physical ill-health of poultry workers

Interactions	Chi square (χ^2)	Significance	Degree of freedom
Education/Gender/Marital status	11.012	0.004*	2
Education/Marital status/Physical ill health	2.716	0.132	4
Gender/Marital status/Physical ill health	12.010	0.002*	2
Education/Gender/Physical ill health	11.249	0.024*	4
Smoking/Alcohol	7.287	0.007*	1
Smoking/Physical ill heath	6.281	0.043*	2
Alcohol/Physical ill health	7.329	0.026*	2
Age/Physical ill health	8.154	0.086	4
Years at work/Physical ill health	2.870	0.580	4
Residence on-off farm/Physical ill health	0.118	0.943	2
Section-types of birds/Physical ill health	0.225	0.894	2

* Statistically significant
Model selection loglinear analysis (SPSS 15.0 for windows)

Table 5: Association of socio-demographic variables with psychological health statuses of poultry workers

Interactions	Chi square (χ^2)	Significance	Degree of freedom
Anxiety			
Education/anxiety	4.810	0.590	4
Gender/Marital status/anxiety	4.536	0.104	2
Marital status/Anxiety	5.587	0.061	2
Gender/Anxiety	15.282	<0.001*	2
Smoking/Anxiety	4.384	0.114	2
Alcohol/Anxiety	0.233	0.890	2
Age/Anxiety	4.074	0.850	8
Years at work/Anxiety	8.721	0.068	4
Residence on-off farm/Anxiety	8.872	0.012*	2
Section-types of birds/Anxiety	10.847	0.004*	2
Depression			
Education/Depression	4.133	0.388	4
Marital status/ Depression	0.692	0.708	2
Gender/ Depression	19.692	<0.001*	2
Smoking/ Depression	1.622	0.444	2
Alcohol/ Depression	1.045	0.593	2
Age/ Depression	1.792	0.773	4
Years at work/ Depression	1.479	0.830	4
Residence on-off farm/ Depression	1.167	0.558	2
Section-types of birds/ Depression	0.270	0.874	2

* Statistically significant
Model selection loglinear analysis (SPSS 15.0 for windows)

Table 6: Association of symptoms of physical ill health, anxiety and depression reported by poultry workers

Interactions	Chi square (χ^2)	Significance	Degree of freedom
Physical ill health/Anxiety	4.055	0.399	4
Physical ill health/Depression	17.625	0.001*	4
Depression/Anxiety	20.340	<0.001*	4

*Statistically significant Model selection loglinear analysis (SPSS 15.0 for windows)

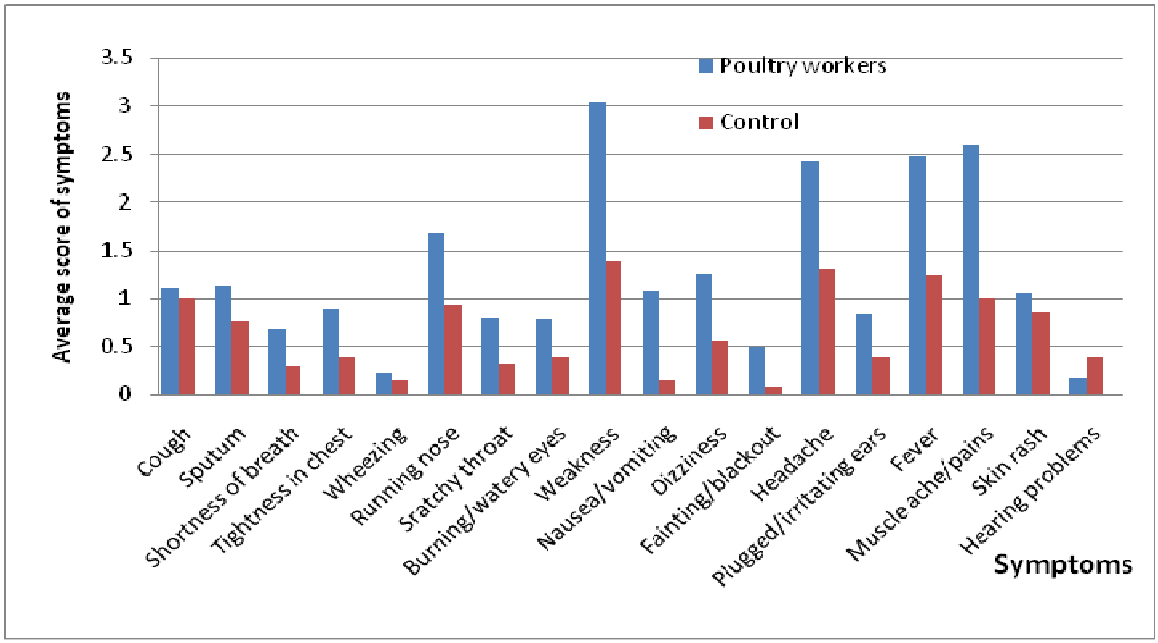

Figure 1: Comparison of frequency of symptoms of physical ill health among poultry workers, and control subjects. (Paired *t* test: Poultry/Control $p < 0.001$)

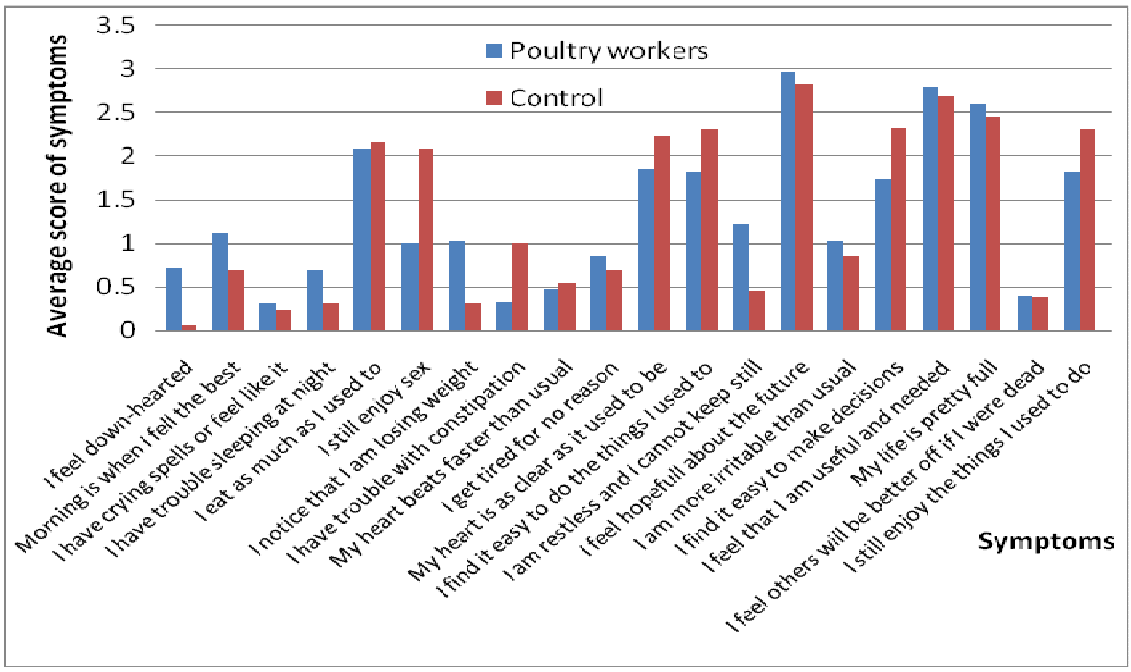

Figure 2: Comparison of frequency of depression between poultry workers and control subjects (Paired *t* test: Poultry/Control $p = 0.489$)

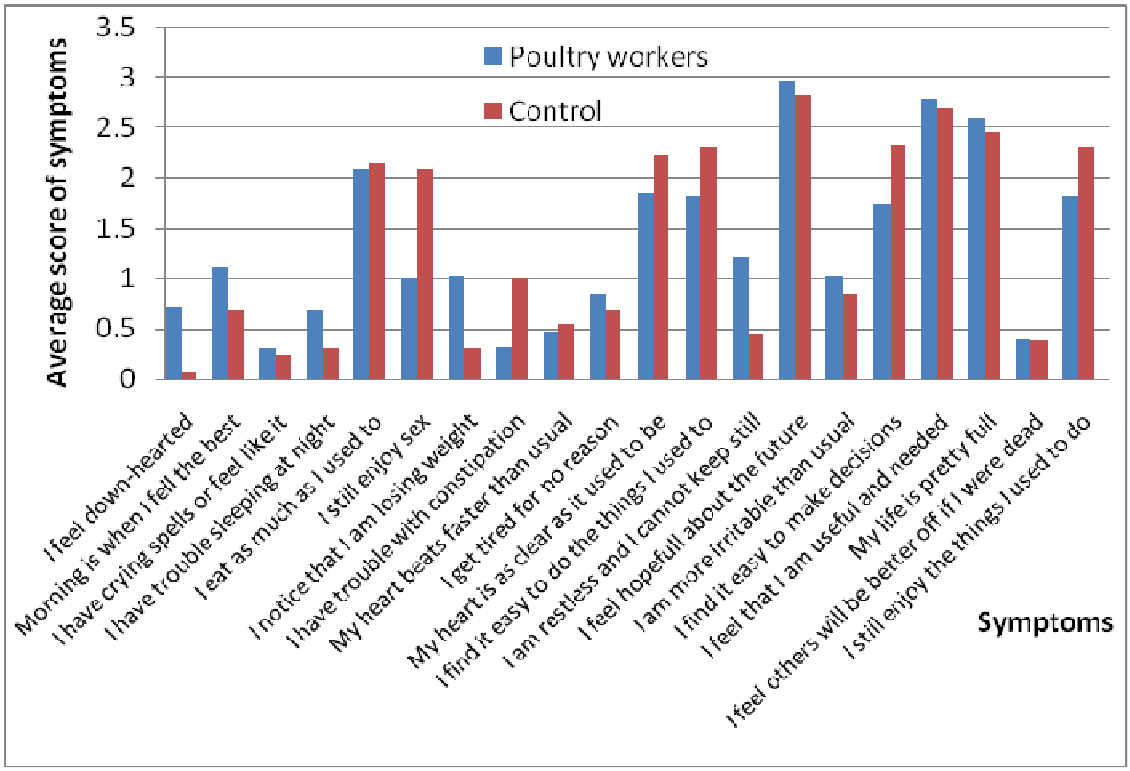

Figure 3: Comparison of frequency of anxiety symptoms among poultry workers and control subjects (Paired *t* test: Poultry/Control $p < 0.001$)