



# Reducing health disparities: the role of sleep deficiency and sleep disorders



Aaron D. Laposky<sup>a,\*</sup>, Eve Van Cauter<sup>b</sup>, Ana V. Diez-Roux<sup>c</sup>

<sup>a</sup> National Heart, Lung and Blood Institute, National Institutes of Health, 6701 Rockledge Drive, Suite 10042, Bethesda, MD 20892-7952, USA

<sup>b</sup> Department of Medicine, University of Chicago, 5841 South Maryland Ave, MC 6092, Chicago, IL 60637, USA

<sup>c</sup> School of Public Health, Drexel University, 3215 Market St., Philadelphia, PA 19104, USA

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## ABSTRACT

Decrements in sleep health, including insufficient sleep duration, irregular timing of sleep, poor sleep quality, and sleep/circadian disorders, are widespread in modern society and are associated with an array of disease risks and outcomes, including those contributing to health disparities (eg, cardiovascular disease, obesity and diabetes, psychiatric illness, and cancer). Recent findings have uncovered racial/ethnic and socioeconomic position differences in sleep health; however, the contribution of sleep deficiency to health disparities remains largely unexplored, and understanding the underlying causes of disparities in sleep health is only beginning to emerge. In 2011, the National Heart, Lung, and Blood Institute (NHLBI) convened a workshop, bringing together sleep and health disparities investigators, to identify research gaps and opportunities to advance sleep and health disparities science. This article provides a brief background and rationale for the workshop, and it disseminates the research recommendations and priorities resulting from the working group discussions.

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## 1. Sleep and health disparities science: emerging opportunities

Eliminating disparities in health by race or ethnicity and socioeconomic position (SEP) remains a fundamental societal challenge. A more complete understanding of the underlying drivers of disparities in health is needed to inform prevention and intervention strategies. The determinants of health disparities include social, environmental, behavioral, and biological factors [1]. Despite abundant research, there is still uncertainty regarding the underlying causes of many health disparities.

Sleep deficiency, which includes insufficient sleep duration, irregular timing of sleep, poor sleep quality, and sleep/circadian disorders, is highly prevalent in modern society. Nearly 30% of men and women and 60% of adolescents fail to obtain sufficient amounts of sleep [2,3], 20% of adults experience excessive daytime sleepiness [4], 5–25% of adults meet objective criteria for sleep-disordered breathing (SDB) [5], 20–30% report insomnia symptoms [6], and nearly one-third of the US workforce is engaged in shift work [7]. The significance of compromised sleep and undiagnosed sleep disorders is underscored by decades of scientific findings associating sleep

deficiency with increased disease risk, including cardiovascular and metabolic disease [8–10], psychiatric illness [11], substance abuse [12], pregnancy complications [13], and impaired neurobehavioral and cognitive impairment [14]. Sleep deficiency is also a well-recognized threat to public safety [15]. These domains of health associated with sleep deficiency are also the ones in which health disparities are well documented, raising important questions about the significance of sleep deficiency as a driver of health disparities.

Recent findings from population-based surveys, including the National Health and Nutrition Examination Survey (NHANES), Behavioral Risk Factor Surveillance System (BRFSS), and National Health Interview Survey (NHIS), have uncovered disparities in habitual self-reported sleep duration, insufficient sleep and daytime sleepiness, and symptoms of SDB by race/ethnicity and a variety of SEP-related indicators (eg, income, education, neighborhood factors, and profession) [3,16–18]. While the majority of research has focused on describing differences in sleep across racial/ethnic groups and SEP strata, the underlying factors contributing to disparities in sleep health are not well understood. This delineation will likely require consideration of interactions among multilevel factors, and it will be critical in identifying modifiable factors for intervention strategies to reduce disparities in sleep health. For example, occupational and psychosocial stress, level of acculturation, neighborhood conditions, work–life balance, comorbid medical conditions, cultural beliefs, and knowledge regarding sleep may all contribute to racial/ethnic differences in sleep [19–21]. Most findings from population-based surveillance tools are based on self-reported sleep

\* Corresponding author. National Institutes of Health, National Heart Lung and Blood Institute, 6701 Rockledge Drive, Suite 10042, Bethesda, MD 20892 7952, USA. Tel.: +1 301 435 0193; fax: +1 301 480 3451.

E-mail address: [laposkya@nhlbi.nih.gov](mailto:laposkya@nhlbi.nih.gov) (A.D. Laposky).

characteristics and symptoms, raising the possibility that cultural differences in reporting health information could account, in part, for some of the disparities identified in sleep health. A future direction for sleep and circadian science will be to develop biomarkers and point-of-care technologies for efficient and high-throughput detection of sleep deficiency and sleep disorders. The application of mobile technologies in surveillance and cohort studies may provide a greater opportunity to obtain objective measurements of sleep duration, circadian alignment, and sleep disorders (eg, sleep apnea) at the population-based level. The inclusion of objective measures of sleep duration, timing, quality, and sleep disorders in surveillance programs and diversity cohorts will provide another level of understanding of disparities in sleep phenotypes and the relationship to disparities in disease risk.

Shift work is consistently associated with multiple health risks [22], and discoveries in basic science have uncovered a direct interface between circadian clock genes and molecular pathways implicated in disease pathophysiology [23–26]. A few studies have examined circadian phenotypes and circadian-related health risks across racial/ethnic groups. In one study, the endogenous circadian period and the phase advancing and delaying effects of light pulses were shown to differ between African American and non-Hispanic white participants [27]. Racial/ethnic differences in the diurnal rhythm of cortisol were reported in a small sample of pre-adolescent boys and girls [28]. Studies have shown a higher prevalence of non-dipping blood pressure in African Americans, which has been associated with an increased risk of cardiovascular morbidity [29,30]. Delineating the cause of racial/ethnic differences in circadian rhythm perturbation represents a novel and potentially important domain for health disparities research.

In addition to characterizing racial/ethnic differences in sleep health and the underlying contributing factors, another opportunity for research is to examine sleep deficiency as a driver of health disparities (eg, cardiovascular disease, obesity and diabetes, and mental illness). Studies that specifically identify the extent to which health disparities in various health outcomes are directly attributable to disparities in sleep health are needed. It is also possible that the impact of sleep deficiencies on health outcomes is modified by race/ethnicity or SEP. Findings from the Coronary Artery Risk Development in Young Adults (CARDIA) cohort revealed an interaction between sleep duration measured by wrist actigraphy and race/ethnicity on blood pressure change over time [31]. Racial/ethnic differences have been uncovered in the association between sleep duration and self-reported hypertension, hyperlipidemia, and diabetes mellitus, as well as objectively measured obesity and inflammatory C-reactive protein (CRP) levels [32,33]. In the NHIS study, a stronger association between short and long sleep duration and diabetes and short sleep duration and obesity was found in African American adults compared with non-Hispanic whites [34,35]. Generally, more attention has been focused on short sleep duration as an adverse exposure, but long sleep duration has also been associated with race/ethnicity, cardiovascular and metabolic disease risk, and all-cause mortality, although these relationships are less well studied and understood [36–38]. A recent study by Hale et al. found that fibrinogen partly mediated the association between long sleep duration and coronary heart disease and mortality in women; however, few studies have examined pathophysiology linking long sleep duration to disease risk or outcomes [39]. Compared to short sleep, it may be less intuitive that long sleep could induce pathophysiology or modify disease risk, rather than representing a marker or consequence of an underlying or comorbid condition. Nonetheless, the U-shaped association between sleep duration and disease risk deserves further consideration, including the interaction with race/ethnicity and health disparities. Sleep apnea is a serious medical condition associated with an array of cardiovascular and metabolic risk indicators and outcomes, and racial/ethnic differences in

prevalence, severity, and knowledge of sleep apnea have been reported [40]. The analysis of NHANES data revealed a stronger relationship between sleep apnea symptoms and hypertension in African American and Hispanic individuals than in non-Hispanic whites [41]. Taken together, these observations indicate that future research not only will have to identify disparities in the prevalence of sleep deficiency but also will have to more completely delineate the extent to which susceptibility to the effects of sleep deficiency differ across racial/ethnic groups and/or SEP strata, and to identify the relevant mechanisms contributing to these differences. As sleep deficiency is emerging as a potential modifiable risk factor in a range of disease conditions, understanding the interactions between sleep and race/ethnicity in shaping disease risk may ultimately improve the delivery of effective health care for sleep disorders and sleep-related conditions in minority populations.

In recent years, the National Heart, Lung, and Blood Institute (NHLBI) has supported objective assessments of sleep in cohorts including minority populations, such as the Jackson Heart Study [42], the Multi-Ethnic Study of Atherosclerosis (MESA) [43], and the Hispanic Community Health Study [44]. NHLBI supported continuous 24-h actigraphy monitoring in a recent cycle of NHANES (2011–2012), providing surrogate measures of sleep duration, quality, and timing in a representative sample of the US population. Furthermore, in 2014, an NHLBI-funded National Sleep Research Resource (NSRR) was launched for public use, representing an integrated resource of demographic, physiological, clinical, and other data from sleep-related cohorts and clinical trials, providing a potential opportunity to examine novel questions about sleep-related health disparities (<https://sleepdata.org/about>). Therefore, in addition to the available self-reported sleep data from surveillance and cohort studies, an increasing amount of objective sleep data is being produced in cohorts amenable to systematic examination of health disparities. The impact of these resources will depend on their use by the research community, and on the significance and timeliness of the scientific questions that investigators propose to study.

## 2. Workshop design and objectives

A mission of the National Institutes of Health is to identify domains of science where critical gaps in knowledge exist and where strategic planning is needed to help close these gaps. In 2011, the NHLBI convened a workshop entitled, “Reducing Health Disparities: The Role of Sleep Deficiency and Sleep Disorders.” The overarching objective of the workshop was to stimulate cross-disciplinary discussion between sleep and health disparities investigators, to elaborate a research agenda to reduce disparities in morbidity and mortality as they relate to sleep health, and to advance our scientific understanding of the role of sleep in optimizing health outcomes. The working group was charged with (1) identifying critical gaps in knowledge that need to be overcome in understanding sleep-related health disparities, (2) prioritizing opportunities for research to fundamentally improve our understanding of sleep-related health disparities, (3) identifying strategies for translation, dissemination, and application to reduce sleep-related health disparities, and (4) assessing the concept of “sleep” as a “fundamental requirement of daily living” and potential implications for future work related to health disparities. The 1.5-day workshop included sessions on (1) disparities in sleep health, (2) etiology of disparities in sleep health, (3) contributions of sleep to unexplained health disparities, and (4) diagnosis and treatment of sleep disorders in minority populations. Based on these discussions, the working group produced a set of research recommendations and priorities for sleep and health disparities research listed below. This special issue of *Sleep Medicine* originates, in part, from the scientific discussions that were catalyzed during the working group

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