Brazilian Journal of Poultry Science
Revista Brasileira de Ciência Avícola
ISSN 1516-635X Apr - Jun 2015 / v.17 / n.2 / 123-136
http://dx.doi.org/10.1590/1516-635x1702123-136

Review

Activities and Ergonomics of Workers in Broiler Hatcheries

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■Keywords

Broiler chicken production, ergonomics, egg hatching, workplace safety.

Submitted: February/2014
Approved: October/2014

ABSTRACT

The objective this study was to assess ergonomic factors, posture and biomechanics of workers of a broiler egg hatchery. The analysis of ergonomic factors was based on physical work load, thermal environment, and exposure to light and noise. The posture of workers was analyzed using photographic records which were evaluated by the software program OWAS (Ovako Working Posture Analysing System). A biomechanics analysis was also performed based on the photographs taken of the employee at various angles, which were used as inputs to the Michigan two-dimensional biomechanical model software program. The results show that certain activities can be considered unhealthy due to the exposure of employees to physical and thermal overload. The continuous noise levels and lighting were outside the range considered adequate by the regulations of the Brazilian Ministry of Labor. The manner in which certain activities are carried out when associated with weight and poor posture can result in body lesions in broiler hatchery employees. It is therefore necessary to apply specific ergonomic programs, including scheduled breaks, training, and other measures in order to reduce or to eliminate the risks involved in these activities.

INTRODUCTION

In the last decades, the Brazilian poultry industry has expanded internationally and can now be considered an industrial complex that should not be analyzed not only from the production perspective, but also through a systemic approach considering technology developments, production efficiency, and diversification of consumption (Tinôco *et al.*, 2004; Menegali *et al.*, 2010).

The concern of the poultry industry to maintain high productivity levels while complying with the rigorous standards of the domestic and international markets relative to environmental sustainability and animal and human welfare has fostered the emergence and the adoption of technical standards that regulate the entire poultry production process. In the context of production, the egg incubation process stands out as a potential source of infection for birds and workers due to the large numbers of undesirable microorganisms present in the environment and to the tasks that result in unhealthy working conditions (Tinôco, 2001; Tessari *et al.*, 2002; Menegali *et al.,* 2010).

In this sense, issues related to the ergonomics of workers of the broiler industry can be improved and thus provide welfare to those employees.

Poor postures (twisting of the spine sometimes associated with carrying heavy loads) while performing specific tasks can often speed up musculoskeletal wear. The study of the relationship between

posture and anatomical structures affected by various pathogens is a growing concern in many fields of science, out of which biomechanics is highlighted (Sacco *et al.*, 2003).

Biomechanics, the science that studies the movement of the human body and its postures according to the laws of mechanics, anatomy, and physiology, can aid in the mechanical interpretation of postures adopted as a function of the chronic use of any implement, of repetitive actions and of inadequate postures (Iida, 2005; Sacco *et al*., 2003; Couto, 1996).

In this context, the objective of this study was to evaluate the ergonomic factors that affect the employees working in a broiler hatchery and to analyze the effect of different postures on their health, based on postural and biomechanical analysis. Based on the results, recommendation are made to provide better working conditions, according to the Regulatory Standards of the Brazilian Ministry of Labor and Employment.

MATERIAL AND METHODS

This study was conducted at a commercial hatchery, during the work shift that begins at 07:30h and ends at 20:00h. The study obtained full consent and authorization of the company's board, management, and employees.

The ergonomic factors of 48 workers (90% of the hatchery's employees) were evaluated, out of which 36 were women and 12 were men, who were classified by age, height, and weight.

The following tasks were analyzed: the arrival of the eggs at the hatchery, egg grading, incubation, egg turning, and chick sexing, vaccination and loading onto transporting trucks.

Physical workload was analyzed using a heart rate monitor (model S610i, Polar Electro, Kempele, Finland), consisting of a digital receiver, an elastic band and a sensor transmitter placed at the height of the chest. This device was placed on the workers at the beginning of the shift (07:00h) and removed at the end of the shift (17:00h), and was carried during the entire shift, including hygiene, lunch and rest breaks. The heart rate monitor was also used by the employees responsible for cleaning the crates and loading them onto the truck from 17:00h to 20:00h.

Based on the collected data, the physical workload of each task and the cardiovascular workload while performing the tasks were determined. Cardiovascular load was calculated according to the following equation:

$$CVL = [(HRW - HRR) / (MHR - HRR)] \times 100 \quad \text{Eq. 1}$$

Where:
CVL = cardiovascular load, in %;
HRW = heart rate at work, in bpm;
HRR = heart rate at rest, in bpm;
MHR = maximum heart rate, (220 – age).

Physical workload was classified according to heart rate while at work (Table 1), as proposed by Couto (1996).

Table 1 – Classification of the workload based on the heart rate when working.

Physical workload	Heart rate in bpm
Very light	< 75
Light	75 – 100
Moderately heavy	100 – 125
Heavy	125 – 150
Very heavy	150 – 175
Extremely heavy	> 175

Source: Couto, 1996.

The WBGT index (wet-bulb glove temperature) was used to evaluate thermal comfort and its correlation with the performance of a particular task. Workers' tolerance to heat exposure was determined according to the Brazilian Legislation on Unhealthy Activities and Operations NR 15 (2004). WBGT data were collected using a WBCT digital thermometer (Wibget, model RSS-214, Ontario, Canada). The device was placed in the geometric center of each room at a height corresponding to average workers' thorax height and programmed to record dry bulb, wet bulb, and black globe temperatures. Data was downloaded and stored on a computer for later analysis.

The WBGT index was calculated using the equation described below for indoor evaluation (no solar load), according to NR 15 (2004):

$$WBGT = 0.7\ nbt + 0.3\ gt \quad \text{Eq. 2}$$

Where:
nbt = natural wet bulb temperature, °C
gt = globe temperature, °C

Using the metabolism rates per type of activity shown in Table 2, type of activity was correlated with the WBGT index (Table 3) in order to determine the adoption or not of scheduled breaks due to thermal overload at the site.

Table 2 – Metabolism rates per activity type.

Type of Activity	kcal/h
Seated at rest	100
Light Work	
Seated, moderate movements with the arms and torso (ex: typing)	125
Seated, moderate movements with the arms and legs (ex: driving)	150
Standing, light work using machines or at a bench, using mainly the arms	150
Moderate Work	
Seated ,vigorous movements with the arms and legs	180
Standing, light work with machines or at a bench, with some movement	175
Standing, moderate work with machines or at a bench, with some movement	220
In movement, moderate work of lifting or pushing	300
Heavy work	
Intermediate work of lifting, pushing or dragging weights	440
Fatiguing work	550

Source: NR 15 (2004).

Table 3 – Tolerance limits for intermittent working with rest periods at the workplace in WBGT (°C).

Working arrangements with intermittent rest in the workplace (per hour)	TYPE OF ACTIVITY		
	LIGHT	MODERATE	HEAVY
Continuous work	up to 30.0	up to 26.7	up to 25.0
45 minutes of work 15 minutes of rest	30.1 to 30.6	26.8 to 28.0	25.1 to 25.9
30 minutes of work 30 minutes of rest	30.7 to 31.4	28.1 to 29.4	26.0 to 27.9
15 minutes of work 45 minutes of rest	31.5 to 32.2	29.5 to 31.1	28.0 to 30.0
Working is not allowed without adoption of adequate control measures	greater than 32.2	greater than 31.1	greater than 30.0

Source: NR 15 (2004).

Noise levels in the workplace were determined using a sound pressure level meter (SPL, model DOS 500, Instrutherm Measuring Instruments, São Paulo, Brazil) with an accuracy of ± 1 dB and resolution of 0.1 dB operating on the compensation scale "A" (Slow), according to a 30-130 scale. Measurements were obtained every 30 minutes in order to detect noise variations during the shift. When determining the continuous noise level equivalent (Leq), a certain period the sound energy was considered as equal to the total sound energy of a succession of discrete noises during the same period (NHO 01, 2001). For the purposes of this standard, Leq is calculated by the following equation:

$$L_{eq} = 10 \log\left[\frac{1}{n}\sum_{i=1}^{n} fi.10^{0,1.Li}\right] \quad \text{Eq. 3}$$

Where:

Leq = continuous equivalent noise level, in dB(A)

n = number of valid measurements

fi = Li noise frequency

Li = instantaneous noise level measured every 10 s, in dB(A).

Noise levels recorded at the hatchery were analyzed and compared with the values established by NR 15 (2004) of the Brazilian legislation.

Lighting evaluation was based on the identification and characterization of the lighting design within each sector of the hatchery. Light in the workplaces was measured using a digital light meter (model LDR-380, Instrutherm Measuring Instruments Ltda, São Paulo, Brazil) with an accuracy of ± 5% (5 digits) and a resolution of 0.01 lux. Readings (in lux) were made by positioning the base of the photocell on a horizontal plane at the workers' height. Data were collected every 30 minutes and the identified illumination values were compared with the values established by the NBR 5413 in 1992.

Postures adopted by employees during working hours were evaluated by the OWAS method (Ovako Working Posture Analyzing System). Postures were analyzed based on the photographic records of the individual in a real work situation. Postures related to the torso, arms, legs were considered, as well as the use of force to perform a function or activity to estimate the proportion of time during which forces are exerted and postures assumed.

During the observation period postures related to the parts of the body were considered, assigning values to each posture using with a six-digit code. The first digit of the code indicates the position of the back; the second, the position of the arms; the third, the position of the legs; the fourth digit indicates the load or use of force, and the fifth and sixth digits, the phase of work (Wilson & Corlett, 1995).

1st Digit - Back

1 – Erect, 2 – Inclined forward or backwards, 3 – Twisted or inclined to the sides, 4 – Inclined and twisted or inclined to the front and the sides

2nd Digit - Arms

1 – Both arms below the level of the shoulders, 2 – One arm at the level of the shoulders or below it, 3 – Both arms at the level of the shoulders or above it.

3rd Digit - Legs

1 – Seated, 2 – Standing with both legs straightened, 3 – Standing with the body weight on one of the straightened legs, 4 – Standing or squatting with both knees bent, 5 - Standing or squatting with one knee bent, 6 - kneeling on one or both knees, 7 - Walking or moving.

4th Digit – Lifting or use of force

1 - Weight or force required are 10 kg or less, 2 – weight or force required exceeds 10 kg, but less than 20 kg, 3 – weight or force needed exceeds 20 kg.

5th and 6th Digits - Phase of work

The two digits are reserved for phase activity ranging from 00 to 99, selected based on subdivision of tasks.

The combination of the positions of the back, arms, legs and the use of force in the OWAS method received a score that was included in the analysis system Win – OWAS, with which it was possible to categorize levels of action for corrective measures.

The method thus classified posture into four categories:

1: normal posture not requiring special care.

2: posture should be checked during the next work routine.

3: posture that deserves short-term attention.

4: posture that deserves immediate attention.

Biomechanical evaluation was based on photographic records of the workers at various angles while performing their activities. The loads involved were measured and used as inputs to the computer program of the two-dimensional biomechanical model for predicting the postures adopted when performing activities as well as the static forces required, developed by the University of Michigan, United States. The two-dimensional biomechanical program evaluates the risk of injury to the shoulder, elbow, back, hip, knee, and ankle. The results obtained with this software allow establishing a recommended load limit, which corresponds to the weight that over 99% of men and 75% of women are able to lift.

RESULTS AND DISCUSSION

Using the data collected by the heart rate monitor and analyzed according to equation 2, physical workload at the hatchery ranged from light to moderately heavy. It was verified that all activities are performed in a standing position with no place for seating. Therefore, according to Fiedler & Venturoli (2002), it is of utmost importance to encourage voluntary adoption of breaks for muscle rest and relaxation, especially when activities require constant standing.

Activities such as egg grading, hatching, and turning, chick sexing and vaccination, removal of the eggshells, and inspection of the incubator, although carried out almost exclusively by women, require little physical force. Additionally, the company adopts a system for rotation of activities to allow for variations in posture and movements, seeking to improve biomechanical aspects (Silva *et al.*, 2010).

Activities including the loading of egg crates that arrive to be incubated, cleaning the plastic crates arriving from egg grading, hatching and sexing (which crates are made of metal in the two latter stages), as well as loading of the crates with chicks that are dispatched to the farms, are considered light to moderately heavy and, therefore, are performed only by men.

The association of incubation + turning activities were classified as light to moderately heavy, due to overload imposed on the physical condition of the employees. Even when performing these activities, an increase heart rate when at work was observed in the hatchery (121 bpm), with CVL of 30%. This is probably due to the force required to remove the carts with egg trays from the incubator and to push them to the egg-turning room. Furthermore, this situation was reported by the employees as the most tiring activity in the hatchery. A heart rate at work of 118 bpm, with a CVL of 32%, was obtained when workers loaded the crates of chicks onto the truck. These values are related to the fact that the employee has to push, lift, and carry several crates at the same time for a period of 40 minutes. According to Couto (1996), during a workday of 8 hours, heart rate should not exceed 110 bpm. Adverse conditions may increase the demand on the cardiac and respiratory systems, thereby compromising workers' health. Therefore, the tasks of moving the incubator carts and chick-crate loading require the establishment of rest pauses.

Workers that load the chick-transport truck are also responsible for cleaning the metal incubator trays. During the performance of this activity, employees wash the trays using large amounts of water. Despite wearing protective boots and plastic garments, workers get wet, which may expose them to the risk of catching a cold. Furthermore, coping with the strong water pressure of the hose, loading metal crates, and pushing carts increased heart rate to 109 bpm, which is close to the value established by Couto (1996) for recommending breaks.

The CCV values obtained for the remaining activities do not demonstrated any need of concern with workers' health.

Activities evaluated by the WBGT index ranged between moderate and heavy, according to specifications of the NR 15 (2004) of the Ministry of Labor and Employment.

In the transfer area, which include the incubation and the egg-turning rooms, the employees enter inside the incubation chamber several times per shift to remove the carts and thereby are exposed to a thermal overload at 37.5°C, whereas in the waiting room of the incubation and egg-turning room, WBGT is around 30°C. Considering that the activity was classified as moderate, the maximum WBGT for this condition should not exceed 26.7°C. Both in the transfer and the turning rooms, the employees are exposed to thermal overload for a period of 2 hours.

Relative to the thermal comfort zone, according to NR 17 (2004), a worker on an 8-hour work shift may be exposed to temperatures ranging from 20 to 23°C and relative air humidity of not less than 40%. According to Grandjean (1998), excessive heat in the workplace results in fatigue and sleepiness, which reduces prompt response and increases the tendency of failure. Marcon (2004) evaluated the thermal comfort in the broiler hatchery chick sexing. The WBGT index ranged from 21°C in the morning to 24°C at the time of greatest sunlight (inside the room). However, when the index reached 24°C, the fan was automatically actioned by the control panel.

The evaluated average noise level complied with the standards set by the NR 15 (2004), which recommends maximum exposure of 85 dB(A) for 8 hours of work. Noise level values obtained in the egg-grading room and in the external area were below that established by NR 15 (2004), possibly due to the absence of noise-generating machinery at these locations. However, inside the incubation and transfer rooms, the noise level was above the recommended standard. The main sources of noise were the incubators and egg-turning machines.

During sexing, the noise level was 83 dB (A). However, vaccination was performed during this stage also. When the vaccination machines completed the score of 100 chicks vaccinated, a loud beep was emitted to warn the employees to begin to fill another crate with birds. At time the beep was emitted (for 2 seconds), the noise generated by the vaccination machine was 101 dB (A), and the noise reached 88 dB (A) in the area chicks were being sexed.

According to Marcon (2004), the noise generated by a beep triggered at the end of the operation of a machine may be useful to the operator, but it can be considered a noise nuisance by the co-workers, who may be concentrated in another task. According to that author, noise should be evaluated in the workplace. Reducing noise may be challenging, starting with machinery design and with use of appropriate personal protective equipment (PPE).

However, it was observed that workers did not use hearing protection. According to Carvalho *et al*. (2008), the employee must be aware of the importance of hearing protection, because long exposure times cause hearing losses. If the workers are not aware that hearing protective devices need to be used continuously and daily, their hearing may be severely impaired, resulting in high labor costs.

Sexing and vaccination were performed together in a single large room. Therefore, due to the noise generated by the vaccination machines and chicks, sound levels constantly varied.

According to the lighting values recommended in NBR 5413 (1992), lighting level was above the standard only in the outdoor area, which was lighted by natural light. In the other sites studied, the lighting was below the optimal values. Lighting in these areas were low probably due to insufficient number of lamps. However, it was observed that the performance of the operations of unloading egg cartons, egg grading, egg transfer, and chick vaccination were not impaired.

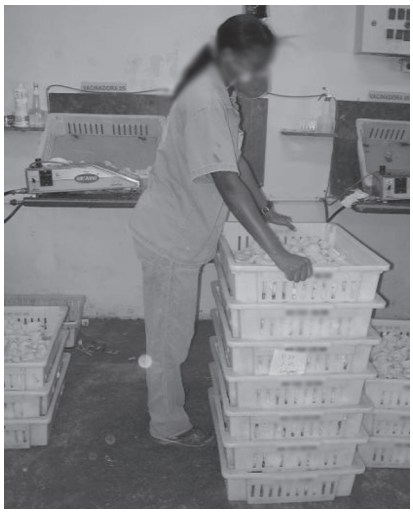
Chicks are sexed by looking at the length of the feathers in the tip of the wing, and therefore, adequate lighting is required. Performing this task under low lighting causes eyestrain and sexing errors. Insufficient lighting also affects loading of chick crates into truck and inspecting inside the incubators. Loading chick crates require careful attention, as crates are separated by sex and farm of destination. The inspection inside the incubator is performed with the aid of manual lamps that are switched on only when necessary.

Work performed under insufficient lighting causes eyestrain problems. According to Iida (2005), visual fatigue is characterized by eye irritation and tearing. Blinking frequency increases and the vision becomes blurred and double, reducing visual accuracy. In more advanced stages, it causes headaches and nausea and may lead to depression and emotional irritability, decreasing productivity and work efficiency.

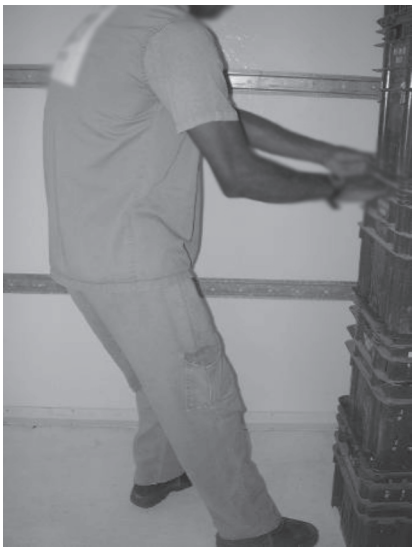
All body postures assumed by the hatchery workers were analyzed and classified by the computer program OWAS for postural assessment. Table 4 presents the photographic record of the postures adopted while performing a given task, the combination of postures, and the category in which these positions are classified.

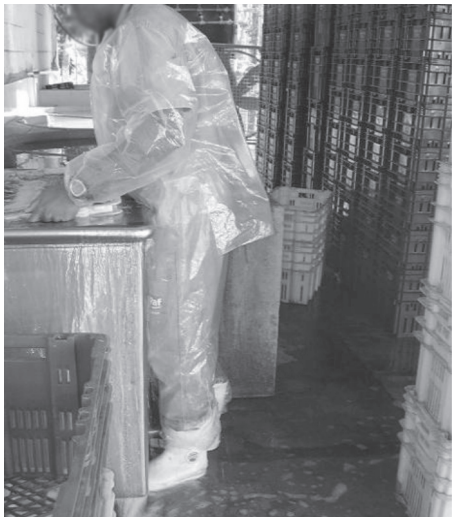
Table 4 - Photographic record of postures, classified according to the OWAS system considering the different activities performed in the broiler hatchery

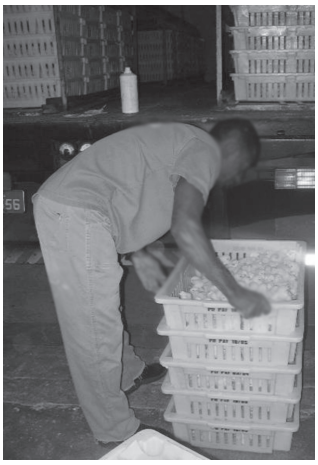
Step activity	Postures	Category
 Egg grading	Straight trunk with both arms below shoulder level, both legs straight and weight lifting below 10 kg 1121	1
 Chick grading	Straight trunk with both arms below shoulder level, standing with outstretched legs and weight lifting below 10 kg 1121	1
 Sexing: Classification of chicks by sex	Straight trunk with both arms below shoulder level, standing with outstretched legs, and weight lifting below 10 kg 1121	1

Step activity	Postures	Category
 Vaccination	Straight trunk with both arms below shoulder level, standing with outstretched legs and weight lifting below 10 kg 1121	1
 Sexing: Moving boxes from sexing to vaccination	Trunk inclined forward, both arms below shoulder level, standing with legs straight and weight lifting below 10 kg 2121	2
 Separation of eggshells and dead chicks	Trunk inclined forward, both arms below shoulder level, standing with legs straight and weight lifting below 10 kg 2121	2

Step activity	Postures	Category
 Raising empty egg crates	Straight trunk with both arms above shoulder level, standing with outstretched legs and weight lifting above 10 kg 1312	2
 Cleaning	Trunk leaning forward with both arms below shoulder level, moving 2171	2
 Sexing: Squatting to pick up chick crates	Trunk leaning forward with both arms at shoulder level, standing with the knees bent and weight lifting below 10 kg 2351	3

Step activity	Postures	Category
 Egg Truck: - Lifting egg cartons	Upper body leaning with both arms at shoulder level, crouching with both knees bent and weight lifting below 10 kg 4341	3
 Egg Truck: - Pulling crates with egg trays	Inclined trunk, arms below shoulder, standing level with the weight on one leg and weight lifting above 20 kg 2133	3
 Removal of eggshells and dead chicks	Straight trunk with both arms below the shoulder level, crouching with both knees bent and weight lifting below 10 kg 2141	3

Step activity	Postures	Category
 Removal of eggshells and dead chicks	Inclining trunk, both arms at shoulder level, standing with weight resting on one leg and weight lifting below 10 kg 2331	3
 Washing egg crates	Inclined trunk with both arms below shoulder level, standing with outstretched legs and weight lifting above 10 kg 2112	3
 Washing metal incubation trays	Trunk leaning forward with both arms at shoulder level, standing with weight on one leg and weight lifting below 10 kg 2331	3

Step activity	Postures	Category
 Loading chick crates onto in the truck: - Organizing the crates to be placed in the truck	Trunk leaning forward with both arms at shoulder level, standing with both legs straight and weight lifting above 10 kg 2322	3
 Loading chick crates onto in the truck: - Lifting crates in the truck	Straight trunk, both arms above shoulder level, legs stretched and weight lifting above 10 kg 1322	3

The posture assumed by employees for egg and chick grading, sexing, and vaccination was classified as category 1 and therefore, was considered normal and requiring no special care. Postures assumed during the lifting of empty egg crates, moving chick crates arriving from sexing to vaccination, the removal of eggshells and dead birds with the box at the height of the chest, and cleaning the rooms, were classified as category 2, requiring only long-term verification.

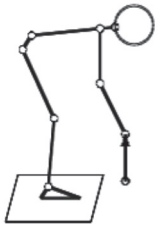
Activities classified in category 3, where posture deserves short-term verification, were observed during pulling and lifting the egg crates, squatting to pick up chick crates, removing eggshells and dead birds when the crate was on the ground or at the top of the cart, washing plastic crates used for chick grading and metal incubator trays, as well as loading chick crates on the truck.

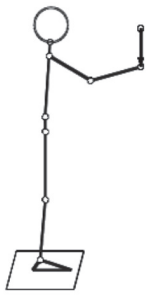
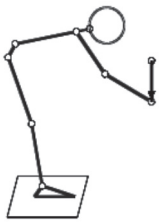
Activities that require workers to assume poor postures, improper handling, and excessive weight lifting may the degeneration of articular discs. The lumbar spine usually suffers the most as it supports the torso, increasing the incidence of pain (Rio & Pires, 2001).

In order to alleviate the problems caused poor posture while performing specific activities, programs to train workers to adopt the correct posture when lifting, carrying, or pulling objects need to be developed.

Table 5 shows the postures that more frequently result in the development of joint damage for each activity, according to forced applied on the joints. The acronym RIJ indicates "No Risk of Injury in Joints", where more than 99% of workers can support the load imposed by the activity without risk to the joints involved, and RLLE indicates "Recommended Load Limit Exceeded", where less 99% of workers can support the load imposed by the activity without risk to the joints involved. Joints in the figures as numbered as: 1 = shoulder, 2 = elbow, 3 = L5/S1 disc (hip), 4 = hip, 5 = knee, 6 = ankle.

Table 5 - Summary of the biomechanical analysis of the activities performed in the hatchery

Activity	Phase of operation	Static posture selected for analysis	Joints and their position to bear the burden					
			1	2	3	4	5	6
Operation of unloading the truck with egg cartons	Pulling a single carton of eggs		RIJ	RIJ	RIJ	RIJ	RIJ	RIJ
	Pulling several egg cartons		RLLE	RLLE	RLLE	RIJ	RLLE	RLLE
Grading eggs	Organizing egg trays		RIJ	RIJ	RIJ	RIJ	RIJ	RIJ
Chick grading	Removing chicks from crate		RIJ	RIJ	RIJ	RLLE	RIJ	RIJ
Sexing	Lifting chick crate		RIJ	RIJ	RIJ	RIJ	RIJ	RIJ
Vaccination	Lifting chick crates		RIJ	RIJ	RIJ	RIJ	RIJ	RIJ

Activity	Phase of operation	Static posture selected for analysis	Joints and their position to bear the burden					
			1	2	3	4	5	6
Removal of eggshells and dead chicks	Removing metal trays from cart		RIJ	RIJ	RIJ	RIJ	RIJ	RIJ
Washing egg crates	Lifting crates		RIJ	RIJ	RIJ	RIJ	RIJ	RIJ
	Pulling crates		RLLE	RLLE	RLLE	RLLE	RLLE	RLLE
Washing metal incubator trays	Removing metal crates from the stand		RIJ	RIJ	RIJ	RIJ	RIJ	RIJ
Loading chick crates into the truck	Organizing crates to be loaded		RIJ	RIJ	RIJ	RIJ	RIJ	RIJ
	Loading the crates in the truck		RLLE	RIJ	RLLE	RIJ	RIJ	RIJ

The analysis performed by the two-dimensional program indicated that, when pulling the egg crates, the workers are subject to risk of injury to the shoulder, elbow, L5/S1 disc, knee and ankle. During the washing of these crates, in addition to the risks mentioned above, there is also a risk for hip injury. This may be due not only of the weight of the crates used to store eggs, but also the postures adopted by the employees while performing these tasks.

During loading of the chick crates onto the truck, workers are exposed to risk of injury to the shoulder and L5/S1 disc due to disc herniation and the thinning of the bones and cartilages that make up this structure. These crates are stacked, forming a set of three or fourth crates that are loaded together into the truck. Back pain was reported by these employees.

It was also verified that some activities may trigger a disorder in the L5/S1 segment. According to Bostrand *et al.* (1989), if the compressive strength is equal to or greater than 3,423 Newtons (N), the workers may suffer severe damage to the musculoskeletal system, including rupture of the intervertebral disc. Therefore, it is necessary to reduce exposure time to this activity and load weight.

During the egg carton unloading from the truck, egg-carton weight exerts a compressive load of 3,225N on the L5/S1 disk of the worker. While removing and washing of the metal incubator trays, the compression force is 2,790N. The load of carrying chick crates for vaccination is 1,593N, while loading chick crates onto the truck which will transport them to the farms, the weight of the material generates a load of 2,153N on the L5/S1 disk.

CONCLUSION

In this study, it was observed that the workers of a broiler hatchery may be exposed to unhealthy working conditions, and some activities associated with weight and poor posture can result in body injury. However, meeting the safety standards, adoption of scheduled breaks, workplace gymnastics, facility improvements, use of personal protective equipment, and training employees on how to properly perform tasks may significantly contribute to reduce injuries and to improve the quality of life of the workers, thereby increasing hatchery productivity.

ACKNOWLEDGEMENTS

To the Foundation for Research Support of the State of Minas Gerais (FAPEMIG), CAPES (Coordination of Improvement of Higher Education Personnel), CNPq (National Council for Scientific and Technological Development) and the Federal University of Viçosa (UFV).

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