

Impact of the number of painful stimuli on life satisfaction among Korean industrial accident workers completing convalescence: dual mediating effects of self-esteem and sleeping time

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Abstract: This study examined the impact of the number of painful stimuli on life satisfaction among workers who experienced an industrial accident and investigated how self-esteem and sleeping time affected life satisfaction. The Korea Workers' Compensation & Welfare Service conducted the first nationwide panel survey on occupational health and safety insurance in 2013–2014 through a stratified systematic sampling on 2,000 industrial accident workers who completed convalescence. Based on the dataset, our study analyzed 1,832 workers experiencing an industrial accident after excluding 168 disease patients. For the research model analysis, a four-stage hierarchical regression analysis technique was applied using the SPSS regression analysis Macro program of PROCESS Procedure. To test mediated indirect effects of the self-esteem and sleeping time, the bootstrapping technique was applied. Life satisfaction, self-esteem and sleeping time decreased as the number of painful stimuli increased. Life satisfaction decreased as self-esteem and sleeping time decreased. On balance, the partial mediation model confirmed that self-esteem and sleeping time both mediate the impact of the number of painful stimuli on life satisfaction.

Key words: Industrial accidents, Pain, Self-esteem, Sleeping time, Life satisfaction

Introduction

The alleviation of pain is a key aim of medical care¹⁾, however, this goal is hampered by an incomplete understanding of the relationship between pain and the specific pathology²⁾. Pain is a common sequela affecting patient quality of life^{3, 4)}, occupational status^{5, 6)} and quality of sleep^{6, 7)}. Pain also has a high impact on the success of rehabilitation and long-term life satisfaction⁸⁾. In particular, musculoskeletal pain is one of the most predominant

types of pain, occupying a large portion of the primary care workload⁹⁾ and affecting patient from many occupation, particularly construction workers¹⁰⁾.

Life satisfaction is defined as the feeling of contentment and a lack of dissatisfaction with life overall¹¹⁾, and is generally used as an index of well-being^{12, 13)}. It has been reported that higher pain intensity considerably decreases life satisfaction¹⁴⁾ and that chronic pain is inversely proportional to life satisfaction¹⁵⁾. Similar research has supported this, stating that pain intensity of chronic musculoskeletal patients in particular is also inversely proportional to life satisfaction¹⁶⁾.

Self-esteem is defined as self-acceptance, or overall affective evaluation of self-worth¹⁶⁾. Moreover, adjust-

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ment to diseases and self-esteem will contribute to variability of the impact of pain on psychological health and well-being¹⁷). Chronic illness coexists with pain, and it is considered to be a lasting stress that provokes cognitive appraisal and provokes the coping progress^{18, 19}).

Self-esteem and life satisfaction are considered indicators of well-being^{20, 21}). Maslow's hierarchy of five basic needs posits that self-esteem should be considered before an individual arrives at the highest level of ego realization, or realization of potential²²). Low self-esteem may lead to adverse physical and mental health conditions, delinquency and low socio-economic status^{23–25}).

Alongside both self-esteem and life satisfaction, diverse instruments have been used to verify the relationship between pain and sleep disturbance^{26–28}). Industrial accident patients, who are the participants in this study, experience chronic pain due to sequelae from various accidents; chronic pain can disturb sleep, as opposed to simple pain, that is more tolerable^{29, 30}). Individually, chronic pain and chronic insomnia incur profound negative consequences for the patient. When they occur concurrently, the combined impact is likely to be magnified in terms of personal suffering and productivity loss³¹). An inter-connection study using a clinical sample reported that sleep disturbance was positively associated with pain intensity^{31, 32}).

Meanwhile, sleep disturbance has also been shown to diminish physical activity during waking hours, and pain intensity was negatively related to physical activity, and as such pain can be thought of as a predictor of limited physical activity³³). Loss of physical independence also weakens self-esteem, which in turn diminishes life satisfaction—both with their own effect on pain. As a recent similar study, Toye *et al.* have addressed the impact of cancer and lumber pain on sleep or self-esteem⁹).

A correlation between life satisfaction/self-esteem/sleeping time and pain intensity has been reported^{14, 19, 33}). Also, the relationship between repeated painful stimuli and chronic low back pain has been reported^{34–36}) as has the relationship of repeated painful stimuli and habituation of perceptual responses^{37, 38}). However, the relationship between life satisfaction/self-esteem/sleeping time and the number of painful stimuli has not yet been described.

The current study analyzes the survey data of the first year (2014) panel survey on industrial insurance, by Korea Workers' Compensation & Welfare Service. We examine the relationship between the number of painful stimuli, self-esteem, sleeping time and life satisfaction, among subjects who experienced an industrial accident. The study aimed to provide fundamental data for the improved wel-

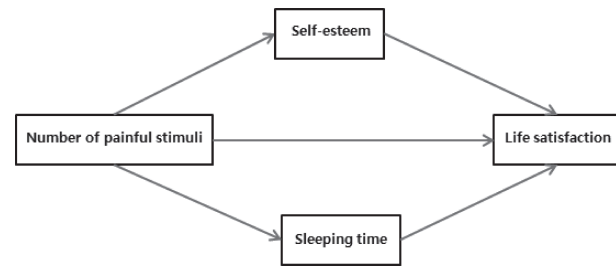


Fig. 1. Research model.

fare of industrial accident patients.

Subjects and Methods

Research model

This study investigated the impact of the number of painful stimuli on life satisfaction among workers who suffered an industrial accident and examined how the mediating factors of self-esteem and sleeping time affect life satisfaction. The number of painful stimuli was set as the predictor, self-esteem and sleeping time were set as mediating factors and life satisfaction was set as the reference variable (Fig. 1).

Analyzed data

Data from the first year of the panel survey of industrial insurance by Korea Labor Welfare Corporation was analyzed. The data was derived from 2,000 industrial accident workers nationwide in Korea who had completed convalescence. The 1,832 subjects were selected through stratified systematic sampling as a means of building fundamental statistical data for mid- and long-term policy planning and business effective evaluation of occupational health and safety insurance. Workers who also suffered from a disease were excluded.

Data on the number of painful stimuli after the industrial accident (1=none, 2=once in a while, 3=several times a week, 4=almost every day, 5=always) were used as the predictor of the number of painful stimuli. A 10-item scale of self-esteem was used³⁹). Each item was had a 4-point Likert scale (1=hardly so, 4=always so) with higher scores denoting higher self-esteem. The average daily sleeping time was used. The life satisfaction was suggested by six items of satisfaction (family income, leisure life, living environment, family relationship, relationship with relatives and social relationship with acquaintance). Each suggested had a 5-point Likert scale (1=very satisfied, 5=very unsatisfied) and was reverse coded. The average value of the six sub-levels was used. Higher scores indicated

Table 1. Demographic characteristics of subjects

Variables	Division	Persons	%	Variables	Division	Persons	%
Sex	Male	1,538	84.0	Disability	Absence	326	17.8
	Female	293	16.0		Presence	1,506	82.2
Education Level	No education	68	3.7	Convalescence period	Less than 3 month	307	16.8
	Elementary school	317	17.3		3~6 month	759	41.4
	Middle school	347	18.9		6~9 month	439	24.0
	High school	819	44.7		9 month ~1 yr	152	8.3
	More than college graduates	281	15.3		More than 1 yr	175	9.6
Age				Minimum = 17, Maximum = 76, M = 49.1, SD = 11.179			

M: mean, SD: standard deviation

Table 2. Skewness and kurtosis of variables

	Minimum	Maximum	Mean	SD	Skewness	Kurtosis
Number of painful stimuli	1	5	2.630	1.143	.608	-.594
Self-esteem	1.30	4	2.961	.443	-.224	-.210
Sleeping time	2	15	6.780	1.200	.035	1.564
Life satisfaction	1.33	5	3.245	.502	-.150	.351

M: Mean, SD: Standard deviation

Table 3. Correlation of the Variables

	Number of painful stimuli	Self-esteem	Sleeping time	Life satisfaction
Number of painful stimuli	1			
Self-esteem	-.197**	1		
Sleeping time	-.134**	.062**	1	
Life satisfaction	-.207**	.423**	.101**	1

** $p < .01$

higher life satisfaction.

Analyses

Prior to the research model analysis, frequency and percentile of the variables were checked using SPSS 20.0 software to examine the demographic characteristics of the research subjects as a basic data analysis. Descriptive statistics analyses including mean, standard deviation, standard error, skewness and kurtosis were performed to check the normal distribution of the variables included in the research model. For research model analysis, a four-stage hierarchical regression analysis technique was applied using the SPSS regression analysis Macro program of PROCESS Procedure⁴⁰. To test the indirect effect of the mediating effects of self-esteem and sleeping time, the bootstrapping technique was applied. For the verification of the significance in research process, the significance level was set at .05 for all data.

Results

Basic data analysis

Table 1 presents the demographic characteristics of the research subjects in this study.

As the linear model including regression analysis basically assumed a normal distribution of the variables, skewness and kurtosis were examined to check the normal distribution of the variables included in the research model. The absolute value of skewness and kurtosis was below 0.608 and 1.564, respectively, for all variables, which satisfied the criterion of skewness (± 3) and kurtosis (± 10)⁴¹. Therefore, it was confirmed that the normal distribution assumption was not problematic (Table 2).

Table 3 shows the correlation of variables considered in this study. Increased number of painful stimuli was related to lower self-esteem ($r = -0.197, p < .01$), less sleeping time ($r = -.134, p < .01$), and lower life satisfaction ($r = -.207, p < .01$). Self-esteem showed positive correlation with sleeping time ($r = .062, p < .01$) and life satisfac-

Table 4. Investigation of dual mediating effects of self-esteem and sleeping time in number of painful stimuli and life satisfaction

Level	Reference variable	Predicator	B	SE	β	T	Model investigation
1	Life satisfaction	Sex	-.0193	.0315	-.0141	-.6127	R=.2604 R ² =.0678 p=.0000
		Age	-.0039	.0123	-.0087	-.3150	
		Educational level	.0608	.0131	.1286	4.6293 ***	
		Convalescence period	-.0390	.0105	-.0937	-3.7285 ***	
		Presence or absence of disability	-.0046	.0320	-.0035	-.1439	
		Number of painful stimuli	-.0665	.0108	-.1514	-6.1715 ***	
2	Self-esteem	Sex	.0005	.0277	.0004	.0179	R=.2681 R ² =.0719 p=.0000
		Age	-.0111	.0108	-.0283	-1.0265	
		Educational level	.0502	.0116	.1203	4.3412 ***	
		Convalescence period	-.0488	.0092	-.1328	-5.2946 ***	
		Presence or absence of disability	.0147	.0282	.0127	.5236	
		Number of painful stimuli	-.0505	.0095	-.1303	-5.3216 ***	
3	Sleeping time	Sex	.2577	.0767	.0788	3.3604 ***	R=.1715 R ² =.0294 p=.0000
		Age	-.0169	.0300	-.0158	-.5620	
		Educational level	.0404	.0320	.0357	1.2606	
		Convalescence period	.0190	.0255	.0191	.7466	
		Presence or absence of disability	.1015	.0780	.0324	1.3014	
		Number of painful stimuli	-.1446	.0263	-.1378	-5.5029 ***	
4	Life satisfaction	Sex	-.0260	.0291	-.0190	-.8932	R=.4545 R ² =.2066 p=.0000
		Age	.0013	.0114	.0030	.1175	
		Educational level	.0382	.0122	.0807	3.1323 ***	
		Convalescence period	-.0185	.0097	-.0445	-1.9018	
		Presence or absence of disability	-.0135	.0296	-.0103	-.4576	
		Number of painful stimuli	-.0411	.0101	-.0936	-4.0713 ***	
		Self esteem	.4305	.0246	.3796	17.5175 ***	
Sleeping time	.0253	.0089	.0605	2.8576 **			

p*<.01 *p*<.001

B: unstandardized coefficient, β : standard coefficient, SE: standard error, t: t-test value

Sex: male; 1, female; 0, Presence or absence of disability: presence; 1, absence; 0

tion ($r=.423, p<.01$), and sleeping time positively correlated with life satisfaction ($r=.101, p<.01$).

Model analysis

Table 4 presents the results of the SPSS Macro analysis controlling for gender, age, education, convalescence period and existence of disability.

Analyzing the mediating effect of self-esteem and sleeping time in a relationship between number of painful stimuli and life satisfaction, the overall effect (c) of the number of painful stimuli on life satisfaction in the first stage turned out to be negative ($B=-.0665, p<.001$). That is, satisfaction decreased as the number of painful stimuli increased. In the second stage, the impact of the number of painful stimuli on self-esteem (primary mediating factor) had a negative effect as the number of painful stimuli increased ($B=-.0505, p<.001$). In other words, self-esteem decreased as the number of painful stimuli

increased. Concerning the impact of the number of painful stimuli on sleeping time (secondary mediating factor) in the third stage, a negative impact was observed following increasing number of painful stimuli ($B=-.1446, p<.001$). In other words, sleeping time decreased as the number of painful stimuli increased. In the fourth stage under the condition of controlling the number of painful stimuli, self-esteem and sleeping time respectively, self-esteem had a positive effect on life satisfaction ($B=.4305, p<.001$), and sleeping time showed a positive effect on life satisfaction ($B=.0253, p<.01$). The direct effect of the number of painful stimuli on life satisfaction was significant ($B=-.0411, p<.001$). These results indicate that self-esteem and sleeping time are partial and dual mediators in a relationship where the number of painful stimuli affects life satisfaction.

Bootstrapping test results using a sample number of 1,000 and 95% confidence interval was done to verify

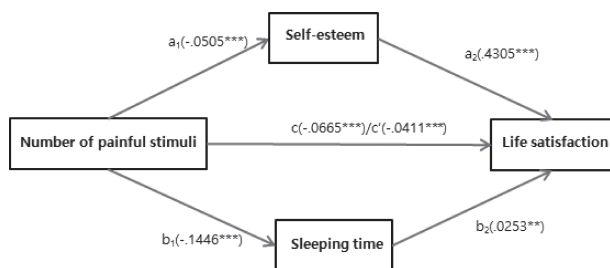
Table 5. Results of bootstrapping technique in indirect effects of self-esteem and sleeping time

Route of indirect effects	Effect coefficient	Boot. SE	95% Confidence Interval	
			Boot. LLCI	Boot. ULCI
Number of painful stimuli → Self-esteem → Life satisfaction	-.0217	.0044	-.0313	-.0135
Number of painful stimuli → Sleeping time → Life satisfaction	-.0037	.0018	-.0078	-.0007
Overall indirect effects	-.0254	.0047	-.0356	-.0166

Boot SE: Bootstrapping standard error

LLCI: lower limit of the confidence interval

ULCI: upper limit of the confidence interval

**Fig. 2. Results of model analysis.**

whether the mediating effect of self-esteem and sleeping time was statistically significant in the indirect impact of the number of painful stimuli on life satisfaction. As is shown in Table 5, upper bound and lower boundaries of every path coefficient did not contain 0 in the 95% confidence interval, implying that the mediating effects of self-esteem and sleeping time were statistically significant. That is, the increase of the number of painful stimuli had negative impact on self-esteem, and the mediating path of the lower self-esteem that in turn lowered life satisfaction was statistically significant. Moreover, the increase of the number of painful stimuli shortened sleeping time, which was a statistically significant mediator of lowered life satisfaction. The direct impact of the number of painful stimuli on life satisfaction was also significant.

The collective data confirmed the partial mediation model that included the dual mediators of self-esteem and sleeping time. Based on these results, the final model for this study was determined (Fig. 2).

Discussion

This study examined whether the number of pain stimuli directly affected life satisfaction, or whether the number of pain stimuli indirectly affected life satisfaction through self-esteem and sleeping time.

We found that life satisfaction gradually decreased, as the number of pain stimuli increased. Correspondingly,

we found that chronic pain had a large negative impact on life satisfaction. This conclusion is correspond with the large-scale Household, Income and Labour Dynamics of Australia (HILDA) survey involving 90,000 respondents, conducted in 2000⁴². Patients with chronic and non-malignant musculoskeletal pain showed lower life satisfaction compared to the general population¹⁵, consistent with the results of our study. The authors of a previous study also argued that chronic non-malignant musculoskeletal pain is related to self-care satisfaction, vocational situation satisfaction, partnership satisfaction and family and social satisfaction.

Concerning musculoskeletal and neurological injury, another study reported that chronic pain of patients with arthritis can be a contributing factor in reducing life satisfaction⁴³. Another study reported that spinal cord injury patients with pain experienced lower life satisfaction, compared to spinal cord injury patients without pain⁸. Similarly, it was shown that an increase in pain among spina bifida patients can decrease physical health and life satisfaction⁴⁴. Self-esteem decreased as the number of pain stimuli increased. That is, people who experience many episodes of pain stimuli, tend to have diminished self-esteem. With such results as those in our study, it is important to recognize that chronic pain can contribute to decrease self-esteem. We also highlight that pain sustained over several years and interferes with a personal life goal, can also have a disastrous effects on self-esteem⁴⁵, which is consistent with our study's results. Moreover, the inability to complete an education program or goals, failure or destabilization of relationships, loss of occupational or career opportunities, restrained from poor and unresponsive relationships with family and friends, inability to participate in community activities, associated cognitive difficulties and lack of financial independence, can all derive from chronic pain and all can contribute to decrease self-esteem⁴⁵. In spite of the fact that pain reduction by enhancing self-esteem has been studied⁴⁶, the medical

and social mechanisms behind pain-mediated reduction of self-esteem remained unknown. Prior research on pain and self-esteem/life satisfaction mainly investigated the change according to pain intensity. Our study has uniquely examined the change in self-esteem, sleeping time and life satisfaction, as the number of pain stimuli increased.

The present findings indicate that life satisfaction increases with higher self-esteem, which is consistent with previous reports that self-esteem positively influences life satisfaction as an intervening variable^{47, 48}). In a study using a sample of 13,118 college students across 31 countries⁴⁹), self-esteem may have a positive relationship as a predictor of life satisfaction⁵⁰), consistent with our results.

We found that sleeping time decreased as the number of pain stimuli increased. In a brainwave-related study, increased high frequency EEG activity in alpha and beta range were observed when pain stimuli were administered at the expense of slow frequency EEG activity, indicating micro-arousal induction of pain^{51, 52}). In another study, pain stimuli delivered to muscles and joints were reported to reduce delta frequency activity, and enhancing high frequency activity in the alpha, beta and sigma range⁵³). The authors concluded that the pain causes lighter sleep and diminishes the restorative effects of slow wave sleep, which is also in line with our study's results. Similarly, it has been argued that thermal nociceptive stimuli produce transient tachycardia⁵⁴) and cortical arousal without frank awakening⁵¹), in every stage of sleep. Since there is no brain wave-related data in the panel dataset that we referred to, we attempted to consider the relationship between the number of painful stimuli and sleeping time, based on existing materials by other researchers. In one such example, in a rat model of chronic pain, sustained pain was related to hyperactivity in raphe magnus pain facilitatory and inhibitory cells, and raphe magnus pain facilitated cell discharge was related to a heightened states of alertness⁵⁵). Among musculoskeletal-related clinical studies, Power *et al.* reported that pain produces substantial effects on patients with arthritis and other chronic conditions⁵⁶). Nicassio *et al.* argued that pain intensity in patients with rheumatoid arthritis is an independent predictor of the sleep disturbances⁵⁷). Similarly, other studies reported that about 42% of patients with chronic lumbar back pain experienced disturbed sleep⁵⁸), as well as identifying a close relationship between pain severity and sleep disturbance⁵⁹).

Finally, longer sleeping time indicated higher life satisfaction in our study, and the mutual interaction between pain and sleep disturbances has been shown to affect life

satisfaction under a variety of medical conditions^{60, 61}). In particular, sleep disturbances originating from chronic pain have been related to the poor quality of life^{62, 63}). Such previous works imply a positive correlation between sleep and life satisfaction, which is supported by the results of our study. As pain severely affects sleep quality, and low quality sleepers reportedly have a higher prevalence of chronic pain, pain treatment is likely to enhance sleep and life satisfaction^{59, 64}).

Conclusions

Life satisfaction and self-esteem decreased with an increase in the number of pain stimuli. Life satisfaction decreased with lowered self-esteem, implicating self-esteem as a mediating factor between the number of pain stimuli and life satisfaction. Sleeping time decreased with an increase in pain stimuli, and life satisfaction decreased with shorter sleeping time. This indicates that sleeping time is a mediating factor between the number of pain stimuli and life satisfaction. In other words, the number of pain stimuli a patient suffers directly affects life satisfaction, self-esteem and sleeping time, and life satisfaction is also indirectly influenced by self-esteem and sleeping time. Considering the multi-factorial consequences of pain, maintaining a holistic and multidisciplinary view on pain treatment becomes as important as treating the pain. Searching for ways to effectively reduce sleep disturbances for the purpose of enhancing life satisfaction is of similar importance⁸).

In conclusion, the number of painful stimuli directly affects life satisfaction and indirectly affects life satisfaction via sleeping time and self-esteem, although the effect size is tiny. An intervention that moderates the relationship is required. Concerning therapeutic strategies, medical interventions aimed at decreasing the number of painful stimuli, improving sleep environment and social psychology rehabilitation program that enhances self-esteem are required to improve life satisfaction.

The present study utilized the panel dataset collected by the Korea Workers' Compensation & Welfare Service, based on a survey of 1,832 Korean subjects, following an industrial accident and completed rehabilitation. Brainwave and physiological data could not be obtained from the panel dataset, hence part of our discussion relied on previous study's results. We introduced pain intensity related research in the Introduction and Discussion sections, since we could not find studies that related the number of painful stimuli. A future comparative analysis

of industrial accident-related data across a range of other countries^{65–67} will prove interesting. As this study is cross-sectional, a further longitudinal study may also be useful to identify causal relationships among the variables with additional clarity.

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