



Published in final edited form as:

*Disabil Health J.* 2020 July ; 13(3): 100887. doi:10.1016/j.dhjo.2020.100887.

## Self-reported short sleep duration among US adults by disability status and functional disability type: Results from the 2016 Behavioral Risk Factor Surveillance System

Catherine A. Okoro, MS, PhD<sup>a,\*</sup>, Elizabeth Courtney-Long, MA, MSPH<sup>b</sup>, Alissa C. Cyrus, MPH<sup>a</sup>, Guixiang Zhao, MD, PhD<sup>c</sup>, Anne G. Wheaton, PhD<sup>c</sup>

<sup>a</sup>Division of Human Development and Disability, National Center on Birth Defects and Developmental Disabilities, Centers for Disease Control and Prevention, Atlanta, GA, USA

<sup>b</sup>Office on Smoking and Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA, USA

<sup>c</sup>Division of Population Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA, USA

### Abstract

**Background:** Short sleep duration is associated with an increased risk of chronic disease and all-cause death. A better understanding of sleep disparities between people with and without disabilities can help inform interventions designed to improve sleep duration among people with disabilities.

**Objective:** To examine population-based prevalence estimates of short sleep duration by disability status and disability type among noninstitutionalized adults aged 18 years.

**Methods:** Data from the 2016 Behavioral Risk Factor Surveillance System were used to assess prevalence of short sleep duration among adults without and with disabilities (serious difficulty with cognition, hearing, mobility, or vision; any difficulty with self-care or independent living). Short sleep duration was defined as <7 h per 24-h period. We used log-binomial regression to estimate prevalence ratios (PRs) and 95% confidence intervals (CIs) while adjusting for socioeconomic and health-related characteristics.

---

\*Corresponding author. Division of Human Development and Disability Centers for Disease Control and Prevention, 4770 Buford Hwy. NE, MS S106-4, Atlanta, GA, 30341-3717, USA. cao0@cdc.gov (C.A. Okoro).

**Publisher's Disclaimer:** Disclaimer

**Publisher's Disclaimer:** The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Prior presentation

A draft form of the paper was presented as a poster presentation at the 2018 Behavioral Risk Factor Surveillance System (BRFSS) Training Workshop.

Declaration of competing interest

The authors have no conflicts of interest to report for this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.dhjo.2020.100887>.

**Results:** Adults with any disability had a higher prevalence of short sleep duration than those without disability (43.8% vs. 31.6%;  $p < .001$ ). After controlling for selected covariates, short sleep was most prevalent among adults with multiple disabilities (PR 1.40, 95% CI: 1.36–1.43), followed by adults with a single disability type (range: PR 1.13, 95% CI: 1.03–1.24 [for independent living disability] to PR 1.25, 95% CI: 1.21–1.30 [for mobility disability]) compared to adults without disability.

**Conclusions:** People with disabilities had a higher likelihood of reporting short sleep duration than those without disabilities. Assessment of sleep duration may be an important component in the provision of medical care to people with disabilities.

## Keywords

Disabilities; Sleep; Health disparities; Adults; BRFSS

---

## Introduction

Sufficient sleep (7 h or more per night for adults) is critical for optimal health and well-being.<sup>1</sup> However, recent estimates show that more than one-third of US adults typically sleep less than is recommended.<sup>2</sup> Population disparities in attaining sufficient sleep exist.<sup>2</sup> Several population-based studies have identified age, gender, race/ethnicity, and socioeconomic status disparities in short sleep duration.<sup>2–4</sup> Relatively fewer studies, however, have focused on short sleep duration by disability status e particularly by functional disability type e even though people with disabilities are more likely to experience sleep problems than people without disabilities.<sup>5–10</sup> Sleep problems have been identified as a secondary condition (i.e., a health condition that occurs after the primary disabling condition) among people with disabilities.<sup>5,6,10–14</sup> For example, evidence from population-based and clinical studies indicate that people with mobility, cognitive, hearing, and vision impairments commonly experience sleep disorders as a secondary condition.<sup>5,6,12–14</sup>

Short sleep duration has been examined among US adults using various definitions of disability.<sup>7,10</sup> In this epidemiologic study, we used the HHS six-question set to examine disparities in short sleep duration by disability status and functional disability type (hearing, vision, cognition, mobility, self-care, and independent living) using data from the 2016 Behavioral Risk Factor Surveillance System (BRFSS).<sup>15</sup> We aimed to expand the knowledge-base on this subject by comparing short sleep duration among adults by disability status, disability type, and number of disability types.

## Methods

### Survey design

The BRFSS is an ongoing, cross-sectional, state-based system of telephone health surveys of noninstitutionalized adults aged 18 years that reside in the United States. BRFSS collects data on health-related behaviors, chronic health conditions, access to health care, and use of preventive health services and practices related to the leading causes of chronic disease, injury, and death in the United States. The median survey response rate among the 50 states and the District of Columbia (DC) was 47.0% in 2016. Additional details about the 2016

BRFSS are available online (<https://www.cdc.gov/brfss/about/index.htm>). The BRFSS protocol was approved by the Centers for Disease Control and Prevention Institutional Review Board.

## Measures

To assess self-reported sleep duration, the survey used the following question: “On average, how many hours of sleep do you get in a 24-h period?” Respondents reported the number of hours in integers. This question has been widely used by other studies to provide population-based estimates of sleep duration.<sup>2,8,16</sup> We defined short sleep duration as sleeping less than 7 h,<sup>1</sup> and thereby, dichotomized sleep duration into (1) < 7 h (mean = 5.5 h) and (2) ≥ 7 h (mean = 7.8 h).

The BRFSS uses the six-question set recommended by HHS<sup>15,17</sup> to measure disability from a functional perspective consistent with the International Classification of Functioning, Disability, and Health.<sup>18</sup> Serious difficulty in hearing, vision, cognition, and mobility, and any difficulty in self-care and independent living were defined with a “yes” answer to the following questions, respectively: 1) “Are you deaf or do you have serious difficulty hearing?” (hearing disability); 2) “Are you blind or do you have serious difficulty seeing even when wearing glasses?” (vision disability); 3) “Because of a physical, mental, or emotional condition, do you have serious difficulty concentrating, remembering, or making decisions?” (cognitive disability); 4) “Do you have serious difficulty walking or climbing stairs?” (mobility disability); 5) “Do you have difficulty dressing or bathing?” (self-care disability); and 6) “Because of a physical, mental, or emotional condition, do you have difficulty doing errands alone such as visiting a doctor’s office or shopping?” (independent living disability). Respondents who answered “yes” to any of the 6 questions were defined as having a disability. Respondents who answered “no” to all 6 questions were defined as having no disability. Since disabilities often occur in combination,<sup>19</sup> particularly mobility limitations, we created two additional mutually exclusive disability measures to further examine the relationship between short sleep duration and disability: 1) A specific disability type — hearing disability only, vision disability only, cognitive disability only, mobility disability only, self-care disability only, independent living disability only, multiple disability types, and no disability and 2) A number of disability types — 1 disability type, 2 disability types, 3 disability types, 4 disability types, and no disability.

## Covariates

We included the following demographic characteristics: age, sex, and race/ethnicity. Socioeconomic characteristics included marital status, educational attainment, employment status, number of children in the household, and federal poverty level (FPL). FPL categories were determined based on the ratio of the adult’s annual household income to the appropriate simplified federal poverty threshold (given family size and number of children) defined by the 2015 U.S. Federal Poverty Guidelines.<sup>20</sup> In addition, due to their association with sleep duration,<sup>9,21</sup> we included several health-related characteristics: cigarette smoking status, leisure-time physical activity, body mass index (BMI), and frequent mental distress (FMD). The FMD measure has been validated among populations with and without disabilities in the United States and Canada.<sup>22</sup>

## Statistical analyses

In 2016, 477,665 adults aged 18 years residing in the 50 states and DC participated in the BRFSS. Respondents with missing data on sleep duration ( $n = 5,602$ ) or disability status ( $n = 18,377$ ) were excluded. We also excluded pregnant women ( $n = 2,385$ ) because of disrupted sleep patterns that can occur during pregnancy. The remaining 451,301 adults, 94.5% (318,438 adults without any of the six types of disability, and 132,863 adults with at least 1 of the 6 types of disability) were included in the study. We used SAS-callable SUDAAN software (v. 9.4, Research Triangle Institute, Research Triangle Park, NC) to account for the complex sample design of BRFSS. We calculated the weighted prevalence estimates with 95% confidence intervals (CIs) for demographic characteristics, socioeconomic characteristics, and health-related characteristics, among adults who reported having 1 or >1 disability type, among adults with any disability (1 type), and among adults without a disability. We utilized log-linear regression modeling with robust variance estimation to estimate prevalence ratios (PRs) with 95% CIs for the relative likelihood of reporting short sleep duration among respondents by disability status, by mutually exclusive disability type, and by number of functional disabilities in unadjusted and adjusted models, in comparison with adults with no disability. Statistical inferences were based on a significance level of  $P = .05$ .

## Results

Overall, 59.8 million (25.5%) adults reported any disability. The prevalence of the functional disability types, regardless of whether the respondent had a single disability type or multiple types, was 53.7% for mobility, 42.1% for cognitive, 26.4% for independent living, 23.0% for hearing, 18.0% for vision, and 14.4% for self-care. More than half (56.6%) of those with any disability had only one disability type, with most having mobility disability (36.2%), followed by cognitive disability (29.9%), and hearing disability (18.3%). Forty-three percent of persons with any disability had two or more disabilities, with most having mobility disability (76.2%) in combination with another disability type, followed by cognitive (58.0%) and independent living (54.5%). Adults with disabilities reported generally lower socioeconomic status (i.e., high school degree/GED, not being employed, living in poverty or near poverty (<200% of FPL)) and having more adverse health-related behaviors and conditions (i.e., current cigarette smoker, physically inactive, obesity, and FMD) than adults with no disability (Table 1).

Adults with any disability reported a higher prevalence of short sleep duration than adults without disabilities (43.8% vs. 31.6%;  $p < .001$ ) (Table 2). Compared to adults without disabilities, adults with 1 disability type (range: 31.9%–44.2%) and those with >1 type (49.8%) reported a higher prevalence of short sleep duration ( $p < .01$  for all, with the exception of hearing disability only).

After full adjustment for confounding variables, compared to adults with no disability, adults with a disability were 26% more likely to report short sleep duration (adjusted PR, 1.26; 95% CI, 1.23–1.29) (Table 2). In the fully-adjusted model, compared to adults with no disability, adults with independent living disability only, hearing disability only, vision disability only, cognitive disability only, self-care disability only, and mobility disability

only were 13%, 14%, 14%, 20%, 23%, and 25%, respectively, more likely to report short sleep duration ( $p < .05$ ,  $p < .001$ ,  $p < .01$ ,  $p < .001$ ,  $p < .05$ , and  $p < .001$ , respectively). Adults with multiple disability types were 40% more likely to report short sleep duration than adults without disability ( $p < .001$ ).

The relative likelihood of reporting short sleep duration increased with an increasing number of disability types. In the fully adjusted model, compared to adults without disability, adults with 1 disability type, 2 disability types, 3 disability types, and 4 disability types were 20%, 34%, 41%, and 55%, respectively, more likely to report short sleep duration (all  $p$  values  $< .001$ ) (Table 2). A significant linear association was found between an increasing number of disability types and short sleep ( $p$  value, test for linear trend  $< 0.001$ ).

## Discussion

This study used the HHS six-question set to examine disparities in short sleep duration by disability status and functional disability type in a large sample of US noninstitutionalized adults. Our results suggest that disparities in short sleep duration exist by disability status and disability type, even after controlling for demographic characteristics, socioeconomic position, and health-related characteristics. The results highlight the substantial disparity in healthy sleep duration (7 h in a 24-h period) between people with disabilities and people without disabilities and identify disability types at increased risk of short sleep duration.

The results of this study are consistent with findings of previous studies that examined associations between short sleep duration and disability status, disability types, and cognitive difficulties.<sup>7,23</sup> Similar to our findings, Shandra et al.<sup>7</sup> found a higher risk of short sleep duration among respondents with cognitive only disability, mobility only disability, or multiple disabilities compared to those with no disability. In contrast to our findings, however, sensory disability was not significantly associated with short sleep duration. Additionally, Shandra et al.<sup>7</sup> found disability-specific differences, with the magnitude of the relative risk of short sleep duration being greater for adults with cognitive disability than for adults with mobility or multiple disabilities. Again, we had slightly different findings, with the magnitude of the relative risk of short sleep duration being greater for adults with multiple disabilities than for adults with a single type of disability. These discrepant findings could be due to the differences in categorization of respondents with sensory disabilities (one category vs. separate categories for hearing and vision), the number of disability types assessed, sample size constraints, or to the different age cohorts used by each study. Additionally, cognitive testing of the HHS question used to assess cognitive disability indicated that it appears to capture a range of conditions, including mental health conditions.<sup>24</sup> In our analysis, we adjusted for FMD, which may, in part, explain our different findings on the association between short sleep duration and cognitive disability. Wheaton et al.<sup>23</sup> examined the effect of short sleep duration on performing daily tasks (e.g., difficulty concentrating, difficulty remembering things, difficulty working on hobbies) among adults aged 20 years using the 2005–2008 National Health and Nutrition Examination Survey. These researchers found that the most prevalent sleep-related difficulty was not being able to concentrate (i.e., cognition). Future research should explore the bi-directional relationship between short sleep durations and disability and specific disability types.

According to the American Academy of Sleep Medicine and Sleep Research Society,<sup>1</sup> short sleep duration is associated with a number of adverse health effects, including increased risk of heart disease, hypertension, stroke, type-2 diabetes, metabolic syndrome, depression, and obesity. While many of these diseases may be disabling,<sup>25</sup> they also rank among the top secondary conditions experienced by people with disabilities.<sup>5,6,11</sup> We found that even when controlling for such factors as cigarette smoking, leisure-time physical activity, obesity, and FMD which can be associated with unhealthy sleep durations,<sup>9,21</sup> people with disabilities remained more likely to report short sleep duration. Consequently, people with disabilities experiencing short sleep duration might be at greater risk for secondary conditions that can exacerbate their primary disabling condition and lead to higher healthcare utilization.

Our study has several limitations. First, the BRFSS telephone survey might understate the true prevalence of disability because it excludes the institutionalized population and those whose disability prevents them from answering the telephone. It is unclear whether institutionalized adults are more or less likely to have shorter sleep durations than those who are noninstitutionalized. Second, all data for disability, sleep duration, and confounders are self-reported. Thus, these data are subject to recall and social desirability biases. Third, although we adjusted for several confounders in our analyses, we were unable to examine other factors associated with sleep duration or disability, such as medication use and pain levels. Finally, BRFSS is a cross-sectional survey, thus it was beyond the scope of this analysis to characterize any causality between short sleep duration and disability.

## Conclusions

In conclusion, we found that people with disabilities had a higher likelihood of short sleep duration than people without disabilities, and the magnitude of the associations between short sleep duration and disability varied by functional disability type. Based on recent sleep recommendations for optimal health, functioning, and well-being,<sup>1</sup> these findings suggest an estimated 26.2 million US adults with disabilities (44%) sleep less than recommended for healthy adults. An opportunity to improve sleep health among people with disabilities exists in the clinical setting where routine assessment of sleep duration and, if needed, referrals to sleep specialists, could be integrated into the provision of medical care. One in four noninstitutionalized US adults has a disability and this population experiences substantial health inequities.<sup>26</sup> It is important that public health efforts to improve healthy sleep durations among the US population are inclusive of people with disabilities in order to reduce the health burden associated with unhealthy sleep durations.

## Acknowledgments

State BRFSS coordinators, CDC Population Health Surveillance Branch, Division of Population Health, and CDC Disability and Health Promotion Branch, Division of Human Development and Disability.

Statement of funding

No funding was received for this study.

## References

1. Watson NF, Badr MS, Belenky G, et al. Joint consensus statement of the American Academy of Sleep Medicine and Sleep Research Society on the recommended amount of sleep for a healthy adult: methodology and discussion. *Sleep*. 2015;38:1161–1183. 10.5665/sleep.4886. [PubMed: 26194576]
2. Liu Y, Wheaton AG, Chapman DP, Cunningham TJ, Lu H, Croft JB. Prevalence of healthy sleep duration among adults—United States, 2014. *MMWR Morb Mortal Wkly Rep*. 2016;65:137–141. 10.15585/mmwr.mm6506a1. [PubMed: 26890214]
3. Grandner MA, Williams NJ, Knutson KL, Roberts D, Jean-Louis G. Sleep disparity, race/ethnicity, and socioeconomic position. *Sleep Med*. 2016;18: 7–18. 10.1016/j.sleep.2015.01.020. [PubMed: 26431755]
4. Xiao Q, Hale L. Neighborhood socioeconomic status, sleep duration, and napping in middle-to-old aged US men and women. *Sleep*. 2018;41 10.1093/sleep/zsy076.
5. Kinne S, Patrick DL, Doyle DL. Prevalence of secondary conditions among people with disabilities. *Am J Publ Health*. 2004;94:443–445.
6. Nosek MA, Hughes RB, Petersen NJ, et al. Secondary conditions in a community-based sample of women with physical disabilities over a 1-year period. *Arch Phys Med Rehabil*. 2006;87:320–327. 10.1016/j.apmr.2005.11.003. [PubMed: 16500164]
7. Shandra CL, Kruger A, Hale L. Disability and sleep duration: evidence from the American time use survey. *Disabil Health J*. 2014;7:325–334. 10.1016/j.dhjo.2014.02.002. [PubMed: 24947574]
8. Brimah P, Oulds F, Olafiranye O, et al. Sleep duration and reported functional capacity among black and white US adults. *J Clin Sleep Med*. 2013;9:605–609. 10.5664/jcsm.2762. [PubMed: 23772195]
9. Krueger PM, Friedman EM. Sleep duration in the United States: a cross-sectional population-based study. *Am J Epidemiol*. 2009;169:1052–1063. 10.1093/aje/kwp023. [PubMed: 19299406]
10. van de Wouw E, Evenhuis HM, Echteld MA. Prevalence, associated factors and treatment of sleep problems in adults with intellectual disability: a systematic review. *Res Dev Disabil*. 2012;33:1310–1332. 10.1016/j.ridd.2012.03.003. [PubMed: 22502859]
11. Turk MA. Secondary conditions and disability In: Field MJ, Jette AM, Martin L, eds. *Workshop on Disability in America: A New Look*. Washington, D.C.: The National Academies Press; 2006:185–193. <https://www.nap.edu/read/11579/chapter/13>. Accessed October 17, 2019.
12. Kinne S Distribution of secondary medical problems, impairments, and participation limitations among adults with disabilities and their relationship to health and other outcomes. *Disabil Health J*. 2008;1:42–50. 10.1016/j.dhjo.2007.11.006. [PubMed: 21122710]
13. Skene DJ, Arendt J. Circadian rhythm sleep disorders in the blind and their treatment with melatonin. *Sleep Med*. 2007;8:651–655. 10.1016/j.sleep.2006.11.013. [PubMed: 17420154]
14. Dalton DS, Cruickshanks KJ, Klein BE, Klein R, Wiley TL, Nondahl DM. The impact of hearing loss on quality of life in older adults. *Gerontol*. 2003;43: 661–668.
15. Office of the Assistant Secretary for Planning and Evaluation. U.S. Department of Health and Human Services Implementation Guidance on Data Collection Standards for Race, Ethnicity, Sex, Primary Language, and Disability Status. Washington, DC: US Department of Health and Human Services; 2011:1–10. <http://aspe.hhs.gov/dataacncl/standards/ACA/4302>. Accessed October 17, 2019.
16. Ford ES, Cunningham TJ, Croft JB. Trends in self-reported sleep duration among US adults from 1985 to 2012. *Sleep*. 2015;38:829–832. 10.5665/sleep.4684. [PubMed: 25669182]
17. Division on Human Development and Disability, National Center on Birth Defects and Developmental Disabilities. *A Data Users' Guide to the Disability Questions Included in the Behavioral Risk Factor Surveillance System*. vol. 2018 Atlanta, GA: Centers for Disease Control and Prevention; 2018:1–8. [https://www.cdc.gov/brfss/data\\_documentation/pdf/BRFSS\\_Data\\_Users\\_Guide\\_on\\_Disability\\_Questions\\_2018-508.pdf](https://www.cdc.gov/brfss/data_documentation/pdf/BRFSS_Data_Users_Guide_on_Disability_Questions_2018-508.pdf). Accessed October 17, 2019.
18. World Health Organization. *International Classification of Functioning, Disability, and Health (ICF)*. Geneva, Switzerland: World Health Organization; 2001.

19. Stevens AC, Carroll DD, Courtney-Long EA, et al. Adults with one or more functional disabilities - United States, 2011–2014. *MMWR Morb Mortal Wkly Rep.* 2016;65:1021–1025. 10.15585/mmwr.mm6538a1. [PubMed: 27684532]
20. Poverty Guidelines. Office of the Assistant Secretary for Planning and Evaluation. Washington, DC: U.S. Department of Health and Human Services; 2015, 2015 <https://aspe.hhs.gov/2015-poverty-guidelines>. Accessed October 17, 2019.
21. Liu Y, Wheaton AG, Chapman DP, Croft JB. Sleep duration and chronic diseases among U.S. adults age 45 years and older: evidence from the 2010 Behavioral Risk Factor Surveillance System. *Sleep.* 2013;36:1421–1427. 10.5665/sleep.3028. [PubMed: 24082301]
22. Centers for Disease Control and Prevention. Measuring Healthy Days: Population Assessment of Health-Related Quality of Life. Atlanta, GA: Centers for Disease Control and Prevention, U.S. Department of Health and Human Services; 2000: 1–40. <https://www.cdc.gov/hrqol/pdfs/mhd.pdf>. Accessed October 17, 2019.
23. Wheaton AG, Liu Y, Perry GS, Croft JB. Effect of short sleep duration on daily activities—United States, 2005–2008. *MMWR Morb Mortal Wkly Rep.* 2011;60: 239–242. [PubMed: 21368739]
24. Miller K, DeMaio DJ. Report of Cognitive Research on Proposed American Community Survey Disability Questions. Washington, DC: National Center for Health Statistics, U.S. Census Bureau; 2006:1–33. <https://www.census.gov/library/working-papers/2006/adrm/ssm2006-06.html>. Accessed October 17, 2019.
25. Theis K, Steinweg A, Helmick C, Courtney-Long E, Bolen J, Lee R. Which one? What kind? How many? Types, causes, and prevalence of disability among U.S. adults. *Disabil Health J.* 2019;12:411–421. 10.1016/j.dhjo.2019.03.001. [PubMed: 31000498]
26. Okoro CA, Hollis ND, Cyrus AC, Griffin-Blake S. Prevalence of disabilities and health care access by disability status and type among adults - United States, 2016. *MMWR Morb Mortal Wkly Rep.* 2018;67:882–887. 10.15585/mmwr.mm6732a3. [PubMed: 30114005]



Weighted prevalence (95% CI) of selected characteristics among adults by type of functional disability and disability status (n = 451,301; N = 234,655,172), BRFSS, 2016.

Table 1

Characteristic	Type of functional disability				Disability status				
	Hearing only (n = 17,660)	Vision only (n = 6,116)	Cognition only (n = 15,508)	Mobility only (n = 30,765)	Self-care only (n = 847)	Independent living only (n = 3,035)	>1 Type (n = 58,932)	Any <sup>a</sup> (n = 132,863)	None (n = 318,438)
<b>Sex</b>									
Men	66.4 (64.9–67.9)	49.4 (46.6–52.2)	46.6 (45.0–48.1)	40.1 (38.8–41.3)	59.0 (52.3–65.4)	36.9 (33.5–40.5)	43.3 (42.4–44.2)	45.9 (45.3–46.4)	50.4 (50.1–50.8)
Women	33.6 (32.1–35.1)	50.6 (47.8–53.4)	53.4 (51.9–55.0)	59.9 (58.7–61.2)	41.0 (34.6–47.7)	63.1 (59.5–66.5)	56.7 (55.8–57.6)	54.1 (53.6–54.7)	49.6 (49.2–49.9)
<b>Age group, y</b>									
18–24	3.5 (2.8–4.2)	11.8 (9.9–14.0)	24.1 (22.6–25.6)	1.8 (1.4–2.2)	<i>b</i>	16.2 (13.4–19.4)	5.1 (4.6–5.6)	8.1 (7.7–8.5)	14.0 (13.8–14.3)
25–34	5.6 (4.9–6.5)	15.5 (13.3–17.9)	22.6 (21.3–23.9)	4.4 (3.9–5.1)	8.1 (4.9–13.0) <sup>c</sup>	20.5 (17.5–23.9)	8.3 (7.7–8.8)	10.4 (10.0–10.8)	19.2 (19.0–19.5)
35–44	6.9 (5.9–8.0)	13.2 (11.4–15.3)	17.0 (15.9–18.2)	7.6 (6.8–8.4)	11.9 (7.8–17.6) <sup>c</sup>	16.0 (13.6–18.8)	11.0 (10.4–11.6)	11.1 (10.8–11.5)	18.1 (17.8–18.4)
45–64	31.8 (30.3–33.4)	38.3 (35.6–41.0)	25.2 (24.0–26.4)	41.8 (40.6–43.0)	50.1 (43.4–56.8)	24.3 (21.5–27.4)	42.8 (41.9–43.6)	37.8 (37.2–38.3)	32.7 (32.4–33.1)
65	52.2 (50.6–53.8)	21.2 (19.5–23.1)	11.1 (10.4–11.9)	44.4 (43.2–45.7)	26.9 (21.9–32.5)	23.0 (20.6–25.6)	32.9 (32.1–33.7)	32.6 (32.1–33.1)	15.9 (15.7–16.1)
<b>Race/ethnicity</b>									
White <sup>d</sup>	79.4 (77.6–81.1)	50.7 (47.9–53.5)	60.5 (58.9–62.1)	66.2 (64.8–67.5)	63.7 (55.9–70.8)	64.6 (60.8–68.1)	64.4 (63.5–65.4)	64.9 (64.3–65.5)	64.6 (64.3–65.0)
Black <sup>d</sup>	6.1 (5.0–7.3)	15.9 (13.9–18.1)	12.6 (11.5–13.7)	14.8 (13.9–15.9)	12.9 (8.7–18.7)	10.0 (7.7–12.8)	13.5 (12.9–14.2)	12.9 (12.5–13.3)	11.3 (11.0–11.5)
Hispanic	9.3 (8.0–10.8)	27.4 (24.5–30.5)	18.8 (17.4–20.2)	13.5 (12.5–14.7)	18.0 (11.8–26.5) <sup>c</sup>	18.1 (15.2–21.4)	15.2 (14.5–16.0)	15.7 (15.1–16.2)	15.6 (15.2–15.9)
All/AN <sup>d</sup>	1.0 (0.8–1.3)	1.0 (0.7–1.3)	1.6 (1.3–2.0)	1.1 (0.9–1.3)	<i>b</i>	1.4 (0.9–2.1) <sup>c</sup>	1.7 (1.6–1.9)	1.4 (1.3–1.6)	0.8 (0.7–0.8)
Asian <sup>d</sup>	2.4 (1.8–3.2)	3.0 (2.2–4.0)	3.6 (3.0–4.5)	2.6 (1.9–3.5)	<i>b</i>	2.7 (1.6–4.7) <sup>c</sup>	2.0 (1.6–2.6)	2.5 (2.2–2.8)	6.0 (5.7–6.2)
Other race/ Multiracial <sup>d</sup>	1.8 (1.5–2.3)	2.1 (1.6–2.7)	2.9 (2.5–3.4)	1.8 (1.5–2.1)	<i>b</i>	3.2 (2.1–4.8) <sup>c</sup>	3.0 (2.7–3.4)	2.6 (2.4–2.8)	1.8 (1.7–1.9)
<b>Marital status</b>									

Characteristic	Type of functional disability			Disability status					
	Hearing only (n = 17,660)	Vision only (n = 6,116)	Cognition only (n = 15,508)	Mobility only (n = 30,765)	Self-care only (n = 847)	Independent living only (n = 3,035)	>1 Type (n = 58,932)	Any <sup>a</sup> (n = 132,863)	None (n = 318,438)
Married/living with partner	61.4 (59.9–63.0)	48.3 (45.5–51.1)	40.9 (39.4–42.4)	51.9 (50.7–53.2)	59.1 (52.6–65.3)	47.1 (43.5–50.8)	42.8 (41.9–43.7)	46.8 (46.2–47.4)	58.7 (58.4–59.1)
Previously married	28.6 (27.2–30.1)	26.4 (24.2–28.9)	20.7 (19.6–21.9)	35.7 (34.6–36.9)	26.9 (21.8–32.8)	25.2 (22.6–28.0)	38.9 (38.1–39.7)	33.0 (32.5–33.5)	15.8 (15.6–16.1)
Never married	10.0 (9.0–11.1)	25.3 (22.8–28.0)	38.4 (36.8–39.9)	12.3 (11.5–13.2)	14.0 (10.4–18.6)	27.6 (24.4–31.1)	18.3 (17.6–19.1)	20.2 (19.7–20.7)	25.5 (25.1–25.8)
<b>Educational attainment</b>									
<High school graduate	13.5 (12.0–15.2)	21.7 (19.2–24.5)	18.4 (17.2–19.7)	19.2 (18.1–20.4)	23.0 (17.0–30.3)	19.0 (16.3–22.1)	28.3 (27.4–29.2)	22.6 (22.1–23.2)	10.2 (10.0–10.5)
High school graduate/GED	30.2 (28.8–31.6)	33.1 (30.6–35.6)	32.3 (30.9–33.7)	32.8 (31.7–34.0)	25.2 (20.5–30.4)	33.1 (29.8–36.6)	32.0 (31.3–32.8)	32.1 (31.6–32.6)	26.7 (26.4–27.0)
Some college/technical school	32.5 (31.0–34.0)	28.6 (26.1–31.3)	33.6 (32.2–35.1)	31.8 (30.7–33.1)	32.6 (26.4–39.6)	32.9 (29.7–36.4)	28.7 (27.9–29.5)	30.7 (30.2–31.3)	31.6 (31.2–31.9)
College graduate	23.8 (22.7–25.0)	16.6 (15.0–18.3)	15.7 (14.8–16.6)	16.1 (15.4–16.9)	19.2 (15.1–24.1)	14.9 (12.8–17.3)	10.9 (10.5–11.3)	14.6 (14.3–14.9)	31.5 (31.2–31.8)
<b>Employment status</b>									
Employed	43.0 (41.3–44.6)	54.3 (51.6–57.1)	53.3 (51.8–54.8)	30.3 (29.1–31.5)	42.4 (35.8–49.2)	39.2 (35.8–42.8)	19.0 (18.3–19.7)	32.2 (31.7–32.8)	66.1 (65.8–66.4)
Unemployed	3.4 (2.7–4.2)	7.8 (6.3–9.6)	9.9 (9.0–10.8)	5.6 (5.0–6.2)	9.7 (5.4–17.1) <sup>c</sup>	7.2 (5.6–9.3)	8.0 (7.5–8.5)	7.3 (7.0–7.7)	4.5 (4.4–4.7)
Unable to work	2.5 (2.1–3.0)	7.2 (5.8–8.8)	8.7 (8.0–9.6)	17.0 (16.1–18.0)	19.3 (14.6–25.0)	15.4 (12.9–18.3)	37.4 (36.6–38.2)	22.4 (21.9–22.9)	1.6 (1.5–1.7)
Student/homemaker/retired	51.1 (49.5–52.8)	30.7 (28.4–33.1)	28.1 (26.7–29.5)	47.1 (45.9–48.3)	28.6 (23.3–34.5)	38.2 (34.8–41.7)	35.6 (34.8–36.5)	38.0 (37.5–38.6)	27.8 (27.5–28.1)
<b>Federal poverty level (%)</b>									
<100	7.5 (6.6–8.4)	19.0 (17.0–21.2)	20.7 (19.5–22.0)	15.5 (14.6–16.5)	20.9 (15.6–27.5)	20.1 (17.2–23.4)	27.0 (26.1–27.8)	20.9 (20.4–21.4)	10.8 (10.5–11.0)
100–199	22.4 (21.0–23.8)	28.4 (25.8–31.2)	25.1 (23.8–26.4)	28.5 (27.5–29.6)	25.3 (19.2–32.5)	28.2 (25.1–31.5)	29.7 (28.9–30.4)	27.8 (27.3–28.3)	17.2 (16.9–17.5)
200	51.3 (49.7–53.0)	34.9 (32.4–37.5)	33.9 (32.5–35.3)	37.8 (36.6–39.0)	39.4 (33.3–45.9)	29.1 (26.1–32.2)	23.2 (22.4–23.9)	31.8 (31.3–32.3)	55.4 (55.0–55.7)
Unknown	18.8 (17.5–20.3)	17.6 (15.7–19.8)	20.3 (19.1–21.6)	18.2 (17.2–19.1)	14.4 (11.0–18.6)	22.7 (19.7–25.9)	20.2 (19.5–20.9)	19.6 (19.1–20.0)	16.7 (16.4–16.9)
<b>Children in household</b>									
0 children	82.2 (80.7–83.6)	63.6 (60.8–66.4)	61.3 (59.8–62.8)	79.8 (78.7–80.8)	70.3 (63.5–76.4)	64.0 (60.4–67.6)	75.2 (74.4–76.0)	73.5 (73.0–74.1)	60.9 (60.6–61.3)

Characteristic	Type of functional disability			Disability status					
	Hearing only (n = 17,660)	Vision only (n = 6,116)	Cognition only (n = 15,508)	Mobility only (n = 30,765)	Self-care only (n = 847)	Independent living only (n = 3,035)	>1 Type (n = 58,932)	Any <sup>a</sup> (n = 132,863)	None (n = 318,438)
1 child	7.9 (6.9–9.0)	15.5 (13.3–18.0)	16.7 (15.6–17.8)	10.1 (9.3–10.9)	15.0 (10.4–21.2)	14.9 (12.4–17.9)	12.0 (11.4–12.6)	12.3 (11.8–12.7)	15.6 (15.3–15.9)
2 children	6.0 (5.3–6.9)	11.8 (9.9–13.9)	12.5 (11.5–13.5)	6.1 (5.4–6.8)	9.2 (5.8–14.4) <sup>c</sup>	11.4 (8.9–14.4)	7.3 (6.8–7.8)	8.1 (7.8–8.5)	14.3 (14.0–14.5)
3 children	3.8 (3.0–4.9)	9.1 (7.6–10.8)	9.5 (8.6–10.5)	4.1 (3.6–4.7)	5.4 (3.3–8.6) <sup>c</sup>	9.7 (7.7–12.1)	5.6 (5.1–6.1)	6.1 (5.8–6.4)	9.2 (9.0–9.5)
<b>Leisure-time physical activity</b>									
Yes	76.1 (74.7–77.5)	73.2 (70.6–75.6)	75.6 (74.3–76.8)	54.5 (53.2–55.7)	61.5 (54.3–68.2)	70.2 (67.0–73.1)	48.8 (47.9–49.6)	59.3 (58.8–59.9)	81.8 (81.6–82.1)
No	23.9 (22.5–25.3)	26.8 (24.4–29.4)	24.4 (23.2–25.7)	45.5 (44.3–46.8)	38.5 (31.8–45.7)	29.8 (26.9–33.0)	51.2 (50.4–52.1)	40.7 (40.1–41.2)	18.2 (17.9–18.4)
<b>Cigarette smoking status</b>									
Current smoker	14.3 (13.2–15.5)	22.5 (20.3–24.9)	27.2 (25.9–28.6)	18.3 (17.4–19.2)	21.9 (16.9–27.8)	27.6 (24.5–30.9)	28.9 (28.1–29.6)	24.5 (24.0–25.0)	13.6 (13.4–13.9)
Former smoker	40.4 (38.7–42.0)	23.6 (21.3–26.0)	21.6 (20.4–22.8)	33.9 (32.8–35.0)	30.7 (25.2–36.8)	23.5 (20.6–26.7)	31.0 (30.3–31.9)	30.4 (29.8–30.9)	22.6 (22.3–22.9)
Never smoker	45.4 (43.8–47.0)	53.9 (51.1–56.7)	51.2 (49.6–52.7)	47.8 (46.6–49.1)	47.4 (40.7–54.3)	48.9 (45.4–52.5)	40.1 (39.2–41.0)	45.1 (44.6–45.7)	63.7 (63.4–64.1)
<b>BMI (kg/m<sup>2</sup>)</b>									
<25.0	29.8 (28.2–31.3)	34.2 (31.5–36.9)	36.2 (34.7–37.6)	18.6 (17.7–19.6)	24.1 (19.2–29.7)	39.0 (35.5–42.6)	25.8 (25.1–26.6)	27.3 (26.8–27.9)	35.1 (34.7–35.4)
25.0–29.9	40.6 (39.0–42.2)	31.9 (29.4–34.5)	30.3 (28.9–31.7)	27.8 (26.7–28.9)	28.5 (23.2–34.6)	28.8 (25.8–31.9)	28.7 (27.9–29.5)	30.2 (29.6–30.7)	34.3 (33.9–34.6)
30.0	25.8 (24.5–27.2)	29.0 (26.6–31.6)	28.5 (27.1–29.9)	46.1 (44.9–47.4)	41.1 (34.3–48.2)	25.8 (22.7–29.2)	39.9 (39.1–40.8)	36.8 (36.3–37.4)	24.8 (24.5–25.1)
Unknown	3.8 (3.3–4.4)	4.9 (3.8–6.3)	5.1 (4.4–5.8)	7.5 (6.8–8.1)	6.3 (4.1–9.5) <sup>c</sup>	6.4 (5.1–8.0)	5.6 (5.2–6.0)	5.7 (5.4–5.9)	5.8 (5.7–6.0)
<b>Frequent mental distress<sup>e</sup></b>									
Yes	7.5 (6.6–8.4)	10.3 (9.0–11.9)	35.9 (34.4–37.4)	12.6 (11.7–13.5)	20.8 (15.7–27.1)	28.0 (24.7–31.5)	38.1 (37.2–38.9)	27.3 (26.8–27.8)	6.3 (6.2–6.5)
No	92.5 (91.6–93.4)	89.7 (88.1–91.0)	64.1 (62.6–65.6)	87.4 (86.5–88.3)	79.2 (72.9–84.3)	72.0 (68.5–75.3)	61.9 (61.1–62.8)	72.7 (72.2–73.2)	93.7 (93.5–93.8)

**Abbreviations:** AI/AN = American Indian/Alaska Native; BMI = body mass index; BRFSS = Behavioral Risk Factor Surveillance System; CI = confidence interval; GED = General Education Development high school equivalency diploma; n = sample size; N = weighted population estimate; y = years.

<sup>a</sup>One or more of the six functional disability types (serious difficulty in hearing, vision, cognition, or mobility, or any difficulty in self-care and independent living).

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

<sup>b</sup>Relative standard error > 30%.

<sup>c</sup>Relative standard error between 20 and 30%.

<sup>d</sup>Non-Hispanic.

<sup>e</sup>Defined as experiencing 14 or more days of poor mental health in the past 30 days.

Table 2

Relative likelihood of short sleep duration<sup>a</sup> among adults by disability status, functional disability type, and number of functional disability types, BRFSS, 2016.

	Unadjusted		Adjusted <sup>b</sup>	
	% (95% CI)	PR (95% CI)	% (95% CI)	APR (95% CI)
<b>Disability status</b>				
No disability	31.6 (31.3–32.0)	1.00	32.2 (31.9–32.6)	1.00
Any disability <sup>c</sup>	43.8 (43.2–44.4)*	1.38 (1.36–1.41)	40.7 (40.0–41.3)*	1.26 (1.23–1.29)
<b>Disability type</b>				
No disability	31.6 (31.3–32.0)	1.00	32.1 (31.7–32.4)	1.00
Hearing only	31.9 (30.3–33.5)	1.01 (0.96–1.06)	36.4 (34.5–38.4)*	1.14 (1.08–1.20)
Vision only	37.5 (34.9–40.2)*	1.19 (1.10–1.27)	36.6 (34.0–39.4)**	1.14 (1.06–1.23)
Cognition only	44.2 (42.7–45.7)*	1.40 (1.35–1.45)	38.6 (37.3–40.0)*	1.20 (1.16–1.25)
Mobility only	39.2 (38.0–40.5)*	1.24 (1.20–1.28)	40.2 (38.9–41.6)*	1.25 (1.21–1.30)
Self-care only	41.4 (35.3–48.4)**	1.31 (1.12–1.53)	39.5 (33.9–46.2)***	1.23 (1.06–1.44)
Independent living only	38.9 (35.5–42.5)*	1.23 (1.12–1.34)	36.3 (33.1–39.8)***	1.13 (1.03–1.24)
Multiple types	49.8 (48.9–50.6)*	1.57 (1.54–1.61)	44.7 (43.7–45.8)*	1.40 (1.36–1.43)
<b>Number of disability types</b> ****				
No disability, n = 318,438	31.6 (31.3–32.0)	1.00	32.0 (31.7–32.4)	1.00
1 type, n = 73,931	39.2 (38.4–39.9)*	1.24 (1.21–1.27)	38.5 (37.7–39.3)*	1.20 (1.17–1.23)
2 types, n = 31,089	45.4 (44.2–46.7)*	1.44 (1.40–1.48)	42.9 (41.6–44.2)*	1.34 (1.30–1.38)
3 types, n = 16,390	50.9 (49.3–52.5)*	1.61 (1.56–1.66)	45.1 (43.5–46.8)*	1.41 (1.35–1.47)
4 types, n = 11,453	59.3 (57.4–61.3)*	1.88 (1.81–1.94)	49.7 (47.8–51.7)*	1.55 (1.49–1.62)

**Abbreviations:** APR, adjusted prevalence ratio; BRFSS, Behavioral Risk Factor Surveillance System; CI, confidence interval; n, sample size; PR, prevalence ratio.

\*  $p < .001$ ;

\*\*  $p < .01$ ;

\*\*\*  $p < .05$ ;

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

\*\*\*  
 $p$  value, test for linear trend < 0.001.

<sup>2</sup>Defined as less than 7 h per 24-h period.

<sup>b</sup>Adjusted for age, sex, race/ethnicity, marital status, educational attainment, employment status, federal poverty level, number of children in household, leisure-time physical activity, cigarette smoking status, body mass index, and frequent mental distress.

<sup>c</sup>One or more of the six functional disability types (serious difficulty in hearing, vision, cognition, or mobility, or any difficulty in self-care and independent living).