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Original Article

# Relationship Between Noise-Related Risk Perception, Knowledge, and the Use of Hearing Protection Devices Among Para Rubber Wood Sawmill Workers

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ABSTRACT

*Background:* The understanding of the relationship between risk perception, knowledge, and protective behaviors could play a major role in occupational risk control and management. Research exploring how workers perceive, recognize, and react to risks in different occupational settings is scarce in Thailand. The aim of this study was to assess the relationship of noise-related risk perceptions and knowledge to the use of hearing protective devices (HPDs) among sawmill workers in Thailand.

*Methods:* Sawmill workers ($n = 540$) from four factories in Trang, Southern Thailand, participated in a questionnaire interview from December 2015 to January 2016. Descriptive statistics and linear regression models were used to explore the risk factors related to HPD use. Path diagram analysis was demonstrated and used to evaluate associations.

*Results:* Risk perception was significantly correlated with HPD use ($p < 0.01$), HPD training ($p = 0.01$), and the number of years of work experience ($p = 0.03$). Sawmill workers were likely to use HPDs based on their risk perception and HPD training. However, HPD training was inversely correlated with age and the number of years of work experience.

*Conclusion:* The study highlights the importance of risk perceptions and knowledge, and these factors should be emphasized in the design and implementation of any personal safety intervention program for sawmill workers.



## 1. Introduction

Occupational accidents, injuries, and related disabilities are significant problems among manufacturing workers in Thailand [1–3]. There are several environmental and occupational factors that influence a worker's safety behaviors and injury risk. For example, previous occupational injury is an important predictor of safety attitudes and behavior [4–6]. Workers' perceptions and knowledge of occupational health risks are rarely assessed in prevention programs for work-related injuries and disability [6]. Risk recognition and risk perception have been found to be related to occupational and environmental risks in the workplace in a number of studies [4,6,7], and risk perception and accident and injury risk have also been linked to workers' experience, safety behavior, and values and beliefs [7].

According to the protection motivation theory, workers are more likely to protect themselves when they anticipate risks and take preventive measures [6,7]. Risk perception is a predictor of safety behaviors [7,8], and the underestimation of objective risk has been shown to be proportional to the probability of accidents [8]. However, research understanding how workers perceive, recognize, and react to risks in different occupational settings is still limited [8–11], particularly in Thailand. It is important to study the different forms by which workers perceive risk and understand occupational exposures, as this appears to be an important factor in determining workplace safety [12]. Causal links among risk recognition, risk

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awareness, risk behavior, and exposure may play a major role for exposure risk control and management [13–16]. The implications of the risk preference theory for accident prevention lie in the recommendations for improving safety attitudes and safety climate in the workplace [7]. For example, workers' risk perceptions may affect the use of personal protective equipment (PPE) designed to reduce the risk of occupational illness or injury [13,14].

Improving occupational safety and work environments improves the quality of life of all employees [17]. In the Para rubber wood industry in Thailand, both governmental agencies and private organizations are focusing on the reduction of occupational hazards and risks as well as accident prevention. A cross-sectional analysis of a workers compensation claim database showed that the largest contributor to claims (26.4%) in Trang Province, Southern Thailand, was from the Para rubber logging and furniture industries [18]. Because Para rubber sheets and their related products are the most important export products of Thailand and account for 40% of the world's production, Para rubber wood industries play a vital role in Thailand's economy.

The major processes in rubber wood sawmill factories consists of six main activities: (1) logging and cutting; (2) sawing; (3) planer mills and rearranging; (4) vacuuming and wood preserving; (5) drying and planks rearranging; and (6) grading, packing, and storing. Briefly, logs are cut into the required length, then sorted and stored in dry area. In the cutting process, the logs are cut into boards by a band saw. Next, sorted sheets are sent to a vacuum tank for preservative treatment, where they were impregnated with fungicide, mainly boric and borax. After impregnation, the sheets are stored to dry prior to shipping or further processing that includes cutting, planning, laminating, and sanding.

The aim of the current study was to assess the relationship between risk perceptions, knowledge, and the use of hearing protection devices (HPDs) in the Para rubber wood sawmill processing industry in Thailand. The study used a multidimensional analysis of several variables that are considered important predictors of HPD uses and risk perceptions. In addition, risk perceptions of occupational exposure and ways of preventing it, either through avoidance or by using HPDs, were explored. This information is important to improve the prevention of occupational health hazards and to minimize occupational exposure risks in the Para wood sawmill processing industry.

## 2. Materials and methods

This study was approved by the ethics committee of Chulalongkorn University Review Board (COA No. 237/2558; research project 210.1/58). All participants received clear explanation of the study purposes and procedures prior to providing written informed consent.

### 2.1. Factory recruitment and settings

Trang Province is located in the south of Thailand and encompasses a large number of Para rubber plantations. To recruit the facilities for participation, invitation letters were sent to the managers of 20 Para rubber wood sawmills in Trang province. Four factories agreed to participate in this study. The research team visited the sites for preliminary assessment to ensure that these sampled sites had similar characteristics in terms of work environment, number of workers, working procedures, size of factories, etc. This preliminary assessment was conducted in October 2015.

In December 2015, we conducted a job safety analysis to identify, analyze, and record: (1) the steps involved in performing a specific task and job title; (2) the existing and potential safety and health hazards associated with each step; and (3) the recommended actions at each procedure that can help eliminate or minimize these hazards and the risk of a workplace injury or disability. In addition, we performed personal and environmental sampling of respirable dust and noise exposure levels, as well as pulmonary function and audiometric tests. These results are reported elsewhere [19,20].

### 2.2. Questionnaire interviews and data validation

We developed the questionnaire based on previous work by the Thai Ministry of Labor [21]. Topics explored included the workers' demographic data, smoking status, medical history, occupational background, PPE usage status and complaints at work, and risk perceptions about noise exposure. In addition, noise induced-hearing loss interview questionnaires were also collected, following the protocol of Arezes and Miguel [22].

Data collection was conducted through face-to-face interviews. To assess risk recognition and risk perception, the authors asked sawmill workers to fill in a grid consisting of several questions on different dimensions of individual perception: occupational noise exposure risk perception, perception of noise effects, outcome expectancy and value, and work safety climate and environment. The risk perception elements of the questionnaire assessed four different domains: domain 1, risk source perception (6 items); domain 2, knowledge about noise (5 items); domain 3, knowledge about hearing protection (5 items); and domain 4, HPD use (8 items).

In quantifying risk perceptions and knowledge, participants were asked to rate the degree to which they agree with the statements by using a 5-point Likert scale ranging from *strongly agree* to *strongly disagree*. These responses were later converted into a numerical code according to a predefined scale definition. Other variables included HPD use and occupational health and safety training.

This study assessed various factors contributing to HPD use. We adapted the conceptual model (Fig. 1), following Pender's health promotion model [20]. In summary, individual risk age, environmental factors, and perceptual–cognitive factors, and risk perceptions, including additional variables related to occupational exposure and the relevance in explaining HPD use, were included in our adapted model.

### 2.3. Statistical analysis

The data analyses were conducted using the statistical software package SPSS version 19 for Windows (Chicago, IL, USA). Results were considered significant where $p < 0.05$. Descriptive statistics and linear regression analyses were used to explore and describe risk factors of HPD use. Hearing loss questionnaire reliability was calculated using Cronbach's alpha for an internal item reliability. Path diagram analysis was used to explore and visualize associations between the dependent variable (HPD use) and independent variables for individual risk factors (e.g., age, hearing loss), cognitive risk factors (e.g., risk perception, noise effect perception) and environmental and other factors (e.g., noise level, HPD training). The results obtained from this analysis were used to establish and hierarchically organize the correlations among variables. In addition, using pathway diagram analysis, it is possible to estimate the effects of contributing variables in HPD use.

## 3. Results and discussion

A total of 540 sawmill workers from four factories completed the interviewer-administered questionnaire. Demographic characteristics and HPD use are shown in Table 1. More than 65% of the workers reported HPD use; usage rates were slightly higher among men (70.1%) than among women (65.2%). Regular HPD use was higher in workers with less than 1 year of working experience (74.5%) and those in the sawing department (70.2%).

There were significant differences among all factories in regard to the four domains of risk perception assessment (i.e., risk source perception, knowledge about hearing protection, and self-efficacy on HPD use) (Table 2).

The correlations between a number of factors showed significantly between risk perception and HPD use ($p < 0.01$), HPD training ($p = 0.01$), and years of work ($p = 0.03$) (Table 3). In addition, HPD use and HPD training were significantly correlated ($p = 0.01$). HPD training was correlated with age ($p = 0.03$) and hearing loss ($p < 0.01$) (Table 3). The pathway diagram showing associations between risk perception, HPD use, and individual and environmental factors was analyzed. Risk perception was positively correlated with HPD training and HPD use. HPD training was negatively correlated with age and year of work. Hearing loss was positively correlated with age and year of work.

Linear regression was used to evaluate the main predictors of HPD use. The multiple of the regression was 0.497, and the adjusted $R^2$, considering the overall number of predictors, was 0.241 ($p = 0.038$), which indicates that the final regression model included variables that accounted for 24.1% of the variability observed in HPD uses (Table 4).

A number of studies have been conducted on workers' risk perception and suggest that these perceptions may be associated with behavior with respect to hazardous sources and safety in occupational settings [8,22,23]. However, many of these studies stressed that risk perception does not directly predict behavior [22,23]. The current study showed that individual risk perception and other work environment and individual risk factors are important predictors of workers' behavior, such as using PPE (HPDs, dust masks, gloves, etc.). These results suggest that individual risk perceptions should be considered in occupational health and safety management and training programs. Further study of the relationship between training programs and risk perception and noise exposure is needed in order to elucidate some of our findings, including the fact that these perceptions may differ among young and/or less experienced workers.

**Table 1**
Demographic characteristics of Para rubber sawmill workers and HPD usage

| Variable[a] | Total ($n = 540$) | HPD use (%) | $p^*$ |
|---|---|---|---|
| Sex | | | |
| Male | 261 | 183 (70.1) | 0.23 |
| Female | 279 | 182 (65.2) | |
| Age (y) | | | |
| <25 | 143 | 98 (68.5) | 0.55 |
| 25–34 | 189 | 125 (66.1) | |
| 35–44 | 135 | 98 (72.6) | |
| >45 | 58 | 37 (63.8) | |
| Experience (y) | | | |
| <1 | 98 | 73 (74.5) | 0.31 |
| 1–5 | 234 | 159 (67.9) | |
| 5–10 | 81 | 55 (67.9) | |
| >10 | 30 | 17 (56.7) | |
| Educational background | | | |
| Primary (<6th grade) | 163 | 107 (65.6) | 0.81 |
| Secondary (<12th grade) | 208 | 143 (68.8) | |
| Higher (>12th grade) | 166 | 113 (68.1) | |
| Department | | | |
| Sawing | 141 | 99 (70.2) | 0.84 |
| Planer mills | 228 | 155 (68.0) | |
| Wood vacuum and preservative | 21 | 12 (57.1) | |
| Maintenance/forklift | 54 | 37 (68.5) | |
| Packing and storage | 28 | 18 (64.3) | |

HPD, hearing protection device.
[a] Chi-square test.
* Significant at $p < 0.05$.

Our previous study documented a number of hazardous exposures among Para rubber wood sawmill processing workers, including vibrating power tools, excessive noise, excessive heat, and wood dusts, electrical hazards, etc. [19]. Use of HPDs among the sawmill workers studied here was associated with their risk perception and HPD training. However, HPD training was slightly negatively correlated with years of experience and age, suggesting a need for continuous training and efforts to promote risk awareness among workers. Our results suggest that individual risk recognition

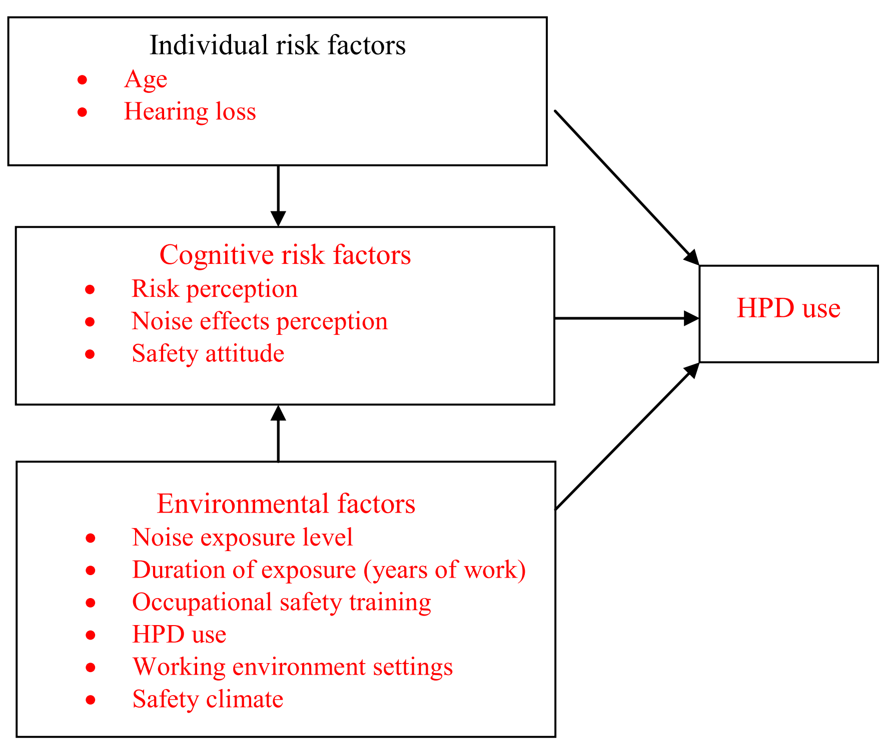


**Fig. 1.** Conceptual model for contributing predictors of hearing protection device (HPD) use in sawmills.

**Table 2**
Descriptive characteristics of noise risk perception, noise and HPD knowledge, and HPD use among Para rubber sawmill workers

| Dimension/Questions[a] | Score, mean (SD) | | | | | $p$* |
|---|---|---|---|---|---|---|
| | Total ($n = 540$) | Factory A ($n = 145$) | Factory B ($n = 244$) | Factory C ($n = 97$) | Factory D ($n = 54$) | |
| Risk perception | | | | | | |
| 1. In your opinion, how risky it is when being exposed to: (where 1 = very high risk and 5 = no risk) | | | | | | |
| 1.1 …any high-noise level, very closely | 2.6 (1.2) | 2.6 (1.3) | 2.6 (1.3) | 2.3 (0.8) | 2.7 (1.3) | <0.01* |
| 1.2 …loud music | 3.4 (1.4) | 3.7 (1.3) | 3.4 (1.4) | 2.9 (1.3) | 3.4 (1.3) | <0.01* |
| 1.3 …very noisy machines | 2.6 (1.2) | 2.7 (1.3) | 2.8 (1.3) | 2.2 (0.8) | 2.6 (1.2) | 0.01* |
| 1.4 …noisy machines in maintenance | 3.4 (1.2) | 3.6 (1.2) | 3.4 (1.3) | 2.8 (0.9) | 3.6 (1.2) | <0.01* |
| 1.5 …traffic noise | 3.4 (1.3) | 3.6 (1.1) | 3.4 (1.3) | 2.9 (1.2) | 3.6 (1.3) | 0.01* |
| 1.6 …noise with misplaced hearing protectors | 3.0 (1.4) | 3.2 (1.5) | 3.1 (1.5) | 2.4 (1.1) | 3.2 (1.4) | <0.01* |
| Knowledge about noise | | | | | | |
| 2. Do you agree with the following statements? (where 1 = strongly agree and 5 = strongly disagree) | | | | | | |
| 2.1 Exposure to high-noise levels can be dangerous for my hearing | 2.4 (1.3) | 2.6 (1.5) | 2.5 (1.4) | 2.1 (0.9) | 2.2 (1.1) | 0.01* |
| 2.2 Any high-noise level can be dangerous | 2.7 (1.3) | 3.0 (1.3) | 2.8 (1.3) | 2.3 (0.8) | 2.4 (0.9) | <0.01* |
| 2.3 It is not necessary to use HPD in my workplace | 3.4 (1.4) | 3.5 (1.4) | 3.4 (1.4) | 3.2 (1.3) | 3.5 (1.4) | 0.09 |
| 2.4 Loud noise can permanently affect my hearing | 2.6 (1.3) | 2.7 (1.4) | 2.7 (1.4) | 2.1 (0.9) | 2.3 (1.2) | 0.01* |
| 2.5 Noise in my workplace is not dangerous | 3.2 (1.4) | 3.4 (1.4) | 3.2 (1.4) | 3.1 (1.2) | 3.2 (1.5) | 0.78 |
| Knowledge about hearing protection | | | | | | |
| 3. Do you agree with the following statements? (where 1 = strongly agree and 5 = strongly disagree) | | | | | | |
| 3.1 There are several types of hearing protectors | 2.5 (1.2) | 2.6 (1.3) | 2.7 (1.3) | 2.0 (0.7) | 2.4 (1.1) | <0.01* |
| 3.2 All hearing protectors offer the same protection | 2.8 (1.2) | 3.1 (1.3) | 2.9 (1.3) | 2.3 (0.7) | 2.7 (1.1) | <0.01* |
| 3.3 The amount of protection I get depends on the duration of HPD use each day | 2.7 (1.2) | 3.1 (1.3) | 2.7 (1.2) | 2.2 (0.8) | 2.6 (1.1) | <0.01* |
| 3.4 I often avoid exposing myself to noise | 2.6 (1.2) | 2.8 (1.2) | 2.8 (1.3) | 2.1 (0.7) | 2.3 (0.9) | <0.01* |
| 3.5 It is possible to reduce noise levels in my workplace | 2.7 (1.3) | 2.8 (1.3) | 2.8 (1.4) | 2.5 (1.1) | 2.4 (1.2) | 0.02* |
| HPD use | | | | | | |
| 4. Do you agree with the following statements? (where 1 = strongly agree and 5 = strongly disagree) | | | | | | |
| 4.1 When I use HPD, I can't talk to my colleagues | 2.9 (1.1) | 3.2 (1.2) | 2.7 (1.2) | 2.9 (1.0) | 2.7 (1.1) | <0.01* |
| 4.2 HPD don't allow me to hear useful sounds | 3.0 (1.1) | 3.3 (1.1) | 2.8 (1.1) | 3.0 (0.8) | 2.7 (1.0) | <0.01* |
| 4.3 When I use HPD I feel that I'm not protected enough | 2.9 (1.1) | 3.2 (1.0) | 2.9 (1.1) | 2.7 (0.9) | 2.6 (1.0) | <0.01* |
| 4.4 I know exactly how to correctly use my HPD | 3.0 (1.1) | 3.2 (1.1) | 3.2 (1.2) | 2.4 (0.8) | 2.6 (0.8) | <0.01* |
| 4.5 I can't use always HPD as it should be used | 2.8 (1.2) | 3.0 (1.0) | 2.9 (1.2) | 2.3 (0.8) | 2.4 (0.8) | <0.01* |
| 4.6 I know the best way to use HPD | 2.9 (1.1) | 3.3 (1.0) | 2.9 (1.1) | 2.3 (0.8) | 2.6 (1.0) | <0.01* |
| 4.7 I make every effort to make sure my HPD is well fitted | 2.9 (1.1) | 3.2 (1.2) | 3.0 (1.2) | 2.4 (0.7) | 2.5 (0.9) | <0.01* |
| 4.8 I am sure that I use HPD in an efficient way | 2.8 (1.1) | 3.1 (1.2) | 2.9 (1.2) | 2.3 (0.8) | 2.5 (0.9) | <0.01* |

HPD, hearing protection device; SD, standard deviation.
[a] Chi-square test.
* Significant at $p < 0.05$.

**Table 3**
Spearman's correlation coefficient matrix between analyzed variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. Risk perception | — | 0.100 | 0.220† | 0.117† | −0.068 | −0.078 | −0.091* |
| 2. Workplace noise level | | — | 0.264* | 0.577† | 0.236* | 0.068 | 0.224* |
| 3. HPD uses | | | — | 0.148† | 0.004 | 0.048 | −0.033 |
| 4. HPD training | | | | — | −0.096* | −0.135 | −0.169† |
| 5. Age | | | | | — | 0.275† | 0.348† |
| 6. Hearing loss | | | | | | — | 0.155* |
| 7. Year of work | | | | | | | — |

HPD, hearing protection device.
* Correlation is significant at the 0.05 level (2-tailed).
† Correlation is significant at the 0.01 level (2-tailed).

**Table 4**
Linear regression model coefficients

| Model | Unstandardized coefficients | | Standardized coefficients | | |
|---|---|---|---|---|---|
| | β | SE | β | $t$ | $p$* |
| Constant | 0.93 | 0.74 | | 1.265 | 0.212 |
| Risk source perception | 0.53 | 0.19 | 0.36 | 2.781 | 0.008* |
| Knowledge about using HPD | 0.47 | 0.22 | 0.28 | 2.139 | 0.038* |

HPD, hearing protection device; SE, standard error.
* Significant at $p < 0.05$.

and risk perceptions should be considered in the design and implementation of occupational safety promotion and injury prevention programs. In addition, such programs should also make special considerations for subgroups of workers such as older and more experienced workers.

This study has several limitations that should be considered when interpreting the results. First, the generalizability of these results to other sawmill operations in Trang, or in other provinces in Thailand, is unknown because of the small number of participating sawmills. Second, several of the variables were measured using self-report measures at the same point in time. This increases the potential for common method variance accounting for some of the relations among these variables [13]. Third, the use of the self-report method to assess safety performance is particularly limiting, because participants may have been motivated to intentionally distort their responses to hide undesirable or prohibited behaviors. Despite their limitations, self-reports remain the most common method for assessing safety performance in occupational safety research [23], due in large part to the difficulty in obtaining accurate ratings from others or in directly observing employees.

In conclusion, the reduction of occupational injuries and illnesses is the ultimate goal in assessing risk perceptions among sawmill workers. Risk perception plays a crucial role for sawmill workers as a main predictor for HPD use, and suggests opportunities for increasing the effectiveness of HPD training programs, although it should be noted that other strategies from the hierarchy of controls, including the use of engineering and administrative controls, are needed in addition to HPD-based interventions. HPD-based interventions are nevertheless the interventions that can most effectively utilize and leverage workers' risk perceptions. The findings of our study could assist policy recommendations that focus on improving risk recognition and risk perception. Further study could provide a critical analysis of risk perception factors and theories to determine which are most salient for reducing risk tolerance and encouraging safer behavior.

## Conflicts of interest

The authors declare no conflicts of interest.

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