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Research Article

Living Longer, With or Without Disability? A Global and Longitudinal Perspective

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Abstract

Background: Significant gains in life expectancy have been achieved, but living longer does not necessarily mean the years gained are productive and healthy. Different theories predict different patterns of time trends in old-age disability prevalence.
Methods: Using the Gateway to Global Aging Data, which provides internationally harmonized longitudinal data from the Health and Retirement Study and its sister surveys, we compare time trends (from 2004 to 2014) in disability prevalence across countries.
Results: Disability prevalence varies greatly across countries, and divergent time trends are observed across countries. For countries such as Belgium, Czechia, and Mexico, we observe an increase of disability prevalence, whereas in countries such as Denmark, England, Greece, Korea, Poland, and Sweden, we observe a substantial decrease in disability prevalence. Looking further into the severity of disability, we often observe differential trends in prevalence, but there is no evidence supporting the dynamic equilibrium hypothesis that predicts increased prevalence of modest disability but a decrease in severe disability prevalence.
Conclusions: Significant gains in life expectancy have translated into different gains in healthy years of life across different countries. Diverse time trends in disability prevalence across countries reaffirm that the expansion of late-life disability is not inevitable.

Keywords: Disability, Activities of daily living, Cross-country comparison, Trends

Significant gains in life expectancy have been achieved in recent years. Globally, life expectancy at birth rose from 67.2 to 70.8 years between 2000–2005 and 2010–2015 (1). The population aged 60 or over is growing faster than all younger age groups. This phenomenon of population aging is occurring throughout the world. In 2017, there were an estimated 962 million people aged 60 or older, comprising 13% of the global population with Europe having the greatest percentage at 25%. With rapid aging projected to continue, by 2050 all regions of the world except Africa will have 25% or more of their populations at ages 60 and older.

This dramatic increase is mainly related to the drastic fall in mortality among the older adults (2,3). The finding that mortality has been delayed considerably raises another important question of whether the years gained or to be gained would be productive and healthy. Despite enormous personal and societal implications, our current understanding of the functional status of the older population globally is limited. Several country-specific studies report time trends for disability prevalence of the older population, but mostly in selected developed countries such as the United States and Japan (4–6). Particularly, international comparisons of time trends in disability prevalence have been quite limited (7).

Different theories yield different predictions about the likely effect of the rising life expectancy on the disability prevalence rate (8). Specifically, noting advances in medicine as the main causal driver of rising life expectancy, Gruenberg proposed the disability expansion hypothesis (9). If increase in life expectancy is driven mainly by the increasing capabilities of medicine to prevent fatal outcomes from degenerative diseases (while everything else about their epidemiology stays more or less the same), then medical advances push down the case fatality rates, but these survivors are more likely to live in disability (10). This theory also posits that more people living to older ages, at which the risk of chronic, nonfatal diseases, and therefore, the likelihood of developing disability are higher. As a result, an increasing time trend in disability prevalence is predicted at population level.

Fries on the other hand proposed the compression of morbidity: resulting from disease prevention efforts by individuals and institutions and behavioral changes, the onset of diseases and disability would be postponed closer to the end of life, whereas the rise in life expectancy is stagnating, reaching its natural limit (11). The compression of disability would manifest itself through declining rates of age-specific disability prevalence in this case. However, the stagnation of life expectancy has been criticized heavily (10), and therefore, whether delay in age of disability onset would be sufficient to shorten the period of disability becomes an empirical question. Combinations of improvements in disability prevention, disability treatment, and longevity of disabled and nondisabled individuals may lead to complex patterns. For example, a combination of improved disability prevention and treatment may lead to lower prevalence at each age but increased longevity of individuals with disability and higher prevalence at the population level due to the larger number of individuals surviving to older ages with disabilities. Therefore, the time trend in disability prevalence is ambivalent under the compression theory.

Manton proposed a dynamic equilibrium hypothesis, which offers an alternate view of the disablement process by highlighting the significance of delay in the progression from less severe to more severe disabled status (12). This hypothesis can be contrasted with the expansion hypothesis, highlighting the postponement of death through life-saving devices, and the compression hypothesis, highlighting the postponement of disability onset (10). Hypothesizing the delay in the progression from modest to severe disability, the dynamic equilibrium hypothesis predicts the increase in moderate disability prevalence at population level, but a decrease in severe disability prevalence.

Prior empirical evidence from selected developed countries suggests mixed finding without rendering a full support for the hypotheses aforementioned (4,7,10). In this study, we use internationally comparable data to compare the time trend in disability prevalence rates in 17 countries across different levels of economic development. We also examine which of the above late-life disability theories is better supported by current evidence for each country.

Methods

Data

We use the harmonized data files that the Gateway to Global Aging Data, an NIH-funded data and information portal, provides for cross-country analysis, using the Health and Retirement Study (HRS)-family surveys in the United States, Mexico, Europe, and Asia. The HRS is a panel study that surveys a representative sample of Americans over the age of 50 and their spouses (of any age). It has been conducted since 1992.

Since 2001, a growing number of sister studies that are purposefully designed to be comparable with the HRS have been initiated across the world, including the English Longitudinal Study of Ageing (ELSA), the Survey of Health, Ageing, and Retirement in Europe (SHARE), the Korean Longitudinal Study of Aging (KLoSA), the Mexican Health and Aging Study (MHAS), and the Chinese Health and Retirement Longitudinal Study (CHARLS). These HRS-family surveys are coordinated with the explicit goal of facilitating cross-country comparisons. Characteristics that apply to most or all of these studies are (i) biennial interviews with respondents and their spouses; (ii) a multidisciplinary questionnaire design that elicits a wealth of information about health, socioeconomic status, demographics, and other topics; and (iii) regular refreshment samples to keep the sample representative of the older population. The details about each survey, their sample sizes, and design features are summarized in Table 1.

There are some notable exceptions to the questionnaire frequency, respondent age, and spouse inclusion for these surveys. Although the majority of surveys conduct interviews biennially, the MHAS experienced a 9-year interval between waves 2 and 3. MHAS, ELSA, and SHARE interview respondents aged 50 and older, the HRS interviews respondents aged 51 and older, KLoSA and CHARLS interview respondents aged 45 and older. The exception to the inclusion of spouses regardless of age is KLoSA that interviews only age-eligible spouses. It is also important to note that the number of countries included in SHARE varies across waves (subject to funding of individual countries). We included the following SHARE countries in our analysis based on the criteria that the number of respondent records for a European country must be greater than 4,000, and there must be more than one wave of data for the country. As a result, we included Austria, Belgium, Czechia, Denmark, Estonia, France, Germany, Greece, Italy, Netherlands, Poland, Slovenia, Spain, Sweden, and Switzerland.

Despite the high degree of coordination, there are numerous small differences ranging from different variable names to blocks of questions about country-specific health care systems or pension

Table 1. Description of HRS-Family Studies

Survey	HRS	MHAS	ELSA	SHARE	KLoSA	CHARLS
Country	United States	Mexico	England	Europe[a]	Korea	China
Age eligibility	51+	50+	50+	50+	45+	45+
One or all eligible person	One	One	All	One	All	One
Spouse inclusion	Regardless of age	Regardless of age	Regardless of age	Regardless of age	Only if age eligible	Regardless of age
Year started	1992	2001	2002	2004	2006	2011
Sample refreshment	Every 3 waves	Wave 3	Waves 3, 4, 6, 7	Waves 2, 4, 5, 6	Wave 5	None
Baseline sample size	12,652	15,186	12,099	30,451	10,254	17,708
Number of individuals	37,495	22,016	18,489	105,316	10,254	24,958
Number of waves	13	4	8	6	6	3
Waves included	5–12	1–4	1–7	1, 2, 4-6[b]	1–4	1, 2, 4

Notes: [a]SHARE covers 28 countries, 27 European countries and Israel, but we included only countries in which the number of respondent records was greater than 4,000 and having more than one wave of data. Hence, we included Austria, Belgium, Czechia, Denmark, Estonia, France, Germany, Greece, Italy, Netherlands, Poland, Slovenia, Spain, Sweden, and Switzerland. Sample sizes refer to these countries only.

[b]SHARE did not conduct longitudinal interviews for Wave 3, and instead collected life-history information.

Sources: RAND HRS Version P (United States), Harmonized MHAS Version A (Mexico), Harmonized ELSA Version D (England), Harmonized SHARE Version D (Europe), Harmonized KLoSA Version B (South Korea), and Harmonized CHARLS Version B.4 (China).

systems. The Gateway to Global Aging Data has developed harmonized versions of these data sources that use consistent variable names and definitions, in user-friendly longitudinal files. These are the files we use in this study. The analysis data are from the RAND HRS Version P (United States), Harmonized MHAS Version A (Mexico), Harmonized ELSA Version D (England), Harmonized SHARE Version D (Europe), Harmonized KLoSA Version B (South Korea), and Harmonized CHARLS Version B.4 (China).

We use data from the waves conducted in the 2000–2015 period. All surveys ask respondents whether they have difficulty with (or that they cannot or do not do) any of a set of basic activities of daily living, including bathing, dressing, feeding, toileting, and getting in or out of bed. Disability is a binary variable, indicating any difficulty in at least one of the activities of daily living. We also create a binary indicator of severe disability, defined by difficulties with three or more of these activities of daily living. Individuals with severe disability are probably in need of more extensive personal assistance and use more resources.

Statistical Analysis

All analyses were performed using Stata (13). Unless otherwise stated, all our analyses use the sampling weights provided by the surveys to ensure representativeness for the sampled population in each wave in each country. We present descriptive analyses for specific countries and years, which are simple (weighted) averages and percentages. The years we focus on are 2004 and 2014, but if these years are not available for a country, we use the closest available year, provided it is not more than 2 years away. In addition, as the changes in population age structure might contribute to changes in disability prevalence rates, we present age-adjusted estimates, following the WHO standard population (14). Standard errors account for clustering at the individual level whenever data from multiple waves are combined.

We formally test two hypotheses for disability prevalence trends, the expansion of disability hypothesis and the dynamic equilibrium hypothesis. The expansion of disability hypothesis predicts an increasing trend in disability prevalence, and the dynamic equilibrium hypothesis posits an increasing trend in modest disability and a decreasing trend in severe disability. The compression of disability theory does not yield a testable hypothesis on disability trends, as discussed earlier. We test each hypothesis separately for each country (see Supplementary Material, Hypothesis Testing, for more details).

Results

Cross-country Variation in Disability Prevalence

Table 2 presents both population-representative and age-adjusted disability prevalence rates among ages 60+ and analogous severe disability prevalence rates among ages 80+. The age thresholds of 60 and 80 are chosen, as these are the age groups often referred to as the older adults and the oldest old (15). There is substantial cross-country variation in disability prevalence: the prevalence rate among ages 60+ in the unhealthiest country is about four times as high as that in the healthiest country in both 2004 and 2014.

Although there is a positive correlation between disability prevalence among ages 60+ and severe disability prevalence among ages

Table 2. Time Trends in Disability Prevalence Rates (in %) by Country

Country	Disability Prevalence Among Ages 60+								Severe Disability Prevalence Among Ages 80+							
	2004				2014				2004				2014			
	Pop. Repr.	*SE*	Age Adj.	*SE*	Pop. Repr.	*SE*	Age Adj.	*SE*	Pop. Repr.	*SE*	Age Adj.	*SE*	Pop. Repr.	*SE*	Age Adj.	*SE*
Austria	12.6	1.1	11.0	0.9	13.7	0.7	10.7	0.6	6.9	2.1	7.0	2.2	16.9	1.8	16.2	1.8
Belgium	16.9	0.9	14.9	0.7	19.8	0.7	16.8	0.6	8.9	1.6	9.7	1.6	10.5	1.1	9.8	1.0
China					21.7	0.5	26.4	0.6					6.0	0.7	17.2	2.2
Czechia	10.2	0.9	9.8	0.9	15.3	0.7	14.6	0.7	4.4	1.4	4.5	1.4	11.3	1.7	12.1	1.7
Denmark	13.4	1.1	11.8	1.0	10.5	0.7	9.4	0.6	8.4	2.1	8.7	2.0	8.5	1.5	8.3	1.5
England	25.4	0.6	23.1	0.5	20.2	0.5	18.3	0.5	9.3	0.9	9.1	0.9	9.8	1.0	9.1	0.9
Estonia					17.8	0.6	15.2	0.6					11.1	1.1	11.6	1.2
France	16.6	0.9	13.7	0.8	17.6	0.7	14.1	0.6	9.6	1.6	9.5	1.6	11.2	1.3	10.6	1.2
Germany	13.7	0.9	12.9	0.8	15.5	0.8	13.2	0.6	7.8	2.2	9.1	2.4	12.8	1.8	12.4	1.7
Greece	13.1	0.9	11.5	0.8	11.4	0.6	8.8	0.4	11.3	2.0	10.7	1.9	8.3	1.1	9.3	1.2
Italy	16.0	1.1	14.4	0.9	16.0	0.7	12.2	0.5	12.3	2.7	14.1	2.6	16.8	1.7	17.2	1.7
Korea	7.1	0.4	8.0	0.4	5.7	0.3	5.6	0.3	15.0	1.5	15.8	1.5	12.7	1.2	13.5	1.2
Mexico	12.0	0.8	11.5	0.7	19.8	0.8	19.5	0.8	15.5	3.1	14.6	2.8	14.3	1.4	15.5	1.5
Netherlands	10.6	0.9	9.3	0.8	9.5	0.6	8.3	0.5	10.4	2.4	10.6	2.3	7.9	1.5	7.9	1.4
Poland	30.8	1.4	28.9	1.3	20.1	1.3	18.5	1.2	22.2	3.3	22.7	3.4	18.3	2.9	17.6	2.8
Slovenia					14.8	0.7	13.2	0.6					11.9	1.5	12.4	1.6
Spain	15.4	1.0	13.0	0.8	16.2	0.8	12.3	0.7	14.8	2.4	14.4	2.3	18.4	1.6	17.1	1.4
Sweden	13.4	0.9	10.4	0.7	10.3	0.6	9.0	0.5	11.2	2.0	10.8	2.0	3.9	0.8	3.5	0.8
Switzerland	9.5	1.3	8.6	1.1	8.6	0.6	7.0	0.5	1.8	1.3	2.0	1.4	2.8	0.8	2.8	0.8
United States	15.9	0.4	14.9	0.3	16.5	0.4	15.6	0.4	7.4	0.5	7.5	0.5	10.0	0.6	9.3	0.6
Range	23.7		20.9		16.0		20.8		20.4		20.7		15.6		14.7	
Ratio	4.3		3.6		3.8		4.7		12.5		11.4		6.5		6.2	

Notes: Pop. Repr. = population representative; Age Adj. = age adjusted. All numbers except "ratio" in percent. Range is difference between highest and lowest in the column; ratio is the ratio of highest to lowest in the column. For some countries, data for 2004 or 2014 were not available and a different year was used: For 2004, 2003 was used for Mexico and 2006 for Czechia, Korea, and Poland. For 2014, 2012 was used for Korea and the Netherlands, and 2015 for Mexico and China. Cells for 2004 are blank for China, Estonia, and Slovenia because no close year was available.

80+, the relationship is far from perfect. For example, England has a relatively high disability rate among ages 60+ (25.4% in 2004 and 20.2% in 2014), but its severe disability rate among ages 80+ is relatively low (9.3% in 2004 and 9.8% in 2014). Conversely, in Korea, the disability rate among ages 60+ is very low (7.1% in 2004 and 5.7% in 2014), but the severe disability rate among ages 80+ is moderately high (15.0% in 2004 and 12.7% in 2014).

We also observe diverse time trends in disability prevalence across countries, as shown in Figure 1. For countries such as Denmark, England, Greece, Korea, Poland, and Sweden, disability prevalence among ages 60+ has dropped substantially from 2004 to 2014. In contrast, in countries such as Mexico, Czechia, and Belgium, the disability prevalence rate has increased during this period.

After adjusting for age, we continue to observe cross-country variation in time trends (Table 2). We observe a large drop in age-adjusted disability prevalence rates in Poland (10.4% age points) and England (4.8% age points), whereas the decreases in Sweden (1.4% age points), and Denmark (2.4% age points) are more modest, and we see substantial increases in Mexico (8.0% age points) and Czechia (4.8%age points) in age-adjusted disability prevalence rates.

The range of country-specific disability prevalence rates among ages 60+ suggests a decrease in cross-country differences from 2004 to 2014, but after adjusting for age, this pattern disappears. However, the cross-country differences in severe disability prevalence rates among age 80+ have decreased substantially even after adjusting for age, which is also the case for the ratio measure. In 2004, the severe disability prevalence rate in the country with the highest rate was 11 times that of the country with the lowest rate, but in 2014, that ratio had decreased to six times.

We further look into severe disabilities among individuals 80 years and older. We observe a noticeable prevalence increase between 2004 and 2014 in Austria (6.9%–16.9%), Czechia (4.4%–11.3%), Germany (7.8%–12.8%), and the United States (7.4%–10.0%), but a decrease in Sweden (11.2%–3.9%). These changes persist after adjustment for age, as given in Table 2.

The trends in severe disability often differ from the trends in modest disability, as shown in Figure 2. For example, the severe disability rates among ages 80+ increased in Mexico, whereas the modest disability rates among ages 60+ decreased. Conversely, severe disability rates among ages 80+ dropped in Italy, whereas modest disability rates among ages 60+ increased. In other countries, the trends in modest and severe disability are consistent. For sample, in Poland, both modest and severe disability prevalence rates increased from 2004 to 2014, whereas in Czechia, both disability prevalence rates dropped. Yet, in other countries such as Sweden and Greece, severe disability prevalence rates increased, whereas modest disability remained stable. In contrast, in countries such as England and Denmark, modest disability rates increased, whereas severe disability remained stable.

Hypothesis Test Results

The expansion hypothesis predicts an increase in disability prevalence. We conducted the one-sided test for a positive change in disability prevalence from 2004 to 2014 for each country. We found a pattern that is consistent with the hypothesis in 9 out of 17 countries, but the predicted increase is statistically significant at the 5% level in only three countries: Belgium, Czechia, and Mexico. Moreover, we find more evidence against the expansion theory with statistically significant decreases in disability prevalence rates in six countries: Denmark, England, Greece, Korea, Poland, and Sweden.

The dynamic equilibrium hypothesis predicts an increase in modest disability prevalence and a decrease in severe disability prevalence. We conducted two separate one-sided tests for an increasing trend in modest disability and a decreasing trend in severe disability rate for each country. We found that in five countries, the estimated change in moderate disability was positive, with statistical significance at the 5% level in three of them (Belgium, Czechia, and Mexico). Conversely, five countries (Denmark, England, Italy, Korea, and Poland) saw a statistically significant decrease in moderate disability. There were seven countries with a decrease in severe disability rates, with statistical significance at the 5% level in three of them (England, Poland, and Sweden). Of the 10 countries with an increase in severe disability, eight were statistically significant (Austria,

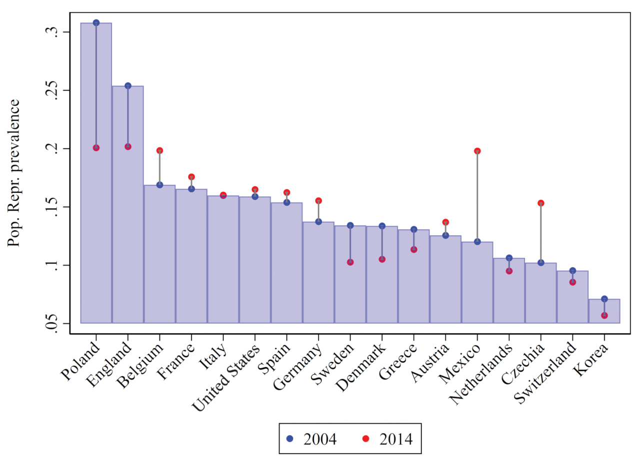

Figure 1. Time trend in disability prevalence rates among ages 60+. Pop. Repr. = population representative. For some countries, data for 2004 or 2014 were not available, and a different year was used. For 2004, 2003 was used for Mexico and 2006 for Czechia, Korea, and Poland. For 2014, 2012 was used for Korea and the Netherlands and 2015 for Mexico. China, Estonia, and Slovenia have been omitted because no data were available within 2 years of 2004.

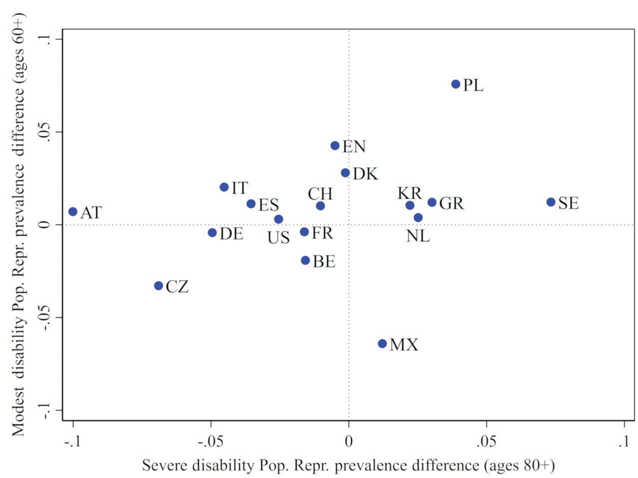

Figure 2. Trends in modest and severe disability prevalence rates by country (2004 vs. 2014). Pop. Repr. = population representative. The prevalence difference is the disability rate in 2004 minus the 2014 disability rate. AT = Austria, BE = Belgium, CZ = Czechia, DK = Denmark, EN = England, FR = France, DE = Germany, GR = Greece, IT = Italy, KR = Korea, MX = Mexico, NL = Netherlands, PL = Poland, ES = Spain, SE = Sweden, CH = Switzerland, US = United States.

Belgium, Czechia, Germany, Italy, Mexico, Spain, and United States). Combining the results from the two tests, there are no countries in which both coefficients have the sign predicted by the dynamic equilibrium hypothesis. In 12 out of 17 countries, at least one of the coefficients is statistically significant in the opposite direction providing strong evidence against the dynamic equilibrium hypothesis; in four countries, the two coefficients have the same sign, but neither is statistically significant. The remaining country (Sweden) comes closest to supporting the dynamic equilibrium hypothesis, with a significant decrease in severe disability and a nonsignificant decrease in moderate disability. In summary, there is no supporting evidence for the dynamic equilibrium hypothesis, and in fact, there is overwhelming evidence against it.

Discussion

In this study, we used harmonized data from the Gateway to Global Aging Data to analyze disability prevalence in the United States, Mexico, and multiple countries in Europe and Asia. We find substantial cross-country variation in prevalence rates of disability building on the earlier cross-sectional analysis (16). The disability prevalence rate among ages 60+ in the unhealthiest country is about four times as high as that in the healthiest country, and after age adjustment, cross-country differences in the disability prevalence rates remained stable.

The prevalence rate of severe disability, which is an important determinant of long-term care demands, shows even greater cross-country variations. In 2014, the country with the highest severe disability rates among ages 80+ has more than six times higher rates than the country with the lowest severe disability rates. Although this cross-country variation has substantially reduced from 2004, such significant cross-country difference calls for attention from both researchers and policy makers.

Although there is close association between disability prevalence rates among ages 60+ and severe disability prevalence rates among ages 80+, the relationship differs by country substantially, suggesting the progression to severe disability occurs at different ages and at different rates across countries. For example, England and the United States have relatively high disability prevalence among ages 60+, but low severe disability prevalence among ages 80+, suggesting slow progression to severe disability, whereas the opposite pattern is observed in South Korea. The exact reasons for these patterns are not entirely clear. One possibility is that how individuals and health care systems respond to initial development of disability may differ across countries. For example, poverty is an important risk factor for disability, and Korea has the highest elderly poverty rate among OECD countries at 49.6% (17). A recent study indicated that older Korean adults with low income have a higher financial burden of health expenditure and less health service utilization, which could result in further and more rapid progression of disabilities (18). As some countries do much better in keeping their disability rates low whereas others do poorly, it is important to further study which factors may have contributed to such cross-country differences.

There are different theories on how an increase in life expectancy may lead to different time trends in disability. Over the 10-year time period from 2004 to 2014, we observe diverse time trends in disability prevalence across countries. These findings do not yield empirical support for the expansion of neither disability hypothesis nor the dynamic equilibrium hypothesis (8–10). Out of 17 countries that we studied, we observe an increasing trend of disability in only three countries: Belgium, Czechia, and Mexico. There is not a single country that shows the consistent pattern of increasing moderate disability and decreasing severe disability prevalence, as the dynamic equilibrium hypothesis predicted.

This study has many strengths: It is based on rich longitudinal data, which has allowed us to examine the time trends in disability prevalence in 17 countries. The data used are from nationally representative samples and most have sample sizes large enough for adequate statistical power. Another strength is that the data used have been collected with the aim of comparability across countries, and we have used harmonized measures of disability, making the data directly comparable.

Some limitations should also be noted. We have focused on difficulties with activities of daily living as the measure of disability. However, disability is complex. We may not be able to extrapolate our findings to other domains of disability, such as instrumental activities of daily living or mobility impairments. Although we compare trends in disability prevalence in a large number of countries, we were not able to examine many low-income countries due to the data unavailability. For example, we are not able to show trends of decreasing disability prevalence in China as other studies have found due to data limitations (15). We also did not explicitly test the compression hypothesis in this article, as the compression hypothesis did not posit specific hypothesis regarding the trends in disability prevalence. Given that we do not find supporting evidence for both the expansion hypothesis and the dynamic equilibrium hypothesis, further investigation of the compression hypothesis would be important.

Despite these limitations, our study is one of the first studies that provides empirical evidence on trends in disability prevalence across 17 countries from three continents. Using internationally comparable data, we examine disability prevalence over a 10-year time period across countries, discovering diverse time trends. Exploiting rich longitudinal data, we empirically test and reject the disability expansion and the dynamic equilibrium hypotheses.

Finally, it is important to note that differential time trends in severe disability prevalence have important policy implications, as severe disability are closely tied to demands for long-term care. For accurate forecasts of future demands for long-term care, trends in severe disability prevalence need to be estimated as precisely as possible, and further trends in severe disability can be modifiable, as demonstrated by divergent time trends across various countries.

Supplementary Material

Supplementary data is available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

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Conflict of Interest

None reported.

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