Chapter 5
Sleep and Sleep Assessment Technologies

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5.1 Importance of Sleep Disorders and the Effects of Aging on Sleep

On average, we sleep about one-third of our lives. Sleep is something we do everyday; yet, it appears from the 2005 Sleep in America Poll conducted by the National Sleep Foundation (NSF) that while about 75% of Americans indicated that they have at least one symptom of a sleep disorder, the same survey indicates that 76% of Americans do not think they have a sleep problem and only 45% would report it to their doctor if they felt they had issues [1]. Although the people who voluntarily lose sleep can resolve their problem without treatment, 10–13% of Americans (30–40 million) are suffering from clinical sleep disorders that cause them to have disrupted sleep and, hence, affect their health [2]. Untreated sleep disorders lead to losses in productivity totaling around $46 billion annually in the USA, health problems including a higher risk for stroke, or even fatality, with an estimated 38,000 deaths annually attributed to complications from sleep apnea [3]. The condition of sleep apnea, or more broadly sleep-disordered breathing (SDB), is quite prevalent in the US population with at least 12 million Americans suffering from it [4] (Figure 5.1).

In 2003, the National Institutes of Health (NIH) released its latest Sleep Disorders Research Plan that outlines research to date in specific areas, but also lays out needs for additional work to be done to advance our understanding of sleep in those areas. As mentioned earlier, SDB, the most prevalent of which is obstructive sleep apnea (OSA), affects millions of Americans, and many of them do not undergo treatment because the condition remains formally undiagnosed [2]. OSA is quantified by counting events termed apneas (stoppages of breathing during sleep for at least 10 s) and hypopneas (an abnormal respiratory event with a decrease in respiratory effort...
or airflow of at least 30% that lasts for at least 10 s) that may occur only a few times an hour in normal subjects or beyond 15 times per hour [5]. The standard therapy to treat SDB uses continuous positive airway pressure (CPAP) devices that are generally composed of a mask and an air pressure system that forces the airways to stay open during sleep. These tend to be cumbersome and expensive; yet, it can be the only way a subject with severe sleep apnea might be able to consistently sleep well [2].

Researchers are beginning to find clues as to the pathogenesis and possible genetic links to the condition of OSA along with other neurological modalities that cause airways to collapse during an apnea. More research needs to be conducted in higher numbers to continue to evaluate these findings and understand more about what causes OSA and how best to treat it. The NIH suggests that current methods for measuring breathing abnormalities are cumbersome, expensive, lack predictive power, and are useless for screening large populations. To accomplish this faster, in a wider population and more natural setting, the NIH states that researchers should “develop novel non-invasive screening/diagnostic methodologies that are less expensive and more widely applicable than standard full polysomnography” [2]. To further challenge sleep studies, there is no comprehensive database that defines normal sleep–wake patterns based on age or gender. As a result, the NIH identifies a need for new methods that can non-invasively monitor sleep and respiration to quantify breathing problems and their consequences [4].