

## Relationship between Low Back Pain and Sleep Quality

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### Introduction

Low back pain (LBP) is a rising health care issue across the globe [1,2], effecting about 80% of the population worldwide [3,4] and imposing an economic burden of at least \$86 billion annually [5,6]. LBP is defined as discomfort in the lumbosacral region of the back that may or may not radiate to the legs, hips, and buttocks. LBP is commonly categorized as acute (6-weeks or shorter), subacute (up to 3 months) or chronic (> 3 months) stages based on the duration of symptoms. Chronic low back pain, although only accounting for 5% of individuals with LBP, represents 75% of the total treatment costs [7,8]. Chronic LBP is associated with significant physical and psychological disability and is a major cause of absenteeism from the workplace worldwide [9]. Sleep is required for normal human functioning. Animals who are deprived of sleep do not survive [10]. Sleep is vital for the proper functioning of most if not all systems including the immune, neurological and the endocrine systems [9] and is critical for cognitive function and learning. Sleep is also important for energy conservation, neuronal recuperation, synaptic homeostasis and brain plasticity [11]. Any alteration in sleep quality greatly influences the normal functions of the body. Reduced duration or quality of sleep impairs motor performance, vigilance, and cognitive abilities [12] and inhibits learning. In particular, sleep deprivation negatively impacts pain perception, functional ability, mood, and overall quality of life [13].

Restoration of sleep is reported to be strongly associated with better physical, cognitive and psychological well-being [11]. Sleep quality is often found to be compromised in individuals with LBP, specifically in chronic LBP [14-19]. As chronic LBP is found to be associated with decreased functional ability, depression, anxiety and quality of life [9-22], disturbance in sleep is also strongly associated with these symptoms [23-25]. These symptoms have also been shown to influence pain perception [21]. However, a majority of the studies do not delineate the causal relationship between sleep quality and its impact on chronic LBP [15,17]; although one study reports sleep disturbance is a risk factor for LBP in adolescent girls [26]. Only one review [15] have discussed the relationship of sleep and chronic LBP, and no review to date has examined the interrelationship of sleep quality, function, pain intensity, psychological factors, and quality of life in individuals with LBP. As poor sleep quality is a major concern among patients with chronic LBP, exploring its impact on pain, function and quality of life is critical to enable researchers in formulating guidelines for patient care and improving our knowledge of sleep disturbance in earlier stages of LBP. Hence, this article explores the impact of sleep quality on individuals with LBP in terms of perception of pain intensity, functional ability, anxiety, depression and quality of life.

Secondly, this is the first review that explores the relationship between sleep quality and LBP across acute, subacute and chronic LBP stages. Finally, the article provides scope for future clinical and research implications related to sleep and LBP in order to enhance the clinical management of LBP. Assessing and addressing sleep issues in people with LBP could have significant impact on recovery and prevention of the progression of acute and subacute LBP to chronic

LBP, which may have tremendous effect on QOL as well as economic impact.

### Relationship between Sleep Quality and Chronic LBP

It is reported that 50 to 70 percent of people with chronic LBP have compromised sleep quality [15,27]. Sleep quality can be assessed by subjective report of how restorative and undisturbed a person's sleep has been, typically using a standardized questionnaire such as the Pittsburgh Sleep Quality Index [18], and by objective measures using standard laboratory polygraphic recordings, home-based recording devices, or actigraphy. Both the subjective and objective measurements of sleep in individuals with chronic LBP reveal a strong association between sleep disturbance and LBP symptoms [15]. Abnormalities in the various dimensions of sleep associated with chronic LBP include a significant reduction in total sleep time, increased night awakenings [19], delay in onset of sleep, and difficulty maintaining sleep [19]. Due to poor sleep quality, individuals with chronic LBP experience poor daytime functioning and report an increase in daytime napping, which significantly impacts pain perception, function and quality of life [15].

#### a. Sleep and pain intensity in people with chronic LBP

Of all symptoms of LBP, pain is the main reason for seeking health care services and is most likely to be associated with sleep problems. In fact a reciprocal relationship between sleep quality and pain perception has been reported [28-30]. Though pain is frequently associated with sleep issues, sleep issues likely exacerbate pain [31]. People with sleep disturbance report increased sensitivity to pain [15], and individuals experiencing high pain intensity have reported significantly less total sleep time, delayed sleep onset, increased night time waking, and decreased sleep efficiency [18,32]. A decrease in slow-wave sleep seems to be responsible for an increased sensitivity to pain, possibly via descending inhibitory pain pathways [10]. Interestingly, improving sleep quality (with CPAP) in adults with insomnia reduced pain sensitivity [33]. The effect of chronic pain on sleep can be described as a vicious circle with mutually harmful influences between pain and sleep associated symptoms [31,34]. The impacts of poor sleep quality on pain perception is not fully understood, and the biological mechanism between sleep and pain is lacking. Evidence suggests poor sleep results in an increased concentration of cytokines and inflammatory mediators which leads to increased pain perception

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[14,35-37]. Haack and colleague (2007) first reported the relationship between reduced sleep time, increased bodily pain perception, and increased IL-6 concentration in healthy women with experimentally induced pain [35]. Heffner et al. [14] confirmed this initial finding by demonstrating that poor sleep quality is associated with increased IL-6 concentration levels and affective pain rating in individuals with chronic LBP. Lack of sleep time or quality likely interferes with the normal regulation of inflammatory mediators and immune processes which may lead to increased neuronal susceptibility and pain perception. Conversely, improving sleep quality in individuals with LBP may decrease pain intensity, possibly via regulating IL-6 concentrations, but this notion needs to be tested.

### **b. Sleep and function in people with chronic LBP**

Sleep quality also has a significant association with functional disability [18,19], although, little research has examined the impact of sleep on functional abilities in people with chronic LBP. People with functional disability due to chronic conditions such as rheumatoid arthritis (Smith, 2009) and other chronic illnesses [37] have been found to experience poor sleep quality. The negative impact on work performance or functional ability is suggested to be the result of sleep related pain modulation [13]. Specifically among individuals with chronic LBP, increased sleep period time is associated with the ability to perform activities of daily living, such as bathing, doing laundry, performing household chores, and community activities [39]. Furthermore, poor sleep quality in people with chronic LBP is also correlated with work disability [40]. Notably, improving sleep quality in adults with insomnia leads to improvement in function [41]. The mechanism of how poor sleep leads to a reduction in functional abilities is unclear, but it is likely due to the interrelationship of sleep, pain perception, fatigue, and cognitive function [34]. One review reported time spent awake after sleep initiation is negatively correlated with walking speed and self-reported function in patients suffering from osteoarthritis [42], and this correlation may be related to inflammatory cytokines i.e. IL-6 levels. However, no studies that we are aware of have examined the specific mechanisms underpinning how poor sleep quality leads to a reduction in function in individuals with chronic LBP. Future studies should confirm this finding in individuals with chronic LBP and test whether interventions aimed at improving sleep characteristics are effective in improving function via affecting circulating cytokines or other possible mechanisms.

### **c. Sleep and quality of life in people with chronic LBP**

The quality of life (QOL) of an individual is greatly influenced by sleep disturbance [43]. Sleep disturbance was negatively correlated with all domains of QOL including, physical, functional, social, and emotional well-being in people with ovarian cancer and chronic pain [25,34]. A similar correlation between sleep quality and QOL is also revealed in individuals with chronic LBP [16-18,34]. Individuals with LBP have significantly lower health-related QOL scores compared with the general population [44]. Lower sleep efficiency, increased awakenings after sleep onset, and subjective reports of poor sleep quality were reported in individuals with chronic LBP compared to healthy controls [18]. Improving sleep quality appears to improve QOL [41]. Specifically, pharmacological treatment to improve sleep quality improves perceived health, function and QOL in patients with insomnia [41]. However, the relationship between sleep quality and QOL in individuals with LBP is not well established [26] and is likely to be influenced by the interrelationship of sleep, pain, and psychological factors. Sleep interventions focusing on sleep quality are

needed to determine their impact on improving QOL in individuals with chronic LBP.

Sleep also plays an important role in the psychosocial well-being of a person. The common psychological parameters associated with poor sleep quality are depression and anxiety [2,19,24,45]. These parameters are also common issues in individuals with chronic LBP. Most studies on individuals with chronic LBP suggest that depression [15,46,47] and anxiety [48,49] are exacerbated by sleep disturbance. However, the interrelationship between sleep, pain, function and psychological parameters have not been fully investigated. Pain related psychological variables (i.e. depression, anxiety) may have a negative impact on pain via inflammatory mediators in individuals with chronic LBP. Also, poor sleep quality may modulate physiological factors that impact pain [50,51]; However, depression does not appear to explain the link between poor sleep quality and elevated IL-6 levels in people with LBP [14], suggesting that sleep disturbance associated with pain may be independent of psychological variables. Further studies are needed to explore these relationships.

### **Relationship between sleep quality and acute or sub-acute LBP**

Although the prevalence of sleep disturbance is widely studied among individuals with chronic LBP, only one study describes the prevalence of sleep disturbance among patients with acute LBP [52], and no studies have assessed sleep disturbances in individuals with subacute LBP. The lack of research on the impact of sleep in individuals with acute or subacute LBP is troubling as sleep is critical for normal body system functioning and healing. A poor understanding of sleep issues in people with acute and subacute LBP could hinder their recovery. Furthermore, because sleep disturbance has been shown to increase cytokines, it is possible that poor sleep quality in individuals with acute or subacute low back pain limits their ability to heal, increases pain perception, and can lead to the progression to chronic LBP. Therefore, much additional research on sleep quality in the various phases of LBP is necessary. Alsaadi and colleagues examined the prevalence of sleep in acute LBP and its relationship to pain intensity [52]. The authors retrospectively examined 1936 individuals who were undergoing treatment for acute LBP and indicated sleep disturbance on the Roland and Morris Disability Questionnaire, "I sleep less well because of my back". Of the individuals with acute LBP investigated, 63% stated that sleep was disturbed due to their back. Furthermore, the presence of sleep disturbance was significantly associated with pain intensity. The authors reported a 10% increase in likelihood of sleep disturbance for every one point increase in pain intensity on the Numeric Rating Scale. This study suggests that sleep disturbance may not just develop with chronicity of pain and provides strong evidence of the high prevalence of sleep disturbance in individuals with acute LBP. The prevalence of sleep disturbance may be even higher among the general population with acute LBP than reported in the study, as the study examined only those seeking care for their LBP. Therefore, research investigating the impact of sleep disturbance on the quality of life, pain perception, and recovery process in individuals with acute and subacute LBP is critical.

### **Clinical Implications and Future Directions**

The impact of poor sleep quality on the QOL, function, and recovery of individuals with LBP is a multifaceted issue. Furthermore, the interaction of these factors is understudied and poorly understood across all stages of LBP. Research findings are unclear if poor sleep quality is a cause or a consequence of LBP [17] and likely this "chicken

or the egg” depends on the individual. However, the evidence demonstrating sleep quality impacts pain perception, functional abilities, psychological parameters, and QOL in individuals with LBP highlights the significant need for the management of sleep issues in people with LBP [16,19]. More research is needed to better understand the directional influence of sleep quality on the various cofactors often experienced by individuals with LBP including pain, anxiety, and depression and how these factors together impact function and QOL. Considering the need for sleep for normal human function and the impact of sleep on pain, function, QOL, and psychological factors, the presence of sleep issues may lead to poor outcomes [52] and consequently higher economic impact with loss of work and wages. However, this relationship has not studied. Specifically, further research needs to be done focusing on the influence of sleep among different phases of LBP to understand the effect of sleep on the transition from one phase to another, as present evidence is limited to the chronic stage only. Since 95% of LBP population comprises of individuals in the acute or subacute stages, there is a critical need to assess sleep in people with acute or subacute LBP. Furthermore, based on the findings of future research, resources may need to be directed toward improving sleep quality in individuals with acute and subacute LBP. In addition the literature is lacking in guiding whether sleep quality should be part of the standard assessment in individuals with acute LBP. Finally, the mechanisms of sleep disturbance in individuals with acute pain may be different than the mechanisms leading to chronic pain and needs investigation.

Even though chronic LBP is more studied than acute or subacute LBP, a clear understanding of the impact of sleep on various dimensions such as pain intensity, anxiety, depression, functional disability and QOL still needs to be determined in individuals with chronic LBP. Routine sleep assessment and sleep hygiene education among individuals with LBP may hasten the recovery process, prevent the progress of acute or subacute LBP to chronic LBP, and may reduce the economic burden of care for individuals with LBP.

Medications used to address pain symptoms can cause sleep disturbance. Therefore, frequently reviewing medications and recommending medications that have less impact on sleep quality could also be beneficial in the management of LBP. The effects of other conservative interventions such as rehabilitation, exercise and complimentary therapies on sleep quality in individuals with LBP should also be examined.

Despite the critical need for sleep, sleep therapy is not widely accepted as a treatment modality for individuals with LBP. A recent study suggests that physiotherapy treatment may improve sleep quality in individuals with chronic LBP [29]. However, it is not known whether improving sleep quality leads to better outcomes in acute, subacute or chronic LBP. Considering the reciprocal relationship between pain, psychological variables and sleep, studies targeting sleep quality may be implemented to tease out this relationship. Further, future studies should be interpreted with caution considering the interrelationship of these important factors. One study provides evidence that managing sleep disturbance improves pain intensity in people with arthritis [53], but further studies are needed to confirm this finding in individuals with LBP. No studies have determined how sleep impacts the ability of individuals to perform their daily activities as well as their work duties in individuals with acute or subacute LBP. Given the economic burden of managing people with LBP, addressing sleep issues and poor sleep quality should be included as part of the

## Conclusion

Sleep is a basic human need and is vital for normal functioning and healing. The relationship between sleep and LBP poses a challenge among the health care personnel in treating individuals with LBP. The impact of sleep quality on LBP in relation to outcomes such as pain intensity, functional disability, anxiety, depression and QOL requires further research to delineate the relationship in order to achieve effective management. Studies to enhance sleep among individuals with LBP could serve a source of new knowledge and may widen the scope of management of patients with LBP.

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## Disclosure

The authors report no conflicts of interest in this work.

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