



## CLINICAL REVIEW

## The effect of working on-call on stress physiology and sleep: A systematic review



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## SUMMARY

On-call work is becoming an increasingly common work pattern, yet the human impacts of this type of work are not well established. Given the likelihood of calls to occur outside regular work hours, it is important to consider the potential impact of working on-call on stress physiology and sleep. The aims of this review were to collate and evaluate evidence on the effects of working on-call from home on stress physiology and sleep. A systematic search of Ebsco Host, Embase, Web of Science, Scopus and ScienceDirect was conducted. Search terms included: *on-call*, *on call*, *standby*, *sleep*, *cortisol*, *heart rate*, *adrenaline*, *noradrenaline*, *nor-adrenaline*, *epinephrine*, *norepinephrine*, *nor-epinephrine*, *salivary alpha amylase* and *alpha amylase*. Eight studies met the inclusion criteria, with only one study investigating the effect of working on-call from home on stress physiology. All eight studies investigated the effect of working on-call from home on sleep. Working on-call from home appears to adversely affect sleep quantity, and in most cases, sleep quality. However, studies did not differentiate between night's on-call from home with and without calls. Data examining the effect of working on-call from home on stress physiology were not sufficient to draw meaningful conclusions.

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## Introduction

Prolonged and irregular work hours are becoming increasingly common in modern society [1–4]. Although there is a large body of research investigating irregular work patterns, such as shift work, one form of irregular work scheduling that has received relatively limited attention to date is ‘on-call’ (or standby) work [5]. During on-call periods, workers must be available at short notice, and are often called to work outside ‘regular hours’ [6]. This type of

scheduling is typically used to provide 24-hour coverage, seven days a week and is utilised when the workload is such that there is no need for personnel to be ‘present’ for an entire shift [5]. Recent data show that approximately 25% of the Australian workforce [7], 50% of German organisations [8] and 20% of the European Union [2] regularly operate with on-call or standby as part of their normal work schedule.

On-call work scheduling varies between occupations, with two main types defined in the literature [5]. One form is where employees remain on site whilst on-call and are usually provided a place to sleep [5,9,10]. Studies have investigated the effect of working on-call on site in doctors [11–13], ships' engineers [14], railroad engineers [15], medical helicopter pilots [4], and salaried firefighters [16]. In the second form of on-call work, employees are able to leave their place of employment and are called if required [5,6,17]. For brevity, this form of on-call work will be termed ‘on-call from home’ in this review, although it should be noted that personnel may not be physically at home whilst on-call, and may in fact be at a site of other employment. This form of on-call work is

*Abbreviations:* EPHP, effective public health practice project; PRISMA, preferred reporting items for systematic reviews and meta-analyses; SD, standard deviation.

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particularly relevant to fire and emergency service workers [17] and maintenance utility workers [18,19], as well as some doctors [20–23], nurses [24] and midwives [5]. This second form of on-call work is the focus of this review.

Although on-call from home scheduling is less expensive for employers than providing full shift coverage on site, it may still come at a human cost [25]. Given that on-call work occurs ‘around the clock’, it is likely that sleep and circadian disruptions occur in populations working on-call from home. One inherent difference between on-call work and other forms of shift work is the unpredictability of when a call may occur. This unpredictability poses a unique work environment that is not faced by those working set shifts and has been identified as a factor that may inhibit workers’ ability to “switch off” and attain a cognitive distance from work when on-call from home [6,17]. This has the potential to affect the lives of on-call workers by adversely impacting on their family time, social life and stress levels [5,17,25,26], and consequently, further disrupting their sleep.

Several studies have shown that being on-call from home results in higher subjective stress levels than when not on-call [6,27–31]. For example, Sutherland and Cooper [31] showed that doctors found night calls and interruption to family life highly stressful. Similarly, French et al. [28] found that doctors’ subjective stress levels were higher when on-call than when off duty and Rout [30] discovered that the uncertainty of being on-call and the on-call commitment was a source of unhappiness for on-call doctors. It is possible that the uncertainty associated with the unpredictability of calls may increase physiological stress. Repeated exposure to elevated physiological stress could ultimately impair the health of on-call workers. When a stressor occurs, two main physiological stress systems are activated: the sympatho-adrenal medullary system and the hypothalamo-pituitary adrenal axis [32,33]. If the stressor is prolonged, repeated or uncontrollable the physiological stress response may become inadequate, and ultimately, result in adverse health problems [34,35]. For example, stress-induced cortisol dysregulation has been positively associated clinical depression [36,37], cardiovascular disease [38,39], type 2 diabetes and stroke [34], and dysregulation of the sympatho-adrenal medullary system has been positively associated with asthma [40] and atherosclerosis [41]. Therefore, it is important to establish whether the sympatho-adrenal medullary system and/or the hypothalamo-pituitary adrenal axis are affected when working on-call from home.

Calls may occur at any time of the day or night, and have the potential to impact sleep (Fig. 1). The curtailment and/or interruption of sleep may potentially affect the safety of on-call workers.

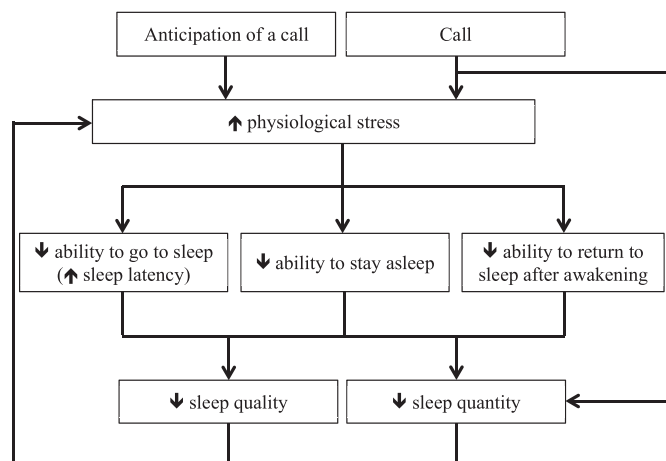


Fig. 1. Schematic representation of the proposed relationship between stress physiology and sleep when working on-call from home. ↑ = increase; ↓ = decrease.

Research shows that a reduction in sleep of just 30 min per night may result in acute performance decrements, such as a slower reaction time and reduced vigilance over time [42]. Furthermore, chronic sleep deprivation and sleep restriction have been shown to have adverse effects on health. Deleterious effects include increased neurobehavioral deficits, blood pressure, body mass index and obesity, adverse cardiovascular events, elevated inflammatory markers and impaired glucose tolerance [43,44]. Consequently, it is important to understand the effect of working on-call from home on sleep.

Studies investigating performance during/following on-call from home provide further evidence for why this topic is important. A retrospective analysis by Benson et al. [45], demonstrated significantly lower adenoma detection rates in procedures performed by gastroenterologists who had been “called in” (we assume on-call from home) for emergency procedures the previous night, compared to when procedures were performed by gastroenterologists who had not been on-call the previous night. Another study, not specifically investigating on-call work, found that there were more complications in cases the day after a night with a sleep opportunity of 6 h or less compared to when doctors had a sleep opportunity of more than 6 h [46]. Although measurement of performance is outside the scope of this review, this research highlights why it is important to understand the sleep and stress of workers operating on-call from home.

There is some evidence to suggest that there is a bidirectional interaction between sleep and stress physiology [47,48]. A review of the interaction between stress and sleep suggests that hyperactivity of the hypothalamo-pituitary adrenal axis can result in sleep fragmentation, decreased slow wave sleep and reduced total sleep time [49]. Sleep disturbances may also contribute to hypothalamo-pituitary adrenal axis dysfunction [49]. Several studies investigating the effect of working on-call on site have shown that sleep is adversely affected prior to a call occurring [14,50–52]. It has been purported that the poorer sleep is due to the stress or anticipation of a call [6,14,17,50,51]. We contend that a similar relationship exists between sleep and stress when operating on-call from home (Fig. 1). Other external factors such as wakefulness at inappropriate biological times, may disturb the synchrony of the circadian rhythm and result in impaired cognitive function [53,54]. However, these factors are outside the scope of the review and are not included in the model.

Given, the potential interaction between sleep and stress and the possible adverse health and safety outcomes that could occur as the results of on-call work, it is important to establish whether working on-call from home is detrimental to stress physiology and sleep. To this end, this review systematically critiqued previous research investigating the effect of working on-call from home on the stress physiology and sleep of workers. Describing the evidence-base for the consequences of this increasingly prevalent work schedule will help to inform on-call practices and the health and safety systems that support on-call workers.

## Methodology

### Search strategy

This review was informed by the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement [55]. A systematic search of the electronic databases Ebsco Host (searching Academic Search Complete, CINAHL, MEDLINE Complete, Psychology and Behavioral Sciences, PsycINFO and SPORTDiscus), Embase, Web of Science, Scopus and ScienceDirect was used to identify relevant English-language peer-reviewed studies published between January 1960 and April 2015. The key words used for the

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