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Work-related pains among the workers associated with pineapple peeling in small fruit processing units of North East India

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ABSTRACT

The present study aimed at investigating work-related pain issues among the workers associated with pineapple peeling activity in small fruit processing units of North East India. The study also assessed the associated levels of ergonomic risk prevalent among the workers and identified ergonomic risk factors associated with pineapple peeling task. A cross-sectional survey was conducted using questionnaire-based interview, pain self-report and direct observation of the activities to understand the prevailing work conditions. Rapid Upper Limb Assessment (RULA) was used to assess the level of ergonomic risks involved. Prevalence of pain, in different body parts of the participants, was found evident with a higher percentage of participants reporting pain in shoulders (41.1%), upper arms (37.1%) and lower back (45.7%) while some had also reported of pain in neck (13.2%), lower arms (15.9%), wrists (12.6%) and palm (6%). For RULA, 89.4% of the participants had a grand score greater than equal to 5 which fell under action level 3 indicating for further investigation and changes soon. Hence, various risk factors influencing pain occurrences were identified using logistic regression, and factors like age, gender, hours of peeling, frequency of rest breaks, perceived work fatigue and years of experience, were found to be associated with risk of pain in at least one of the body parts. Identification of these risk factors laid down path for the future course of actions and improvements to address the work pain related issues among workers. *Relevance to industry:* The study established pain prevalence associated with manual pineapple peeling task and identified the potential risk factors, laying down basis for possible future actions to address work pain related issues and enhance productivity of the workers.

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1. Introduction

Work related pain issues have always been an area of investigation and improvement especially for industries involving labour intensive operations and techniques (Cherng et al., 2009; Mirka et al., 2011; Motamedzade et al., 2007; Spasojević et al., 2015). Fruit processing is one such industry that involves a large number of labour intensive tasks and activities for processing different types of fruits and hence, susceptible to work-related pain issues that need ergonomics investigation and relevant intervention (Rai et al., 2012). Pineapple processing related activities also fall under the ambit of fruit processing and ask for an in-depth ergonomics study because many small fruit processing units, process pineapple using labour intensive techniques, especially for peeling, as evident

in case of the units in North East India.

Northeastern states of India are among the largest producers of pineapples in the country, and there are many small fruit processing units in the region which process pineapple during the peak harvest season (Kumar, 2011). In pineapple processing, peeling was typically considered to be a difficult, repetitive and time-taking task. Adopting awkward postures, performing work with repetitive forceful movements, prolonged work periods, lack of adequate work rests, improper work tools and workstation were some of the features commonly associated with pineapple peeling task in these small processing units. Pineapple, being an acidic fruit, was hazardous to be handled bare handed. Whereas, if gloves were used, the wet juicy fruit was too slippery to be held properly while peeling, making the task more difficult and uncomfortable, that enhanced the risk of MSDs, adversely affecting the efficiency as well as productivity of workers (Agaliotis et al., 2013). The prevailing work conditions in these pineapple processing units strongly indicated the presence of task-related issues.

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There had been some in-depth research works reported on the evaluation of ergonomic risk factors related to workers engaged in similar processing tasks but pineapple processing. A study on workers, engaged in fish processing, evaluated the related ergonomics issues and suggested the probable interventions to address them (Nag and Nag, 2007). Similarly, studies had been reported in the area of meat processing, where meat cutting and packaging tasks were studied and various risk factors associated with occupational health problems, like work related awkward posture, repetitive movements and muscular force exertion, were identified (Keyserling et al., 1992; Grant and Habes, 1997; Sormunen et al., 2006). Research had also been reported in the area of *Aonla* (Indian gooseberry) processing that established the improper working conditions and ineffective working tools as the major factors leading to work injuries and hence, loss in productivity of the workers (Shikdar and Sawaqed, 2003; Rai et al., 2012). As far as pineapple processing and specifically pineapple peeling is concerned, there had not been much of work reported in the area except a limited study that identified pineapple peeling as a labour intensive job, in addition to the detailed investigation on tea leaf plucking task (Bhattacharyya and Chakrabarti, 2012).

Hence, the study aimed at addressing the occupational health related issues and identifying ergonomic risk factors among the workers involved in pineapple peeling across the small fruit processing units of North East India. The investigation covers work-related health issues in terms of pain prevalence among the workers engaged in pineapple peeling activity, assessment of upper limb related ergonomic risk levels and identification of different work-related factors inducing risk of pains in different body parts of the workers.

2. Method

2.1. Participants

The cross-sectional study included randomly selected 151 participants (Assam-80, Meghalaya-33, Nagaland- 16 and Tripura-22) from 17 pineapple processing units from across the north eastern states (Assam-12, Meghalaya-3, Nagaland-1, and Tripura-1). The sample consisted of 63 men and 88 women workers. These workers were engaged in a wide range of activities that started right from unloading of the pineapples to sorting, peeling, slicing, pulping, juice extracting, packaging, storing, etc. The study was focussed on the issues related to peeling that was considered to be a major task, consuming a significant span of the processing time. The participants reporting any previous history of pain due to diseases, accidents or any pain injuries were excluded from this study.

2.2. Task characteristics

Pineapple processing was observed to start with the peeling task that had been carried out manually using local tools that included different type of knives (Fig. 1a), traditional device called *Baithi* (Fig. 1b) or a punch cutter (Fig. 1c).

There were mainly three techniques used for peeling the fruit i.e. technique 1- peeling using knife supporting it on a base (Fig. 2a), technique 2-peeling using *Baithi* (Fig. 2b) and technique 3-peeling using knife by holding the fruit in one hand (Fig. 2c). There were some other peeling techniques used as well, like peeling the sliced pineapple using punch cutter (Fig. 2d), observed at some of the units which were comparatively lesser repetitive and faster. We refer the other miscellaneous peeling techniques as technique-4.

Different body part movements and postures were involved during each peeling technique that has been described as following:

- For “technique 1”, the trunk bent forward at some angle accompanied with forward/side bending of the neck. For peeling fruit along the curved surface, the wrists angle gradually changed from pronation to neutral to supination. Simultaneously, the vertical downward force along with reciprocating horizontal motion was applied by the hand.
- For “technique 2”, the workers adopted a posture similar to squatting. Both the foot, though properly resting on the ground, were at slightly different levels as one foot pressed the base of *Baithi*. The trunk bent forward almost continuously and had a frequent forward and backward movement to enhance the cutting force.
- For “technique 3”, one hand was continuously engaged in holding the fruit without any support. The other hand was used repetitively for cutting off the peel using a knife. During peeling, the trunk bent forward for most of the time and the arms worked across the midline of the body.
- For other techniques like peeling slices using punch cutter (referred to as “technique-4”), the operation was generally done in standing position and the vertical force was applied on the die with an extended arms position. The neck bent to check and ensure that die was placed properly. The trunk repetitively bent forward to enhance the cutting force.

2.3. Data collection

Data, collected through questionnaire-based interviews, assessment checklist and direct observations of the peeling process, consisted of personal information like age, years of experience and the occupational information like the daily work routine, tasks handled, techniques used, number of working hours, general working conditions, level of job satisfaction, perceived work fatigue, etc. Observations and assessment checklist were used while conducting Rapid Upper Limb Assessment (RULA). RULA was used to assess the kind of postures and forces involved in peeling as they often lead to pain related issues (Öztürk and Esin, 2011).

The data, collected on nominal, ordinal and ratio scale, included information regarding frequency of rest breaks, level of job satisfaction, marital status, level of education, gender of workers, peeling technique used, perceived work fatigue and hours of peeling. Age of workers and years of experience have been collected as ratio scale data. Also, the body discomfort chart and analog pain rating scale (Borg's scale) was used to determine the occurrences and intensity of pain in various body parts of the workers during last three months. Taking the pain scores greater than equal to 3 as “pain” and score less than 3 as “no pain”, responses of the participants were analysed for ascertaining prevalence of pain (Meksawi et al., 2012). Since, in all the techniques, the upper limbs were mainly involved, RULA was used to ascertain the level of ergonomic risks involved and the urgency of intervention (McAtamney and Corlett, 1993). The ergonomic risk factors were ascertained through observations and contextual inquiry. Videos and photographs of workers, while performing the task, were also taken along with the direct observation wherever possible. Data collection was performed in accordance with Helsinki protocol (WMAH, 2001).

2.4. Statistical analysis

The statistical analysis was performed using IBM SPSS Statistics Ver. 20.0. Descriptive statistical analysis was used to represent the personal data, physical and psychosocial characteristics, distribution of reported pains and RULA scores for individual body parts as well as for the overall scores. Multivariate analysis was done using

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