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Sleep Disturbances and Hip Fractures

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Abstract

Hip fractures, which remain highly prevalent among the elderly and produce enormous social and economic costs, have not truly abated in prevalence despite years of research that outlines a multitude of preventable risk factors and intervention programs. This review aimed to examine if sleep disturbances have a bearing on the risk of incurring a hip fracture directly or indirectly, among older adults. The specific aim was to explore and summarize what we know, and how this might inform future research and practice. To this end, PUBMED, Web of Science, Scopus, and Google Scholar data bases were searched to uncover available data representing the topic of sleep in relation to hip fractures among the elderly. Articles of note were scrutinized and summarized in narrative form. Results showed very few studies on the topic prevail, even with no restriction on years examined, and of these, discordant, rather than any solid uniform conclusions prevail. It is concluded there is a need to explore this topic carefully, including both the direct, as well as the indirect impact of sleep that may place an older adult at heightened risk for a fall and hip fracture injury as well as subsequent fractures.

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Introduction

The ability to sleep for an adequate time period, plus the quality of sleep encountered on a daily basis represent emergent issues of public health high import in the context of efforts to impact optimal health and wellbeing in the older population [1]. Indeed sleep disturbances, including low quality sleep, disturbed sleep, sleep debt, deficits, and sleep deprivation remain highly common health correlates, especially among the older population, even though they often go unrecognized and untreated [2]. This is noteworthy because among the many detrimental health issues associated with sleep deficits are numerous comorbid health conditions known to heighten fall risk [3], and possibly poor bone health [1], as well as falls and fall injuries that may result in one or bone fractures, especially fractures of the hip joint that impose so much excess morbidity and excess mortality rates among the elderly [4]. In turn, fractures such as those at the hip joint may lead to sleep disturbances, especially lengthy sleep durations [5] that are documented falls and hip fracture risk factors [6].

Other work indicates that even though no association between measures of bone mineral density and sleep quality or duration may exist [7], many studies have shown that those individuals who consistently experience less than eight hours of sleep may, in turn, suffer from exhaustion as well as irritability, and have less ability to concentrate. They may also be more prone to suffer from arterial disease (especially those that sleep less than four hours), which can lead to an increased falls risk. They may also exhibit higher depression and anxiety rates, perform less well functionally and suffer more accidents and injuries such as fractures due to their lowered alertness and protective reflexive abilities [1]. Unsurprisingly, Cauley et al. [4] found poor sleep quality, insomnia, and more sleep disturbances were also associated with an increased odds of recurrent falls, a potential precursor of hip fractures. Min et al. [8] further report that older adults with sleep problems and who take sleep medications show a significantly higher risk of falls than older adults with similar features who do not experience sleep problems or take sleep medications. Sleep problems were also longitudinally associated with an increased falls risk in older community based adults [9, 10].

In this regard, hip fractures among the elderly represent a widespread health condition where multiple studies have revealed the great importance of preventing this injury and limiting or eliminating an array of preventable factors that raise hip fracture risk, such as falls, as opposed to treating this condition after the fact or relying largely on pharmacologic bone building interventions among the frail elderly [11] Among these possible modifiable factors in this respect are aspects of sleep, including sleep deprivation, and the use of medications to enhance sleep [12].

Since the literature is non-conclusive in this regard, however, and efforts to prevent hip fractures, which impose enormous disability consequences in the older population [13] have not made great strides in past years, it was felt that a closer examination of this topic, was warranted, and would be helpful given the observed sleep related epidemic recently discussed, and which may be magnified among the elderly during the 2020 COVID-19 pandemic lock downs in the community and high risk of older adults living in this sphere who may be vulnerable to this lethal virus.

Ample research shows that hip fractures frequently result in premature mortality, serious morbidity among survivors, significant independence losses, and excessive re- hospitalizations/nursing home admission rates. They are also associated with enormous financial costs; high post-operative and post-discharge complications rates; and higher rates of utilization of outpatient and home help services than non-fractured controls [14, 15].

Other common hip fracture associated morbidity outcomes include decreases in:

- Life quality
- Muscle strength capacity
- Balance capacity
- Physical and global functioning
- Cognitive functioning

There may also be excessive morbidity due to:

- Related soft tissue injuries

- Fear of recurrent falls
- An increased risk of multiple falls
- A marked loss of confidence in one's ability to return to independent living
- 2nd or 3rd hip fractures [14, 18]

In this respect, two differing topics, the role of intrinsic sleep related associations, versus extrinsic factors that can modify sleep and functional response time such as sleep medication were examined.

Objectives

The key aim was to pinpoint if there is sufficient evidence to guide more focused preventive strategies against hip fractures that address the possible role of sleep in this regard.

A second aim was to advance ideas for related research and practice in this area.

Rationale

Sleep is often marred by the presence of pain, as well as physiological changes accompanying aging, such as fears and anxieties. Depression, common in older adults, can also impact sleep quality and duration. Coupled with medications that either over stimulate or produce or induce suboptimal reflex responses, likely to also be common among the older population, as well as frailty, and muscle weakness, a lack of sleep or sleep disturbances that becomes chronic may arguably be expected to heighten the risk for falling that can predate a hip fracture [16].

Recovery after a painful hip fracture and surgery may further be anticipated to interfere with sleep in some cases [17], as well being a risk factor for additional low energy fractures [18].

Sleep problems, common in normal and pathologic aging, and older adults such as various degrees of difficulty falling asleep, and remaining asleep, as well as sleep disorders such as insomnia, parasomnias, sleep apnea, and sleep-related movement disorders are likely to occur in at least 50% of the older population [2, 3]. Medical and psychiatric disorders as well as medication usage may also be expected to foster sleep disturbances as well as contributing to these problems in this group [19, 20]. Those with mild cognitive impairments and dementia may experience more severe sleep problems and disease progression that often leads to falls and fractures [21] and should probably be carefully evaluated. According to Essien et al. [6] the independent association between falls and short sleep duration and disturbed sleep among middle-aged and older adults may warrant targeting in similar populations, and has truly not been done in a concerted way to date, with the exception of efforts to limit or withdraw medications that may foster falls risk.

Methodology

To obtain some insight into this basically uncharted hip fracture associated topic and a hope that this exercise might be used to guide future practice or research recommendations or both, available research data on the current topic were intensively sought. To this end, the author relied primarily on the largest data base in the world known as PUBMED as well as Web of Science Consolidated, Scopus, and Google Scholar. No restriction was placed on year of publication, or research methodology, and the key words used were '*sleep and hip fractures*' or '*sleep deprivation/ disturbances and falls, or hip fractures*' All articles published in English that appeared to be relevant in the context of the topic of sleep health and hip fractures among older community dwelling adults were scanned and those that met these criteria are summarized in this brief review in terms of their sampling approaches, measurement procedures, and overall conclusions. With very few available studies, only a narrative summary was considered possible. Excluded were proposals, abstracts, articles focusing on young adults or athletes, hip fracture surgery issues and outcomes, nursing home based and falls prevention studies.

Results

The PUBMED data base exploration yielded 96 possible articles on the topic of sleep and hip fractures as of July 20, 2020. As with Web of Science Consolidated, Scopus, and Google Scholar most listed references in PUBMED, which were also listed in the aforementioned additional data bases were not strictly related to the current topic, even though they were categorized as representing the topic.

Among these articles, selected after very careful

review of all potential studies, and systematic reviews, one noteworthy report by Cauley et al. [4] who drew upon the Women's Health initiative to examine the degree to which sleep disturbances may influence falls and fracture incidence among 157,306 women produced several clinically important observations. Based on an annual self-report of falling, where falling two or more times was defined as "recurrent falling" during each year of follow-up, the authors modeled the resulting data using a repeated measures logistic regression model approach to investigate the association between the reported sleep disturbances and the time that elapsed before the first reported fracture. The authors further examined the risks of recurrent falls and fracture relative to sleep duration using the duration of seven hours as their referent, as well as other aspects of sleep disturbances, insomnia status, and sleep quality. The average reported follow-up time for falls was 7.6 years and 12.0 years for fractures. In their multivariable models, adjustments were made for comorbidity, medications, and physical function. Results showed that women who were defined as short sleepers (≤5 hours), along with those defined as long sleepers (≥10 hours) were found to have an increased odds of recurrent falls. The attributes of sleep quality, insomnia, and more sleep disturbances were similarly associated with a higher risk of incurring a recurrent fall. Short sleep periods were further associated with an increased risk of all fractures, but surprisingly not hip fractures. Although there was little association between other sleep characteristics and fracture occurrences in this study, it was a concluded that both short and long sleep duration and poor sleep quality are independently associated with an increased risk of recurrent falls, and in a modest way with an increased fracture risk.

In a related study by Swanson et al. [7] the authors tried to use objective measures of sleep duration to determine if this factor has any association with bone mineral density that might increase fracture risk, either directly, or more commonly subsequent to a fall. To this end, nocturnal sleep duration, assessed objectively as well as subjectively, was not independently associated with bone mineral density in the postmenopausal women who constituted the sample. Moreover, no clinically or statistically significant differences in total hip or femoral neck bone density measures were observed relative to the objectively assessed nocturnal sleep duration data after adjusting for body mass index in either dichotomized (N = 874) or continuous (N = 1624) sleep duration models or when the subjective sleep duration measures were used. When sleep duration measures included daytime naps were assessed, it was noted that the longer sleep duration was associated with a lower total hip bone mineral density outcome. The results were obtained only for post menopausal women and did not focus on hip fracture incidence or other variables that can impact bone mineral density though. It is also possible too, to fracture healthy bones, if the magnitude of a fall or related injury is sufficiently high or the falling surface is non compliant or both. Fitzpatrick et al. [12] further suggest that factors related to falls and fracture, such as fall severity or direction, may be more discriminatory predictors of hip fracture risk than osteoporosis in older women. Medications for sleep, which may have no direct or immediate bone effect may however cause balance or dizziness issues in their own right. As well, longer sleep durations over time might be expected to impact bone mineral density and muscle function unfavorably if inactivity is unduly prolonged [22].

According to Stone et al. [23], self-reported long sleep and daily napping are indeed associated with greater risk of falls and fractures in older women. Data for this conclusion were derived from a prospective cohort study of osteoporosis that included 8100 community-dwelling Caucasian women aged 69 and older (mean age 77) who had their sleep and nap habits assessed using a questionnaire at their fourth clinic visit. Fall frequency during the subsequent year was ascertained using tri-annual questionnaire. Incident hip and nonspinal fractures during six years of follow-up were confirmed using radiographic reports. Results showed 553 women suffered hip fractures, and 1,938 suffered nonspinal fractures. In multivariate models, women who reported napping daily had significantly higher odds of suffering two or more falls during the subsequent year and were more likely to suffer a hip fracture than women who did not nap daily. Those sleeping at least 10 hours/24 had a higher risk of nonspinal fracture and a similar but nonsignificant increased risk of hip fracture to those who reported sleeping between 8 and 9 hours. It was concluded that

self-reported long sleep and daily napping are associated with greater risk of falls and fractures in older women.

A contrary finding however, was that of Avidan et al. [24] who examined the relationship between insomnia, hypnotic use, falls, and hip fractures in older people through a secondary analysis of a large, longitudinal, assessment database of 437 nursing homes in Michigan, where residents were 65 years of age and older at baseline and were followed-up over a period of 150 to 210 days. Logistic regression modeled any follow-up report of fall or hip fracture with the predictors being baseline insomnia reports (previous month) and use of hypnotics (previous week). Potential confounders taken into account included standard measures of functional status, cognitive status, intensity of resource utilization, proximity to death, illness burden, numbers of medications, emergency room visits, nursing home new admission, age, and sex. Results showed hypnotic use did not predict falls. In contrast, insomnia predicted future falls, while untreated insomnia and hypnotic-treated (unresponsive) insomnia predicted more falls than the absence of insomnia. After adjustment for confounding variables, however, insomnia and hypnotic use were not associated with subsequent hip fracture, even though insomnia, but not hypnotic use, was associated with a greater risk of subsequent falls. However, it was concluded that older age, poor sleep, and the use of the "Z" sedative hypnotic drugs (for example, zopiclone, eszopiclone, zolpidem, and zaleplon) that are commonly used to promote sleep in this group, can be expected to increase the risk of falls and fractures among older adults through mechanisms related to cognitive and psychomotor impairment according to Andrade [20].

In an analogous study, Tsur et al. [25] who did not specifically assess sleep attributes specifically among 82 people, 53 women and 29 men, who fell and fractured their hip, and underwent surgery, showed that 39 cases had fallen as a result of extrinsic factors and 43 as a result of intrinsic factors. Included among the factors, both medical and non-medical that may have influenced falls were some who suffered from slight or no disturbances in attention and concentration to a modest or high degree. The role of sleep was not detailed, however.

In a further study by Rogers et al. [26] examining the role of dysregulated rest-activity rhythm patterns and falls, the later acrophase was found to be associated with a modestly greater risk of falls, but not fractures in elderly men. In this study, the authors used wrist-worn actigraphy to measure sleep rest activity attributes over 4.8 ± 0.8 24-h periods among men older than 67 years who were contacted every four months to report occurrence of falls/fractures. Logistic regression was used to estimate the likelihood of recurrent falls in the year after the visit. Proportional hazards models were used to estimate the risk (hazard ratio, HR) of fractures.

A large earlier study by Holmberg et al. [27] of 22,444 men, mean age 44 years, and 10,902 women, mean age 50 years with a follow-up of to 16 years with regard to occurrence of fracture found 135 women had one low-energy hip fracture each, and 166 in men. Among the significant predictors, were reported sleep disturbances, an observation supported by Bakken et al. [19] for adults who take drugs to reduce sleep disturbances, Kulukci et al. for older adults with chronic pain [28], and Kanis et al. [29]. As well, Yoshimura et al. [30] who conducted a prospective study among Japanese adults that examined hip fracture determinants found these to include sleep disturbance, sleeping in a Western-style bed, and drinking more than three cups of coffee daily, which could hamper sleep.

In sum, while non-conclusive there is tentative evidence in our view for the following provisional associations shown in Figure 1. that can be examined in the future.

Discussion

The very detrimental impact of sustaining one or more hip fractures, which is very common among older women and men, has been extensively studied with few emergent sound preventive approaches that can be applied on a population wide basis. Among the less well studied hip fracture determinants is sleep as a key health behaviour and outcome and the lack of attention in this regard to related research may explain the partial lack of universal success with falls prevention approaches.

This report strove to uncover what is known about this topic and whether there is support for

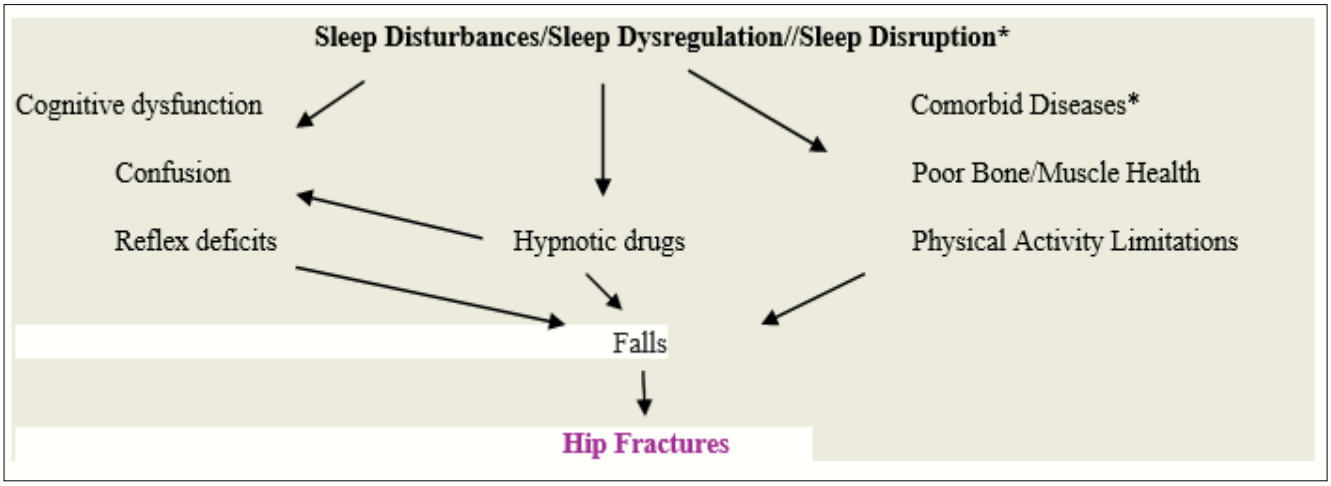

Figure 1. Possible interactive associations between sleep challenges in the older population and hip fractures and their outcomes [* predicts possible further fractures] [15, 18-20, 28]

ongoing and insightful study of this topic given the plausible linkages that have been observed between key health status indicators and sleep hygiene in various populations, including the elderly.

The aim was to identify if more specific intervention points to offset the risk of incurring disability as a result of this injury are indicated, and if so, to offer practitioners related recommendations based on the current science base. First an in-depth search of the literature using the key terms: sleep and hip fracture was conducted. Then, the results of relevant studies, which were very few in number, were analysed. All potential articles listed on the data base were first scanned for relevance, and those that focused on the topic at hand were reviewed systematically for relevant clinical data and conclusions. These data revealed hip fracture injuries may be associated in some cases with some form of sleep disturbance directly or indirectly in the older population, but that more study is needed to tease out conflicting findings, and validate potentially clinically relevant findings.

According to the data, therefore, even though there is no universal agreement, sleep disturbances, that are common in older adults, may have a bearing on the development of some fractures, if for example chronic sleep problems predispose the individual to osteoporosis and poor bone and muscle health [31], along with confusion or deficient reflex responses. Swanson et al. [7] too imply that adequate sleep is important for numerous biological processes and the functioning of several body systems including optimal bone health. Shulman et al. [17] further report that at follow-up, poor sleep is independently associated with poor emotional status, that may impact fracture healing processes, as well as general personal safety, that could have a bearing on hip fractures and their outcomes, while according to Andrade [20] drugs that are used to induce sleep where sleep problems prevail, these should be used judiciously or substituted by nonpharmacologic interventions for insomnia to avoid any potential falls or fracture risk. As well, patients prescribed Z-drugs as well as their caregivers should be apprised of the risk of falls and fractures and counseled about practical measures they can take to reduce the risk. Moreover, in light of these risks, physicians are urged to carefully consider these findings before prescribing such medications to older adults, especially those who are frail or vulnerable [32].

Since both short as well as long sleep durations appear to be significantly associated with falls [33], it is recommended that older adults be carefully questioned by their care providers about their normal average nights length of sleep, and as required, help them to understand that both too little as well as too much sleep can prove equally problematic in increasing falls and fracture risk. The number of days in the week where poor sleep is evident should also be examined, as the

falls risk increases with number of sleep related days reported [6]. Min et al. [8] report that even if the association between sleep problems and risk of falls among the elderly are conflicting, some specific sleep problems such as extremely short sleep duration, daytime sleepiness and naps do appear to be significantly related to falls in a sufficient number of older adults, hence careful assessment of any sleep issue, followed by non pharmacologic tailored interventions appears warranted. The identification of sleep disturbances, for example those due to pain, may especially help identify high-risk elders who may benefit from fall prevention education [9].

In the meantime, since sleep problems are approaching epidemic levels, and falls and fractures among the elderly remain serious impediments to a high life quality, more carefully designed research that can reliably assess sleep as well as sleep components and their association with various form of hip fracture, plus clarification of discrepancies in the literature are strongly advocated and encouraged. The use of apps to track sleep issues, and/or falls events, as well as health status, which was not found in any clinical study presently reviewed may be one way of garnering more insightful individual data.

As outlined by Widera [34], far greater attention should be paid to the palliation of sleeping difficulties in the older adult, not only to improve life quality, but also to reduce their chances of incurring injurious falls and disabling fractures.

- In the interim, attributes needing clarification in future research in this regard are role of: Daytime sleepiness*
- Naps*
- Sleep duration*
- Sleep quality Sleep
- Disorders Sleep
- Disturbances Sleep
- Debt
- Sleep fragmentation
- [* established correlates of falls in the elderly][36]

Plus the possible predictive, moderating, or mediating role of:

- Age
- Comorbid status
- Depression
- Gender
- Medications
- Pain

Attention to instrumentation that is not reliant on memory or subjective reports is strongly urged.

Conclusion

In addition to suffering from falls and hip fractures at high rates, older adults who incur one or more sleep disruptions on a consistent basis, are more likely than not to be at higher risk for injurious falls, and possible hip fractures than those who have consistently adequate periods of quality sleep.

However, despite years of hip fracture research, support for efforts to focus on sleep hygiene in preventive efforts are very few and far between, even though more data than not imply sleep disturbances that are longstanding may be overlooked, but important hip fracture determinants.

More effort to establish the range of sleep issues that can impact hip fracture risk and that can adequately test the relationships depicted in Figure 1 over protracted time periods, will undoubtedly help meantime to reduce the chances of an older adult dying from this injury [35] and possibly sustaining further fractures or poor health due to sleep challenges associated with hip fracture recovery and is strongly encouraged.

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N/A

Conflicts of Interest

None

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