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Prevalence and ergonomic risk factors of musculoskeletal disorders in a farm of Bindura, Zimbabwe

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ABSTRACT

There is an increase in body discomfort complaints (upper limbs) amongst farm employees. Farm records reviewed, explain lack of adequate identification, monitoring and evaluation of ergonomic risks. Operations in a farm are physically demanding with more common work related challenges which may lead to Musculoskeletal Disorders (MSDs). Furthermore, National Social Security Authority (NSSA) reports reveal more pronounced work – related musculoskeletal disorders in the agricultural sector and scanty interventions. The trend of risk factors for MSDs in the farming community has not been adequately investigated in low and low- middle income countries. Therefore, a study among 30 participants (15 farm employees, 10 students and five lecturers)working at the Bindura University of Science Education farm was carried out through the usage of the Rapid Upper Limb Assessment (RULA) technique to identify awkward postures resulting in MSDs and the Nordic Musculoskeletal Questionnaire in order to identify body discomfort association to work postures. The cross – sectional census study was conducted as an experimental and observational research. The study employed purposive sampling through media capturing in five departments (piggery, cattle, teaching and learning unit, poultry and the field). Results indicated that the piggery and teaching and learning unit had the highest scores in awkward postures in the right and left hand sides. However, the right hand side had the highest mean (5.30±1.4) than the left hand side (5.03±1.4). The teaching and learning unit had the highest frequency of perceived body discomfort (68.82%).Two age groups were used, and the age group (≥32) had the highest body discomfort response mean of (20.40). The most affected body part was the lower back with (79.89%). Furthermore, females reported the highest body discomfort (19.33) than males with a significant difference at $P \leq 0.05$. In conclusion the Bindura University of Science Education farm employees are at an extreme risk of developing musculoskeletal disorders. This is underpinned by awkward postures which result in high levels of body discomfort. This has subsequent implications on productivity levels at the farm.

Key words: Ergonomics, body discomfort, RULA, Musculoskeletal Disorders, Risks, Farm

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1. INTRODUCTION

Several complaints of body discomfort amongst farm employees have not been accounted for in farms. In most scenarios noted, pain is either being experienced in the upper body or upper limbs. Farm records reviewed at the farm understudy, show inadequate identification and inadequate monitoring and evaluation of ergonomic risks as there was no checklist for key aspects on the farm's sections, tools, physical environment, chemicals and welfare among others. Furthermore, at national level, NSSA's Annual Statistics Reports of 2010 – 2011 reveal that work – related musculoskeletal disorders have more pronounced risks in agriculture and limited studies have been done (Sombatsawat *et al.*, 2019; Jain *et al.*, 2018). To that effect, the Bindura University of Science Education (BUSE) farm logbook's inadequacies showed that there was need for an improved ergonomic risk investigation. The study goes has potential to benefit the employees, thus eliminating harsh working conditions and the introduction of controls to reduce the impact of WMSDs. The study will assist with logistical compliance of the farm to the set legal requirements such as the Labour Act (2006) Chapter 28:01. The Act has emphasis on the working environment and employee relationships. This will aid law formulation and promulgation, trend analysis and fill in a research gap on farm ergonomic risks especially in the global south where agriculture mechanisation is still to be fully utilised. Worldwide, farming is regarded as a hazardous and physically strenuous occupation (Sombatsawat *et al.*, 2019; Jain *et al.*, 2018; Micheletti Cremasco *et al.*, 2020). It is associated with potential risk of work – related musculo – skeletal disorders (Sombatsawat *et al.*, 2019; Jain *et al.*, 2018; Walker – Bone and Palmer, 2002). According to (Niu, 2010) the International Labour Organization (ILO) statistics revealed 160 million work – related illnesses that occur annually and farming work – related musculoskeletal disorders (WMSDs) have shown leading rates of recurrence. Notable experiences show that farm ergonomics in both high and low income countries is being given less priority (Jain *et al.*, 2018). Some studies in USA and India categorize work – related musculoskeletal disorders into awkward and static postures (Meyers *et al.*, 2001; Nonnenmann *et al.*, 2010; Jain *et al.*, 2018). A similar case study in Brazil further related work – related musculoskeletal disorders to be a resultant of a mismatch between working equipment and worker's physical capacity (Bartels *et al.*, 2000; De Roo *et al.*, 2000). This is because it requires repetitive, forceful pushing and pulling heavy equipment, persistent exertions of hands, heavy lifting, exposure to the harsh environment, whole body vibrations and persistent awkward postures (Caffaro *et al.*, 2016; Sombatsawat *et al.*, 2019). Other scholars view musculoskeletal disorders as a resultant of frequent experiences to a stressor (Richardson *et al.*, 2005; Kotowski *et al.*, 2009). In South Korea, common stressors found were in the form of low back pain, osteoarthritis of the knee and hip, hand – arm vibration syndrome and finally neck and upper limb strains (Cha *et al.*, 2009). In the Southern African Development Community (SADC) region, inadequate studies on farm ergonomic risks have been done hence the problem continues to escalate (Purnawatt, 2007). Previous studies (Mukwazhe and Gwisai, 2016) in Zimbabwe show that ergonomic risk and hazard structures are non – existent hence people continue to be affected. This is a similar observation to what obtains in the present study. A case study of an agriculture college on farm ergonomics revealed that most farm activities are associated with ergonomic risk factors such as awkward postures, gender, duration of exposure and age. Furthermore, workers participate in planting, harvesting and maintenance which require the mentioned risk factors. Therefore the study aims to identify the frequency of body discomfort and their correspondence to ergonomic risk causes, while on the other hand determine prevalence of ergonomic risk at the farm.

2. MATERIALS AND METHODS

Bindura University of Science Education farm is located 15 kilometres from Bindura CBD (Longitude $31^{0}27'48''$ E and Latitude $17^{0}18'72''$S). The farm is in agro – ecological region one of Zimbabwe, which is considered to be a temperate climate. Heavy rains are experienced in the area averaging 847.6 mm per year (Mavhura *et al.*, 2015). The area is well known for crop production. Moreover, the farm also has a dam that is used for irrigation purposes. The 540 hectare farm has five departments. These are namely; piggery, poultry, fields, cattle breeding, teaching and learning unit. A total of 215 hectares has ground tubing which is permanent and is irrigable. The teaching and learning unit is meant for research and study purposes.

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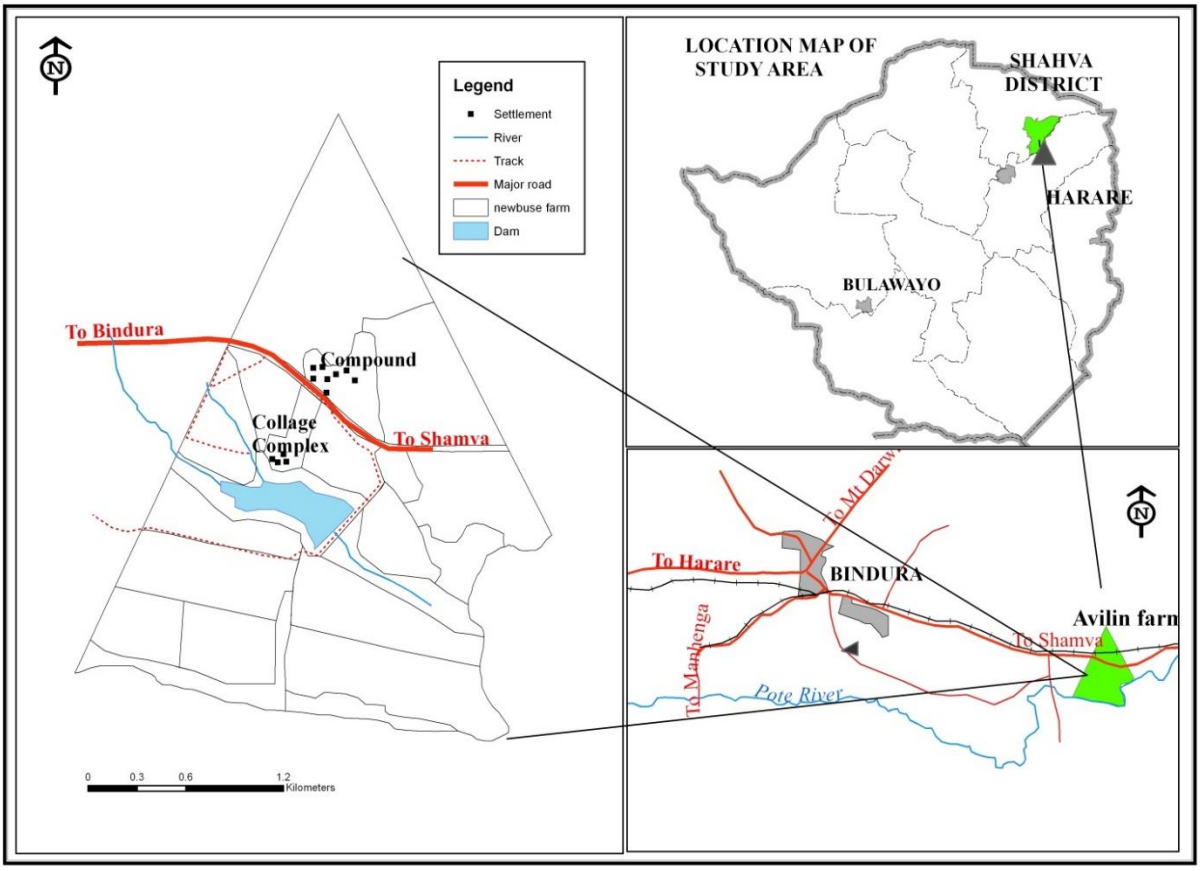

Figure 1: Location of Bindura University Farm

Research Design and Data Collection

The cross – sectional study was conducted as an experimental and observational research (Figure 1). All (30) employees with activities at the farm were involved in the study (15 males and 15 females). The participants comprised of 15 farm employees, 10 students and five academics. The farm manager's office provided information on the schedule, maps and shifts on the farm. The farm map was used to identify workstations at the farm whilst farm schedules determined which activity to begin with. Exclusion criteria were as follows: refusal of participation in this study, absence at work at the interview time, or length of access to institutional farm activities of not less than 12 months. The researcher used purposive sampling in capturing media thus within two months (September to October 2016). The media was then used in Rapid Upper Limb Assessment (RULA) so as to identify awkward postures which result in work – related musculoskeletal disorders (see previous studies Micheletti Cremasco *et al.*, 2019; Walker – Bone and Palmer, 2002; Kolstrup and Jakob, 2016). Media for the assessment was done during a working shift from 0700hrs to 1700hrs. Standardized Nordic Musculoskeletal questionnaires were used to identify how body discomfort corresponded to work postures which were being done throughout the week and how the body parts responded (Kuorinka *et al.*, 1987). Data collection was done using a camera. The captured videos and pictures were used in showing postures done by the workers during working hours. The captured media was assessed using the Rapid Upper Limp Assessment tool (RULA). A Nordic Musculoskeletal questionnaire adopted from (Palmer, 1996) was used to identify the relationship between the postures and body discomfort response.

The Rapid Upper Limb Assessment (RULA) was used as a posture screening survey tool. Media was captured on neck and upper – limb loading in mainly sedentary tasks so as to illustrate the postures portrayed (see previous studies Micheletti Cremasco *et al.*, 2019; Walker – Bone and Palmer, 2002; Kolstrup and Jakob, 2016). Images and videos captured considered the right side and left side as 2 independent variables. Using a protractor measured angles from captured data. The data was the scored using the Rapid Upper Limb Assessment score sheet adopted form. A summary of scores were counted and two groups were obtained. Group A consisted of the lower arm, wrist, upper arm and wrist then group B had the neck, legs and the trunk. The total scores of the two groups were then combined and transformed to produce the grand total. The grand score obtained were equated to four levels of risk stating table. The four levels were "acceptable, investigation, change needed soon and change needed immediately.

RULA provided scores which were used in assessing the relationship between postures and age (see previous studies Micheletti Cremasco *et al.*, 2019; Walker – Bone and Palmer, 2002; Kolstrup and Jakob, 2016). The relationship between postures and human body response was deduced from both Rapid Upper Limb Assessment and Standardized Nordic Musculoskeletal Questionnaire (NMQ).

A census method was observed in piloting the standardized Nordic Musculoskeletal Questionnaires amongst 30 participants. The Nordic musculoskeletal questionnaires were used in assessing body discomfort with correspondence to the workstation. Participants were then given clear – cut instructions for responding to the Nordic Musculoskeletal Questionnaire. There was no any further assistance or prompting to the respondents. The standardized Nordic Musculoskeletal questionnaire denoted nine body parts which are, the neck, shoulders, upper back, elbows, wrist, lower back hips knees and ankles. The questionnaire included a question on discomfort levels in different parts of the body: Have you during the last 12 months regularly experienced aches, pains and discomfort in the: neck, shoulders, elbows, hands/ wrists, upper back, lower back, hips, knees, or feet? The nine questions required a yes or no answer from the respondents. In addition, other questions on the questionnaire asked of any visits to the doctor, discomfort during the last week and if the pain had resulted in one not being able to perform daily work. Based on the majority of participants being illiterate, a revised type of a common standardized Nordic questionnaire was used. The standardized Nordic questionnaire had a picture of nine different body parts. The questionnaire was administered at the beginning of the week and collected at the end of the week. This enabled the worker to have a chance to complete the questionnaire without any disturbance.

Sampling Technique, Ethical Considerations and Data Analysis

Cluster randomization sampling was done in selecting participants for the study. Each cluster comprised of 6 employees. The study considered confidentially in the type of questionnaire used. The questionnaires used numbers as identity. The pictures taken for Rapid Upper Limb Assessment (RULA) only considered the upper limbs and excluded the participants' faces as done in previous studies (Kotowski *et al.*, 2009; Kolstrup and Jakob, 2016). Data obtained from the RULA and Nordic questionnaire was analysed using Statistical Package for Social Sciences (SPSS) Version 21.0. A one way ANOVA was used in analysing how age influences ergonomic risks. Gender was then analysed by independent sample *T*-test. Data was then presented in tables and graphs. Two normality tests were done for the RULA scores. These were parametric and non – parametric tests which are Shapiro Wilk and Man – Whitney U.

3. RESULTS

Participants Demographic Data

The age of participants had a range of 21 to 45 for all the departments [i.e. cattle (26 – 45), teaching and learning (27 – 34), field (26 – 45), piggery (29 – 35) and poultry (21 – 34)]. The mean age for the departments was as follows; cattle (34.83±3.516^{a}), teaching and learning (30.17±1.195^{b}), field (35.67±3.232^{c}), piggery (31.50±1.057^{d}) and poultry (27.50±2.125^{e}). The cattle and field department had the highest significant difference of age (±3.516^{a} and ±3.232^{c}). The field department had the highest mean age (35.67). The cattle and field department both had a maximum age of (45).

Table 1: SNQ response mean and standard deviation for body discomfort across age

Age	Mean	Std. Deviation	P value
≥32	20.40	4.837	≤ 0.05
< 32	17.07	5.750	≤ 0.05

Table 1 represented the mean and standard deviation for age amongst all the farm employees. The table shows that employees of age group (≥32) have the lowest standard deviation of (4.837) whereas the other age group has (5.750). The age group (< 32) has a lower mean value of (17.07) than (≥32) age group with (20.40). The significant difference across the two groups was [age group (≥32) having (0 .007) and the other age group with (0.006)].

RULA Scores

The Rapid Upper Limb Assessment (RULA) score sheet was analysed amongst 30 employees. Each employee had two scores thus the Right Hand Side (RHS) and the Left Hand Side (LHS). The two sides were analysed separately (see Table 2).

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Table 2: Means and standard deviation of RULA scores

Parameter	Mean ± Std. Deviation	P - Value
RHS	5.30±1.393	≤0.05
LHS	5.03±1.351	≤0.05

Table 2 shows that there is a significant difference in means between the RHS and the LHS. The RHS has a higher mean than the LHS (see Table 3). The RHS has a higher standard deviation with (±1.393) as compared to the LHS which recorded (±1.351).

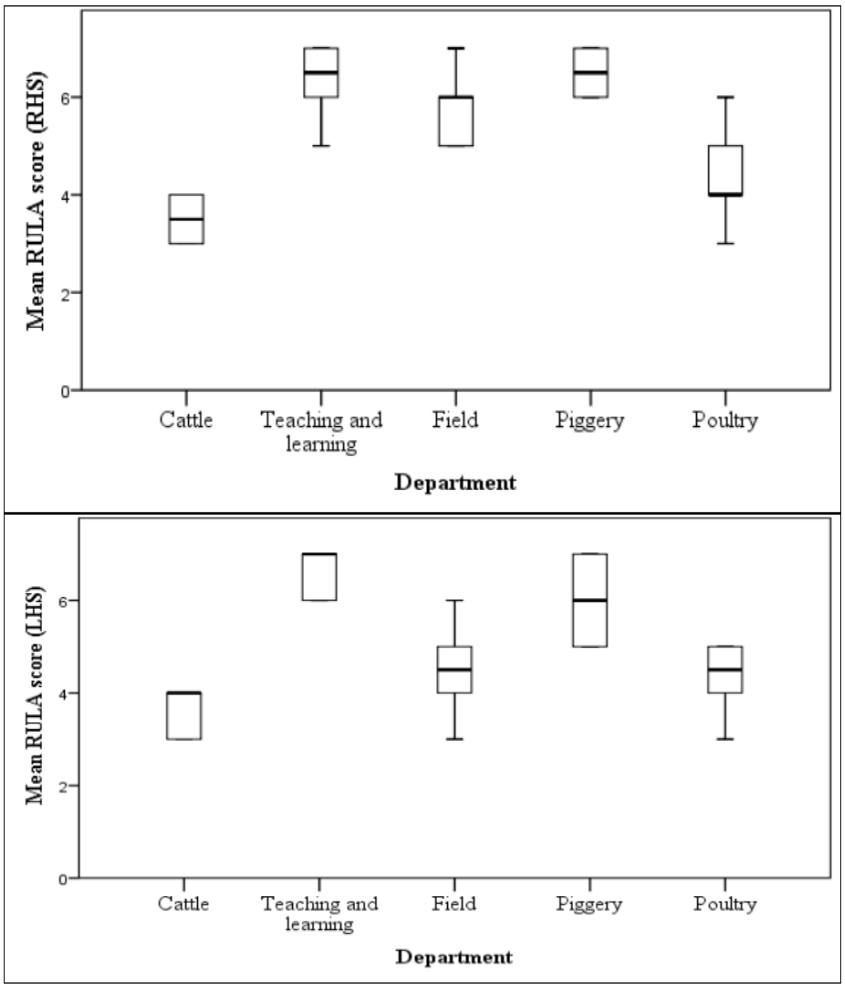

Figure 2: The mean RULA scores for RHS and LHS across all Departments

Figure 2 shows that the maximum score for RHS was (7) in the teaching and learning unit, field and piggery departments indicating a very high risk. The results from the figure also show that the teaching and learning unit and piggery have the same average score (6.5). For LHS, the highest score is a (7) for teaching and learning and piggery departments. The majority of employees in the teaching and learning unit have an average score of (7).

Standardised Nordic Questionnaire Respondents across specified Questions

The following questions are represented as follows:

A: have you at any time during the last 12 months had trouble with?

B: during the last 12 months have you been prevented from carrying out normal activities?

C: during the last 12 months have you seen a physician for this condition?

D: during the last 12 days have you had trouble with?

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Table 3: Overall Responses across different Questions

Question	A	B	C	D
Cattle	17	15	11	19
Field	37	33	15	32
Teaching and Learning	**42**	30	**28**	**40**
Piggery	41	30	20	39
Poultry	37	28	18	30
Total	**174**	136	92	**160**

Table 3 shows the overall responses across departments at BUSE farm. The responses were high at question A, followed by D, B and C respectively. The teaching and learning unit recorded the highest responses in question A, C and D. Amongst the four questions outlined; question C had the least responses.

Standardised Nordic Questionnaire Responses across Nine Body Parts

Table 4 shows that the two leading fields affected by an indication of more body parts are the field department [neck (23), lowerback (23) and ankles/feet (20)] ; the teaching and learning unit[shoulder (16), upperback (18) and hips/thighs (19)] and the piggery department [elbows (18) and knees (23)]. Findings generally show that the majority of workers across three departments had more complaints (field, teaching and learning unit and piggery) respectively.

Table 4: The complaints of body parts affected across all departments (N = 30).

Department	Cattle	Field	Teaching and learning	Piggery	Poultry	TOTAL
Body Part						
Neck	0	**23**	15	13	17	68
Shoulder	7	7	16	15	**17**	**62**
Upper back	14	13	**18**	6	13	64
Elbows	0	0	15	**18**	11	44
Wrist/hands	**17**	8	13	16	15	69
Lower back	17	**23**	22	20	14	96
Hips/thighs	1	9	**19**	2	12	43
Knees	3	14	9	**23**	10	59
Ankles/feet	3	**20**	13	17	4	57

Rapid Upper Limb Assessment Parametric and Non Parametric test

Table 5 shows the significance levels for the tests for Shapiro Wilk and Man – Whitney U.

Table 5: Tests of Normality and Statistics

	Department	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
RHS	Cattle	.319	6	.056	.683	6	.004
	Teaching and learning	.293	6	.117	.822	6	.091
	Field	.254	6	**.200***	.866	6	.212
	Piggery	.319	16	.056	.683	6	.004
	Poultry	.293	6	.117	.915	6	.473
LHS	Cattle	.407	6	.002	.640	6	.001
	Teaching and learning	.407	6	.002	.640	6	.001
	Field	.183	6	**.200***	.960	6	.820

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	Piggery	.202	6	**.200***	.853	6	.167
	Poultry	.293	6	.117	.822	6	.09
**. This is a lower bound of the true significance.*							
a. Lilliefors Significance Correction							

Body Discomfort Responses across Gender

Table 6 shows that the males have a lower mean than the female with (18.13 and 19.33, respectively). There is a significant difference between the female and the male. The male have a higher standard deviation than the females.

Table 6: Mean and Standard error for Body Discomfort according to Gender

GENDER	MEAN	STD. DEVIATION	P VALUE
Male	18.13	**5.927**	≤0.05
Female	19.33	5.150	≤0.05
Total	18.73	5.489	≤0.05

Table 7 shows the significant aspects of comparison based on the independent factors. This suggests working postures at the farm requires further examination and immediate interventions to allow for rapid change.

Table 7: Significance levels based on the listed independent factors (N = 30).

INDEPENDENT FACTOR	STATISTICS MEAN (SD) AND STANDARD ERROR	SIGNIFICANCE LEVEL (P VALUE ≤ 0.05)
AGE (YR)		
≥32	20.40	≤ 0.05
< 32	17.07	≤ 0.05
AGE BY CLUSTER (YR)		
Cattle	34.83±3.516[a]	≤ 0.05
Teaching and Learning	30.17±1.195[b]	≤ 0.05
Field	35.67±3.232[c]	≤ 0.05
Piggery	31.50±1.057[d]	≤ 0.05
Poultry	27.50±2.125[e]	≤ 0.05
GENDER		
Male(15)	-	
Female(15)	-	
HAND DOMINATION		
Left Hand	5.03±1.351	≤ 0.05
Right Hand	5.30±1.393	≤ 0.05
OCCUPATION		
Lecturers (5)	-	
Farm Employees (15)	-	
Students (10)	-	

Table 8 shows the related risk of pain in different body parts using binomial logistic regression. The cattle department, field department, piggery and poultry respectively were significantly affected in that order. The neck, shoulder, elbows, hips/thighs, knees and ankles/feet recorded at least two departments with significant aspects.

Table 8: Factors related to risk of pain in different body parts – binomial logistic regression (N = 30)

FACTOR AGE BY CLUSTER (YR)		Neck (n=20)	Shoulder (n=19)	Upper back (n=19)	Elbows (n=13)	Wrist/hands (n=21)	Lower back (n=29)	Hips/thighs (n=13)	Knees (n=18)	Ankles/feet (n=17)
CATTLE	OR	0.0164	0.3043	0.8750	0.0164	1.3077	1.3077	0.0345	0.1111	0.1111
	95% CI	0.0009 – 0.3047	0.0927 – 0.9997	0.2909 – 2.6322	0.0009 – 0.2897	0.4048 – 4.2247	0.0746 – 22.9346	0.0042 – 0.2827	0.0264 – 0.4673	0.0269 – 0.4593
	P VALUE ≤0.05	**S**	**S**	NS	**S**	NS	NS	**S**	**S**	**S**
FIELD	OR	3.2857	0.3043	0.7647	0.0164	0.3636	3.2857	0.4286	0.8750	2
	95% CI	0.9717 - 11.1099	0.0927- 0.9997	0.2534- 2.3077	0.0009- 0.2897	0.1065-1.2419	0.1811- 59.6021	0.1529- 1.2009	0.2988- 2.5627	0.6789-5.8917
	P VALUE ≤0.05	**S**	**S**	NS	**S**	NS	NS	NS	NS	NS
TEACHING AND LEARNING	OR	1	1.1429	1.5	1	0.7647	2.75	1.7273	0.4286	0.7647
	95% CI	0.3225 - 3.1006	0.3799 - 3.4380	0.4944 - 4.5514	0.3746 - 2.6696	0.2367-2.4705	0.1532 - 49.3611	0.6344 - 4.7031	0.1401 - 1.3110	0.2663 – 2.1957
	P VALUE ≤0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
PIGGERY	OR	0.7647	1	0.2500	1.5	1.1429	2	0.0714	3.2857	1.3077
	95% CI	0.2456 - 2.3808	0.3328- 3.0051	0.0735- 0.8504	0.5558 - 4.0479	0.3548-3.6812	0.1130- 35.4127	0.0146- 0.3483	1.0254- 10.5286	0.4554 – 3.7547
	P VALUE ≤0.05	NS	NS	**S**	NS	NS	NS	**S**	**S**	NS
POULTRY	OR	1.3077	1.3077	0.7647	0.5789	1	0.8750	0.6667	0.5	0.1538
	95% CI	0.4200 - 4.0713	0.4333- 3.9463	0.2534- 2.3077	0.2126- 1.5764	0.3108-3.2179	0.0500- 15.3272	0.2470- 1.7991	0.1659- 1.5065	0.0418-0.5665
	P VALUE ≤0.05	NS	NS	NS	NS	NS	NS	NS	NS	**S**

4. DISCUSSION

Awkward Postures' influence to Ergonomic Risks

The increased technical expansion on farms has apparently perceived the increased levels lowering of awkward postures. In this study, the cattle department perceived the lowest RULA scores on both hand sides. This shows that awkward postures are being practiced at low rates. Similar studies revealed that awkward postures were low hence increasing productivity (Costa and Camarotto, 2012; Micheletti Cremasco *et al.*, 2019). An in – depth analysis shows that, the group has experienced aged employees who are well versed with how to overcome awkward postures. Nevertheless, the piggery and teaching and learning unit recorded the highest RULA scores. On the contrary, this is because the two departments are associated with bending and twisting of the upper limbs. Similar studies (Das, 2015; Fulmer *et al.*, 2002) revealed that the majority (53%) experienced awkward postures. High rates of recurrence were observed in the field department and this had negative impacts to overall performance as observed in previous studies (Das and Gangopadhyay, 2011). This was because awkward postures were mostly observed during the strenuous activity of assembling of the centre pivot as observed in other studies elsewhere (Sombatsawat *et al.*, 2019; Jain *et al.*, 2018). On the other hand, lack of resources led to makeshift pivot assembling. This is despite findings elsewhere (Kotowski *et al.*, 2009) revealing

that new innovations reduce or avoid awkward postures. On the RHS, RULA scores have a higher mean than the LHS because most of the employees are right handed.

The Influence of Age on Ergonomic Risks

In epidemiological studies, every aging population is prone to work – related musculoskeletal diseases. In this study, age group (≥32) had the highest response rate on body discomfort as it is the most active age group on the farm. This is similar to previous studies where experienced farmers have increased levels of incidence the inexperienced young farmers (Salminen 2004). Furthermore, the work schedule played an important role in the occurrence of WMSDs. This has been observed in previous studies (McMillan *et al.,* 2015) where every farm employee is vulnerable to any response related to WMSDs. In addition to age and employment criteria; technologies used at each farm play a part in increasing the burden. Moreover, with different diets, genetic makeup and varying levels of metabolism, each generation tends to have its musculoskeletal system react differently to workplace conditions.

The Influence of Gender on Ergonomic Risks

Irregular distribution of work tasks and duties between females (n =15) and males (n =15) is one of the reasons why females experience high recurrence rates than males. In Table 6, gender means and standard deviations revealed that females had the highest response rate with a mean of (19.33). This was probably because the farm has females who are involved in the teaching and learning unit and piggery departments which are related to high prevalence rates of ergonomic risks. In similar case studies (Das, 2015; Vyas, 2012) females had a higher overall discomfort than male employees. Furthermore, females tend to have compromised health levels during pregnancy and birth periods or when they undergo their monthly menstrual cycle. This has placed them at high risk of complaining of work – related musculoskeletal disorders. Similar studies (Cha *et al.,* 2009) also found out that females had high complaints and prevalence than the males. However, other studies obtained a different conclusion where there was no variation on gender, response rate to body discomfort between the males and females (McMillan *et al.,* 2015). A possible variation could be as a result of farming machinery and tools which are often designed in males' capacities and physical abilities.

Work – station's influence on Ergonomic Risks

The results revealed that body response depends with work stations (Table 5). The field department has the highest response rate in the neck (23) lower back (23) and ankles (20). This is because the departmental activities require use of those specific upper limbs especially in setting up the pivot and driving a tractor. Similar studies also obtained results which revealed that employees in a workstation with vast activities are at risk of WMSDs (Osborne *et al.,* 2013; Patil *et al.,* 2018). The poultry department had the highest response rate on the shoulder (17) whilst teaching and learning unit had (17) responses in the upper back. This is because poultry has high demands of lifting stock feed and the teaching and learning unit has activities such as crop spraying and land clearing by the use of hand lawn mowers or grass cutters. The piggery department has the highest response rate in the knees and elbows with (24 and 18, respectively). This was possibly because it involved bending of the knees and elbows during pig slaughtering. An overall view of five departments' responses shows that the farm is a breeding ground for WMSD. Similar studies indicated that large farms with different departments contribute to WMSDs (Sombatsawat *et al.,* 2019; Costa and Camarotto, 2012). A related study (Vyas, 2012) also had workstations having high discomfort rates depending on the relation to the type of activities. A major observation of the findings is that the farm is different in terms of technology hence there are high response rates.

Ergonomic Risk Exposure Duration

The farm schedule shows that farm employees are exposed to 8 or 9 working hours a day. This has resulted in most of the farm departments having their response rates being above (50%). The cattle department has the smallest response rate (28.7 %). This was probably because it requires little time on the farm schedule. A similar research also revealed that farms exposing employees to long periods of working were more prone to produce higher response rates which result in work – related musculoskeletal disorders (Osborne *et al.,* 2010; Mushayi *et al.,* 2014). However a different outcome was revealed amongst the Saskatchewan farmers where duration of work exposure did not correspond to response rates across all departments (McMillan *et al.,* 2015).Studies differ because some farms have long periods of exposure and use modern methods of farming which require less awkward postures.

Ergonomic Risk Management

The study revealed, all body parts having high response rates. This shows that top management has not developed a system to lower the response rates. In a similar studies (Suutarinen, 2003) high response rates are associated with poor management.

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Moreover, high response rates across indicate that the top management does not have a system that safe guards the employees' safety. Thus, the employees had the highest responses for body discomfort occurring in the past 12 months as also observed in previous studies among farmers (Das *et al.,* 2013). On the other hand Vyas (2012), found out that low discomfort rates are also associated with good management skills such as education and design intervention towards ergonomic risks. The neck and elbows are the only parts with no response rates in some departments. This could be due to the introduction of mechanization interventions within the farm. A related study had the same findings and the top management introduced new interventions which reduced the discomfort response rates (Bhattacharyya and Chakrabarti, 2012).

Common Exposure Levels of Ergonomic Risks

The findings show that the lower back had the highest response rates amongst the nine body parts. This is probably because all farm activities are associated with awkward postures that have an effect on the lower back than any other body part. This has been observed in previous studies where farmers also obtained high levels of reported lower back pain as the most frequent discomfort zone with (37% and 60 %) in the neck (Osborne *et al.,* 2010). However, a similar study obtained different findings where employees had high risks to wrist discomfort (Osborne *et al.,* 2013).

LIMITATIONS

This study has several limitations. Similar to many other studies using the Nordic Questionnaire, the process of data collection through interviews of events in the past 12 months may cause recall bias when answering the question, especially the recall of work – related musculoskeletal disorder symptoms (Luan *et al.,* 2018). Furthermore, the investigators were cognisant that RULA results are at a high – level risk for non-permanent jobs while the left and right side of the body are assessed independently and RULA does not take into account the time the worker takes to carry out a task (Gomez – Galan *et al.,* 2020). Nevertheless, the investigators have been well trained and have tried to exploit these events carefully to limit this bias. On the other hand the institutional farm is undergoing development and the farm employee number (hence the limited number of participants) is yet to grow as more activities are at an infant stage.

5. CONCLUSION

Farm employees are at high risk of developing WMSDs. The posture analysis revealed that participants worked continuously in awkward and stressful postures during different activities at the five departments of the farm. Most of the postures adopted by participants were found to be hazardous as revealed by the NMQ and RULA methods. Consequently, they suffered from discomfort in different parts of their body, specifically in the lower back, knees, ankle, elbows, neck and hand regions. This study also showed that farm employees suffered from excessive thermal stress which affected their health. Farm employees suffered from severe and physiological stress due to the hazardous working condition and work behaviour and increased heart rates, which also affected their health and overall work performance. Awkward postures, carrying heavy equipment, twisting and long periods of exposure are the major benefactors to high prevalence of ergonomic risk. There is an urgent need to reduce the vulnerability of ergonomic risk as observed in the study.

Recommendations

The study recommends farm employees to engage into a safety and health culture. The culture should have the top management allocated roles and responsibility towards ergonomic safety. Moreover, training and awareness of employees and top management on safety skills should be addressed. Lastly the top management should purchase improved technology so as to reduce awkward postures.

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Conflicts of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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