



# Toward the Creation of a Patient-Reported Disability Index

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## **Key Takeaways**

Based on a newly-developed, initially-validated, and continuously-scored Disability Index that reflects the presence and severity of five different types of disability, we estimate that 5% of the representative noninstitutionalized U.S. adult population can be classified as “most impaired,” 8% as “somewhat impaired,” and 87% as “least impaired.” The “least impaired” category includes people who report no impairment. The Disability Index was developed using nationally representative 2014-2015 National Health Interview Survey data.

Mobility impairment is the most common type of disability, with 25% of people who are “somewhat impaired” reporting *a lot of difficulty* or an inability to function in this area and 70% of people who are “most impaired” reporting *a lot of difficulty* or an inability to function in this area. Vision, hearing, self-care, and cognitive impairments are substantially less common than mobility impairment, with only 1-5% of people who are “somewhat impaired” and 12-22% of people who are “most impaired” reporting having *a lot of difficulty* or an inability to function in one or more of these areas.

The Disability Index is a single summary measure of disability based on publicly available survey data. We present both a continuous and a categorical form of the index. The index can be used in the future to measure the extent to which quality of care and access to care vary along a single dimension of disability. The index may also be useful for assessing whether there is heterogeneity in disability-related disparities in health care for different population subgroups.

## **Introduction**

The goal of this *Research Report* is to summarize the development and initial validation of a Disability Index that reflects the presence and severity of different types of disability measured by the National Health Interview Survey (NHIS). This Disability Index represents a single summary measure of disability that uses publicly available and widely used national health survey data. Because the Disability Index summarizes multiple disability items as a single dimension, it can be used in the future to assess variability in quality of care and access to care along this dimension. The Disability Index may also be useful for assessing heterogeneity in disability-related disparities for different population subgroups. As detailed in this report, we developed the Disability Index based on data from a general population sample. As we note later, the method we used may be applied to data from populations with greater disability, such as Medicare or Medicaid populations.

It is estimated that 12% to 30% of Americans have a disability (Altman and Bernstein 2008; Oreskovich and Zimmerman 2012; Brault 2012; Okoro et al. 2016). The health care of persons with disabilities has recently been identified as a priority area for research (National Institutes of Health Medical Rehabilitation Coordinating Committee 2017), but progress in this area has been slow due in part to a lack of consensus about how to define and measure disability (Krahn et al. 2015).

In 2002, representatives from the National Center on Health Statistics (NCHS) and comparable agencies from outside the U.S. convened to develop a short set of measures of disability for use in population surveys worldwide (Madans et al. 2011). This set of measures, which is grounded

in a conceptual model developed by the World Health Organization (WHO) (World Health Organization 2018; Kostanjsek 2011), covers six functional domains: seeing, hearing, walking, cognition, self-care, and communication (see Definitions on page 10 for more information). In 2008, the WHO set of disability indicators was added to the NHIS to enable identification of adults at risk of experiencing limited or restricted participation in society. In completing the measures, respondents are asked to indicate whether they have *no difficulty* performing a function (scored 0), *some difficulty* (scored 1), *a lot of difficulty* (scored 2), or are *unable to do* the function (scored 3).

Although the development of the WHO set of disability indicators represents an important advancement in the measurement of disability, researchers who have used these items to date have tended to ignore potentially useful information in participants' responses. For example, some researchers have defined disability as having serious difficulty with at least one of a set of disability types (e.g., Carroll et al. 2014; Courtney-Long et al. 2014). This approach does not distinguish respondents with serious difficulty in one domain of functioning from respondents with serious difficulty in multiple domains, nor does it recognize that different types and severity of disability may be associated with different levels of well-being and medical need.

Because the impact of disability is likely to be continuous, a measure that attempts to capture that impact should also be scored continuously (rather than dichotomously) and should distinguish levels of disability severity. A simple way of creating such a continuous measure is to sum the number of disabilities that a person reports, as is sometimes done with activities of daily living and instrumental activities of daily living (e.g., Stevens et al., 2016). While this approach has the advantage of being easy to implement and interpret, it implies the unlikely assumption that each disability type corresponds to the same level of medical need or intervention.

Another way of creating a continuous measure of disability is to develop a weighted summary score. In this approach, each individual disability type would be assigned a weight that determines the importance the disability is given in the resulting summary score. These weights could be adapted from ones that have already been published (e.g., the Global Burden of Disease cumulative burden disability weights or the WHO Disability Assessment scoring; Salomon et al. 2015; Ustun et al. 2010). However, this approach would require selecting only a subset of items from the weights that do not necessarily match the NHIS items. A second way of developing a weighted summary score--which is the approach used in this report—is to empirically derive information about disability using a suitable criterion measure.

In this *Research Report*, we describe the development and initial validation of a continuously-scored weighted index of disability derived from analyses of disability data from the 2014-2015 NHIS Adult Functioning and Disability (AFD) supplement survey (N=18,303 in 2014 and N=16,939 in 2015). All AFD respondents were aged 18 years or older. We excluded 1,818 AFD respondents (5.2%) who provided no responses to any of the disability items. There were 91 (0.3%) AFD respondents who completed some but not all of the disability items. In such instances, we imputed a 0 ("no limitations") for the disability items with no response, as it is common for respondents to misunderstand long sequences of similar items as a "check-all-that-apply" format (Orr et al. 2013). The NHIS is an ongoing annual national survey conducted by the Centers for Disease Control and Prevention's NCHS. It is the principal source of national health

information and is widely used for measuring health and healthcare disparities in the general noninstitutionalized U.S. adult population.

The Disability Index reflects the presence and severity of five different types of disability: seeing, hearing, walking, cognition, and self-care (Table 1 and Definitions on page 10). The sixth domain, communication, was not included in the final Disability Index (see below and Appendix 1 for details). The criterion measure that we used for deriving the weights assigned to each disability type is self-rated health, which is strongly related to mortality (DeSalvo et al. 2006). Because these weights were derived from information contained in the NHIS, they are representative of the noninstitutionalized population of U.S. adults and thus have broad applicability.

### **Methods Used to Develop and Validate the Disability Index**

Following an approach used by Mujica-Mota et al. (2015), we developed and validated the Disability Index by establishing that it is negatively related to a simple, widely-accepted summary measure of health: self-rated health. Self-rated health is perhaps the best single-item measure of health—it is predictive of future health care utilization, morbidity, illness recovery, functional decline, and mortality (see Benyamini et al. 2003 for summary of this research; Jylha 2009), and it is widely available in survey data.

Our first step was to generate a summary disability score for each respondent based on a linear regression model predicting self-rated health. In our analysis, we rescaled self-rated health (1=poor to 5=excellent) to a 0-100 scale and then predicted the rescaled score from each of the six disability items (scored 0-3), where each disability item was included as a linear term. Because the association between self-rated health and disability may be nonlinear, we employed linear splines. For each disability item, we also included a single linear spline term. This additional term allows the estimated difference between *a lot of difficulty* (level 2) and *some difficulty* (level 1) to be different from the estimated difference between *no difficulty* (level 0) and *some difficulty*. The spline term is similar to an interaction between the linear term and an indicator of *a lot of difficulty*.

Unlike other functional domains, some respondents with communication difficulties rated their quality of life higher than respondents with no communication difficulties, after regression adjustment. To ensure increasing disability was not associated with better predicted health, we dropped terms for communication impairment from the model (see Appendix 1 for details and related results). For this reason, our final modeling approach predicted the rescaled self-rated health score from each of five disability items: seeing, hearing, walking, cognition, and self-care.

Self-rated health may be affected by socio-demographic characteristics in a way that is not related to health (e.g., response tendencies, frames of references; Hays et al. 1993; Junghaenel et al. 2017). For example, people tend to compare their health status against their peer group (i.e., other people of similar age/race/ethnicity/education). There may also be socio-demographic differences in the use of extreme response tendencies. To remove the effects of these exogenous contributors to a person's appraisal of his or her own health, the regression model controlled for gender, age (both linearly and categorically scored), dual enrollment in Medicaid and Medicare, Medicare status, English language proficiency, education, marital status, race and ethnicity,

Census region, and household income. Indicators for missing information on each of the socio-demographic characteristics were also included as control variables. Since respondents may use activity-limitation scales differently, we kept those reporting no limitations in our analysis.

The analyses used SAS version 9.3 survey procedures to account for the complex NHIS survey design and household income imputations. Results of regression models are shown in Appendix 1. Because comorbidities and other health measures are relevant contributors to self-rated health, the model does not adjust for their contribution to self-rated health.

Based on this model, we calculated covariate-adjusted self-rated health scores for each respondent using the method of recycled predictions (Graubard and Korn 1999). These scores represent variation in self-rated health that is associated solely with disability. In other words, the covariate-adjusted score is the expected self-rated health score for a given person if the person's socio-demographic characteristics corresponded to those of the average person in the noninstitutionalized U.S. adult population. The range of predicted self-rated health scores on this covariate-adjusted index was 4.5 to 72.8 ( $M = 66.3$ ,  $SD = 11.1$ ).

We then created a standardized (z-score) Disability Index by subtracting the sample mean from each score and dividing the difference by the sample standard deviation. Scores on this standardized Disability Index were used to assign respondents to one of three groups ("least impaired," "somewhat impaired," and "most impaired"). To define these groups, we identified cut points that were one standard deviation apart on the index. Respondents with z-scores greater than -1 were designated "least impaired," those with z-scores between -2 and -1 (i.e.,  $\geq -2$  and  $\leq -1$ ) were designated "somewhat impaired," and those with z-scores less than or equal to -2 were designated "most impaired." All cut points are less than zero because the Disability Index has a skewed distribution (an aggregation of scores at the low end), reflecting the fact that the NHIS sample is representative of the general population and thus mostly unimpaired. These cut points were selected to meet the potentially competing goals of having impairment groups that are reasonably sized (to ensure reliable sub-group estimates of quality of care and other measures) and represent reasonably distinct levels of disability.

As a preliminary validation and illustration of our approach, we compared the disability and socio-demographic characteristics of the representative noninstitutionalized U.S. adult population who were categorized as persons who are "least impaired," "somewhat impaired," and "most impaired" per our standardized index. We also determined which socio-demographic characteristics were associated with impairment group, using bivariate and multivariate logistic regression models to predict being classified as a person who is "somewhat impaired" versus "least impaired" and as a person who is "most impaired" versus "least impaired" (reference group).

## Results

In the fully-adjusted model (results shown in Appendix 1), severity of mobility limitations was the strongest predictor of self-rated health (-15 points on a 0-100 self-rated health scale for each additional severity level), followed by self-care (-10 points), cognition (-7 points), vision (-5 points), and hearing (-3 points). Negative coefficients for disability type severities indicate a negative association with predicted self-rated health (0-100 scale, where 0 represents poor health

and 100 represents excellent health). In other words, self-rated health decreases as severity of disability increases.

However, positive coefficients for each disability spline term indicate that once a respondent moves from *some difficulty* to *a lot of difficulty*, the negative effects of disability on self-rated health diminish. For example, a respondent with a single level-1 (*some difficulty*) mobility impairment is predicted to have a 15-point decrease in general health score compared to those with no such impairment, but a respondent with a single level-2 (*a lot of difficulty*) mobility impairment is predicted to have a 22-point ( $-15*2 + 8$ ) decrease and a respondent with a single level-3 (*unable to do*) impairment to have a 29-point ( $-15*3 + 8*2$ ) decrease. This means that the difference in quality of life between reporting *no difficulty* and *some difficulty* (15 points) is greater than the quality of life difference associated with reporting *some difficulty* and *a lot of difficulty* (7 points) or *some difficulty* and being *unable to do* an activity (7 points).

Table 2 shows the distribution of the NHIS sample by impairment group, weighted to represent the noninstitutionalized U.S. adult population. Based on the categorization scheme, 5% of the population was considered “most impaired,” 8% of the population “somewhat impaired,” and 87% of the population “least impaired.”

Table 3 characterizes, for each disability, severity of disability by impairment group. The proportion of the noninstitutionalized U.S. adult population that had *no difficulty* ranged from 82% (for hearing) to 97% (for self-care). The proportion that had *great difficulty* (defined as *a lot of difficulty* or *unable to do*) ranged from <1% (for self-care) to 6% (for mobility). The three impairment groups differed most in terms of the proportion who had great mobility limitations: they were present in 0% of people who are “least impaired,” 25% of people who are “somewhat impaired,” and 70% of people who are “most impaired.”

The pattern of limitations varied by impairment group. Those who are “least impaired” had just 4% with any mobility limitation, while those who are “somewhat impaired” and “most impaired” contained nearly everyone with any mobility limitation. Cognitive, hearing, and vision limitations were also uncommon among those who are “least impaired” (9%-13% with any limitation), occurred in approximately one-third or more of those who are “somewhat impaired” (33%-45% with any limitation), and were present in more than half of those who are “most impaired” (60%-75% with any limitation). Self-care limitations were the least common: rare among those who are “least impaired” (<1% with any limitation), uncommon among those who are “somewhat impaired” (5% with any limitations), and present in approximately half of those who are “most impaired” (47% with any limitation).

Table 4 shows the estimated proportion of the noninstitutionalized U.S. adult population with no limitation in any of the five areas of functioning, in addition to the estimated proportion with any limitation in one, two, or three or more of the five areas of functioning. It also shows these same distributions by impairment group. About two-thirds of the noninstitutionalized U.S. adult population had no limitations (65%), 22% had one limitation, 9% had two limitations, and 4% had three or more limitations. All of those with no limitations were classified as “least impaired,” and they constituted almost three-quarters of that group. Almost all of the remainder of that group had a single limitation (23%), and none had three or more limitations. Of those who are

“somewhat impaired,” 60% had two limitations while the remainder had either one (30%) or three or more (10%) limitations. Of those who are “most impaired,” 62% had three or more limitations while almost all of the remainder had two limitations (31%).

Table 5 displays the proportion of people with great limitations, which here we define as having *a lot of difficulty* or being *unable to do* the activity. In the overall noninstitutionalized U.S. adult population, only 8% had a great limitation in one or more areas of functioning, and only 1% had a great limitation in two or more areas. Of those who are “least impaired,” 2% had a great limitation in a single area of functioning and the remainder had no great limitation. Of those who are “somewhat impaired,” 31% had a great limitation in one area of functioning, 2% in two areas, and 0% in three or more areas. Of those who are “most impaired,” a majority had at least one great limitation (76%), with 14% having great limitations in two areas of functioning, and 3% having great limitations in three or more areas.

To summarize across Tables 3, 4, and 5, only about one-quarter of those who are “least impaired” have any functional limitations, and those who do most often have *some difficulty* in a single area of functioning. The areas in which people who are “least impaired” have *some difficulty* are most often hearing or vision. All of those who are “somewhat impaired” have at least one limitation, and a majority of this group has two limitations (usually *some difficulty* but occasionally greater limitation). A majority of those who are “somewhat impaired” have mobility limitations, and when a great limitation exists, it is usually in mobility. A majority of those who are “most impaired” have three or more limitations (see Table 4), and at least one of those is a great limitation (see Table 5). Among those who are “most impaired,” nearly all have mobility limitations, and a majority has *great* mobility limitations. A majority has cognitive, hearing, and vision impairments, as well.

Table 6 describes the socio-demographic characteristics of the noninstitutionalized U.S. adult population and each of the three impairment groups. Compared to those who are “somewhat impaired” and those who are “most impaired,” those who are “least impaired” were more often male (50% of those who are “least impaired” vs. 41% of those who are “somewhat impaired” and 39% of those who are “most impaired”;  $p < 0.001$  for both bivariate tests of differences), younger (3% were aged 80 years or older versus 13% of those who are “somewhat impaired” and 22% of those who are “most impaired”;  $p < 0.001$  for the “most impaired” test), less often covered by Medicare alone (15% versus 43% of those who are “somewhat impaired” and 48% of people who are “most impaired”;  $p < 0.001$  for both tests), and less often dually eligible (1% versus 7% of those who are “somewhat impaired” and 15% of those who are “most impaired”;  $p < 0.001$  for both tests).

People who are “least impaired” were the most socioeconomically advantaged: they more often held a Bachelor’s degree (33% compared with 20% of those who are “somewhat impaired” and 13% of those who are “most impaired”;  $p < 0.001$  for both bivariate tests of differences), were more likely to be married (54% versus 50% of those who are “somewhat impaired” and 43% of those who are “most impaired”;  $p < 0.001$  for both tests), and more often reported an income of at least \$75,000 (11% versus 4% of those who are “somewhat impaired” and 1% of those who are “most impaired”;  $p < 0.001$  for “most impaired”). Additionally, people who are “least impaired” were more often Hispanic (16% versus 11% of those who are “somewhat impaired” and 12% of

those who are “most impaired”;  $p < 0.001$  for both tests) and Asian (6% versus 3% of both groups;  $p < 0.001$  for both tests).

Relative to those who are “somewhat impaired,” those who are “most impaired” were more often aged 80 years or older (22% versus 14%), were more often covered by Medicare alone (48% versus 43%) or in combination with Medicaid (15% versus 7%), had lower English language proficiency (10% versus 6% for proficiency groups *not well* or *not at all*), were less educated (29% versus 19% with *less than a high school degree*), and were more frequently non-White (33% versus 29%).

Multivariate patterns parallel the bivariate patterns with some exceptions. Controlling for Medicare and dual-eligibility coverage, age demonstrated a complex relationship with impairment status, with people who were younger (35-64 years) and older (80 years or older) being more likely to be “somewhat impaired” or “most impaired” than people aged 65-79 years. Many of the bivariate associations between impairment group and each of Medicare coverage, dual-eligibility, and marital status were diminished after controlling for other socio-demographic factors.

## **Discussion**

This *Research Report* summarizes the development and initial validation of a continuously scored Disability Index that reflects the presence and severity of five disability types assessed by the NHIS. The Disability Index can be used in future research as a single-dimensional summary measure. With the index, researchers will be able to measure the extent to which quality of care and access to care vary along this single dimension. They will also be able to potentially assess whether there is heterogeneity in disparities across people with different levels of impairment. This method can be used as a guideline for researchers to standardize the index to other populations of interest. Future work might be undertaken to further validate the measure using a broader range of criteria and/or measures (e.g., cost or utilization). It is also possible that by using different cut points based on a different z-score distribution, the same method may be applied to other populations, such as Medicare and Medicaid beneficiaries.



## **Definitions**

### **Vision**

Respondents were asked to report how much difficulty they have seeing, even when wearing glasses. Response options were “*no difficulty*,” “*some difficulty*,” “*a lot of difficulty*,” and “*unable to do*.” People who reported having *a lot of difficulty* or being *unable to see* were considered to be greatly impaired for the purposes of Tables 3, 4, and 5.

### **Hearing**

Respondents were asked to report how much difficulty they have hearing, even when using a hearing aid. Response options were “*no difficulty*,” “*some difficulty*,” “*a lot of difficulty*,” and “*unable to do*.” People who reported having *a lot of difficulty* or being *unable to hear* were considered to be greatly impaired for the purposes of Tables 3, 4, and 5.

### **Cognition**

Respondents were asked to report how much difficulty they have remembering or concentrating. Response options were “*no difficulty*,” “*some difficulty*,” “*a lot of difficulty*,” and “*unable to do*.” People who reported having *a lot of difficulty* or being *unable to remember or concentrate* were considered to be greatly impaired for the purposes of Tables 3, 4, and 5.

### **Communication**

Respondents were asked to report how much difficulty they have communicating, including understanding or being understood. Response options were “*no difficulty*,” “*some difficulty*,” “*a lot of difficulty*,” and “*unable to do*.” For reasons explained above and in Appendix 1, communication impairments are not discussed in the results section.

### **Mobility**

Respondents were asked to report how much difficulty they have walking or climbing stairs. Response options were “*no difficulty*,” “*some difficulty*,” “*a lot of difficulty*,” and “*unable to do*.” People who reported having *a lot of difficulty* or being *unable to walk or climb stairs* were considered to be greatly impaired for the purposes of Tables 3, 4, and 5.

### **Self-care**

Respondents were asked to report how much difficulty they have with self-care, including walking all over or dressing. Response options were “*no difficulty*,” “*some difficulty*,” “*a lot of difficulty*,” and “*unable to do*.” People who reported having *a lot of difficulty* or being *unable to perform self-care* were considered to be greatly impaired for the purposes of Tables 3, 4, and 5.

### **Socio-demographic Characteristics**

In the linear regression model predicting self-rated health that was used to generate the summary disability scores, we controlled for socio-demographic characteristics that affect self-rated health in a way that is not directly related to health (e.g., through response tendencies). These characteristics include gender, age (linearly scored and categorical), dual enrollment in Medicare and Medicaid, Medicare status, limited English language proficiency, education, marital status, race and ethnicity, Census region, and household income. Indicators for missing information on each of the socio-demographic characteristics were also included as control variables.

## **Disability Index Groups**

Each respondent was assigned a summary disability score (i.e., predicted self-rated general health) based on their reported difficulty in five areas of functioning, adjusted for socio-demographic characteristics. Disability summary scores were transformed to z-scores by subtracting the sample mean and then dividing the difference by the sample standard deviation. This allows for a distribution centered around zero with a standard deviation of 1. Scores on this standardized Disability Index were used to assign respondents to one of three Disability Index groups (“least impaired,” “somewhat impaired,” and “most impaired”) based on a set of cut points: respondents with z-scores  $>-1$  were classified as “least impaired,” with z-scores between  $-2$  and  $-1$  (i.e.,  $\geq -2$  and  $\leq -1$ ) as “somewhat impaired,” and with z-scores  $< -2$  as “most impaired.”

## **Data Sources and Sample**

Data used in this highlight come from the 2014 and 2015 National Health Interview Survey (NHIS) Adult Functioning and Disability (AFD) supplement. The NHIS is the principal source of information on the health of the civilian non-institutionalized population of the United States and is one of the major data collection programs of the National Center for Health Statistics, part of the Centers for Disease Control and Prevention. The AFD fielded with the 2014 and 2015 NHIS Sample Adult modules is part of an international project to develop and test improved measures of functioning. The Sample Adult module includes questions about sample adults’ functioning in various basic and complex activity domains: vision (difficulty seeing), hearing (difficulty hearing), mobility (difficulty walking, climbing steps, or moving around), communication (difficulty communicating), and cognition (difficulty remembering or concentrating) (National Center for Health Statistics 2014, National Center for Health Statistics 2015).

The number of respondents for the NHIS varies each year. The total number of NHIS survey respondents was 36,697 in 2014 and 33,672 in 2015. One adult is randomly selected from each household for an additional survey related to health issues. A random sample of approximately half of these adult respondents was selected for the AFD questions. The number of AFD respondents was 18,303 in 2014 and 16,939 in 2015. We excluded 1,818 AFD respondents (5.2%) who provided no responses to any of the disability items (National Center for Health Statistics 2014, National Center for Health Statistics 2015).

## **Limitations**

One limitation relates to the scope of the disability items included in the Disability Index. While the questions used to capture the five WHO recommended disability items examined here (i.e., vision, hearing, cognition, mobility, and self-care) are likely to capture adults who are most disabled, they are likely to underrepresent adults with psychiatric and cognitive disabilities because of impairments to higher-order functioning (e.g., learning, decision making) (Mont 2007). Analyses of NHIS data suggest that mental health disability is potentially very important, especially among those who report disability due to a chronic condition (Mojtabai 2011). Information on U.S. adults with intellectual disabilities is not routinely collected, though it is generally recognized that this population experiences disparities in care (Krahn and Fox 2014). A second limitation relates to the coarse categories used to compare scores on the Disability Index by insurance type. Our reference category was a broad one that included everyone without Medicare coverage. Future work should investigate distinctions in the index according to finer

grained categories that would ideally include commercially-insured individuals, those with Medicaid only, and the uninsured.

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<b>Table 1. Description of Disability Types included in Disability Index</b>	
<b>Disability Type</b>	<b>Items</b>
Seeing	Do you have difficulty seeing, even when wearing glasses?
Hearing	Do you have difficulty hearing, even when using a hearing aid?
Walking	Do you have any difficulty walking or climbing steps?
Cognition	Do you have difficulty remembering or concentrating?
Self-care	Do you have difficulty with self-care, such as washing all over or dressing?

**Note:** Response categories for all items are: Would you say no difficulty, some difficulty, a lot of difficulty, or are you unable to do this?



<b>Table 2. Impairment Groups Based on Segmentation of Z-Scores on the Disability Index</b>			
<b>Impairment group</b>	<b>Z-score range</b>	<b>U.S. Population (%)</b>	<b>NHIS Sample Size</b>
<b>Least impaired</b>	> -1	87	28,241
<b>Somewhat impaired</b>	> -2 to -1	8	2,974
<b>Most impaired</b>	≤ -2	5	2,209

**Note:** Data are from the 2014-2015 National Health Interview Survey (NHIS) ( $n = 33,424$ ). 1,818 respondents were excluded from the analysis due to missing responses on all disability items. Percentages are weighted to be representative of the noninstitutionalized U.S. adult population.

	<b>U.S. Population [100%]</b>			<b>Least impaired (z-score &gt; -1) [87%]</b>			<b>Somewhat impaired (z-score &gt; -2 to -1) [8%]</b>			<b>Most impaired (z-score ≤ -2) [5%]</b>		
	<b>Extent of Limitation</b>			<b>Extent of Limitation</b>			<b>Extent of Limitation</b>			<b>Extent of Limitation</b>		
<b>Disability Type</b>	<b>% None</b>	<b>% Some</b>	<b>% Great<sup>^</sup></b>	<b>% None</b>	<b>% Some</b>	<b>% Great<sup>^</sup></b>	<b>% None</b>	<b>% Some</b>	<b>% Great<sup>^</sup></b>	<b>% None</b>	<b>% Some</b>	<b>% Great<sup>^</sup></b>
Mobility	83.7	10.7	5.6	95.9	4.1	0.0	4.0	71.4	24.6	0.1	30.1	69.8
Cognitive	85.5	12.4	2.2	90.8	8.4	0.8	67.3	29.0	3.7	24.9	53.1	22.0
Self-care	96.6	2.6	0.9	99.3	0.6	0.1	94.9	4.0	1.2	53.2	32.7	14.1
Hearing	82.0	15.9	2.0	87.1	11.9	1.0	54.9	40.0	5.2	38.4	47.6	14.0
Vision	84.7	13.6	1.7	89.0	10.2	0.8	66.7	28.6	4.8	39.9	47.5	12.6

**Note:** Data are from the 2014-2015 National Health Interview Survey (NHIS) ( $n = 33,424$ ). 1,818 respondents were excluded from the analysis due to missing responses on all disability items. Response options for the five disability types are: “no difficulty,” “some difficulty,” “a lot of difficulty,” and “unable to do.” Percentages are weighted to be representative of the noninstitutionalized U.S. adult population.

<sup>^</sup> Percent indicating “a lot of difficulty” or “unable to do.”

**Table 4. Summary of the Number of Any Limitations, by Impairment Group**

<b>Number of Limitations</b>	<b>U.S. Population [100%]</b>	<b>Least Impaired (z-score &gt; -1) [87%]</b>	<b>Somewhat Impaired (z-score &gt; -2 to -1) [8%]</b>	<b>Most Impaired (z-score ≤ -2) [5%]</b>
0	64.7%	74.4%	0.0%	0.0%
1	22.4%	22.6%	30.4%	7.2%
2	8.9%	3.0%	59.6%	31.3%
3 or more	4.0%	0.0%	10.0%	61.5%
Total	100%	100%	100%	100%

**Note:** Data are from the 2014-2015 National Health Interview Survey (NHIS) ( $n = 33,424$ ). 1,818 respondents were removed from the index due to missing disability responses. Response options for the five disability types are: “no difficulty,” “some difficulty,” “a lot of difficulty,” and “unable to do.” Percentages are weighted to be representative of the noninstitutionalized U.S. adult population.

**Table 5. Summary of the Number of Great Limitations (*a lot of difficulty and unable to do the function*), by Impairment Group**

<b>Number of Limitations</b>	<b>U.S. Population [100%]</b>	<b>Least Impaired (z-score &gt; -1) [87%]</b>	<b>Somewhat Impaired (z-score &gt; -2 to -1) [8%]</b>	<b>Most Impaired (z-score ≤ -2) [5%]</b>
0	91.9%	98.2%	67.5%	23.8%
1	7.0%	1.8%	30.5%	58.9%
2	0.9%	0.0%	2.0%	14.4%
3 or more	0.2%	0.0%	0.0%	2.9%
Total	100%	100%	100%	100%

**Note:** Data are from the 2014-2015 National Health Interview Survey (NHIS) ( $n = 33,424$ ). 1,818 respondents were removed from the index due to missing disability responses. Response options for the five disability types are: “no difficulty,” “some difficulty,” “a lot of difficulty,” and “unable to do.” Percentages are weighted to be representative of the noninstitutionalized U.S. adult population.

**Table 6. Summary of Socio-demographic Characteristics, by Impairment Group**

	U.S. Population [n=33,424; 100%]	Least Impaired (z-score > -1) [n=28,241; 87%] <i>reference group</i>	Somewhat Impaired (z-score > -2 to -1) [n=2,974; 8%]			Most Impaired (z-score ≤ -2) [n=2,209; 5%]		
	Weighted %	Weighted %	Weighted %	Bivariate Odds Ratios <sup>†</sup>	Multivariate Odds Ratios <sup>‡</sup>	Weighted %	Bivariate Odds Ratios <sup>†</sup>	Multivariate Odds Ratios <sup>‡</sup>
<b>Male</b>	48.4	49.7	40.8	0.70 (0.63, 0.78) <sup>***</sup>	0.84 (0.74, 0.95) <sup>**</sup>	39.0	0.65 (0.57, 0.73) <sup>***</sup>	0.86 (0.74, 0.99) <sup>*</sup>
<b>Age<sup>§</sup></b>								
18-34 years	30.3	33.5	10.0	1.06 (0.57, 1.97)	2.06 (1.05, 4.07) <sup>*</sup>	6.6	0.80 (0.40, 1.62)	1.59 (0.68, 3.74)
35-49 years	24.9	26.6	13.8	0.87 (0.57, 1.33)	2.56 (1.60, 4.10) <sup>***</sup>	13.1	0.92 (0.56, 1.51)	3.77 (2.11, 6.73) <sup>***</sup>
50-64 years	25.8	24.7	34.5	1.19 (0.95, 1.50)	3.32 (2.47, 4.46) <sup>***</sup>	31.3	1.17 (0.89, 1.54)	4.54 (3.21, 6.43) <sup>***</sup>
65-79 years	14.6	12.6	28.4	<i>reference</i>	<i>reference</i>	26.8	<i>reference</i>	<i>reference</i>
80+ years	4.5	2.6	13.4	1.27 (1.00, 1.61)	1.19 (0.93, 1.52)	22.3	2.18 (1.68, 2.82) <sup>***</sup>	2.11 (1.61, 2.77) <sup>***</sup>

<b>Insurance status</b>								
Other insurance status	79.1	84.2	50.4	<i>reference</i>	<i>reference</i>	37.0	<i>reference</i>	<i>reference</i>
Dual eligibility	2.4	1.2	6.9	9.51 (7.61, 11.87) <sup>***</sup>	3.46 (2.58, 4.64) <sup>***</sup>	15.0	28.99 (23.47, 35.82) <sup>***</sup>	7.11 (5.24, 9.64) <sup>***</sup>
Medicare alone	18.5	14.6	42.7	4.9 (4.38, 5.48) <sup>***</sup>	2.2 (1.72, 2.81) <sup>***</sup>	48.0	7.65 (6.67, 8.78) <sup>***</sup>	2.94 (2.21, 3.91) <sup>***</sup>
Missing	0.6	0.6	0.3	0.88 (0.35, 2.18)	0.89 (0.36, 2.23)	1.0	4.04 (1.78, 9.14) <sup>***</sup>	3.48 (1.34, 9.04) <sup>*</sup>
<b>English language proficiency</b>								
Very well	88.5	88.8	88.5	<i>reference</i>	<i>reference</i>	83.3	<i>reference</i>	<i>reference</i>
Well	5.8	5.7	5.5	0.96 (0.76, 1.21)	1.05 (0.8, 1.39)	7.1	1.32 (1.06, 1.64) <sup>*</sup>	1.25 (0.95, 1.65)
Not well	3.7	3.6	3.7	1.03 (0.79, 1.35)	1.04 (0.75, 1.45)	4.2	1.25 (0.95, 1.64)	1.1 (0.76, 1.59)
Not at all	2.1	1.9	2.3	1.24 (0.87, 1.76)	0.89 (0.59, 1.35)	5.4	3.12 (2.35, 4.15) <sup>***</sup>	1.77 (1.13, 2.78) <sup>*</sup>
Missing	0.0	0.0	0.0	1.40 (0.14, 13.99)	2.28 (0.17, 31.22)	0.0	0.00 (0.00, 0.00) <sup>***</sup>	0.00 (0.00, 0.00) <sup>***</sup>

<b>Education</b>								
Less than high school	12.9	11.4	18.9	1.33 (1.13, 1.56)***	1.29 (1.06, 1.57)*	28.8	1.99 (1.69, 2.34)***	1.62 (1.32, 1.98)***
High school or GED	25.1	24.3	30.4	<i>reference</i>	<i>reference</i>	30.9	<i>reference</i>	<i>reference</i>
Some college or associates degree	30.7	31.0	30.7	0.79 (0.69, 0.91)***	0.98 (0.85, 1.14)	26.3	0.67 (0.57, 0.79)***	0.92 (0.77, 1.10)
Bachelor's degree or more	30.8	32.9	19.6	0.48 (0.41, 0.56)***	0.63 (0.54, 0.75)***	12.7	0.30 (0.25, 0.37)***	0.50 (0.41, 0.62)***
Missing	0.5	0.4	0.3	0.53 (0.23, 1.24)	0.45 (0.20, 1.03)	1.2	2.28 (1.27, 4.12)**	1.61 (0.74, 3.51)
<b>Marital status</b>								
Separated	2.1	1.9	2.5	2.46 (1.78, 3.40)***	1.19 (0.85, 1.66)	3.9	3.76 (2.72, 5.19)***	1.54 (1.04, 2.29)*
Divorced	11.3	10.6	16.8	2.99 (2.49, 3.59)***	1.17 (0.95, 1.44)	16.1	2.81 (2.27, 3.47)***	0.92 (0.71, 1.18)
Married or Living with a Partner	53.1	54.0	49.7	1.73 (1.47, 2.04)***	0.86 (0.72, 1.04)	43.0	1.47 (1.2, 1.79)***	0.72 (0.57, 0.90)**
Single	27.2	29.0	15.4	<i>reference</i>	<i>reference</i>	15.7	<i>reference</i>	<i>reference</i>
Widowed	6.2	4.4	15.6	6.64 (5.51, 8.00)***	1.01 (0.80, 1.27)	21.2	8.86 (7.16, 10.97)***	0.89 (0.67, 1.17)

Missing	0.1	0.1	0.0	0.53 (0.13, 2.17)	0.20 (0.05, 0.84)*	0.2	2.09 (0.76, 5.79)	0.59 (0.15, 2.26)
<b>Race/ethnicity</b>								
American Indian/Alaska Native	0.6	0.5	1.0	1.81 (1.01, 3.24)*	1.98 (1.00, 3.94)	1.1	2.08 (1.1, 3.92)*	1.71 (0.83, 3.53)
Asian or Pacific Islander	5.6	6.0	2.9	0.44 (0.33, 0.59)***	0.57 (0.41, 0.79)***	3.1	0.51 (0.37, 0.70)***	0.57 (0.40, 0.83)**
Black	11.5	11.3	13.0	1.05 (0.91, 1.22)	1.04 (0.88, 1.24)	13.6	1.17 (0.99, 1.37)	1.04 (0.85, 1.27)
Hispanic	15.6	16.2	11.2	0.63 (0.54, 0.74)***	0.73 (0.58, 0.91)**	12.1	0.72 (0.61, 0.86)***	0.66 (0.50, 0.88)**
Multiracial	1.4	1.3	1.2	0.81 (0.53, 1.26)	1.04 (0.68, 1.6)	3.1	2.22 (1.35, 3.65)**	3.06 (1.66, 5.64)***
White	65.2	64.6	70.6	<i>reference</i>	<i>reference</i>	66.8	<i>reference</i>	<i>reference</i>
Missing	0.1	0.1	0.1	0.69 (0.16, 2.99)	1.08 (0.24, 5.01)	0.2	1.88 (0.56, 6.36)	3.35 (0.91, 12.31)
<b>Census region</b>								
Northeast	17.6	18.1	15.2	<i>reference</i>	<i>reference</i>	14.4	<i>reference</i>	<i>reference</i>
Midwest	22.3	22.2	22.7	1.22 (1.02, 1.45)*	1.29 (1.07, 1.55)**	25.0	1.41 (1.14, 1.74)**	1.64 (1.30, 2.08)***



South	37.3	36.8	41.0	1.32 (1.13, 1.55)***	1.37 (1.16, 1.62)***	39.6	1.34 (1.11, 1.62)**	1.43 (1.15, 1.76)**
West	22.7	23.0	21.1	1.09 (0.92, 1.30)	1.35 (1.12, 1.62)**	20.9	1.14 (0.93, 1.40)	1.48 (1.17, 1.87)**
<b>Household income</b>								
\$0–14,999	12.2	13.0	8.7	1.44 (1.11, 1.85)**	1.55 (1.19, 2.01)**	5.2	1.85 (1.23, 2.77)**	1.92 (1.28, 2.88)**
\$15,000– 34,999	16.0	17.5	7.7	<i>reference</i>	<i>reference</i>	3.6	<i>reference</i>	<i>reference</i>
\$35,000– 54,999	11.4	12.4	5.9	1.03 (0.76, 1.40)	1.05 (0.77, 1.43)	2.1	0.78 (0.48, 1.27)	0.84 (0.51, 1.36)
\$55,000– 74,999	6.6	7.3	2.3	0.73 (0.51, 1.06)	0.74 (0.51, 1.07)	1.0	0.59 (0.28, 1.24)	0.65 (0.31, 1.39)
\$75,000 +	9.5	10.5	3.9	0.8 (0.56, 1.13)	0.86 (0.59, 1.25)	0.6	0.27 (0.13, 0.54)***	0.33 (0.16, 0.67)**
Missing	44.3	39.3	71.4	5.33 (4.34, 6.53)***	3.07 (2.45, 3.85)***	87.5	13.8 (10.26, 18.57)***	6.86 (5.00, 9.43)***

**Note:** Data are from the 2014-2015 NHIS (n=33,424). 1,818 respondents were removed from the model due to missing disability. GED = General Education Diploma. Persons in all racial groups were non-Hispanic; persons who self-identified as Hispanic might have been any race. Model outcomes included binary (1/0) indicators for inclusion in the “somewhat impaired” and “most impaired” groups with the “least impaired” group as the referent. All results are weighted according to NHIS documentation to be representative of the noninstitutionalized U.S. adult population. Significance levels are represented as follows: \*  $0.01 \leq p < 0.05$ , \*\*  $0.001 \leq p < 0.01$ , \*\*\*  $p < 0.001$ .

† Bivariate models were run for each characteristic set one at a time.

‡ A multivariate model was run including all characteristics as predictors.

§ Linear age was included with age indicators but is not shown here.

**Appendix 1. Multivariate Regression Adjusted Models Predicting Self-Rated Health (scored 0 for poor health to 100 for excellent health) from Six and Five Disability Severity Measures, and First Degree Linear Spline Terms for Disability Severity Measures, 2014 and 2015 NHIS**

Regression results from Table A2.1 under the initial model, using all six disabilities types, showed very small positive coefficients for communication main and linear spline terms, neither of which was significantly different from zero. Using this initial model parameterization, 35 respondents that had only a communication disability at any level resulted in higher predicted health scores than respondents with no disabilities at all. Thus, to ensure that increasing disability was not associated with a better health score, we excluded communication terms as predictors from our final model and do not discuss this disability type in results, since no additional information about self-rated health was gained on top of the five other disabilities types.

**Table A2.1 Original and Final Multivariate Regression Models Results Predicting Self-Rated Health**

Respondent Characteristics	Initial Model 6 disability severities included		Final Model 5 disability severities included (excluding communication)	
	Coefficient	Standard Error	Coefficient	Standard Error
Disability types (each scored 0-3: “no difficulty” to “unable to do”)				
Vision	-4.58 ***	0.37	-4.58 ***	0.37
Hearing	-2.82 ***	0.36	-2.82 ***	0.36
Cognition	-7.06 ***	0.40	-7.03 ***	0.39
Mobility	-15.05 ***	0.42	-15.05 ***	0.42
Self-Care	-10.35 ***	0.81	-10.32 ***	0.81
Communication	0.34	0.69	--	--
Disability types linear spline (each scored 0-2: “no difficulty” and "some difficulty" to “unable to do”)				
Vision spline	3.38 **	1.04	3.44 ***	1.04
Hearing spline	1.76	0.99	1.92	0.99
Cognition spline	2.17 *	1.06	2.45 *	1.05
Mobility spline	8.29 ***	0.76	8.31 ***	0.76

Respondent Characteristics	Initial Model 6 disability severities included		Final Model 5 disability severities included (excluding communication)	
	Coefficient	Standard Error	Coefficient	Standard Error
Self-Care spline	8.45 ***	1.52	8.84 ***	1.50
Communication spline	1.45	1.49	--	--
Male	-1.83 ***	0.25	-1.83 ***	0.25
Age (continuous) [Referent: 65-79 years]	-0.36 ***	0.03	-0.35 ***	0.03
18-34 years	-12.50 ***	1.40	-12.47 ***	1.40
35-49 years	-14.03 ***	1.06	-14.01 ***	1.06
50-64 years	-12.71 ***	0.78	-12.70 ***	0.78
80 years and older	8.55 ***	0.77	8.54 ***	0.77
Dual eligibility	-5.94 ***	0.87	-5.95 ***	0.87
Medicare beneficiary	-5.53 ***	0.69	-5.51 ***	0.69
Missing Medicare status	4.02 *	1.65	4.00 *	1.65
English language proficiency				
Well	-1.77 **	0.56	-1.71 **	0.55
Not well	-2.25 **	0.72	-2.14 **	0.72
Not at all	-3.05 **	0.93	-2.93 **	0.93
Missing	-2.75	7.70	-2.76	7.70
Education [Referent: High school graduate]				
Less than high school	-3.29 ***	0.44	-3.29 ***	0.44
Some college or associates degree	2.26 ***	0.33	2.26 ***	0.33
Bachelor's degree or higher	6.87 ***	0.35	6.87 ***	0.35
Missing	0.5	1.82	0.55	1.82
Marital status [Referent: Single]				
Separated	-4.62 ***	0.89	-4.67 ***	0.89
Divorced	-0.74	0.49	-0.76	0.49

Respondent Characteristics	Initial Model 6 disability severities included		Final Model 5 disability severities included (excluding communication)	
	Coefficient	Standard Error	Coefficient	Standard Error
Married or living with a partner	1.24 ***	0.36	1.22 ***	0.35
Widowed	2.32 ***	0.67	2.29 ***	0.67
Missing	-2.85	3.30	-2.92	3.30
Race/Ethnicity [Referent: non-Hispanic White]				
Hispanic	-2.13 ***	0.41	-2.14 ***	0.41
Black	-4.04 ***	0.40	-4.03 ***	0.40
American Indian/Alaska Native	-3.60 *	1.59	-3.61 *	1.59
Asian or Pacific Islander	-2.10 ***	0.57	-2.09 ***	0.57
Multiracial	-1.94	1.03	-1.95	1.03
Missing	-1.76	3.77	-1.76	3.77
Census Region [Referent: Northeast]				
Midwest	-0.66	0.39	-0.67	0.39
South	-0.49	0.35	-0.49	0.35
West	0.43	0.39	0.42	0.39
Household Income [Referent: \$15,000-\$34,999]				
\$0 - \$14,999	-1.95 ***	0.47	-1.95 ***	0.47
\$35,000-\$54,999	1.63 **	0.49	1.63 **	0.49
\$55,000-74,999	1.79 ***	0.54	1.80 ***	0.54
\$75,000 and over	4.88 ***	0.50	4.89 ***	0.50
Missing	-4.44 ***	0.40	-4.43 ***	0.40
Intercept	102.69 ***	2.12	102.65 ***	2.12

Respondent Characteristics	Initial Model 6 disability severities included		Final Model 5 disability severities included (excluding communication)	
	Coefficient	Standard Error	Coefficient	Standard Error

**Notes:** Persons in all racial groups were non-Hispanic; persons who self-identified as Hispanic might have been any race. Cell entries represent the coefficients from a regression model that predicts self-rated health (linearly scored 0-100, where 0 represents poor health and 100 represents excellent health) from all respondent characteristics shown in the table. A statistically significant negative coefficient indicates a characteristic that is associated with worse self-rated health; a statistically significant positive coefficient indicates a characteristic associated with better self-rated health. Significance levels are represented as follows: \*  $0.01 \leq p < 0.05$ , \*\*  $0.001 \leq p < 0.01$ , \*\*\*  $p < 0.001$ .

Estimates and standard errors are calculated from weighted 2014 and 2015 National Health Interview Survey (NHIS) data. 1,818 respondents were removed from the model due to missing disability responses; an additional 16 respondents were not used in the underlying predictive model due to missing general health status. Estimates were weighted according to guidelines published by the NHIS to represent the noninstitutionalized U.S. adult population. See Center for Disease Control and Prevention (June 2016). Responses are taken from adults 18 and older in the NHIS AFD 2014 and 2015 data. Only bolded disability types and disability spline terms were allowed to vary when calculating the Disability Index score. Socio-demographic adjusters were fixed to the population average.