



## Musculoskeletal problems and ergonomic risk assessment in rubber tappers: A community-based study in southern Thailand

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### ABSTRACT

This study aimed to evaluate the prevalence of musculoskeletal disorders and ergonomic risk levels, and identify ergonomic factors related to low back pain in rubber tappers. A cross-sectional survey was conducted in Chumporn Province, Southern Thailand. Subjects with a history of major trauma or certain pre-existing back disorders were excluded. A questionnaire-based interview, pain self-report form, direct observation of the workers, and a video-based analysis of working postures using the Rapid Upper Limb Assessment (RULA) method were used. Over half (52.9%) of the participants had low back pain during the previous 3 months, while the prevalence of pain in the legs, upper arms, neck, wrists, and lower arms were 14.8%, 8.9%, 3.0%, 2.3%, and 2.1%, respectively. The average final RULA grand score of 5.25 corresponded to an action level of 3, which indicated the need for prompt medical investigation and work habit changes. From logistic regression analysis, the tapping levels and tapping postures including high frequencies of twisting, bending, and extension of trunk were significantly associated with low back pain. Other independent risk factors included a high frequency of weight lifting, high perceived fatigue from work, and lower levels of social support, education and income. Rubber tapping is regarded as an occupational risk for musculoskeletal disorders (MSDs). An abnormal ergonomic factor in rubber tapping increases the risk of low back pain among rubber tappers. Preventive measures should be developed to minimize this problem in the future.

*Relevance to industry:* The results of this study suggested the need for the development and implementation of a program using ergonomic concepts to reduce low back pain for rubber tappers.

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### 1. Introduction

Musculoskeletal disorders (MSDs) are often work-related and are a major public health concern. The prevalence of MSDs varies from 15 to 42% (Hoogendoorn et al., 1999). The highest prevalence is found in unskilled laborers such as farmers (Hoogendoorn et al., 1999; Holmberg et al., 2003; Punnett et al., 2005), forest workers (Gallis, 2006), and construction workers (Kuwashima et al., 1997). On average, 31% of farmers reported having daily back pain for a week or more during the previous 12 months compared to 18.5%–28.4% in the general population (Cassidy et al., 1998; Park et al., 2001). Risk factors include physical, psychological, and socio-demographic aspects (Bongers et al., 1993; Winkel and Mathiassen,

1994; Devereux et al., 1999, 2002). Physical ergonomic factors such as the combination of load and postures (Heather and John, 2003), postural activities (Reid et al., 2010), awkward working postures (Burdorf et al., 1993; Choobineh et al., 2009; Scuffham et al., 2010), heavy weight lifting (Andersen et al., 2007; Pan and Chiou, 1999), manual materials handling (Kuiper et al., 1999; Yip, 2001; Yeung et al., 2002), prolonged periods of standing or walking (Xiang et al., 1999; Andersen et al., 2007; Balasubramanian et al., 2009), long working hours per shift (Raanaas and Anderson, 2008), trunk twisting (Sbriccoli et al., 2004; Hartman et al., 2005), repetitive movements or monotonous work (Thorbjornsson et al., 1998; Guo, 2002; Juul-Kristensen and Jensen, 2005), and poor working conditions (Saurin and de Macedo Guimaraes, 2008) are associated with MSDs, especially low back pain.

Psychological demands and social work factors for low back pain include job demands and social or co-worker support (Thorbjornsson et al., 1998; van den Heuvel et al., 2004; Larsman and Hanse, 2009; Canjuga et al., 2010). Larsman and Hanse, 2009; Canjuga et al., 2010), job satisfaction (Hoogendoorn et al., 2002;

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van den Heuvel et al., 2004), a degree of satisfaction with leisure time activities (Thorbjornsson et al., 1998; Van Nieuwenhuysse et al., 2004), night shift work (Eriksen et al., 2004), high job insecurity (Lee et al., 2008), and work stress (Oksuz, 2006).

Rubber tapping is an important occupation in Asia especially in Thailand, Indonesia, Malaysia, India, and Sri Lanka, with approximately 1.2 million workers in the southern part of Thailand in the year 2009. However, a previous report revealed that rubber tapping is a high risk occupation for developing MSDs. Rubber tappers were reported to have a high prevalence (55%) of low back pain followed by carpal tunnel syndrome (19%) (Bensa-ard et al., 2004). MSDs among rubber tappers may relate to possible ergonomic problems from working such as an awkward work posture and highly repetitive work.

Rubber tapping is the process by which natural rubber is collected. When the circumference of the tree trunk reaches 50 cm, the tapping can be begun. Normally, the tree is divided into two or three sections circumferentially. One section can be cut for about 5 years and then the next section is begun. The tapping level is usually started at a height of 150 cm above the ground and then moves down nearly to ground level and then the next part of the tree trunk is started at a level of 150 cm again. A special sharp tapping knife is used to cut the tree bark downward at a 30° angle along a left to right oblique curve that cuts through the latex vessels. In performing rubber tapping (Fig. 1.), the rubber tapper's forearm, lower arms, and wrists must maintain a degree of flexion, while the trunk posture is in a degree of forward bending and laterally twisted which depends on the height of the tapping level. This work task often involves rubber tappers being in ergonomically awkward activities, such as the repetitive tapping movement which is often repeated hundreds of times per day in awkward postures of the upper limbs, neck, trunk, and legs. These ergonomic problems may be a cause of MSDs in rubber tappers. However, our literature review shows that the ergonomic risk assessment of rubber tapping work and the association with MSDs has never been evaluated. Currently, the Rapid Upper Limb Assessment (RULA) is commonly used tool for evaluating ergonomic risk of work-related MSDs due to work posture, muscle use, and forces exerted on the upper arms, lower arms, wrists, and legs (McAtamney and Nigel Corlett, 1993; Cook and Kothiyal, 1998; Massaccesi et al., 2003; Pourmahabadian and Azam, 2006) which is linked to job characteristics and physical demand of rubber tappers.

To effectively address MSDs problems among rubber tappers, this study aimed to evaluate the prevalence of musculoskeletal disorders and ergonomic risk levels of rubber tapping postures, and also to identify ergonomic factors influencing low back pain among rubber tappers.



Fig. 1. The rubber tapping process involves repetitive trunk bending and twisting, with considerable arm exertion at the same time.

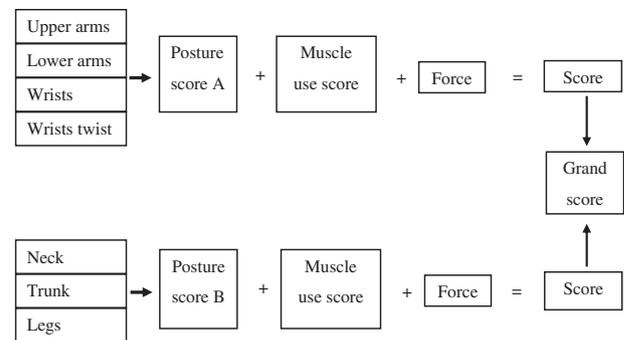


Fig. 2. The rapid upper limb assessment scoring.

## 2. Materials and methods

### 2.1. Ethics approval

This study was approved by the Ethics Committee of the Faculty of Medicine, Prince of Songkla University. An explanation of the study was given to all participants and formal signed consents were obtained before any data were collected.

### 2.2. Study setting

Due to the difficulty of data collection by video recording of the rubber tapping posture that is usually performed during the night, the study setting was selected based on the feasibility to access the data. Data collection took place in 23 villages of 3 sub-districts of Sawi District, Chumphon Province, Thailand from October 2008 to February 2009, when the work was steady.

### 2.3. Study design

A cross-sectional survey was conducted using face-to-face interviews, direct observation of the rubber tapping work and a video-based analysis of the working postures using the Rapid Upper Limb Assessment (RULA) method.

### 2.4. Study population

The study population consisted of Thai rubber tappers in Sawi District, Chumphon Province who were employed in a rubber plantation for at least one month and were between 15 and 60 years old. Participants who had any history of major back trauma such as a motor vehicle accident, sports injury, fall from height, potentially serious spinal condition including cancer, compression fracture, spinal infection, ankylosing spondylitis, spinal stenosis, herniated disc, cauda equina syndrome, drug abuse and mental disorder were excluded.

### 2.5. Sample size

Based on a previous study which reported a prevalence of low back pain among rubber tappers of 55%, with a small design effect due to systematic random sampling of 1.2 and an estimated non-response rate of 10% that is usually used for field survey, the required sample size was 502 subjects. This sample size is also enough to test the hypothesis with a significance level of 0.05 which estimates that low back pain was 45% among an abnormal ergonomic exposure group and 36% among a non-exposure group. Due to no existing study of risk factors for low back pain among rubber tappers, we estimated the prevalence of low back pain

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