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RULA and REBA risk assessment system on salt workers in Occidental Mindoro, Philippines

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Abstract

This descriptive study focused on the ergonomic risk assessment of salt workers in Occidental Mindoro to determine which work activities posed risks to the farmworkers and assess the relationship between profile variables and the total pain and body parts pain experienced by the salt workers. The Nordic Questionnaire was used to detect symptoms composed of 28 multiple choice questions and structured into two well-differentiated parts; the first part refers to symptoms in nine parts of the body (neck, shoulders, elbows, wrists/hands, upper back, lower back, hip/thighs, knees, and ankles) during the last 12 months. The second part refers to the neck, shoulders, and lower back symptoms throughout the subject's working life/seven days beforehand. Correlation analysis and descriptive statistics were used to interpret data. The study's findings revealed that the salt workers are middle adults, have been working in the salt farms for most of their lives, have heights and weights within the average height and weight for Filipino males. Results further suggest that the work activities that posed risks and caused pain to the salt workers are, transporting salt, collecting salt, and filling the salterns with brine. Moreover, age and years of working are also significantly related to the pain in body parts experienced by the salt workers in doing the activities that pose risks to them. The body parts that are likely to feel pain are the neck, lower and upper back, and knees. Lastly, in knowing the risky work activities of salt farmers, mitigation measures can be proposed.

Keywords: *Salt Farming, Body Pain Score, Nordic Questionnaire, Correlation Analysis*

INTRODUCTION

Occupational safety and health are important to consider in all industry sectors in carrying out their task to prevent work-related diseases and work accidents (Sulzer-Azaroff et al., 1990). Musculoskeletal disorder (MSDs) is one of the most common occupational disorders caused by improper posture due to working conditions (Yazdani & Wells, 2018; da Costa & Vierira, 2009). MSDs develop due to physical work exertions, incorrect movement, and repetitive movements in a short or long time (Virmani & Ravindra, 2021). Traditional farming is one of the agricultural sectors that poised a higher ergonomic risk (Jo et al., 2016). Occidental Mindoro, located in the southern part of Luzon Island in the Philippines, is known as one of the leading producers of salt, having a 12% of the country's salt requirements equivalent to 17,000 metric tons (Verdey & Abilay, 2017).

Salt farming is a labor-intensive job that requires manual operations and long hours of working in the field that imposes a higher occupational safety and health risk. Also, salt workers lack social and social, and health security even if exposed to hazardous work-environment factors and work in extreme climatic conditions. However, a limited study assesses the risk related to salt workers. Therefore, the purpose of the study is to investigate the ergonomics of salt farming, particularly on the activities that bring the most pain and strain to the salt farmers' bodies since salt farming is a labor-intensive industry. Moreover, to identify the different work activities that may pose a risk in the job salt farmers through the participant's demographic information and total pain score. Finally, to provide mitigation measures that will help reduce the risks to salt farmers in Occidental Mindoro.

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RESEARCH METHODOLOGY

I.1. Research design

The current research utilized a descriptive study that gathered data from the salt farmers on the occupational risks they are exposed to using the Nordic questionnaire as the main research instrument.

I.2. Study site

The research was conducted in five salt farms in the municipalities of San Jose and Magsaysay, both salt-top producing municipalities in Occidental Mindoro. The participants were selected using simple random sampling based on the master list of workers provided by the salt farms during the field visits of the researchers to avoid bias.

I.3. Participants

A total of 24 salt farmers were interviewed and observed. The participants were directly involved in salt production, from tending to the salterns, including the supply, concentration, and crystallizing ponds, harvesting and hauling salt from the salt beds to the drying area, and working in the salt farm for at least six months.

I.4. Procedures

Initial observation and survey were made on the salt farms included in the study. Initial interviews were also done with the target respondents. A self-made questionnaire and a Standard Nordic Body Map Questionnaire were next administered to the salt farmers during the subsequent visits. Demographics were collected and the pain score of each work activity. Data was gathered in February and March 2020, which are the peak months of salt production in the province of Occidental Mindoro. The Nordic Questionnaire (Hemawati & Sutarto, 2014) detects neck, back, shoulders, and extremities symptoms. It is composed of 28 multiple choice questions and structured into two well-differentiated parts; the first part refers to symptoms in nine parts of the body (neck, shoulders, elbows, wrists/hands, upper back, lower back, hip/thighs, knees, and ankles during the last 12 months. The second part refers to the symptoms in three body parts (neck, shoulders, and lower back) throughout the subject's working life/seven days beforehand.

The work postures of the salt workers were photographed while doing the activity and were subjected to body segmentation measurements. The segmentation measurements were analyzed using the Rapid Upper Limb Assessment (RULA) and Rapid Entire Body Assessment (REBA) to obtain the risk of musculoskeletal disease in the salt collection and transport.

I.5. Statistical analysis

A normality test was first made when the data had been collected to ensure that the data was in a normal distribution. Mean, and percentage were used to describe the demographics of the salt farmers, while Spearman's correlation was used to test the relationship of important variables in the study.

FINDINGS AND DISCUSSION

I.6. Demographic profile of the participants

Since this is an ergonomic study, it is important to determine the demographics of the respondents for later correlation with the pain score and other variables. These demographics include age, height, weight, and years of experience in salt farming. Sex was excluded since all the salt farmers participants were males, as shown in Table 1. The age distribution of salt farmers, the age range of 26-30 has the highest number comprising with 25%, followed by 21-25 and 31-35 with 21%, 36-40 years old with 17% 46-50 with 12% and 41-45 with 4%. It can be gleaned from the results that the salt workers are relatively young since strength and stamina are needed in salt farming which requires long hours under the scorching heat of the sun. Work experience distribution of the respondents shows that 37% each had been involved in salt farming for 6-10 years and 0-5 years, respectively. It also indicates that 13% had been salt farming for 11-15 and 16-20 years, respectively. These denote a wide distribution of salt farming experience was new to the job while some had been there during the last 20 years of

their lives.

In terms of height distribution, most (46%) of the respondents measured 166-170 centimeters. An equal percentage of 17% each accounted for those 161-165 and 171-175 centimeters tall, respectively. Moreover, 8% of respondents had heights ranging from 151-155 and 156-160 centimeters, respectively. Lastly, 4% of the respondents were within the height range of 176-180 centimeters. The average height for a Filipino male was 163.22 centimeters. When distributed in weight, it indicated more (34%) salt farmers whose weights ranged from 56-60 kilograms and 25% each comprise those with 61-65 and 71-75 kilograms, respectively. Lastly, 4% each had 51-55 and 76-80 kilograms, respectively. The last two groups belonged to the lower and upper extremes in weight. The average weight for a Filipino male is 61.3 kilograms.

Table 1. Percent distribution of demographic profile of the participants

Demographics	Range	Percentage (%)
Age (years)	21-25	21
	26-30	25
	31-35	21
	36-40	17
	41-45	12
	46-50	4
Height (cm)	151-155	8
	156-160	8
	161-165	17
	166-170	46
	171-175	17
	176-180	4
Weight (kg)	51-55	4
	56-60	34
	61-65	25
	66-70	8
	71-75	25
	76-80	4
Experience in Salt Farming (years)	0-5	37
	6-10	37
	11-15	13
	16-20	13

I.7. Salt farming work activities that pose risks to the salt farmers

In an interview with the salt farmers, it was found that the salt-farming-related activities that posed the biggest risk to them were transporting/lifting the harvested salt from the salt beds to the drying/hauling area, salt harvesting, and filling the salterns with brine.

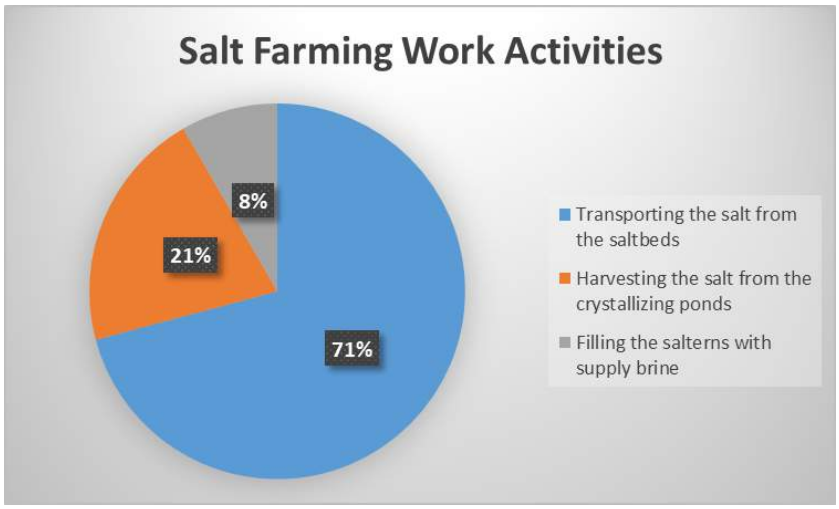

Fig. 1. Work activities that pose risk to salt farmers

The researchers found out that the activities that contributed the biggest pain to the salt farmers were: transporting the salt from the salt beds to the drying area/hauling point (70.83%), harvesting the salt from the crystallizing ponds (20.83%), and filling the salterns with brine (8.33%) as shown in Fig.1. This finding was consistent with that of Sudaryana (2018), who found that among the salt farming activities, the tasks that contributed the most to bodily pain experienced by the salt workers were harvesting, hauling, and putting the harvested salt in salt baskets.

I.8. Pain contribution of the activities that pose risks to the salt farmers

An evaluation of the respondents' scores in the NORDIC questionnaire revealed that transporting the salts from the salt bed contributed the most pain (35%) followed by harvesting the salt from the crystallizing pond by putting the salts in baskets (34%) and filing the salterns with (31%). Figure 2 shows the summary of pain scores per work activity.

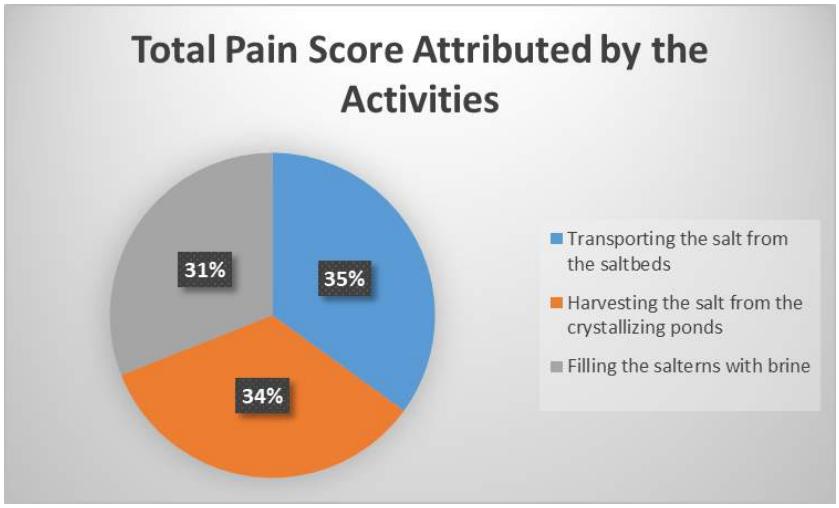

Figure 2. Total pain score attributed by the activities

I.9. Relationship between Demographic Characteristics and Pain Score

Spearman's correlation was run to determine the relationship between long-term effects and the demographic variables to determine the work activities that pose the most risks to the salt farmers. Results of the analysis indicate a negative correlation between the height and the long-term effect of pain (r_s = -.412, n = 24, p= 0.045) (see Table 2). It signifies that the shorter the height of the salt farmer, the more intense the long-term effect of pain will be. In terms of the other demographic variables, no significant relationships were found. Similarly, Wisnu (2018) found a significant relationship between the height and the weight of a salt worker in the long-term effect of pain.

Interestingly, he found a positive correlation between the weight of the salt workers, while the present study only found a relationship in terms of the height of the salt workers and the long-term effect of pain.

Table 2. Correlation analysis between long term effect of pain and demographics

Long term effect (total pain scores)	Demographics	Correlation (r_s)	Significance	Interpretation
	Age	0.195	0.362	Not significant
	Height	-0.412	0.045	Significant
	Weight	0.019	0.929	Not significant
	Years of experience in salt farming	0.041	0.847	Not significant

I.10. Relationship between the total pain in transporting salt and demographic characteristics

In the correlation analysis to determine the relationship between the total pain score brought by transporting salt, it is indicated that the age has a positive correlation with the total pain scores (r_s = .542, n = 24, p <.05). The number of years in salt farming was also positively correlated with the total pin score. (r_s = .475, n = 24, p <.05) as shown in Table 3. These findings signify that the pain increases as one advance in age. It also rises as the years of salt making increase. Essentially, as one gets older while working on a salt farm, his pain from transporting salt will also increase. Moreover, the longer the salt worker stays on the job, the greater his pain from hauling salt.

Table 3. Spearman's correlation value for work activity transporting of salt vs demographics

Salt Farming Work Activity	Demographics	Correlation (r_s)	Significance	Interpretation
Transporting of salt from salt beds	Age	0.542	0.006	Significant
	Height	-0.022	0.917	Not Significant
	Weight	0.165	0.442	Not significant
	Years of experience in salt farming	0.475	0.019	Significant

I.11. Relationship between the demographics and the pain in body parts when transporting salt

A correlation analysis was made to test the relationship between the salt workers' demographic characteristics and the pain in the body parts they experience from transporting salt. A Standardized Nordic Questionnaire was distributed to the twenty-four salt farmers. A spearman's correlation was run for the different body parts: neck, shoulders, upper back, elbows, wrists/hands, lower back, hip/thigh, knees, and ankle/feet.

Results of the analysis indicate that years in salt farming has a positive correlation with upper back pain (r_s = .555, n = 24, p <.05), age and years and salt farming are positively correlated with the wrist (r_s= .574, n = 24, p <.05) (r_s = .438, n = 24, p <.05) respectively. Lower back pain positively correlates with age and years in salt farming. (r_s = .569, n = 24, p <.05) (r_s= .61, n = 24, p <.05) (see Table 4). These findings indicate that the longer the salt workers stay in salt farming and the older they get, the more pain in several body parts will be experienced, notably in the upper back, lower back, and wrists.

Table 4. Correlation analysis between pain in body parts of transporting of salt and demographics of salt workers

Pain in Body Parts	Demographics	Correlation (r_s)	Significance	Interpretation
Lower back	Age	0.569	0.004	Significant
	Years of experience in salt farming	0.61	0.002	Significant
Upper back	Years of experience in salt farming	0.555	0.005	Significant
Wrist	Age	0.574	0.003	Significant
	Years of experience in salt farming	0.438	0.032	Significant

I.12. Relationship between the total pain in collecting salt and demographic characteristics

Table 5 shows the correlation analysis between the total pain scores of the work activity of collecting salts and the demographic characteristics of the salt workers. The analysis results indicate that a direct positive correlation between the pain associated with harvesting salt with the years in salt farming exists (rs = .407, n = 24, p <.05). Other demographic variables are not significantly related to the total pain score in collecting salt. The finding implies that as one stays longer in salt farming doing the salt collection, the higher the probability that he would experience body pains.

Table 5. Correlation analysis between pain from harvesting the salts from the crystallizing pond and demographics

Salt Farming Work Activity	Demographics	Correlation (r_s)	Significance	Interpretation
Harvesting the salts from the crystallizing pond	Age	.258	.224	Not Significant
	Height	-.335	.109	Not Significant
	Weight	-.059	.784	Not significant
	Years of experience in salt farming	.407	.048	Significant

I.13. Relationship between the demographics and the pain in body parts when harvesting salt

Table 6 summarizes spearman's correlation test of the demographics and the pain in body parts when harvesting salts. It shows that the age and years in salt farming have positive correlation with the pain in shoulders (rs = .517, n = 24, p <.05) (rs = .434, n = 24, p <.05) and also has a positive relationship with the pain in the lower back (rs = .421, n = 24, p <.05) (rs =.608, n = 24, p <.05). These findings suggest that as the salt workers get older and stay on the job, they will likely experience pain in the shoulders and lower back. Collecting salt involves the extensive use of shoulders by raking, and bad posture while harvesting might account for the pain experienced in the lower back section of the body (Schall, 2014).

Table 6. Correlation analysis between pain in body parts experienced while harvesting the salts from the crystallizing pond and demographics

Pain in Body Parts	Demographics	Correlation (r_s)	Significance	Interpretation
Lower back	Age	0.421	0.04	Significant
	Years of experience in salt farming	0.608	.002	Significant
Shoulder	Age	0.517	0.01	Significant
	Years of experience in salt farming	0.434	0.034	Significant

I.14. Relationship between the total pain in filling the salterns with brine and demographic characteristics

Using the spearman's correlation test, the researchers found out that age has a positive correlation with the total pain scores in filling the salterns with brine and not significant with others (rs = .406, n = 24, p <.05) (see Table 7). This finding indicates that the pain from filling the salterns with brine increases as the salt worker gets older. Interestingly, this task involves using arms and shoulders heavily and can be very taxing when done repeatedly without a break.

Table 7. Correlation analysis between pain from filling the salterns with brine and demographics

Salt Farming Work Activity	Demographics	Correlation (r_s)	Significance	Interpretation
Filling the salterns with brine	Age	0.406	0.049	Significant
	Height	-0.174	0.415	Not Significant
	Weight	0.092	0.668	Not Significant
	Years of experience in salt farming	0.368	0.077	Not significant

3.10. Relationship between the demographics and the pain in body parts when filling the salterns with brine

Table 8 summarizes the correlation analysis between the demographic characteristics of the salt farmers and the body pain experienced from filling the salterns with brine. The results imply that age and years in salt farming are positively correlated with the upper back pain (rs =.494, n = 24, p <.05) (rs = .442, n = 24, p <.05). Knees pain also has a positive correlation in age (rs = .517, n = 24, p <.05). Essentially, these findings indicate that advancing in age and continued working in a salt farm will result in a salt worker's experiencing lower back and knee pains.

Table 8. Correlation analysis between pain in body parts in filling the salterns with brine and demographics

Pain in Body Parts	Demographics	Correlation (r_s)	Significance	Interpretation
Knees	Age	0.517	0.01	Significant
Upper back	Age	0.494	0.014	Significant
	Years of experience in salt farming	0.442	0.031	Significant

3.11. Work postures that pose risks to the salt workers

Upon observing the salt farmers while working, the body postures that need to be corrected are transporting the salt from the salt beds and harvesting the salt from the crystallizing ponds. The said

two salt farming work activities impose a high-risk index compared to filling the salterns with brine.

Figure 3. Harvesting the salt

Figure 4. Transporting the salt

The salt workers did the activity of harvesting the salt from the crystallizing ponds with the legs bent and the back forming a very large angle; the hand's position also forms a very large angle. The RULA score for this position is 7 (Table 9).

Table 9. Rapid Upper Limb Assessment for salt farming work activities (RULA)

Salt Farming Work Activities	Risk Index Average
Transporting the salt from the salt beds	7.18
Harvesting the salt from the crystallizing ponds	7
Filling the salterns with brine	7

The activity of transporting the salt was carried out with the back bent, the foot slightly bent so that it supports a weight of fewer than 10 kilograms, and the neck forms an angle. The REBA score for this lifting position is 12 (Table 10).

Table 10. Rapid Entire Body Assessment for salt farming work activities (REBA)

Salt Farming Work Activities	Risk Index Average
Transporting the salt from the salt beds	11.73
Harvesting the salt from the crystallizing ponds	10.91
Filling the salterns with brine	10.27

For RULA, any score above six and REBA score higher than four poses a very high risk to the workers (Middlesworth, 2020). A recommended body posture has to be implemented to attain a nominal risk index of 1. In collecting salt, the task should be done by bending the knees and squatting, keeping the back and the neck straight so that the angles of the arms formed are also not too large and the body position is stable (Figure 5). For transporting the salt, lifting should be done in a squat position to

keep the back straight so that the weight of the load is spread evenly on the body (Figure 6).

Fig 5. Correct body posture in harvesting salt

Fig 6. Correct Body posture in lifting/transporting the salt

CONCLUSION AND FURTHER RESEARCH

A descriptive study and observation were conducted to assess salt farmers' occupational and health risks in Occidental Mindoro, Philippines. The analysis showed that participants aged 21-30 working in the salt farms from 0 to 20 years have an average height of 163 centimeters and are mainly within the weight range of 50-60 kilograms. The work activities that pose risks and cause pain to the sat workers are, transporting salt, collecting salt, and filling the salterns with brine. Moreover, the demographic characteristics are significantly related to the total pain score resulting in activities that pose a hazard to the salt workers. Age and years of working in the salt farms are significantly related to the pain in body parts experienced by the salt workers in doing the activities that pose risks to them. The body parts that are likely to feel pain are the neck, lower and upper back, and knees. A mitigation plan can be proposed through the results of the current study knowing the risky work activities of salt farmers.

This research could potentially be considered the first study in the Philippines that assessed occupational and health risks of salt farmers. This study serves as the first step in mitigating risks of injuries and other occupational health-related disorders in the salt farming sector. Further studies could increase the number of participants and age groups to broaden the results. Moreover, to apply RULA and REBA to investigate the risks brought by other post-harvest activities the working posture of the salt workers.

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