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POSTURAL ANALYSIS AND BIOMECHANICS OF WORKERS IN POULTRY SLAUGHTERHOUSE

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Engineering conference ABSTRACT The production and consumption of chickens has been steadily increasing in recent decades. Along with this, the slaughter and processing of poultry has increased and changed rapidly as population of major urban centers increases. Parallel to this development, the processing industry of poultry began to pay attention to how the activity is performed, and how the machinery, equipment and environment influences the occurrence of bodily injury. Working in a poultry slaughterhouse comprises high health risk, this study aimed to evaluate postural and biomechanical analysis of workers in this environment. The posture and the biomechanics were analyzed from photographic records of the individuals when at work. The postural analysis was interpreted in accordance with the method OWAS (Ovako Working Posture Analyzing System) and biomechanical evaluation was performed using a two-dimensional biomechanical model prediction of postures computer program (Michigan). The data collected revealed that the unloading of boxes from the delivery vehicles, scalding and plucking (cleaning sector), and the lifting and pushing of boxes from various sectors to the freezing and shredded areas were worth improving in the short term. With respect to biomechanics, it was observed that the loading of boxes with pieces of chicken, stemming both from the cutting room and sector of frayed, exposed workers to injury to the elbow, shoulder and back. Thus, one can conclude that the loading weight and inappropriate or incorrect postures are responsible for physical injuries of workers in a poultry slaughterhouse.

Keywords: Postural analysis, biomechanics, slaughterhouse poultry

INTRODUCTION The posture is the relative positioning of body parts as head, trunk and limbs in space. Keeping good posture is important in order to complete a specific work without discomfort and stress.

Any deviation in the shape of the spine can lead to functional requirements that can prejudice the individual. Thus, Oliver (1999) defines good posture as the “corporal attitude” that a person assumes, in which she is “using the least amount of muscular effort

and at the same time protecting the corporal support structure against trauma". Unfavorable attitudes cause increase in worker fatigue and leads over the time to serious injuries, and also, this is the greatest cause of work absences and human suffering (Couto, 1996).

In this context, biomechanics is the science that study the interaction between work and man, under the point of view of the movements of the skeletal muscle involved and its consequences. Such science considers the analysis, basically, of the issue of body postures at work and application of the related forces (Iida, 2005). According to Dul & Weerdmeester (1995), from the biomechanics we can estimate the strength that occurs in muscles and joints during a posture or a movement.

The slaughter of animals in slaughterhouses is a kind of work that presents to be a growing problem related to occupational diseases, because it is a labor activity in which people demand physical repetitive strength and incorrect postures, that come from the inadequate of ergonomic features in the furniture and equipments. In addition, the tasks are extremely targeted (Defanico, 2007; Delwing, 2007).

Based on the risks that the activities in the poultry slaughterhouses offer to workers health, the aim of this work was to carry a postural and biomechanical analysis of the workers in such facility, in order to propose rules to improve their work condition.

METODOLOGY

• Location

The study was carried out at the slaughterhouse of the "Pif Paf Alimentos S/A" Company, in Visconde do Rio Branco city, Zona da Mata Mineira, Minas Gerais State, Brazil, with coordinates 21 ° 07 'S, 42 ° 27' W and 349 m altitude. The experiment was carried out during June and July 2008, during the first work shift in the slaughterhouse, with journeys starting at 03:00, 04:00 and 05:00 a.m. and finishing at 01:00, 02:00 and 03: 00 p.m., respectively.

The activities analyzed were: putting the chickens off from the boxes, hanging them, plucking them, make the manual bleeding, make the evisceration, manage the cuts for the national market, manage the cuts for exportation and in the chiller, make the separation of feet and internal parts, manage the packaging in the cutting room for national market and for exportation.

• Postural analysis

The method of OWAS (Ovako Working Posture Analyzing System) was used to evaluate the positions taken by employees during the workday. The postures were analyzed from the individual photographic records in real work situation. In such analysis It were considered the postures related to the trunk, arms and legs, in addition to the force necessary to perform a specific function and the phase of the activity, from which it was estimated the proportion of time in which the forces were applied and the postures were adopted.

During the observation, it were considered the positions related to the body members, being assigned values to these positions, in a code of six digits. The first digit indicated the position of the back; the second one, the position of the arms; the third one, the position of the legs; the fourth one, the load lifted or force involved and; the fifth and sixth (Wilson e Corlett, 1995).

1st Digit - Back

1 – upright

- 2 – Forward or backward
- 3 – Twisted or tilted sideway
- 4 – Tilted and twisted or tilted forward and sideway
- 2nd Digit – Arms
 - 1 – Both arms below the shoulder level
 - 2 – One arm at the shoulder level or below
 - 3 – Both arms at the shoulder level or above
- 3rd Digit – Legs
 - 1 – Sitting down
 - 2 – Standing up with both legs straight
 - 3 – Standing up with load on one straight leg
 - 4 – Standing up or crouching with both knees curved
 - 5 – Standing up or crouching with one knee curved
 - 6 – Kneeling on one or both knees
 - 7 – Walking or moving
- 4th Digit - Load lifted or force involved in
 - 1 – Load or force is up to 10 kg
 - 2 – Load or force is more than 10 kg, but up to 20 kg
 - 3 – Load or force is more than 20 kg
- 5th Digit - Stage of work
- 6th Digit - Stage of work

The last two digits(*) were reserved for the stage of activity ranging from 00 to 99, selected from the subdivision of tasks.

The combination of positions of the back, arms, legs and use of force in the method OWAS received a score, that meant the “posture” and it was included in the analysis by means of the Win-OWAS system, from which it was possible categorize four levels of corrective actions, in the following way:

- 1st- normal posture dispensing care.
- 2nd- posture should be checked during the next routine work.
- 3rd- posture that needs to pay attention to in the short term.
- 4th- posture that needs immediate attention.

• **Biomechanics**

Biomechanical analysis was based on photographic records made with the workers at various angles during their usual activities. The loads involved were measured and used as input in the computational program applied to the two dimensional biomechanical model for predicting postures while the individual is doing usual activities, as well as the static forces, required to finish such activities. This model was developed in the University of Michigan, United States of America.

Based on the results of this computational routine we can assess the possibility of damage to the shoulder, elbow, back, hip, knee and ankle of the individuals evaluated. From these results it is also allowed the establishment of the recommended limit load, which corresponds to the one that more than 99% of men and 75% of women can lift up.

• **Data Analysis**

The ergonomic factors, such as biomechanical standards and posture of the workers of the broiler slaughterhouse, were studied comparing the averages obtained with

the limits established by the Norms Regulamentory of the Ministry of Labor and Employment – Brazilian Norm.

RESULTS AND DISCUSSION

• Postural analysis

To perform the postural assessment, were analyzed the postures adopted by workers in the slaughterhouse, which were classified according to method of OWAS. In the Table 1 it is shown the photographic record of the postures adopted by them to perform specific tasks, as well as the combination of postures and category in which it were classified.

Table 1 - Photographic record of the postures adopted by workers, according to the OWAS system, considering the different stages of activities carried out in the broiler slaughterhouse.

Activity	Postures	Category
Manual bloodletting 	Erect trunk, with both arms below the shoulders level, standing up with both straight legs and lifting up load up to 10 kg 1121	1
Evisceration: with hands down 	Erect trunk, with both arms below the shoulders level, standing up with both straight legs and lifting up load up to 10 kg 1121	1
Cutting pieces, on the table, to National market 	Erect trunk, with both arms below the shoulders level, standing up with both straight legs and lifting up load up to 10 kg 1121	1

<p>Cut pieces, on the table, to International market</p> 	<p>Erect trunk, with both arms below the shoulders level, standing up with both straight legs and lifting up load up to 10 kg 1121</p>	<p>1</p>
<p>Packing of cuts to National market</p> 	<p>Trunk tilted forward, with both arms below the shoulders level, standing up with straight legs and lifting up loads up to 10 kg 2121</p>	<p>1</p>
<p>Packing of cuts to International market</p> 	<p>Trunk tilted forward, with both arms below the shoulders level, standing up with straight legs and lifting up loads up to 10 kg 2121</p>	<p>1</p>
<p>Separation of the feet</p> 	<p>Trunk tilted forward, with both arms below the shoulders level, standing up with straight legs and lifting up loads up to 10 kg 2121</p>	<p>1</p>
<p>Separation of the internal parts</p> 	<p>Trunk tilted forward, with both arms below the shoulders level, standing up with straight legs and lifting up loads up to 10 kg 2121</p>	<p>1</p>

<p>Hanging up the chickens</p> 	<p>Erect trunk, with both arms at the shoulders level, standing up with both straight legs and lifting up loads up to 10 kg 1321</p>	<p>2</p>
<p>Plucking</p> 	<p>Trunk tilted forward with both arms above the shoulders level, standing up with straight legs and lifting up loads up 10 kg 2321</p>	<p>2</p>
<p>Evisceration: with hands up</p> 	<p>Trunk tilted forward with both arms below the shoulders level, standing up with straight legs and lifting up loads up to 10 kg 2121</p>	<p>2</p>
<p>Output of the chiller: hanging up the chicken in the Conveyor Line</p> 	<p>Trunk tilted forward, with both arms at shoulder level, standing up with load on one straight leg and lifting up load up to 10 kg 2331</p>	<p>2</p>
<p>Cutting pieces in the Conveyor Line National market</p> 	<p>Erect trunk, with both arms at shoulder level, standing up with load on one straight leg and lifting up load up to 10 kg 1321</p>	<p>2</p>

<p>Cutting pieces in the Conveyor Line International market</p> 	<p>Erect trunk, with both arms at shoulder level, standing up with load on one straight leg and lifting up load up to 10 kg</p> <p>1321</p>	<p>2</p>
<p>Unloading the chicken boxes</p> 	<p>Trunk twisted to the side, with one arm at the shoulder level, walking on and lifting up load up to 20 kg</p> <p>3272</p>	<p>3</p>
<p>Cleaning the plucking area</p> 	<p>Trunk folded forward, with arms at the shoulder level, knees curved and lifting up loads between 10 and 20 kg</p> <p>2342</p>	<p>3</p>
<p>Lifting up the boxes in the sector of shredded</p> 	<p>Trunk folded forward, with both arms below the shoulders level, standing up with straight legs and lifting up loads between 10 and 20 kg</p> <p>2122</p>	<p>3</p>
<p>Lifting up the boxes in the sector of frozen pieces</p> 	<p>Trunk folded forward, with both arms at the shoulders level, crouching down and lifting up loads between 10 and 20 kg</p> <p>2342</p>	<p>3</p>

The posture adopted by the workers to do activities such as manual bleeding, evisceration being their hands down, cutting the chicken pieces put on the table for the national and international markets, besides packing of these and separation of feet and internal parts, was placed as category 1, that is considered normal, and therefore exempt care.

The ones classified as category 2, which need to be verified in long term were: hanging up the chickens in the conveyor line for slaughter; adjust of the carcass in the conveyor line placed on the sectors of scalding and plucking; lifting the chickens from the chiller up to the conveyor line and; cutting of the chickens pieces placed in the conveyor line.

Activities classified as category 3, for which ones the posture of workers deserves attention in short term, have been identified during the unloading of the chicken boxes from the truck; cleaning of the areas of scalding and plucking, and the act of lifting and pushing the boxes coming from various sectors in the slaughterhouse to the areas of freezing and stock.

The postures adopted by these workers could be aggravated and classified in other categories if the analysis took into account the number of repetitions performed by them.

According to Delwings (2007), the workers in the slaughterhouses are exposed to high repeatability of the same movement pattern, besides incorrect postures of the upper limbs, as well as compression of the delicate structures of the below limbs. This author did note that the repeatability is an important risk factor that associated with other ones such as cold from low temperatures in the work environment, emphasize these effects.

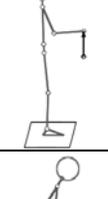
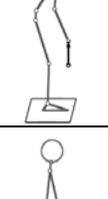
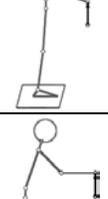
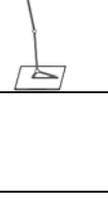
In addition, according to Defani (2007), in most cases, these postures become even more damaging when it is necessary bending of the spine, which is required by the need to direct the attention downward, to manage the work process.

• **Biomechanics**

In the Table 2 is presented the summary of the biomechanical analysis of the operations carried out at the slaughterhouse. For each stage of these activities is shown on this table if the joints have some kind of problem caused by the workload. The symbol SRL represents "Without Risk of Damage in the Joints", indicating that more than 99% of the workers can support the load imposed by the activity without risk to the joints involved. The symbol CLR represents "Recommended Limit Load Exceeded ", that is, less than 99% of workers can support the load imposed by the activity without risk to the joints involved. The numbers represent the joints, in the following way: 1 indicates the shoulder, 2 indicates the elbow, 3 indicates the L5/S1 disc (back), 4 indicates hip, 5 indicates the knee and 6 indicates the ankle.

Table 2 - Summary of biomechanical analysis for the activities carried out in the broiler slaughterhouses.

Activity	Stage of the Activity	Static posture selected for analysis	Joints and their respective condition to support the load					
			1	2	3	4	5	6
Unloading of the chicken boxes from the truck	Unloading the chicken boxes		SRL	SRL	SRL	SRL	SRL	SRL
Lifting up the chickens	Removing chickens from the box to put in the Conveyor Line		SRL	SRL	SRL	SRL	SRL	SRL

	Hang the chickens on the Conveyor Line		SRL	SRL	SRL	SRL	SRL	SRL
Plucking	Adjusting the carcasses on the Conveyor Line		SRL	SRL	SRL	SRL	SRL	SRL
	Removing the defective carcasses off the Conveyor Line		SRL	SRL	SRL	SRL	SRL	SRL
Removing the chickens from the chiller	Taking off the carcasses just out of the chiller		SRL	SRL	SRL	SRL	SRL	SRL
	Putting the carcasses on the Conveyor Line		SRL	SRL	SRL	SRL	SRL	SRL
Packing the chicken pieces for the national market	Packing the chicken pieces		SRL	SRL	SRL	SRL	SRL	SRL
	Carrying the boxes of packages to the sectors of freezing and shredded		CRL	CRL	CRL	SRL	SRL	SRL
Packing the chicken pieces for the international market	Packing the chicken pieces		SRL	SRL	SRL	SRL	SRL	SRL
	Carrying the package boxes		CRL	CRL	CRL	SRL	SRL	SRL

Because the software do not considers the number of repetitions performed by the workers in each activity and also the weight of the chickens, considerably low, most of the workers analyzed by two-dimensional model, were not under risk of damage to their joints. In fact, was detected the risk of injury to the elbow, shoulder and back especially due the actions of carrying the boxes with pieces of chicken, that were coming from the cutting areas for the national and international market, besides the ones coming from the sector of shredded.

Sant'Ana & Walger (2001) studied the postural analysis of workers in a poultry slaughterhouse and concluded that they are exposed to the risk of injury to his shoulder, wrist, spine and lumbar-sacral spine due to the standing up and static work, repetitive movements of the upper limbs and, in addition, trunk with inadequate posture.

Problems related to disorders or diseases in the L5/S1 segment of spine, were not observed on the workers at the slaughterhouse studied. It is believed that this is due to the low weight of the chickens and of the boxes, being these last one ranging from 10 to 20kg.

CONCLUSION Based on the data analyzed it is concluded that actions of removing the boxes of chickens from the truck, cleaning the sectors of scalding and plucking, as well as the act of lifting and push the boxes that were coming from various sectors to the freezing area, mean risks for the workers posture. In addition, the act of carrying the boxes with pieces of chicken, that were coming from both sectors, cuts and shredded, can affect the elbow and shoulder of the workers.

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