How Does Mortality Among Disability-Program Beneficiaries Compare with That of the General Population? A Summary of Actuarial Estimates

by Javier Meseguer*

Using period mortality estimates published in Social Security Administration actuarial studies, this article compares the mortality experiences of Disability Insurance (DI) beneficiaries and the general population for various periods 1970–2015 with historical comparisons from as early as 1900. Advances (and setbacks) in health care and other factors have contributed to trends and fluctuations in mortality rates overall and for DI beneficiaries. Legislative changes and administrative factors have additionally affected trends in DI awards, benefit terminations, diagnostic distributions, and mortality for beneficiaries. Although the longevity gap between the general population and DI beneficiaries has narrowed in recent decades, it remains large as of 2015. For example, DI beneficiaries aged 25 and older in their first year on the rolls have faced mortality rates far exceeding those associated with the 1918 influenza pandemic for the general public at those ages.

Introduction

How does the mortality experience of Disability Insurance (DI) beneficiaries compare with that of the general population? Since at least the late 1970s, the Social Security Administration's (SSA's) Office of the Chief Actuary (OCACT) has published a number of studies estimating the period mortality and, in some cases, life expectancy of DI disabled-worker beneficiaries, covering study periods that, taken together, encompass more than three decades (the 1970s, 1990s, and 2000s, as well as 2011–2015). Because mortality among DI beneficiaries is highest in the first few years of benefit receipt, the estimates are calculated both by age and for different durations of survival on the disability rolls. In this article, I analyze estimates published in nine SSA actuarial studies:

- Study No. 74. "Graduated select and ultimate death termination rates for male and female disabled workers, 1968–1974 OASDI [Old-Age, Survivors, and Disability Insurance] experience" (Bayo and Wilkin 1977, Tables 8–9).
- Study No. 75. "Graduated select and ultimate death termination rates for male and female disabled workers, 1973–1976 OASDI experience" (Bayo, Goss, and Weissman 1978, Tables 9–10).
- Study No. 81. "Graduated select and ultimate death termination rates for male and female disabled workers, 1975–1978 OASDI experience" (Schobel 1980, Tables 4–5).
- Study No. 93. "Male and female death rates by calendar age at entitlement and duration of disability per 1,000 currently entitled from the

Selected Abbreviations

AIDS	acquired immunodeficiency syndrome
CDR	continuing disability review
DDS	Disability Determination Service
DI	Disability Insurance
FRA	full retirement age
HAART	highly active antiretroviral therapy

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Selected Abbreviations—*Continued*

HIV	human immunodeficiency virus
OASDI	Old-Age, Survivors, and Disability Insurance
OASI	Old-Age and Survivors Insurance
OCACT	Office of the Chief Actuary
SSA	Social Security Administration
SSI	Supplemental Security Income

1977–1980 Disabled Worker Termination Study" (Kelley and Lopez 1984, Tables 5–6).

- Study No. 114. "DI male and female disabled worker probability of death (1991–1995 Social Security disability experience)" and "DI male and female disabled worker expected future lifetime (1991–1995 Social Security disability experience)" (Zayatz 1999, Tables 7A–7B and 12A–12B).
- Study No. 118. "Male and female disabled workers probability of death (1996–2000 Social Security DI disability experience)" and "Male and female disabled workers expected future lifetime (1996–2000 Social Security DI disability experience)" (Zayatz 2005, Tables 7A–7B and 9A–9B).
- Study No. 122. "Male and female disabled workers probability of death (2001–2005 Social Security DI disability experience)" and "Male and female disabled workers expected future lifetime (2001–2005 Social Security DI disability experience)" (Zayatz 2011, Tables 7A–7B and 9A–9B).
- Study No. 123. "Male and female disabled workers probability of death (2006–2010 Social Security DI disability experience)" and "Male and female disabled workers expected future time on combined DI and OASI [Old-Age and Survivors Insurance] rolls (excluding possibility of recovery) (2006–2010 Social Security DI disability experience)" (Zayatz 2015, Tables 7A–7B and 9A–9B).
- Study No. 125. "Male and female disabled workers probability of death (2011–2015 Social Security DI disability experience)" and "Male and female disabled workers expected future time on combined DI and OASI rolls (excluding possibility of recovery) (2011–2015 Social Security DI disability experience)" (Barrick-Funk 2020, Tables 7A–7B and 9A–9B).

This article consists of eight sections, including this introduction. The next section provides a chronology of demographic, economic, epidemiological, and regulatory events that have affected the disability program and influenced mortality among the pool of DI beneficiaries. The third section reports DI period mortality by age and sex over different periods of survival on the rolls and includes absolute and relative comparisons with both historical and contemporaneous (same-period) mortality in the general population. The fourth section centers on period life expectancy, focusing on the years of premature death associated with qualifying for DI benefits. The fifth section discusses two recent distributional trends that have likely contributed to mortality decline among DI beneficiaries: the changing composition of the beneficiary population by diagnostic group and the growing role of medical-vocational considerations in determining disability-benefit eligibility. The sixth section addresses the widening gap in mortality and life expectancy for people with different earnings and education levels in the general population. This distributional gap is particularly pertinent, given that DI beneficiaries tend to have lower earnings and educational attainment prior to disability onset. The seventh section discusses the interaction between mortality, morbidity, and the ability to work, as well as ongoing trends in self-reported disability measured in national surveys. Chronic disorders are becoming the main cause of death at older ages, suggesting that a longer life may not necessarily be a healthy one and that increasing life expectancy may be problematic as a measure of improvement in the average health of the population. A summary section concludes the article.

Factors Affecting Mortality Among DI Beneficiaries: A Chronology

DI is funded through payroll tax contributions and aims to protect workers who cannot work because of a disability. State Disability Determination Service (DDS) agencies make the initial medical determination of benefit eligibility, although denied claimants can pursue multiple levels of appeal or can reapply. SSA assesses disability through a sequential evaluation process, described in detail in Wixon and Strand (2013). If a claimant has an impairment that is severe but does not meet or equal the medical criteria contained in SSA's Listing of Impairments,[1] the agency evaluates the applicant's ability to do past work, based on his or her physical and mental residual functional capacity (RFC). RFC accounts for the claimant's medically related exertional and nonexertional limitations (such as capacity to stand, lift, and understand or follow instructions). If the claimant is unable to do past work, factors known as vocational considerations are

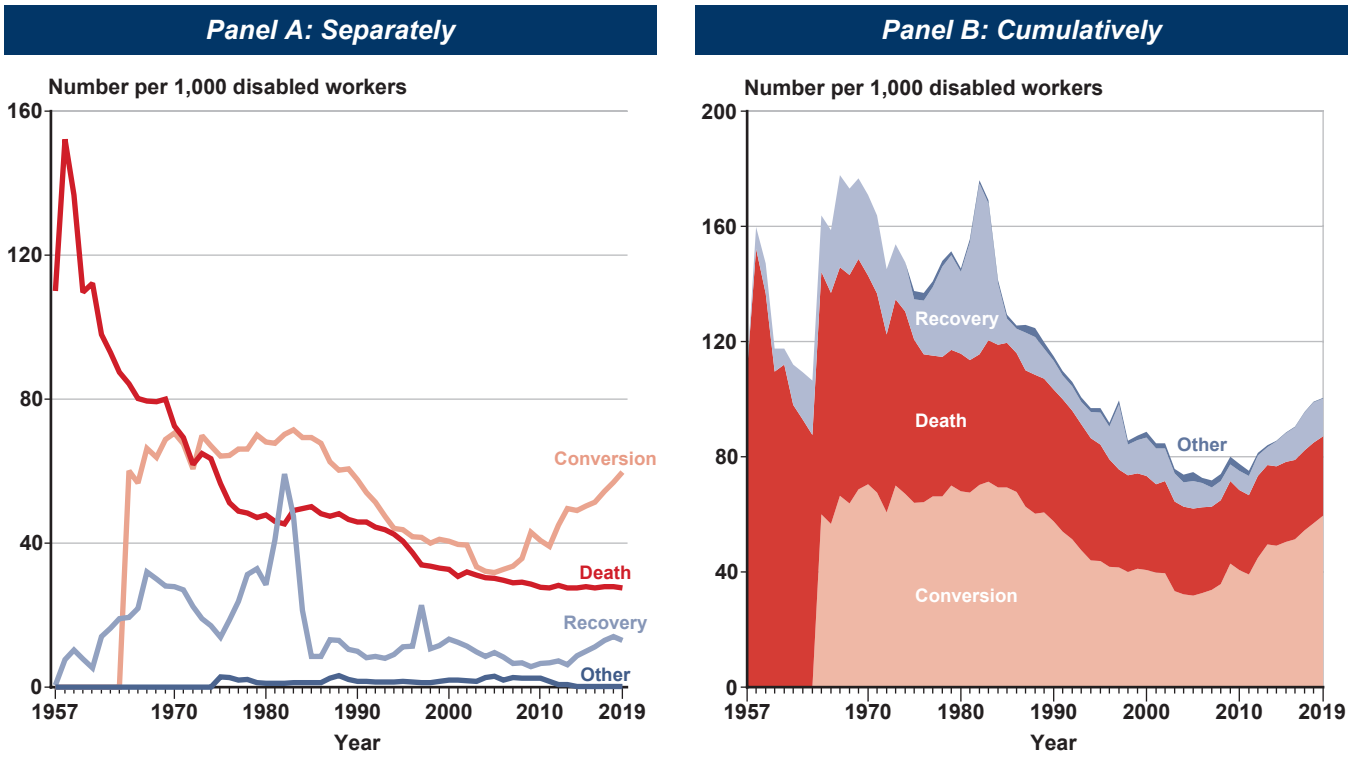
then used to determine the claimant's ability to do any other work in the national economy. For a given RFC (for example, ability to do sedentary work versus light or heavy work), age, education, past work experience, and transferable skills provide a decisional framework commonly referred to as the vocational grid. Age, for example, is a vocational factor because older workers are assumed to have a harder time adjusting to new work environments and learning new skills.

Broad trends in DI program entry and exit are affected by economic, demographic, technological, administrative, and regulatory factors in addition to an individual's medical condition. This section provides a chronology of events that may have influenced the relative health of beneficiaries entering and exiting the rolls in a given period, which might contribute to changes in the mortality experience of beneficiaries over time.[2] The discussion proceeds chronologically, with subsections dedicated to various periods from the 1950s to the present, although certain themes and topics are relevant to and discussed in more than one subsection.

The 1950s and 1960s

The first disability cash benefits were paid in 1957 to disabled workers aged 50–64 with a permanent disability. Throughout the 1960s, legislative changes to the DI program expanded eligibility substantially. For instance, the age-50 requirement was dropped in 1960, enabling younger disabled applicants to enter the rolls. The effects of removing the age-50 requirement had largely been absorbed by 1965, when the definition of a qualifying disability was changed from "permanent" to "expected to last at least 12 months," thereby expanding the pool of potential beneficiaries.[3] In 1967, legislation relaxed the insured-status requirements for individuals younger than 31, making it easier for workers in their 20s to qualify for benefits. Given the enormous differences in eligibility criteria that these legislative changes brought about, the mortality experience of DI beneficiaries before the late 1960s is not comparable with that of beneficiaries in subsequent periods. As shown in Chart 1, there were about 152 deaths per thousand beneficiaries in 1958, compared with 72.5 by 1970.

Chart 1.
DI disabled-worker benefit gross termination rates (age-unadjusted), by reason, 1957–2019



SOURCES: Schobel (1980, Table 3); Kelley and Lopez (1984, Table 4); Zayatz (1999, 2005, 2011, 2015, Table 5); and Barrick-Funk (2020, Table 5).

NOTE: Conversion to OASI retired-worker benefits occurs automatically at full retirement age (FRA). "Other" consists largely of elective OASI conversions at ages 62 to FRA.

1970–1975

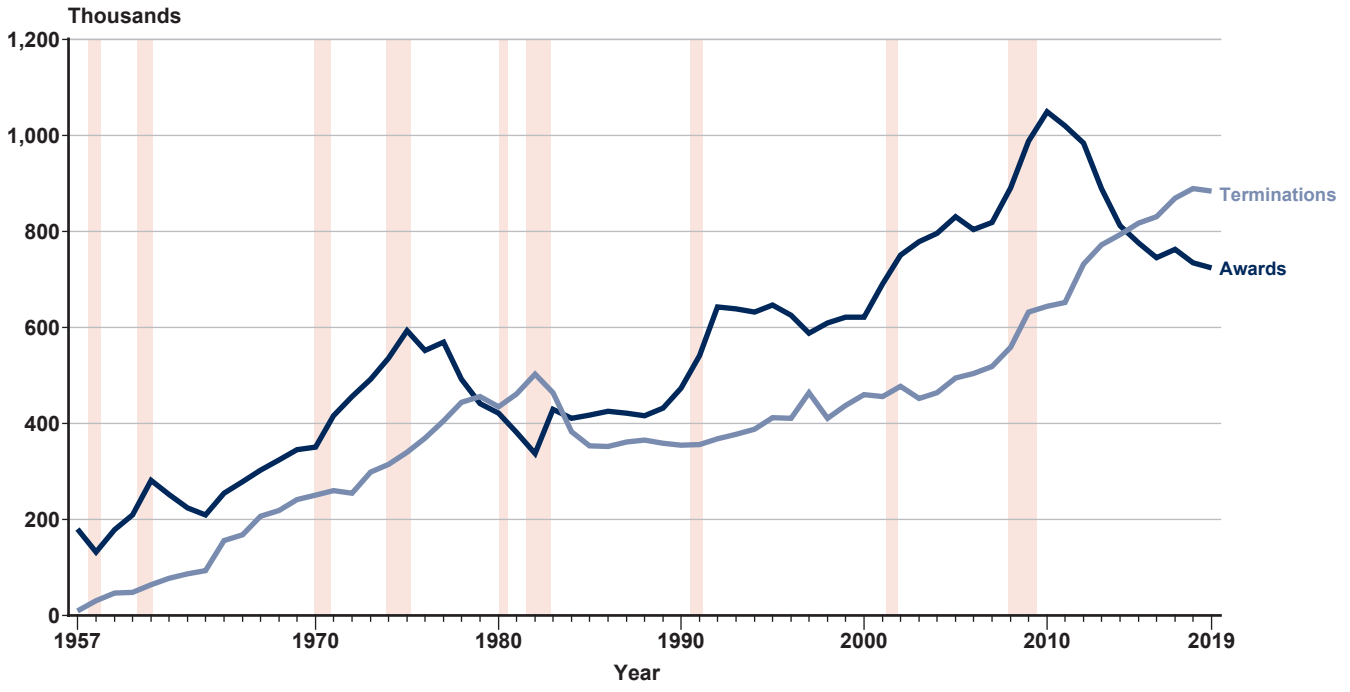
The first half of the 1970s witnessed a rapid increase in the number of DI awards, jumping from 350,000 in 1970 to about 592,000 by 1975 (Chart 2). This was a period of economic stagflation, oil supply shocks, and a stock market crash. According to Schobel (1980), the legislative changes to the program in the 1960s cannot fully explain the growth in awards during this period. Rather, three distinct events likely contributed to the large volume of applications and awards. First, there were economic recessions in 1970 and 1973–1975 (indicated by the shaded areas in Chart 2). The volume of applications tends to increase during recessions and the characteristics of claimants during these periods can vary substantially. Workers in poor health are more likely to lose their jobs and have greater difficulty finding new ones during economic downturns. As a result, recessions tend to be associated with higher numbers of applications and awards, but lower allowance rates.[4]

A second factor contributing to the observed surge in awards during this period was the introduction of two new programs: Black Lung Benefits in 1970 and Supplemental Security Income (SSI) in 1974. SSI provides means-tested cash payments for individuals with disabilities; SSI applicants who have not reached full retirement age (FRA) and are insured under DI are required to apply for DI benefits concurrently. Black Lung Benefit applicants from Appalachia frequently filed for OASDI benefits as well (Puckett 2010). According to Bayo and Wilkin (1977),

> by fiscal year 1974, not only was the SSA taking in over 1,200,000 [DI] claims per year, but it had also taken in over 500,000 disability claims under the black lung program … and it was taking in over 1,000,000 disability claims per year under the [SSI] program.

Third, various legislative changes contributed to the surge in applications and awards by making disability benefit receipt relatively more attractive. In particular, Congress enacted across-the-board benefit increases to protect beneficiaries against inflation, first with a series of specially legislated increases in the early 1970s and then with annual automatic indexing of benefits beginning in 1975. Consequently, new benefit levels began to replace a higher share of predisability earnings; the rising replacement rates thus provided a stronger incentive to apply for benefits. According to Kearney (2005/2006), the share of new beneficiaries

Chart 2.
Number of DI disabled-worker benefit awards and terminations, 1957–2019



SOURCES: National Bureau of Economic Research (2021); Schobel (1980, Tables 1 and 3); Kelley and Lopez (1984, Tables 1 and 4); Zayatz (1999, 2005, 2011, 2015, Tables 3 and 5); and Barrick-Funk (2020, Tables 3 and 5).

NOTE: Shaded areas indicate economic recessions.

with a replacement rate of 80 percent or higher rose from 13 percent in 1970 to about 40 percent in 1980. In addition, by 1973, Medicare benefits became available to DI beneficiaries after 2 years on the rolls.

As a quality control measure, SSA is required to review a certain percentage of benefit allowances determined at the DDS level. This process is called preeffectuation review.[5] In addition, beneficiaries are subject to periodic continuing disability reviews (CDRs), through which the agency can suspend benefits if it determines a beneficiary is no longer disabled. The large volume of applications during the first half of the 1970s placed a great deal of strain on SSA's resources, drastically curtailing the capacity to conduct both types of review. According to Kearney (2005/2006), the proportion of awards undergoing preeffectuation reviews dropped to 5 percent during the early 1970s, compared with previous levels of about 70 percent. Further, SSA suspended CDRs for several years during this period to reallocate resources toward processing Black Lung Benefit and SSI claims (Puckett 2010).

Diminished quality control—and pressure on disability adjudicators to make quick determinations to avoid a large backlog of cases—may have further contributed to the observed rise in awards. Meanwhile, the suspension of CDRs likely led to the decline in benefit terminations tied to medical improvement. For instance, in 1970, about 28 of every 1,000 program enrollments were terminated because of recovery (Chart 1). By 1975, the gross recovery rate had dropped by half, to 13.9 beneficiaries per 1,000 enrollments. The high earnings replacement rates during this period provided further incentive to stay in the program. The number of applicants with claims denied at the DDS level who then pursued appeals at the hearing level, where administrative law judges make disability determinations, also increased in the early 1970s.

1976–1982

The volume of DI awards declined sharply from 1977 to 1982, while terminations climbed rapidly. Prior to 2015, the period 1979–1983 is the only window in the historical DI data in which annual terminations exceeded awards, peaking in 1982 (Chart 2). In that year, 166,000 more DI beneficiaries exited the program than entered it. The first in a series of efforts to control rising costs associated with the disability programs came in the late 1970s. The automatic cost-of-living adjustment (COLA) had led to a substantial rise in replacement rates, in part because the benefit indexing formula was implemented in 1974, when prices were rising much faster than wages. The Social Security Amendments of 1977 adjusted the benefit formula downward to decouple COLAs from price increases and to stabilize replacement rates (Kearney 2005/2006). Workers' earnings under the revised formula were indexed to changes in average wages instead of prices.

Changes to disability law in 1980 led to further restrictions on the DI program, such as capping total family benefits and imposing tighter DDS performance standards—for example, requiring a 65 percent preeffectuation review rate by 1983. The law added incentives to return to work and restricted the introduction of new evidence in a hearing-level decision (Kearney 2005/2006). It also required more frequent CDRs (at least every 3 years) for beneficiaries without a permanent disability.

Several General Accounting Office reports in the late 1970s criticized SSA for not conducting CDRs, suggesting that significant numbers of beneficiaries might no longer be disabled. In response, SSA began an aggressive effort that resulted in the termination of benefits for a substantial portion of beneficiaries, particularly among those with mental impairments, although many eventually returned to the rolls on appeal. The CDRs were "de novo reviews" (reopening the initial determination) and retroactive, which led to public controversy. According to Puckett (2010),

> collecting disability payments that were now deemed erroneous from former beneficiaries became a major piece of SSA's debt management initiative. SSA issued overpayment notices asking for repayment of huge sums of money to people with a history of mental impairments who were no longer receiving a monthly check. A few of these individuals committed suicide, and these tragedies were widely reported on newspaper front pages.

From 1980 to 1982, the number of benefit terminations because of recovery almost doubled, reaching more than 169,000 former beneficiaries. Exits associated with recovery reached a historical maximum in 1982 and only in that year did recovery exceed death in both volume and gross termination rates (Charts 1 and 3). This unprecedented number of benefit terminations occurred in the middle of a severe recession. Moreover, the large volumes of CDRs and ensuing appeals led to enormous workloads at all levels of adjudication, including a record number of 50,000 cases pending in Federal Court by mid-1984.[6] Among the

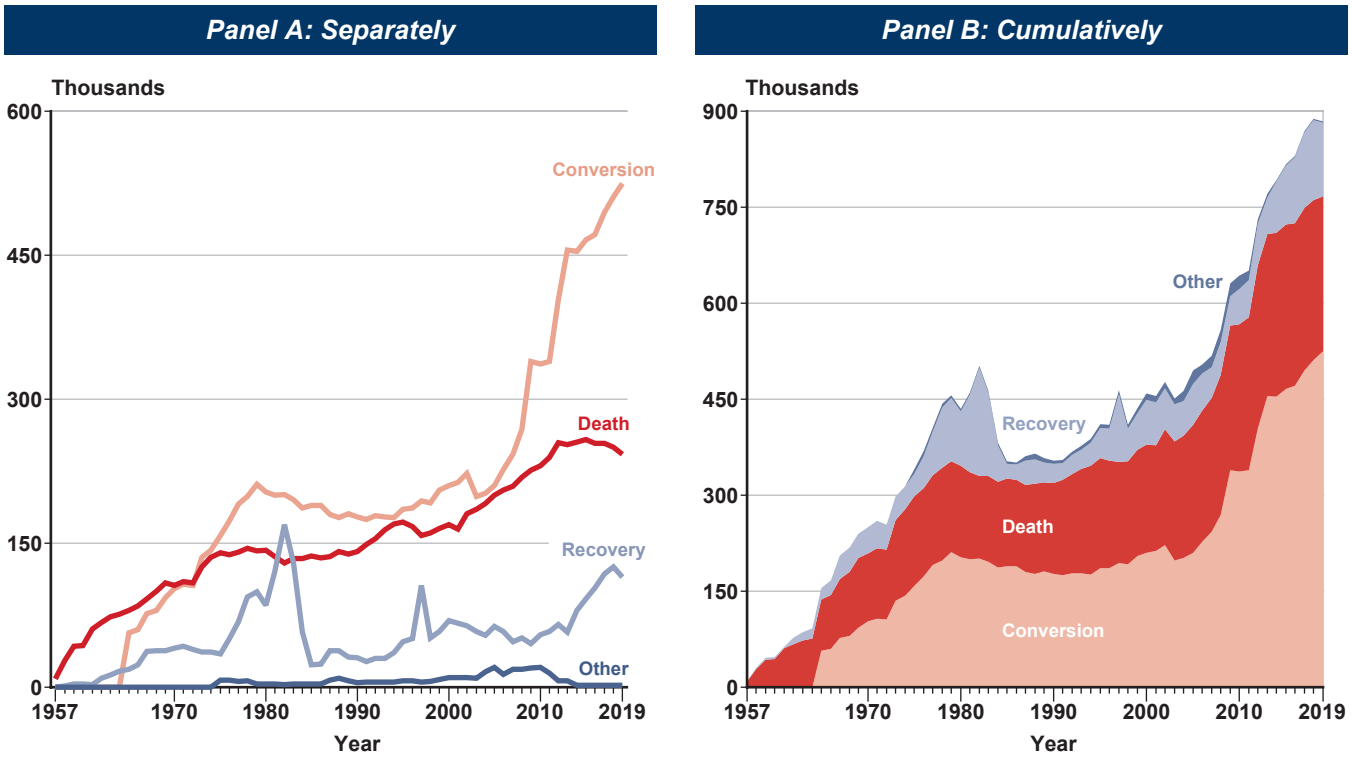
latter was a lawsuit by the Association of Administrative Law Judges, which perceived the de novo reviews as a challenge to the judges' independent decision making. Many states feared the financial consequences, as the burden of the terminations would fall disproportionately on state programs, particularly for the mentally ill. Under pressure from constituents, Congress held dozens of hearings on the subject. Eventually, the governors of 23 states ordered the suspension of CDRs, leading SSA to impose a temporary moratorium.

A number of court decisions challenged SSA policy through the first half of the 1980s. "By the end of 1984, all circuits of the U.S. Court system, led by a Ninth Circuit ruling, had ruled that SSA must apply some form of medical improvement standards or a presumption of continuing disability before benefits could be terminated" (Puckett 2010). Another ruling found SSA in violation of the law in its review of cases involving mental impairments. Court decisions challenging SSA policy culminated in the threat of contempt proceedings against the Secretary of Health and Human Services for nonacquiescence.[7] The court objected to SSA's practice of restoring benefits to a successful appellant who had been removed from the rolls without changing its policy to reflect the circuit court decision.

1983–1990

In 1983, awards and terminations began to level off. The Social Security Disability Benefits Reform Act of 1984 aimed to reverse the prior trends of sharp increases (or declines) in awards and terminations, and the numbers of both would hold relatively steady through the rest of the 1980s. As part of the standard of proof in a CDR decision to terminate benefits, the law required a finding of medical improvement. In addition, greater emphasis was placed on the roles of multiple nonsevere impairments, pain, and the opinion of the treating physician. SSA released final rules for the revised listings of mental impairments in 1986. According to SSA (2006), the large one-time spike in mental-impairment awards in 1986 (Chart 4) reflects the fact that "many cases were not adjudicated until new mental regulations were issued in 1986." The net

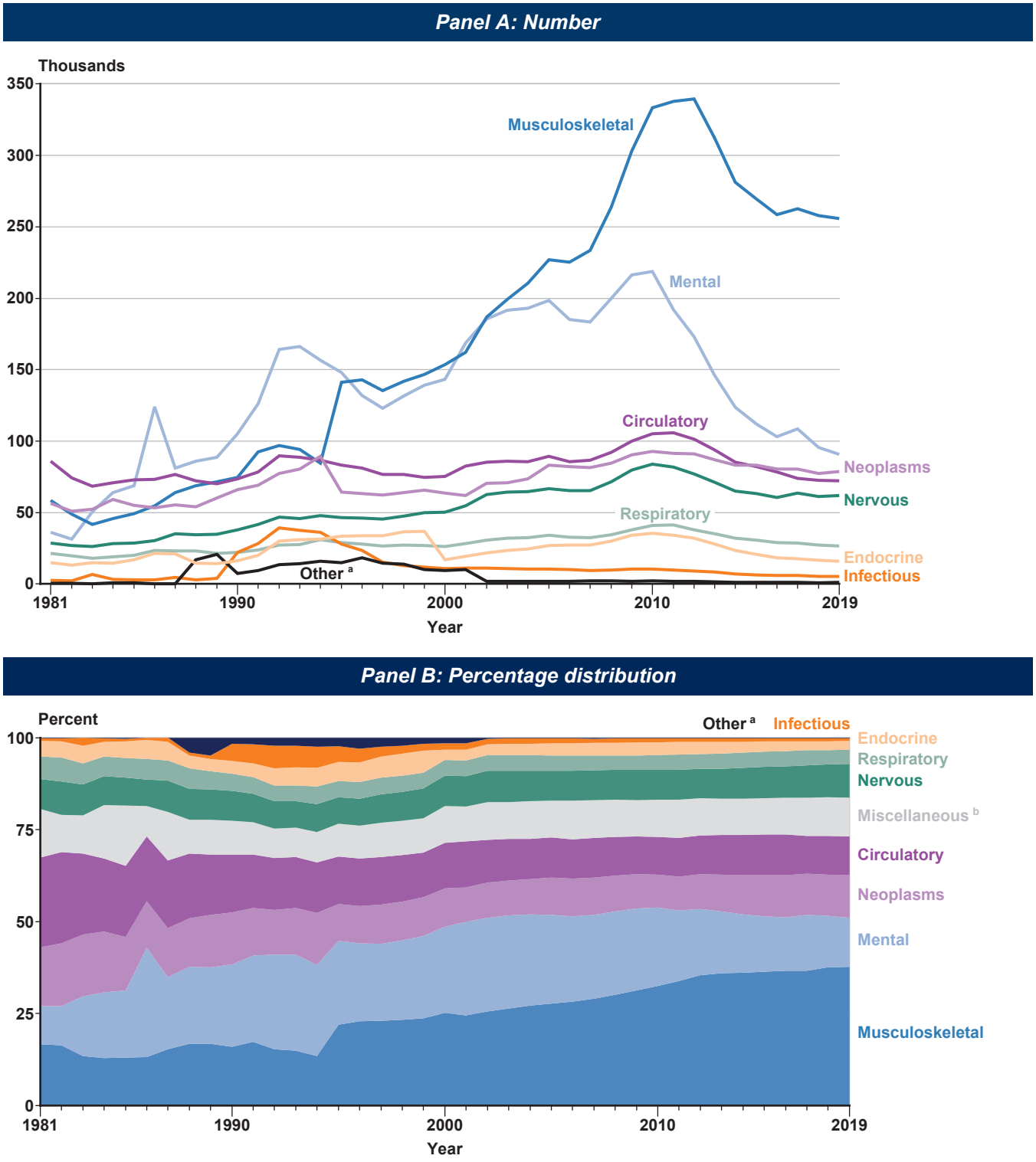
Chart 3.
Number of DI disabled-worker benefit terminations, by reason, 1957–2019



SOURCES: Schobel (1980, Table 3); Kelley and Lopez (1984, Table 4); Zayatz (1999, 2005, 2011, 2015, Table 5); and Barrick-Funk (2020, Table 5).

NOTE: Conversion to OASI retired-worker benefits occurs automatically at FRA. "Other" consists largely of elective OASI conversions at ages 62 to FRA.

Chart 4.
Number and percentage distribution of DI disabled-worker benefit awards, by body system of primary diagnosis, 1981–2019



SOURCE: SSA (2020, Table 40).

a. HIV/AIDS-related impairments were classified under "other" impairments until 1990, when they were reclassified under infectious and parasitic diseases.

b. Comprises congenital anomalies; injuries; diseases of blood and blood-forming organs, the digestive system, the genitourinary system, and skin and subcutaneous tissue; and ill-defined impairment codes classified as "unknown."

effect on mortality of the various legislative changes that took place throughout the 1980s is unclear. Many of the benefit terminations in the early part of the decade were reversed on appeal and the 1984 law made substantial changes to the determination process and the rules for conducting CDRs. To date, no actuarial studies have documented the mortality experience of DI beneficiaries during the 1980s.

1991–1995

As the economy weathered a recession in 1990–1991, the number of DI awards began a brief but rapid rise, particularly for mental disorders (Chart 4). In 1993, there were more than 635,000 awards and 26 percent of them were associated with a mental primary impairment. The early 1990s were also peak years of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS)-related deaths in the United States.

In SSA's *Annual Statistical Report on the Social Security Disability Insurance Program*, HIV and AIDS cases were not categorized under "infectious and parasitic diseases" until 1990, having been included in the "other" category in prior years. This shift is evident in the increasing share of awards for infectious and parasitic impairments in the 1990s, reaching a maximum of 6.2 percent of all awards in 1992 (Chart 4).[8]

The Estimates of Period Mortality section below illustrates the unusually high period mortality among young male DI beneficiaries during their first few years of entitlement in the early 1990s (Zayatz 1999), which can be traced to HIV/AIDS-related deaths. According to Barrick and Zayatz (2005),

> the death rate among those afflicted was so high that monthly benefit payments were often made only for a relatively short period of time, if at all. Many never received payments, failing to survive the requisite 5-month waiting period under the DI program. One third of those who made it onto the rolls because of HIV impairments had died by the end of the calendar year in which they became entitled; two-thirds had died by the end of the following year.

1996–2000

The second half of the 1990s witnessed a leveling in the number of awards while benefit terminations rose steadily. The Contract with America Advancement Act of 1996 provided funding specifically for CDRs and disqualified applicants and beneficiaries for whom drug addiction or alcoholism contributed materially to disability. This led to a sharp spike in benefit terminations because of recovery in 1997 (Charts 1 and 3). Specifically, from 1996 to 1997, the number of terminations because of recovery more than doubled, as beneficiaries with a material addiction were removed from the rolls, while the gross recovery rate experienced a one-time jump from 11.3 to 22.7 per thousand disabled-worker beneficiaries (Chart 1).[9]

Awards based on HIV diagnoses declined throughout the second half of the 1990s (Chart 4). Barrick and Zayatz (2005) reported dramatic reductions in mortality consistent with Centers for Disease Control and Prevention findings that attributed the change to the widespread use of an effective treatment called highly active antiretroviral therapy (HAART) beginning in 1996. Accompanying the HIV-related mortality improvement during this period was a documented shift in the composition of HIV diagnoses from symptomatic toward asymptomatic impairments. Based on the period tables in Barrick and Zayatz (2005), a man entering the DI/SSI rolls with an AIDS-related diagnosis at age 35 was, during 1992–1996, expected to live 4.88 years. By the 1997–2001 period, the corresponding life expectancy had increased to 12.89 years. In comparison, life expectancy at age 35 during the first year of entitlement among the entire male DI-beneficiary population in 1991–1995 was 23.29 years (Zayatz 1999).

Both the effective treatment of HIV diagnoses beginning in 1996 and the 1997 legislative changes involving addiction are credited with lowering DI award rates and mortality during the late 1990s. According to Zayatz (2015),

> age-specific disability incidence among female workers is typically lower than males. However, beginning in the late 1990s, female incidence began to exceed that for males at ages 30–54. Although both genders were experiencing a general decline in incidence beginning in the mid-90s, the decline is more pronounced among males. This is likely due to the elimination of [drug addiction or alcoholism] as a disabling impairment and a sharp decline in HIV impairments, both of which are predominantly male incidence categories. Note that the decline in incidence rates among females did not come from a decline in the number of awards, but rather from an increase in the exposed population.

From 1986 to 1996, increases in women's labor force participation resulted in an additional 10.7 million disability-insured women. The female share of DI beneficiaries in current-payment status rose from less than one-third (31.3 percent) in 1975 to almost half (49.5 percent) by 2019 (Barrick-Funk 2020).

In 1995, SSA began to capture information on final determinations after all appeals and thereby improved the accuracy of its reported data on awards by primary diagnostic group. Through 1994, the primary diagnostic group of cases awarded at the appeals hearing level and beyond had been imputed from the information available on the original DDS determination. The main effect of improved accuracy in the data collected after 1994 appears to involve a large jump in awards associated with musculoskeletal impairments, from 85,000 in 1994 to 141,000 in 1995, and a decline in awards associated with malignant neoplasms, from 89,000 in 1994 to 64,000 in 1995 (Chart 4). This change predates the removal of obesity from SSA's medical Listing of Impairments in 1999, which is reflected in Chart 4 by the decline in awards associated with endocrine, nutritional, and metabolic diseases from 37,000 in 1999 to 17,000 in 2000.[10]

2001–2010

The first half of the decade was characterized by a large increase in DI awards—from more than 621,000 new disabled-worker beneficiaries in 2000 to almost 830,000 by 2005 (Chart 2 and Chart 5, panel A)—and an economic recession in 2001 (reflecting the bursting of the dot-com bubble and the terrorist attacks on September 11). That period was followed by a brief, modest decline in awards in 2006–2007, then another sharp jump in awards in 2008–2010, driven by the Great Recession (characterized by the subprime mortgage crisis and the global financial collapse).[11]

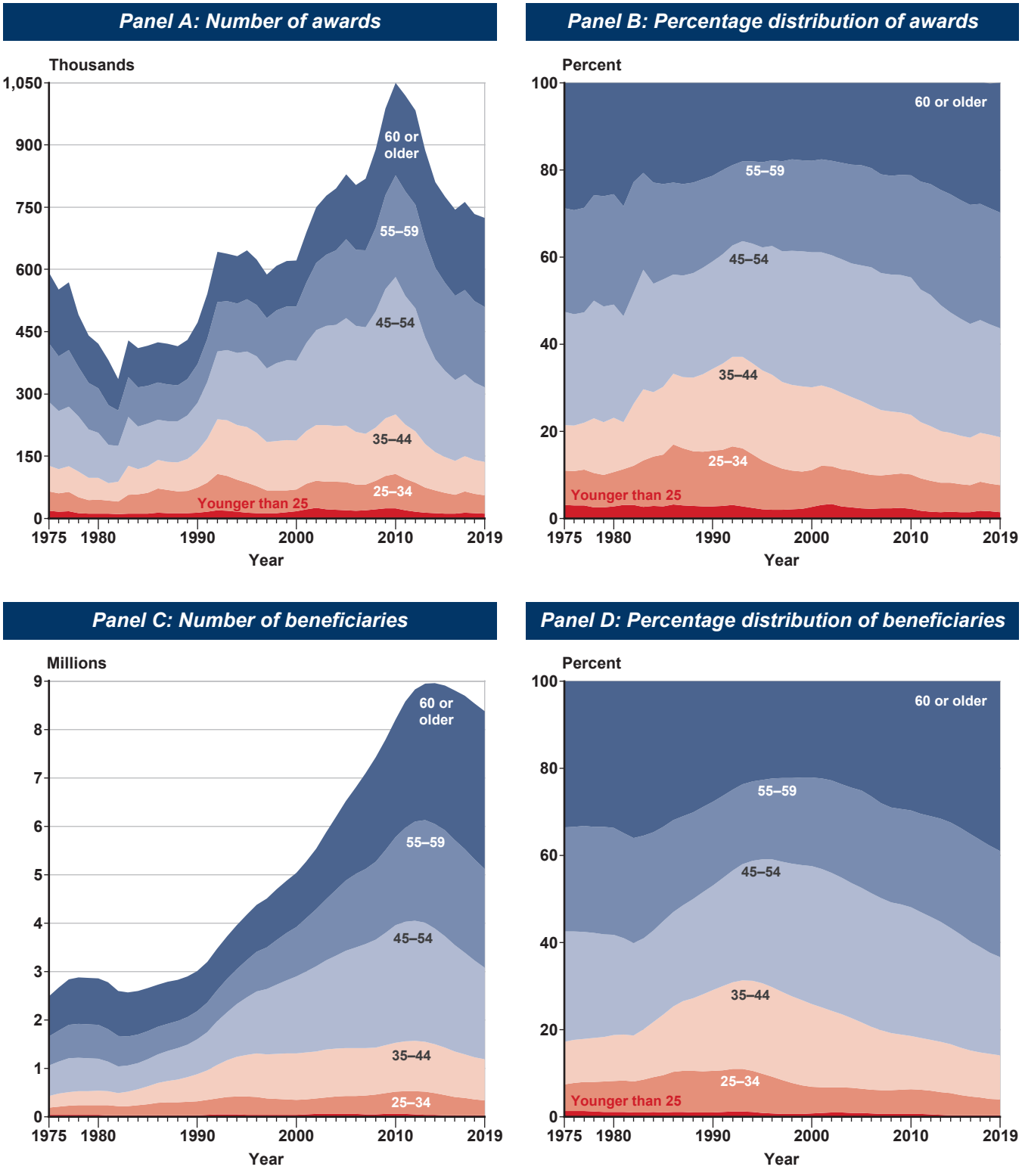
Notable shifts in DI exits because of conversion occurred in the 2000s. DI benefits automatically convert to OASI benefits when the beneficiary reaches FRA.[12] However, beginning at age 62, DI beneficiaries can choose to switch to OASI and receive retirement benefits (reduced for claiming before FRA) instead.[13] For those choosing to switch, common reasons include differences in the maximum family benefits payable under the DI and OASI programs and a desire to avoid a partial or full offset of worker's compensation benefits that retaining DI could trigger. Fear of losing disability benefits could also motivate a switch.

DI conversions to OASI benefits increased steadily throughout the decade, except for an unusual temporary decline in 2003–2004 (Charts 1 and 3). The 1983 Social Security Act Amendments established incremental increases in FRAs for workers born in 1938 and later years; 2003 was thus the first year in which workers reaching age 65 did not necessarily reach their FRA.[14] The effect is most evident in the "dip" in the gross conversion rate between 2003 and 2006 illustrated in Chart 1. In addition, the often-negligible "other" category of terminations, which typically consists largely of beneficiaries switching to reduced retirement benefits before FRA, increased throughout the 2000s. That increase resulted mostly from a Special Disability Workload that SSA undertook from 2001 to 2011 after discovering errors in the determinations of insured status for approximately 130,000 SSI recipients, many of whom were found to qualify for concurrent DI benefits (Zayatz 2015). Unlike the early-retirement-age beneficiaries who switch to OASI benefits and usually constitute most of the "other" benefit-termination category, many of these special workload cases involved young recipients with mental impairments.

Throughout the 2000s, the large cohort of baby boomers (born from 1946 through 1964) began entering peak disability-onset ages and drove an increase in the median age of the population. By 2010, baby boomers ranged from 46 to 64 years of age. Chart 5, panel B shows that the proportion of awards to individuals younger than 45 declined from 30.6 percent in 2001 to 23.9 percent by 2010, reversing the pattern of increase observed during the 1980s and early 1990s. Conversions also rose very rapidly during the second half of the decade, from 42.5 percent of benefit terminations in 2005 to 52.4 percent by 2010.

The rapid expansion of the DI rolls throughout the 1990s and 2000s contributed to a perception that the program might be on an unsustainable path. For instance, Autor and Duggan (2006) identified contemporary labor market trends that incentivized low-wage workers to apply for benefits, along with the changes in the disability determination process enacted in 1984, as key factors in DI unsustainability. However, according to Pattison and Waldron (2013), "three factors—(1) population growth, (2) the growth in the proportion of women insured for disability, and (3) the movement of the large baby boom generation into disability-prone ages—explain 90 percent of the growth in new disabled-worker entitlements over the 36-year subperiod (1972–2008)." Although Pattison and Waldron analyzed growth in new DI awards (incidence), Liebman (2015) reached qualitatively similar conclusions by focusing on prevalence

Chart 5.
Number and percentage distribution of DI disabled-worker benefit awards and beneficiaries in current-payment status, by age group, 1975–2019



SOURCES: Zayatz (1999, 2005, 2011, 2015, Tables 3 and 6); and Barrick-Funk (2020, Tables 3 and 6).

(the total number of beneficiaries as a share of the insured population):

> The impression in policy circles that disability enrollment and spending are "out of control" appears to be the result of confounding the legislatively induced bounce-back of incidence rates in the late 1980s and early 1990s with the largely demographically induced increases of the past two decades.[15]

2011–2019

The most recent DI trend is a steep decline in awards and a large increase in benefit terminations. In Chart 5, panels A and B show the number and percentage distribution of awards by age group, while panels C and D show the same for DI beneficiaries in current-payment status. The latter is a stock variable, while the former is a flow variable. Specifically, the number of beneficiaries on the DI rolls at a given time t is determined by the number of beneficiaries in current-payment status during the previous period (t−1) plus the difference between the flow of awards and terminations from t−1 to t.

The number of awards has been declining since 2010, while terminations began to exceed awards after 2014 (Chart 2). From 2015 through 2019, more than half a million more beneficiaries exited the DI rolls than entered them. In 2019 alone, there were 524,927 exits via conversion, representing 59.4 percent of benefit terminations. Historically, the only other period with more annual terminations than awards was 1979–1983, as noted earlier, although the circumstances were very different then. Some of the factors reversing the gap between awards and terminations in the last decade appear to be low unemployment and a growing population of older disabled beneficiaries. The proportion of DI beneficiaries in current-payment status who are aged 60 or older has been steadily increasing in the last two decades, from 22.2 percent in 2000 to 39.0 percent by 2019 (Chart 5, panel D).

Note that the oldest baby boomers (the 1946 birth cohort) reached age 66—their FRA—in 2012, and the youngest baby boomers will reach their FRAs throughout the 2020s. The uptick in OASI conversions since the late 2000s shown in Chart 3 also reflects a pattern of deferrals resulting from scheduled progressive increases in FRAs. According to Zayatz (2015), the introduction of higher FRAs for later birth cohorts implies a greater actuarial reduction in early retirement benefits and may induce older workers to seek disability benefits as an alternative to reduced retirement benefits. In addition, the decline in labor-force participation rates since the early 2000s suggests that many potential claimants may no longer satisfy the recency-of-work test for DI insured status, which could play a role in the downward trend in awards since 2010 (Chart 2 and Chart 5, panel A).

Another consequence of an older population is a change in the diagnostic composition of new DI beneficiaries. As I discuss in detail in the Recent Trends in Disability Awards section, different disorders have different ages of likely onset; for example, mental impairments such as schizophrenia and affective/mood and anxiety disorders have peak incidence among young adults. The highest incidence probabilities for a primary or secondary diagnosis of affective/mood disorder among 2009 disabled-worker benefit applicants at the DDS level involved claimants in their late 20s and early 30s. By contrast, the peak ages for a primary or secondary diagnosis of a disorder of the back were late 40s and early 50s. The age group with the highest share of claimants diagnosed with the two impairments combined was the early 40s (Meseguer 2018, Chart 8).

Chart 4, panel B shows that the percentage of awards with a mental impairment as the primary diagnosis was 25.5 percent in 2001 but had dropped to 13.3 percent by 2019. In the same period, the share of awards with musculoskeletal-disorder primary diagnoses rose from 24.5 percent to 37.7 percent. In fact, since 2002, musculoskeletal impairments have become the leading primary diagnosis for new awards. As the median age of the population rises, the diagnostic composition of awards and of beneficiaries in current-payment status is likely to skew further toward disorders with higher incidence at older ages.[16]

Estimates of Period Mortality

In this Section, I compare mortality of DI beneficiaries with that of their counterparts in the general population. Mortality among DI beneficiaries is highest during the first few years of entitlement (that is, of benefit receipt), regardless of age at entitlement; thereafter, mortality declines with each additional year survived on the DI rolls. For this reason, the SSA actuarial studies calculate period mortality either by age at entitlement or by attained (current) age at various lengths of time on the DI rolls. All DI mortality measures in the charts and tables that follow are indexed by attained age, or age at entitlement plus number of years on the rolls.

Consider as a concrete example Table 7A in Zayatz (2015), reproduced here as Table 1. Zayatz notes: "The value $q_{[x]+t}$ at duration t represents the probability of

Table 1.
Men entitled to DI disabled-worker benefits 2006–2010: Death probabilities, by age and time on the rolls

Age at entitlement	Completed duration (years since entitlement)											Ultimate age
	0	1	2	3	4	5	6	7	8	9	10 or more	
16	0.004005	0.007118	0.005243	0.005808	0.004028	0.002434	0.009198	0.007122	0.005716	0.006213	0.008136	26
17	0.005733	0.008269	0.006200	0.006732	0.004814	0.004741	0.007013	0.007116	0.006395	0.005513	0.006905	27
18	0.007308	0.008883	0.006932	0.007155	0.006209	0.007076	0.004693	0.006643	0.006733	0.005497	0.006352	28
19	0.009912	0.008377	0.007283	0.007686	0.006205	0.006500	0.004569	0.005458	0.007248	0.005377	0.005880	29
20	0.010149	0.008646	0.006905	0.007953	0.006470	0.006162	0.004441	0.006121	0.007672	0.005341	0.006108	30
21	0.011103	0.010265	0.007296	0.007620	0.006774	0.005655	0.005015	0.004967	0.006140	0.006874	0.007012	31
22	0.012094	0.011228	0.009187	0.008027	0.007389	0.006408	0.006813	0.005581	0.006505	0.006665	0.007916	32
23	0.013836	0.011179	0.009447	0.007643	0.006611	0.007118	0.007323	0.005613	0.007006	0.006227	0.008116	33
24	0.015161	0.011926	0.009826	0.008297	0.009101	0.009227	0.007863	0.007654	0.007651	0.007779	0.009324	34
25	0.018140	0.014673	0.011113	0.010623	0.011169	0.008417	0.008942	0.008349	0.008298	0.008464	0.009091	35
26	0.018564	0.016495	0.013518	0.011573	0.010589	0.008277	0.009743	0.010199	0.009877	0.010236	0.009375	36
27	0.020113	0.017388	0.013371	0.013152	0.011160	0.008675	0.011310	0.010835	0.010458	0.010874	0.010365	37
28	0.020724	0.018155	0.013458	0.014264	0.011917	0.010631	0.011378	0.011353	0.010614	0.011099	0.011003	38
29	0.021458	0.016934	0.013899	0.012967	0.012085	0.013262	0.011405	0.011686	0.012879	0.012467	0.011339	39
30	0.023200	0.017115	0.015756	0.014714	0.011684	0.012936	0.012060	0.012233	0.012293	0.013085	0.011527	40
31	0.024571	0.017734	0.015653	0.015981	0.012800	0.012994	0.013193	0.013713	0.013573	0.014216	0.013354	41
32	0.024515	0.017861	0.017122	0.014963	0.013807	0.014220	0.013867	0.013669	0.013467	0.014543	0.013894	42
33	0.025472	0.019277	0.015627	0.015147	0.014157	0.014467	0.014338	0.014137	0.013848	0.015326	0.014453	43
34	0.026543	0.021196	0.016385	0.016307	0.015505	0.015411	0.014422	0.015058	0.015485	0.015910	0.015402	44
35	0.028307	0.020641	0.016911	0.016015	0.015144	0.015943	0.015318	0.015467	0.017319	0.017290	0.015730	45
36	0.029553	0.021818	0.015583	0.017742	0.015664	0.015792	0.016567	0.016336	0.016864	0.018095	0.016623	46
37	0.031385	0.024737	0.018076	0.017275	0.016308	0.016980	0.017910	0.017621	0.017296	0.019528	0.017254	47
38	0.031170	0.024702	0.020663	0.018570	0.016709	0.017127	0.016991	0.017793	0.018280	0.020344	0.018444	48
39	0.031760	0.023666	0.020930	0.019676	0.017793	0.016971	0.018185	0.019764	0.019799	0.020364	0.019330	49
40	0.033996	0.025886	0.021615	0.020828	0.018276	0.019744	0.019021	0.020915	0.019346	0.020367	0.021099	50
41	0.037454	0.027476	0.021614	0.019927	0.021049	0.020233	0.021340	0.020950	0.021474	0.022797	0.022125	51
42	0.042254	0.029028	0.024078	0.021666	0.021654	0.021111	0.020751	0.022591	0.024108	0.024209	0.022946	52
43	0.043253	0.030026	0.025109	0.023848	0.021864	0.023325	0.022413	0.023813	0.024088	0.025639	0.024665	53
44	0.047810	0.030554	0.025663	0.024035	0.024225	0.023838	0.025207	0.025413	0.026245	0.028749	0.026031	54
45	0.048081	0.031913	0.028376	0.025577	0.025257	0.026351	0.026729	0.026663	0.026773	0.028648	0.027221	55
46	0.052341	0.033774	0.028944	0.026922	0.026840	0.026631	0.026597	0.027912	0.029313	0.030353	0.028951	56
47	0.058179	0.037569	0.030009	0.029002	0.028099	0.028074	0.027621	0.029062	0.030591	0.032001	0.030184	57
48	0.063102	0.039881	0.032815	0.030991	0.029464	0.029392	0.029290	0.029774	0.030323	0.032387	0.031587	58
49	0.064043	0.043206	0.033119	0.031247	0.029065	0.030218	0.030251	0.031965	0.031652	0.032654	0.033641	59
50	0.047733	0.034242	0.029994	0.029417	0.028782	0.028373	0.029795	0.031248	0.030506	0.033644	0.034318	60
51	0.060387	0.040972	0.033382	0.030202	0.030311	0.030353	0.031738	0.032343	0.033140	0.036774	0.036444	61
52	0.064606	0.042419	0.034941	0.032608	0.030983	0.032156	0.032335	0.033528	0.034646	0.036037	0.038363	62
53	0.067887	0.045619	0.037972	0.034237	0.032802	0.032727	0.031872	0.034376	0.037637	0.038761	0.041034	63
54	0.069555	0.046707	0.035569	0.034591	0.032746	0.033390	0.034824	0.037122	0.038282	0.041385	0.042186	64
55	0.053986	0.039017	0.032103	0.030704	0.030946	0.031538	0.033814	0.035627	0.037044	0.040646	0.041976	65
56	0.062545	0.042695	0.034206	0.033525	0.032278	0.033869	0.035190	0.039125	0.039132	0.041303	0.047624	66
57	0.063949	0.043076	0.035000	0.033490	0.033836	0.036481	0.038043	0.040093	0.040390	0.045543	0.049946	67
58	0.066925	0.045721	0.037491	0.035357	0.036548	0.038511	0.040046	0.038783	0.045576	0.048301	0.052884	68
59	0.066950	0.046406	0.038999	0.036654	0.037211	0.037375	0.038736	0.043914	0.047481	0.051386	0.055771	69
60	0.064286	0.046916	0.039314	0.037607	0.037372	0.037410	0.043402	0.045616	0.048726	0.052754	0.058466	70
61	0.074153	0.049555	0.041682	0.039464	0.038908	0.043873	0.047364	0.048433	0.052576	0.054822	0.061678	71
62	0.081539	0.054098	0.044189	0.042764	0.045562	0.045980	0.049717	0.052812	0.055874	0.057919	0.065458	72
63	0.095425	0.063973	0.051745	0.050283	0.050324	0.054444	0.056046	0.060056	0.065220	0.065203	0.069131	73
64	0.115021	0.070370	0.055579	0.055825	0.056144	0.062203	0.061766	0.064501	0.073359	0.073558	0.073835	74
65	0.123763	0.074767	0.055770	0.060810	0.060725	0.062011	0.064728	0.066258	0.081121	0.081981	0.079210	75

SOURCE: Zayatz (2015, Table 7A).

NOTE: Refer to age at entitlement for men with 0 to 9 years duration. Refer to ultimate age (age at last birthday) only for those with 10 or more years.

death—in a multiple-decrement environment—during the (t+1) year of entitlement for those originally entitled to disability benefits at entitlement age [x] who have attained age [x]+t." The table shows that a male beneficiary who attained age 35 during the first year of entitlement (duration t=0) faced a mortality rate of 0.028307 in 2006–2010. By contrast, a male beneficiary who attained age 35 after 1 year on the rolls (that is, who was entitled at age 34), faced a mortality rate of 0.021196 during the second year of entitlement (duration t=1). Stepwise tracking of the table entries diagonally upward and to the right maintains an attained-age constant across each additional year survived on the rolls.

The methodology for constructing the actuarial period mortality tables is detailed in Zayatz (1999, 59–64) and Zayatz (2015, 99–104). The earlier actuarial studies, which cover often-overlapping subperiods in the 1970s, generally present mortality estimates for a 5-year "select period"—that is, for each of six durations on the DI rolls (0 [year of entitlement], 1, 2, 3, 4, and 5 or more years).[17] The more recent studies—encompassing the DI mortality experience in the 1990s, in the 2000s, and for 2011–2015—employ a 10-year select period.[18] After 10 years on the rolls, a beneficiary's chance of dying is assumed not to be affected by an incremental increase in duration; thus, the probabilities of death for such beneficiaries depend only on ultimate age. In other words, in Table 1, the probability of death for a 60-year-old man with 10 or more years on the rolls is 0.034318 regardless of whether he has received benefits for 30 years (since age 30) or for 20 years since age 40 (Zayatz 2015, 99).

Notice also that Table 1 accounts only for postentitlement deaths. Thus, claimants who die during the 5-month waiting period fall outside the scope of measurement:

> The mortality experience reported in this study is affected by several unique circumstances. First, it is recognized that a claimant may die while waiting for a disability determination. Since observation of a participant is contingent upon entitlement, a disability which results in death prior to entitlement will not be an "observed" death. As a result, the probability of death during the first year of entitlement may be artificially low. (Zayatz 1999, 59)

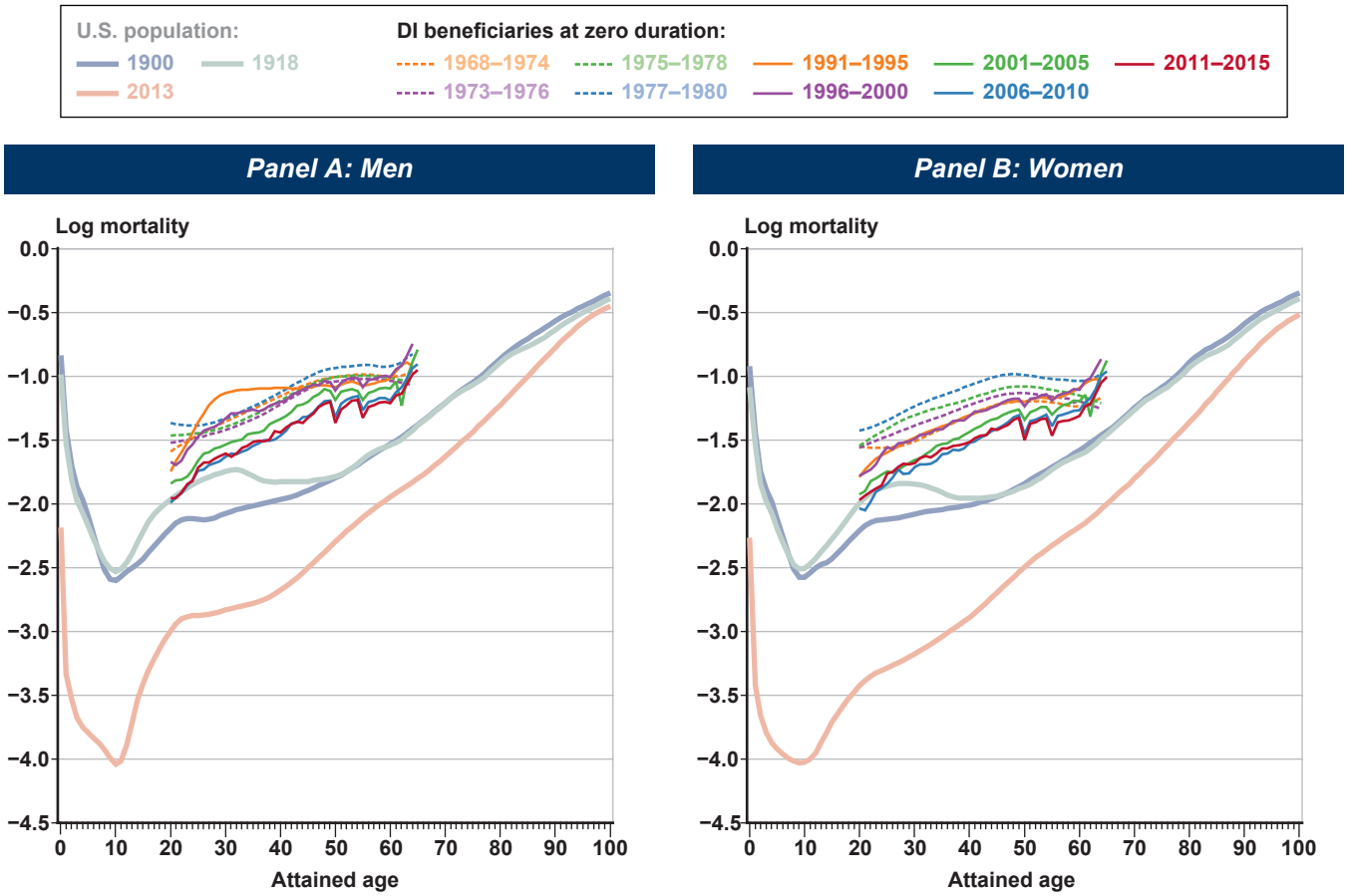
Chart 6 plots the logarithm of period mortality as a function of age for men (panel A) and women (panel B). It covers the general population as of selected years and the DI-beneficiary population during the first year of entitlement (zero duration) in various periods. The three general-population lines, spanning the entire 0–100 age range, derive from OCACT's historical period mortality tables.[19] They represent the general population in 1900, the earliest year available in the historical data file; 1918, the year of the influenza pandemic that killed an estimated 50 million to 100 million people worldwide; and 2013, the midpoint of the study period (2011–2015) of the most recent actuarial study (Barrick-Funk 2020). In 1918, the influenza virus was of a strain unusually deadly to young healthy adults, as documented by Taubenberger and Morens (2006) and reflected in Chart 6, which shows how period mortality after about age 8 was higher in 1918 than in 1900 for males until age 59 and females until age 47. Unsurprisingly, the chart shows a significantly lower log mortality for 2013 than those for 1900 and 1918, reflecting nearly a century of advances in medicine, science, diet and nutrition, public health, workplace safety, and many other factors.[20]

Chart 6 also plots the log mortality age profiles of DI beneficiaries during the first year of entitlement (zero duration) from the nine actuarial studies I survey. The plots are clustered in a generally descending pattern from earlier to later periods.

For a wide age range (such as from birth to age 100 in Chart 6), mortality is commonly graphed in the logarithmic scale. The reason for this is a well-established empirical regularity known as Gompertz's law, wherein the mortality rate of human populations increases exponentially with age and thus linearly in the logarithmic scale. If Chart 6 were graphed in the original scale, mortality differences between the series for younger ages would be impossible to discern because of the overpowering influence of the exponentially higher mortality values for older ages. However, it is still possible to render a meaningful depiction of mortality in its original scale over the narrower age range relevant to the DI program.

Charts 7 and 8 plot male and female mortality, respectively, at ages 14 to 75 for the general population and for DI beneficiaries in each of the first 5 years of entitlement (durations 0–4) and for those surviving at least 10 years on the rolls.[21] Together, Charts 6–8 reveal a number of relevant patterns. Clearly, mortality among DI beneficiaries is highest at every age during the first few years of entitlement and declines with the number of years on the DI rolls. From their early 20s into their early 60s, DI beneficiaries during the most recent period available (2011–2015) faced much higher

Chart 6.
Period log mortality rates, by sex and age: DI disabled-worker beneficiaries in the first year of entitlement, various periods 1968–2015; and general population, selected years 1900–2013



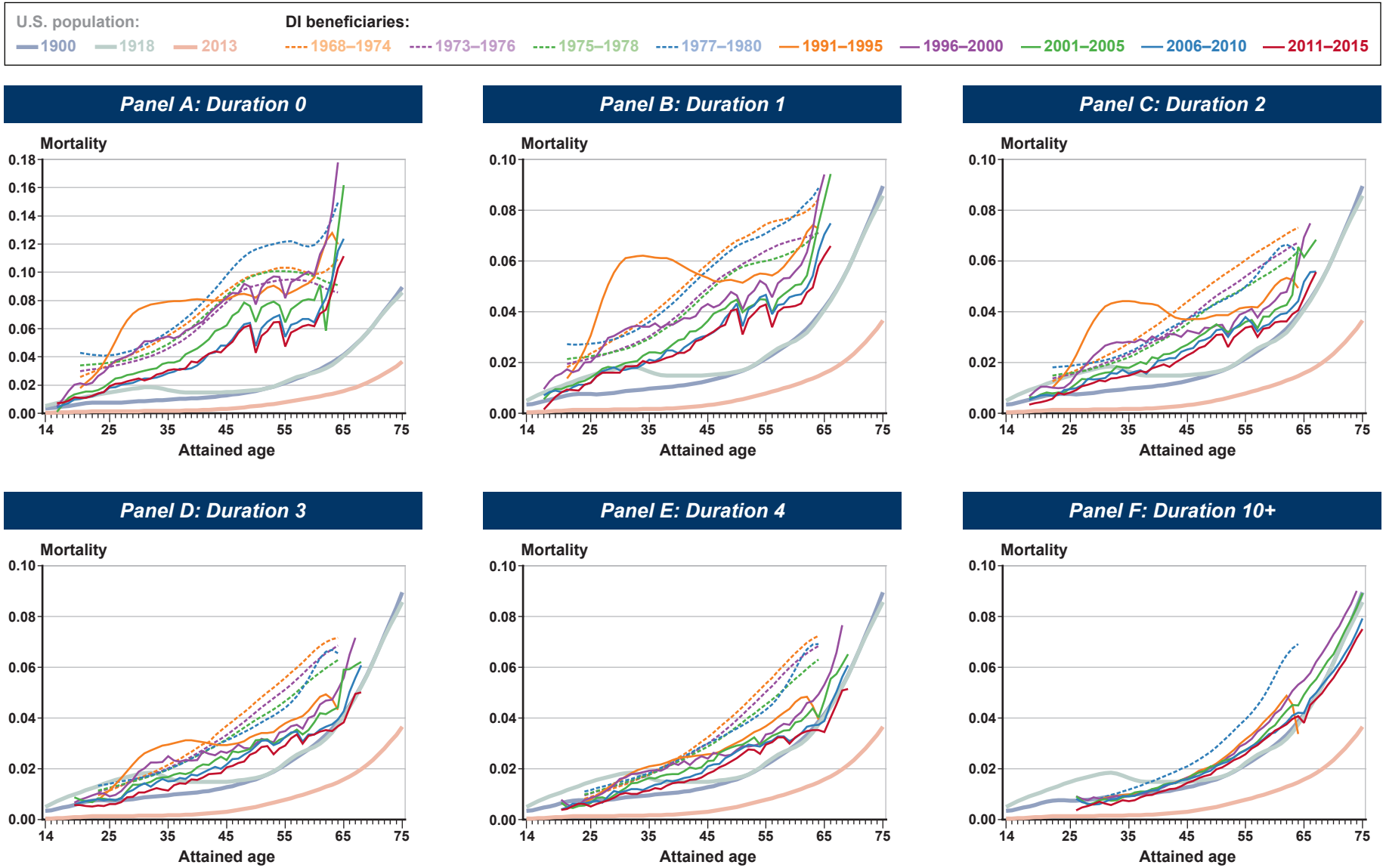
SOURCES: Bell and Miller (2005, Table 6); Bayo and Wilkin (1977, Tables 8 and 9); Bayo, Goss, and Weissman (1978, Tables 9 and 10); Schobel (1980, Tables 4 and 5); Kelley and Lopez (1984, Tables 5 and 6); Zayatz (1999, 2005, 2011, 2015, Tables 7A and 7B); and Barrick-Funk (2020, Tables 7A and 7B).

mortality in the first year of entitlement than their general-population counterparts did during the 1918 influenza pandemic (Chart 6 and panel A in Charts 7 and 8).

The longer DI beneficiaries survive on the rolls, the more mortality rates in different periods converge. After surviving at least 10 years on the DI rolls (panel F in Charts 7 and 8), DI beneficiary mortality exhibits an exponential rise as a function of age (linear in the logarithmic scale), similar to that of the general population. Nevertheless, the actual mortality experience for these DI beneficiaries is closer to that of the general population in the early 1900s, before the DI program or Social Security existed. Panel F in Charts 7 and 8 shows that beneficiaries who enter the rolls with impairments that are not immediately deadly and who survive for a long period thereafter still end up with much higher contemporaneous mortality than their counterparts in the general population.

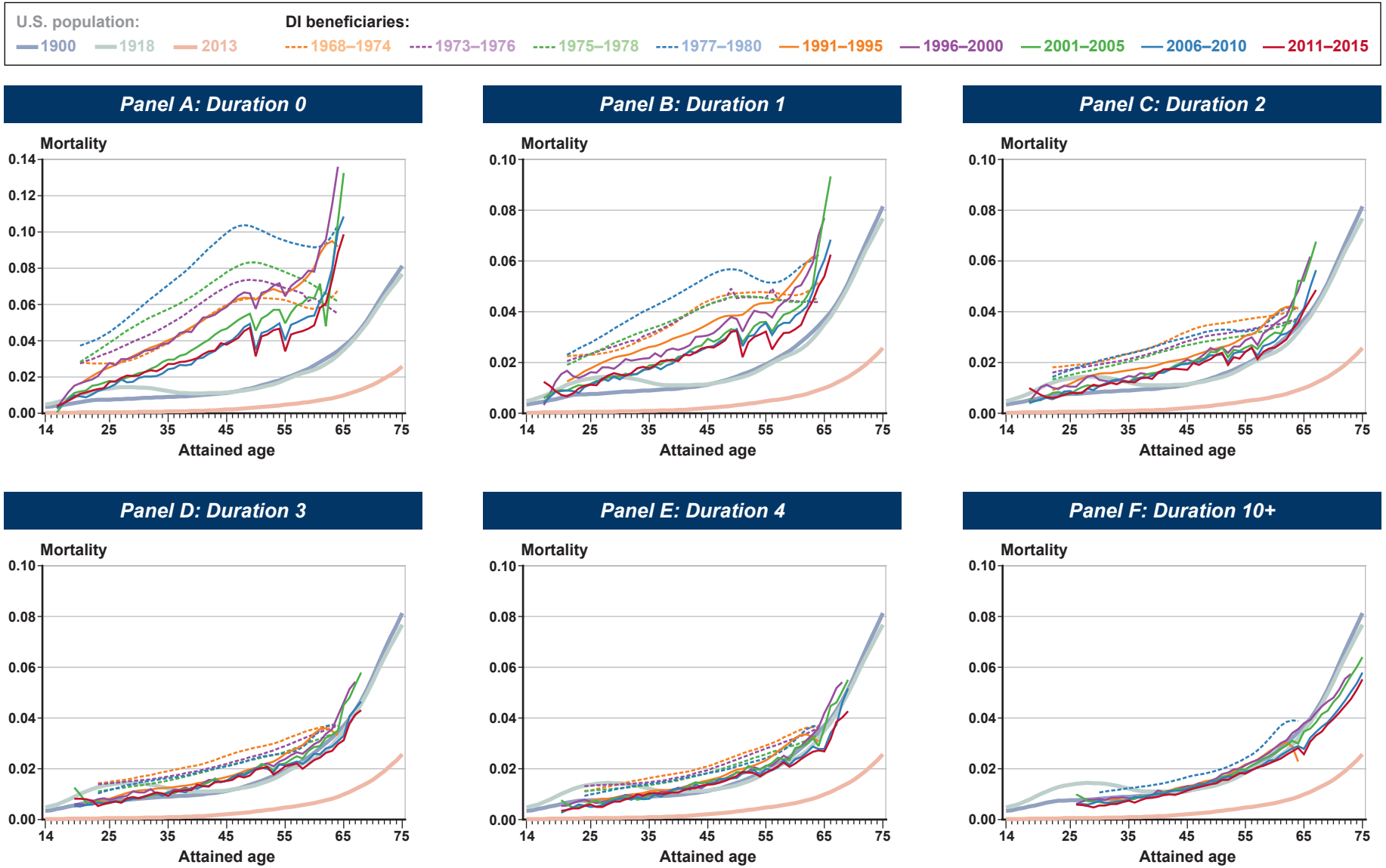
One remarkable feature in Chart 7 is the unusually high mortality among young male beneficiaries during the first few years of entitlement in 1991–1995, which can be attributed largely to HIV/AIDS-related deaths, as noted earlier. This pattern is evident through the first 4 years of entitlement (durations 0–3) and appears to a lesser extent for the 1996–2000 period as well, before dissipating at longer durations. For male beneficiaries aged roughly 25–40, mortality during the first 4 years of entitlement was substantially higher in 1991–1995 than at any time during the 1970s (Chart 7). This is in sharp contrast with the experience of female beneficiaries over the same period (Chart 8), with mortality far higher during most subperiods of the 1970s than during the 1990s.

Chart 7.
Male period mortality rates, by age: DI disabled-worker beneficiaries by duration of entitlement, various periods 1968–2015; and general population, selected years 1900–2013



SOURCES: Bell and Miller (2005, Table 6); Bayo and Wilkin (1977, Table 8); Bayo, Goss, and Weissman (1978, Table 9); Schobel (1980, Table 4); Kelley and Lopez (1984, Table 5); Zayatz (1999, 2005, 2011, 2015, Table 7A); and Barrick-Funk (2020, Table 7A).

Chart 8.
Female period mortality rates, by age: DI disabled-worker beneficiaries by duration of entitlement, various periods 1968–2015; and general population, selected years 1900–2013



SOURCES: Bell and Miller (2005, Table 6); Bayo and Wilkin (1977, Table 9); Bayo, Goss, and Weissman (1978, Table 10); Schobel (1980, Table 5); Kelley and Lopez (1984, Table 6); Zayatz (1999, 2005, 2011, 2015, Table 7B); and Barrick-Funk (2020, Table 7B).

As discussed in the Chronology section, DI enrollment expanded substantially in the first half of the 1970s. Multiple recessions, rapid increases in award volumes, declines in benefit terminations based on medical recovery, temporary suspension of CDRs, fewer quality control reviews, high benefit-to-predisability earnings replacement rates, and increasing workloads for disability examiners handling two new programs (Black Lung Benefits and SSI) all contributed to the expansion. These developments, reflecting economic and administrative changes rather than broad health trends, nevertheless appear consistent with a population of DI beneficiaries who are relatively healthier (and thus have lower mortality), on average, than those of other periods. By contrast, the 1977–1982 period was contractionary, with steep declines in awards, frequent CDRs targeting beneficiaries with mental impairments, and a sharp increase in exits based on recovery, all of which hint at possibly higher DI-beneficiary mortality. Female DI mortality during the first year of entitlement seems to confirm this supposition, increasing across all ages for successive 1970s subperiods. Male mortality at zero duration in 1977–1980 was also higher than in any other subperiod of the 1970s, although the pattern across successive subperiods is less clear-cut than that for female beneficiaries.

Another interesting pattern in Charts 7 and 8 is the considerable flattening in mortality growth as a function of age during the first year of DI entitlement, beginning around ages 45 to 50. The vocational grid provides one potential explanation. For the 1990s and particularly for the post-2000 periods, the mortality curves dip sharply around ages 50 and 55, corresponding to less-restrictive age thresholds for DI allowances in the vocational grid. Clearly, the decline in mortality at the age thresholds has become more pronounced over time, which is consistent with the steady increase in the share of awards based on medical-vocational criteria. Another factor that can affect DI mortality is the possibility of conversion to reduced retirement benefits beginning at age 62. In this context, it is worth noting the sharp drop in mortality at age 62 during the first year of entitlement for both men and women in 2001–2005 (panel A in Charts 7 and 8). This steep decline in mortality overlaps the previously discussed drop in benefit terminations based on conversion in 2003 (Charts 1 and 3) driven by the higher FRAs of the 1938 and later birth cohorts.

The distinctive DI mortality patterns at the vocational-grid age thresholds suggest that the mortality of beneficiaries at older ages would be higher if not for the effect of the grid. After all, without the grid, older claimants would be able to enter the rolls based only on medical factors. Notice also a similar, albeit smoothed, slow-down of period mortality at older ages during the first year of DI entitlement in the 1970s subperiods. Fewer claimants entered the rolls through medical-vocational considerations in those years.

Whatever effect the vocational grid may have on DI mortality, beneficiaries who enter the rolls at older ages face a much higher mortality than do their counterparts in the general population, regardless of observation period. For instance, during 2011–2015, a 50-year-old male beneficiary in the first year of entitlement faced a mortality rate of 0.04266, which because of the age-threshold effect was slightly lower than the mortality faced by a 43-year-old male beneficiary in similar circumstances. Yet, this death rate exceeded that of a 50-year-old man in the general population more than a century earlier (in 1900) by a factor of 2.7. The same 50-year-old male beneficiary faced a mortality rate higher than that of a contemporary 76-year-old man in the general population.[22]

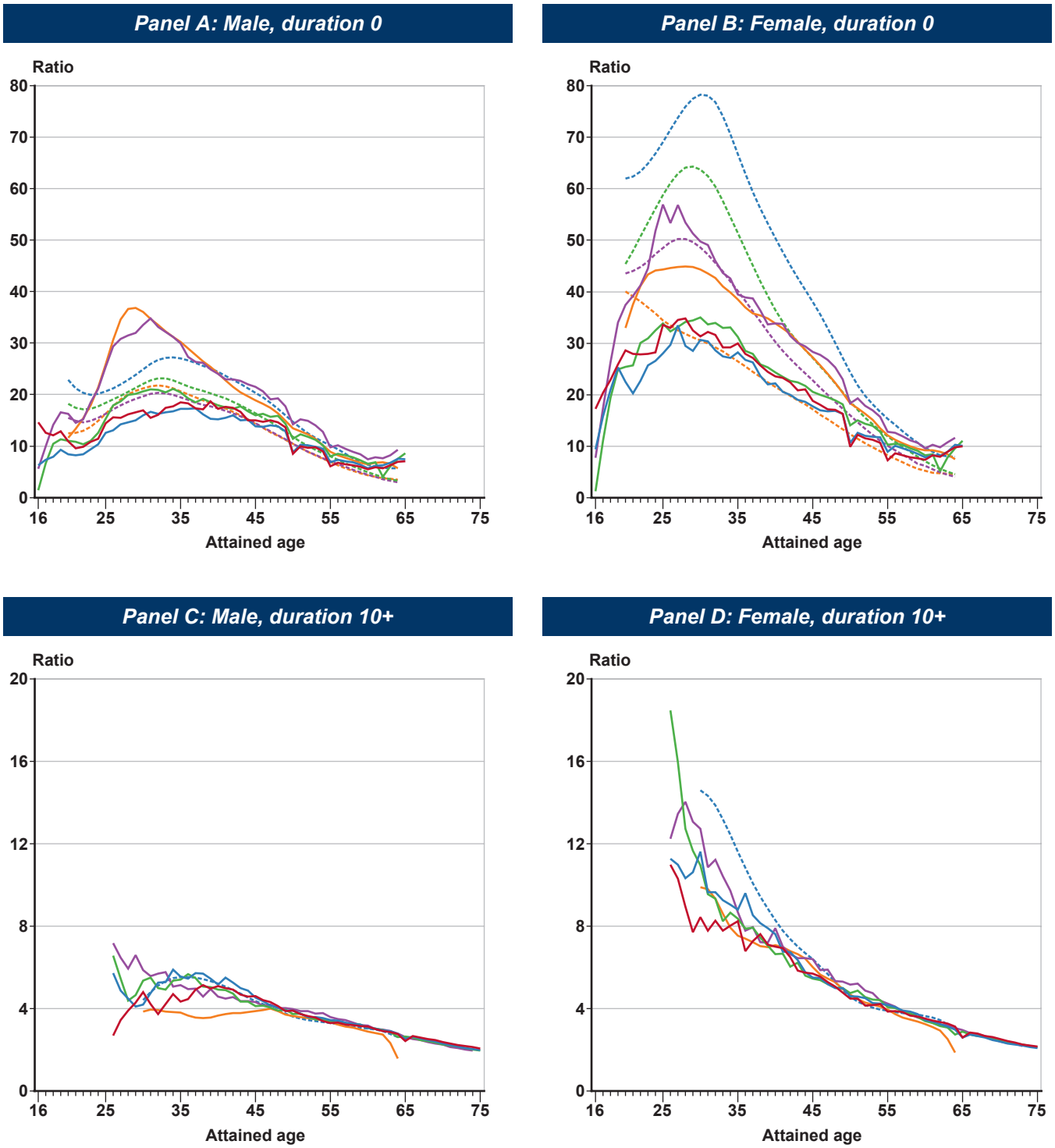
Contemporaneous Differences in Mortality by Age and Sex

Chart 9 plots the ratios of DI-beneficiary mortality to contemporaneous general-population mortality at every available age. For brevity, I refer to this as the "DI mortality ratio" hereafter. Panels A and B respectively plot the male and female mortality ratios during the first year of DI entitlement and panels C and D respectively plot the male and female mortality ratios after surviving at least 10 years on the rolls. Notice that by focusing on the two duration extremes (0, 10 or more) in this article, I highlight the maximum range in mortality differences between DI beneficiaries at a given age. Such a range illustrates the mortality experience of DI beneficiaries in varying degrees of poor health.

All the plotted mortality ratios in Chart 9 are greater than 1, indicating that DI-beneficiary mortality is always higher than general-population mortality regardless of age, enrollment period, and duration on the rolls. However, the difference can range from a factor of about 3 (for men aged 60 in 2011–2015 after surviving on the rolls for at least 10 years) to more than 70 (for women in their mid-20s to mid-30s and in their first year receiving benefits during 1977–1980).

In both the general and DI-beneficiary populations, male mortality is typically higher than female mortality at any age. Nevertheless, the female DI mortality ratios are higher than the ratios for men. This shows

Chart 9.
Mortality-rate ratios of DI disabled-worker beneficiaries to the general population, by sex, age, and duration of DI entitlement, various periods 1968–2015



SOURCES: Bell and Miller (2005, Table 6); Bayo and Wilkin (1977, Tables 8 and 9); Bayo, Goss, and Weissman (1978, Tables 9 and 10); Schobel (1980, Tables 4 and 5); Kelley and Lopez (1984, Tables 5 and 6); Zayatz (1999, 2005, 2011, 2015, Tables 7A and 7B); and Barrick-Funk (2020, Tables 7A and 7B).

that the mortality gender gap is wider in the general population than among DI beneficiaries. Put differently, male mortality exceeds female mortality by a larger factor in the general population than in the DI-beneficiary population. For instance, mortality for a 40-year-old man was about 17 times higher for a DI beneficiary in the first year of entitlement during 2011–2015 than for his counterpart in the general population. On the other hand, mortality for a 40-year-old woman was 23.5 times higher for a DI beneficiary in her first year of entitlement in 2011–2015 than for her counterpart in the general population. This result appears to be consistent across different enrollment periods and entitlement durations.

A second broad pattern revealed by Chart 9 involves age. The male and female mortality ratios are highest at younger ages (mid-20s and 30s). Mortality increases with age regardless of DI participation, but the mortality rates of young adults in the general population are comparatively very low. As a result, DI-beneficiary mortality at these ages exceeds general-population mortality by a much larger factor. In conclusion, in absolute terms (magnitude), older beneficiaries have higher mortality than younger ones and male beneficiaries tend to have higher mortality than do female beneficiaries. However, in relative terms (compared to their reference group in the general population), female and young DI beneficiaries are worse off by a larger factor. This finding is also evident in Chart 6, which shows higher mortality rates for older beneficiaries, but the vertical distances between DI-beneficiary log mortality rates and general-population log rates are greater for the young than for the old.

In general, the male DI mortality ratio at benefit duration 0 was highest for beneficiaries in their 20s and 30s during the 1990s. However, the ratio for 2001–2005 was similar to that of the early 1970s. The female DI mortality ratio at benefit duration 0 was highest at ages 20–60 during 1977–1980. Of particular note is the monotonic increase in the ratio across successive 1970s subperiods, mirroring the mortality-rate pattern in Chart 8, panel A.

Mortality Improvement

Table 2 summarizes the average rate of change in mortality for both the general and DI-beneficiary populations in the period 1977–2015 and, separately, in only the latter portion of it (1991–2015). All changes are negative, indicating mortality improvement (decline) over time. Consider, for instance, the experience of men aged 30–39. For DI beneficiaries at zero duration, the mortality rate declined by 63.0 percent, on average, from 1991 to 2015.[23] By contrast, the average rate of mortality improvement among men aged 30–39 in the general population over the most comparable available period (1993–2013) was substantially lower, at 35.3 percent. However, the average rate of mortality improvement for DI beneficiaries reaching their thirties after at least 10 years on the rolls (21.5 percent) was lower than that for the contemporary general population.

The periods of coverage in Table 2 were determined by data availability, which may bias the findings. Specifically, 1991–1995 was a period of unprecedented high mortality, driven by AIDS-related deaths, for young male beneficiaries; but it also provides the earliest mortality estimates from the most recent actuarial studies. Similarly, mortality during the first year of entitlement was substantially higher at all ages in the latter part of the 1970s than in the early part of that decade. However, of the actuarial studies covering the 1970s, I chose to use only the one encompassing the 1977–1980 period because it alone extends the mortality estimates to 10 or more years of benefit duration. Table 2 clearly shows that during the first year of entitlement, DI-beneficiary mortality for men and women aged 20–59 improved at often substantially higher average rates than those in the general population throughout both the 1977–2015 and 1991–2015 periods. Mortality at zero duration has also improved at a much faster rate over time, relative to the experience of beneficiaries with at least 10 years on the rolls.

Chart 10 compares general-population mortality at ages 35, 50, and 60 over the period 1900–2014 with the DI mortality estimates from the six actuarial studies with 10-year select periods. Dual plots for DI beneficiaries track mortality during the first year of entitlement and after at least 10 years of entitlement. These plots represent the mortality experience of the least healthy and the healthiest DI beneficiaries, in terms of longevity. Notice that for a given year, the vertical distance between the general-population mortality and the midpoint of the DI mortalities measures the difference in contemporaneous mortality between the two populations.[24]

The mortality gap between the most and least longevous DI beneficiaries has narrowed considerably over time. At age 35, for instance, the distance between the upper and lower bounds in Chart 10 declined by a factor of approximately 3 for women over the 1977–2015 period and for men over the 1991–2015 subperiod. For male DI beneficiaries in the first year of entitlement,

Table 2.
Average percentage change in mortality rates over the periods 1977–2015 and 1991–2015 for the general population and for short- and long-term DI disabled-worker beneficiaries, by age group

Age group	From 1977–1980 to 2011–2015			From 1991–1995 to 2011–2015		
		DI beneficiary for—			DI beneficiary for—	
	U.S. population [a]	Less than 1 year	10 years or longer	U.S. population [b]	Less than 1 year	10 years or longer
			Men			
20–29	-32.56	-59.53	. . .	-23.88	-56.05	. . .
30–39	-23.98	-49.41	-33.37	-35.33	-63.03	-21.46
40–49	-36.30	-49.49	-32.86	-28.15	-41.10	-14.74
50–59	-38.08	-52.03	-33.94	-18.51	-34.65	-16.11
60–64	-44.80	-40.61	-40.71	-27.78	-31.64	-10.94
			Women			
20–29	-26.05	-65.39	. . .	-11.96	-35.60	. . .
30–39	-16.23	-63.25	-43.64	-12.70	-35.85	-16.52
40–49	-28.41	-60.67	-31.41	-8.76	-34.23	-12.96
50–59	-27.60	-55.87	-24.74	-13.95	-38.09	-12.58
60–64	-33.91	-31.76	-32.01	-26.21	-26.96	-7.19

SOURCES: Author's calculations based on Bell and Miller (2005, Table 6); Bayo and Wilkin (1977, Tables 8 and 9); Bayo, Goss, and Weissman (1978, Tables 9 and 10); Schobel (1980, Tables 4 and 5); Kelley and Lopez (1984, Tables 5 and 6); Zayatz (1999, 2005, 2011, 2015, Tables 7A and 7B); and Barrick-Funk (2020, Tables 7A and 7B).

NOTES: Percentages are computed by averaging individual rates of decline by single year of age.

. . . = not applicable.

a. For the period 1978–2013.

b. For the period 1993–2013.

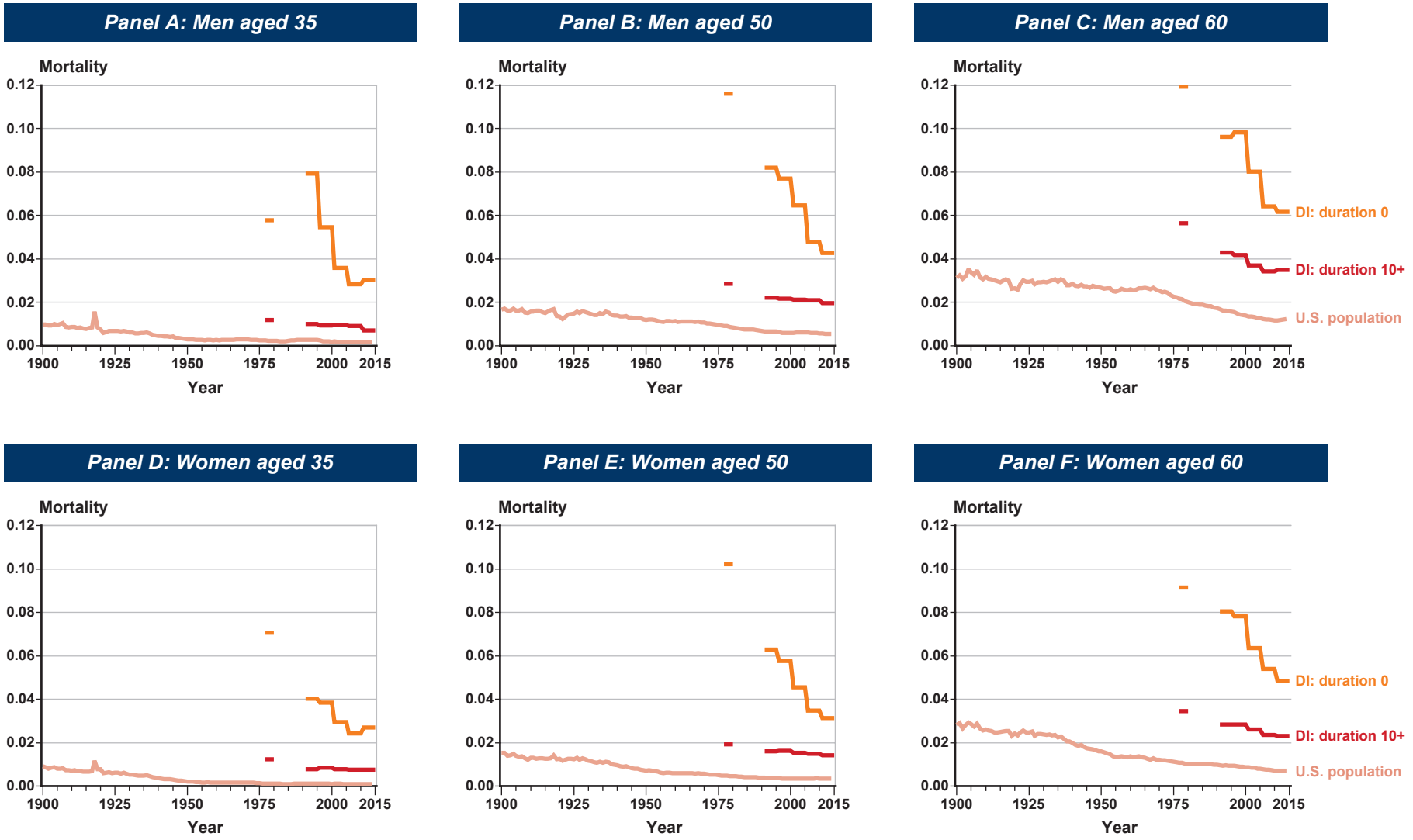
mortality at age 35 declined from more than 30 times the magnitude of mortality for 35-year-old men in the general population in 1991–1995 to 18.5 times greater by 2011–2015 (Chart 9). Likewise, the female DI mortality ratio at age 35 and duration 0 declined from 66.7 in 1977–1980 to about 30 by 2011–2015. At age 35 after surviving at least 10 years on the rolls, DI mortality ratios during the most recently available period (2011–2015) were 8.2 for women and 4.3 for men. In historical terms, male beneficiary mortality in 2011–2015 at age 35 and 10 or more years on the rolls was greater than general-population mortality in 1921 for that age.

At age 50, the gap in DI mortality by duration was 3.8 times wider for men in 1977–1980 than in 2011–2015 and 4.9 times wider for women over the same span (Chart 10, panels B and E, respectively). Recall from Chart 8 that because 50 is an age threshold in the vocational grid, DI-beneficiary mortality upon entering the rolls at age 50 is substantially lower than those at the neighboring ages 49 and 51. The pattern is particularly significant in the most recent periods and is observed also for age 55 (another grid threshold). Nevertheless, for beneficiaries in their first year on the DI rolls, mortality at age 50 during 2011–2015 exceeded contemporaneous general-population mortality by factors of 8.5 and 9.9 for men and women, respectively. Even at 10 or more years on the DI rolls, mortality at age 50 in 2011–2015 was 3.9 times higher for men and 4.5 times higher for women than for their general-population counterparts. From a historical perspective, both male and female DI-beneficiary mortality at age 50 after surviving at least 10 years on the rolls exceeded the general-population mortality at age 50 from more than a century earlier, in 1900.

Finally, by age 60 (panels C and F in Chart 10), the mortality gap between the most and least longevous DI beneficiaries declined by half from 1991–1995 to 2011–2015. For beneficiaries aged 60 in their first year on the DI rolls, mortality during 2011–2015 exceeded contemporaneous general-population mortality by factors of 5.5 and 7.4 for men and women, respectively. For beneficiaries aged 60 after surviving on the rolls for at least 10 years, female mortality in 2011–2015 was higher than general-population mortality at age 60 had been in 1919, while male beneficiary mortality exceeded the 1900 level of its general-population counterpart.

In general, the patterns displayed in Charts 6–10 and Table 2 document a substantial if rather uneven

Chart 10.
Mortality rates at ages 35, 50, and 60, by sex: DI disabled-worker beneficiaries by entitlement duration, and general population, selected years 1900–2015



SOURCES: Bell and Miller (2005, Table 6); Kelley and Lopez (1984, Tables 5 and 6); Zayatz (1999, 2005, 2011, 2015, Tables 7A and 7B); and Barrick-Funk (2020, Tables 7A and 7B).

improvement over time in the mortality of DI beneficiaries at all ages during the first year of entitlement. For men, mortality—particularly at older ages—increased from the period 1968–1974 to 1977–1980. At the height of the AIDS epidemic in the early 1990s, male mortality among DI beneficiaries increased dramatically at younger ages (25–41), relative to that of the 1968–74 period. Then, during the second half of the 1990s, the death rate for young adult men contracted significantly. That mortality-rate decline was likely linked to the systematic use of HAART beginning in 1996 and to the permanent policy change regarding the treatment of drug addiction and alcoholism in disability determinations beginning in 1997. Nevertheless, DI-beneficiary mortality increased between the first and second halves of the 1990s for beneficiaries older than 44, except at the vocational grid's age thresholds. The transition from the second half of the 1990s to the first and second halves of the 2000s led to significant mortality improvement at all ages. Yet the most recent experience has been mixed: Mortality declined modestly from 2006–2010 to 2011–2015 for beneficiaries aged 45 or older, but it increased at younger ages.

The mortality experience of female DI beneficiaries during the first year of entitlement differed from that of male beneficiaries in important ways. Mortality increased dramatically for all ages in successive subperiods from 1968–1974 to 1977–1980. By the early 1990s, female DI-beneficiary mortality was substantially lower than it had been in the late 1970s, but it was still similar to that of the 1968–1974 period for beneficiaries in their mid-20s to about age 50. Female DI-beneficiary mortality improved little between the first and second halves of the 1990s, but it improved significantly across all ages from 1996–2000 to 2006–2010. The most recent data reveal a modest and continued mortality decline through 2011–2015 for beneficiaries older than 48, but higher mortality at younger ages.

Estimates of Period Life Expectancy

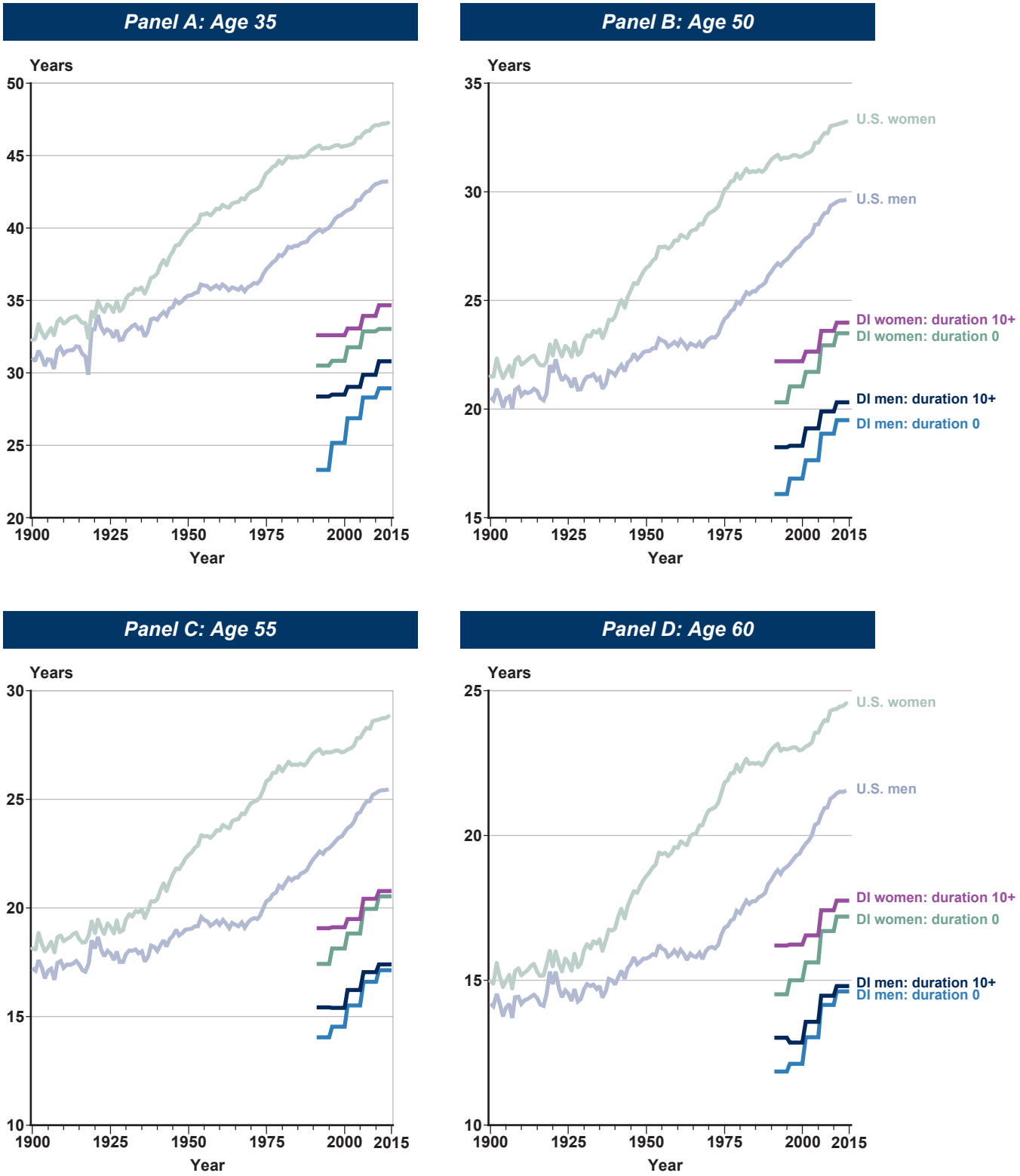
One intuitively appealing measure associated with mortality is life expectancy. Specifically, period life expectancy at a given age and year represents the expected length of life for a hypothetical person if the cross-section of death rates at each subsequent age is applied. In other words, period life expectancy uses age-specific mortality rates from a single year and assumes that those rates apply through the remainder of a person's life. Chart 11 shows male and female life expectancy for both the general population and DI beneficiaries at selected ages (35, 50, 55, and 60). As with Chart 10, the dual plots showing the bounds for the estimated period life expectancy of DI beneficiaries for 1991–2015 correspond to the two entitlement-duration extremes.[25] In this case, however, the upper bounds reflect the experience of the most longevous beneficiaries (10 or more years on the rolls), while the lower bounds represent life expectancy during the first year of entitlement (zero duration).

Consistent with the discussion in the previous section, rapid recent improvement in DI mortality at zero duration has dramatically reduced the gap in mortality and life expectancy between the least and most longevous beneficiaries. For instance, at age 35, the difference in DI life expectancy between duration extremes for men and women during 1991–1995 was 5.1 years and 2.1 years, respectively. However, by 2011–2015, the gap in life expectancy for beneficiaries stood at 1.9 years for men and 1.6 years for women. Similarly, after surviving on the DI rolls for at least 10 years and attaining age 50 during the 1991–1995 period, male and female beneficiaries were expected to outlive their counterparts at zero duration by 2.1 and 1.9 additional years, respectively. By 2011–2015, for DI beneficiaries aged 50, the gap in life expectancy by benefit duration had shrunk to 0.8 years for men and 0.5 years for women.

Chart 11 provides a historical perspective on the comparison of life expectancy between DI beneficiaries and the general population. It shows how long ago one must look to find a life expectancy for the general population that is similar to that of recent DI beneficiaries. Panel A shows that a man in the first year after entering the DI rolls at age 35 (zero duration) had a remaining life expectancy of 23.3 years in the first half of the 1990s and 28.9 years in the first half of the 2010s. By contrast, period life expectancy in the general population for a 35-year-old man during the 1918 influenza pandemic was about 30 years. For a woman in the first year after entering the rolls at age 35 (zero duration), remaining life expectancy was 30.5 years in 1991–1995 and about 33 years in 2011–2015; period life expectancy for a 35-year-old woman in the general population in 1918 was 32.4 years. Among DI beneficiaries attaining age 35 after surviving on the rolls for 10 or more years, period life expectancy in 2011–2015 was 30.8 years for men and 34.7 years for women.

Panel B of Chart 11 shows period life expectancy at age 50. A man in his first year of entitlement after entering the DI rolls at age 50 was expected to live, on average, 16.1 years in the early 1990s and 19.5 years

Chart 11.
Period life expectancy at ages 35, 50, 55, and 60, by sex: DI disabled-worker beneficiaries by entitlement duration, and general population, selected years 1900–2015



SOURCES: Bell and Miller (2005, Table 6); Zayatz (1999, Tables 12A and 12B); Zayatz (2005, 2011, 2015, Tables 9A and 9B); and Barrick-Funk (2020, Tables 9A and 9B).

in the first half of the 2010s. By contrast, the lowest general-population life expectancy in the historical series for men at age 50 was 20 years, in 1907. Likewise, a woman entering the rolls at age 50 (zero duration) was expected to live 20.3 years in the early 1990s and 23.5 years during 2011–2015. The latter closely corresponds to U.S. female life expectancy at age 50 in 1930 (23.2 years). After surviving on the rolls for at least 10 years, a male DI beneficiary attaining age 50 was expected to live 18.2 years in 1991 and 20.3 years in 2015. Expected future lifetimes for a female beneficiary in similar circumstances were 22.2 and 24.0 years, respectively. Put differently, at age 50 in the first half of the 2010s, the "healthiest" male DI beneficiaries had a period life expectancy comparable to that of a 50-year-old man in the general population in 1900, while the "healthiest" female DI beneficiaries had a life expectancy similar to that of their counterparts in the general population in 1938.

A comparison of period life expectancy at age 55 appears as panel C of Chart 11. A man in his first year after entering the DI rolls at age 55 was expected to have 14.1 years of life remaining in 1991–1995 and 17.2 years remaining in 2011–2015. The latter amount is about the same period life expectancy for a 55-year-old man in the general population in 1903 (17.3 years). A female beneficiary in her first year of entitlement at age 55 in 1991–1995 had a life expectancy of 17.4 years. By 2011–2015, female beneficiary life expectancy at age 55 and zero duration (20.6 years) was similar to that of 55-year-old women in the general population in 1940. Among the "healthiest" DI beneficiaries attaining age 55 (those surviving 10 or more years on the rolls), life expectancies across the 1991–2015 entitlement period ranged from 15.4 to 17.4 years for men and from 19.1 to 20.8 years for women.

Chart 11, panel D plots period life expectancy at age 60. In a beneficiary's first year on the DI rolls at age 60 in 1991–1995, expected remaining years of life were 11.8 for men and 14.5 for women. By 2011–2015, male DI life expectancy at age 60 during the first year of entitlement (14.6 years) was similar to that of men in the general population in 1902, while female DI life expectancy was comparable to that of women in the general population in 1941 (17.2 years). After 10 or more years of entitlement, life expectancy at age 60 was 13.0 years in 1991–1995 and 14.8 years in 2011–2015 for men; the corresponding expectancies for women were 16.2 and 17.8 years.

Overall, the life expectancies of both male and female DI beneficiaries at zero duration during the 1991–2015 period have improved at substantially higher rates than those of the general population. For the most longevous beneficiaries (10 or more years on the rolls), however, relative changes in life expectancy were more nuanced. Female DI life expectancy at the longest entitlement duration improved at a higher rate than that of women in the general population, but male DI life expectancy improved at roughly similar rates as those of men in the general population. This finding reflects the fact that mortality in the general population has declined more rapidly for men than for women. Note also the uneven rate of improvement in the life expectancy of DI beneficiaries from one 5-year subperiod to the next. Specifically, period life expectancy at 10 or more years on the rolls remained essentially flat throughout the 1990s for both male and female beneficiaries then rose substantially from 2001 through 2010.

Contemporaneous Differences in Life Expectancy

In Chart 11, the vertical distance from a given point on the men's or women's general-population curve to the midpoint between the zero and 10-or-more duration plots for male and female DI beneficiaries represents the contemporaneous gap in life expectancy between beneficiaries and the general population. This gap provides a measure of the reduction in normal remaining life expectancy associated with DI entitlement, based on the definition of period life expectancy.

Chart 12 plots the differences in contemporaneous life expectancy between DI beneficiaries and the general population by age and sex. Paired lines plot the upper and lower bounds for each of the 5-year study periods (1991–1995, 1996–2000, 2001–2005, 2006–2010, and 2011–2015) and correspond to the least and most longevous beneficiaries, respectively. Specifically, the vertical axes in the panels indicate the reduction in normal life expectancy because of disability. In addition, Table 3 shows similar information for four selected ages, by sex and study period. For example: In 1993, a man in the general population aged 35 was expected to live to age 74.74. By contrast, a 35-year-old male DI beneficiary in his first year of entitlement during 1991–1995 was expected to live to age 58.29. Table 3 and Chart 12 show that the difference is 16.45 fewer years for the beneficiary. Likewise, a male beneficiary aged 35 in 1991–1995 after 10 or more years on the rolls was expected to live to age 63.36, which represents a premature death of 11.38 years.

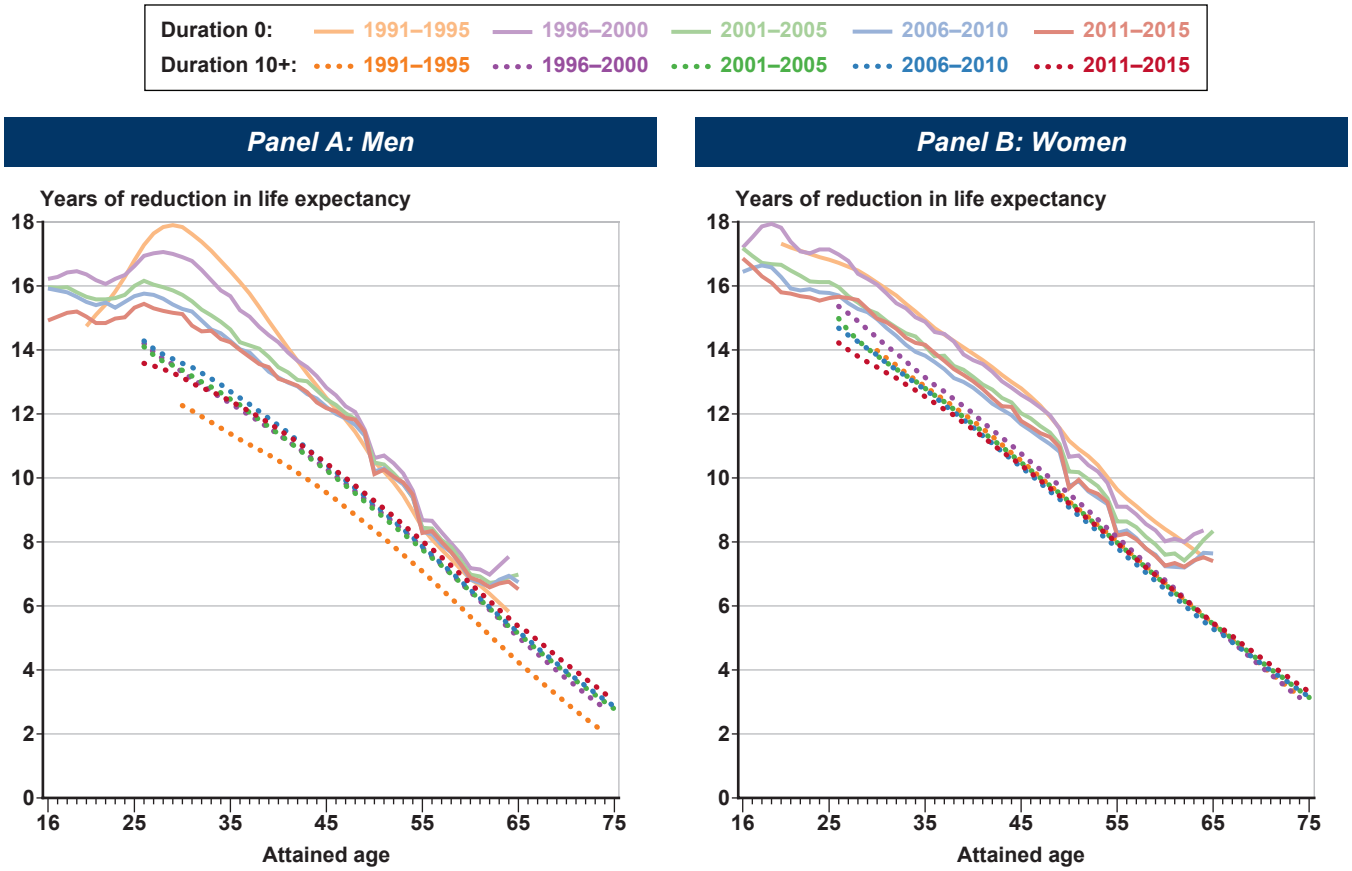
One interesting feature of Chart 12, panel A is the gap in life expectancy corresponding to the

"healthiest" male DI beneficiaries (those with 10 or more years on the rolls), which is visibly smaller in the first half of the 1990s than in the remaining subperiods. For example, at age 50, the male gap in life expectancy in 1991–1995 was 8.36 years, but it exceeded 9 years in all other subperiods (Table 3). Chart 11 helps to explain why this is the case. Specifically, life expectancy for male and female DI beneficiaries at 10 or more years of duration remained flat throughout the 1990s. However, life expectancy in the general population increased sharply for men through this period, while it stayed relatively flat for women. As a result, between the first and second half of the 1990s, the number of years of premature death among DI beneficiaries stayed roughly similar for women but jumped noticeably for men.

The most remarkable feature of Charts 11 and 12 and Table 3 is the magnitude of the gap in period life expectancy between the two populations. During the first year of entitlement at age 35, the number of expected years of premature death for DI beneficiaries ranged from 14.24 to 16.45 for men and from 13.82 to 14.94 for women across the study periods (Table 3). At age 50, the first threshold of the vocational grid, male and female beneficiaries were expected to live for 10.11–10.62 and 9.69–11.17 fewer years, respectively, than their counterparts in the general population, depending on the study period. Likewise, the range of the life-expectancy gaps for 55-year-old beneficiaries during the first year of entitlement was 8.27–8.67 years for men and 8.20–9.65 years for women. Finally, at age 60, the number of years of premature death at zero duration ranged from 6.82 to 7.18 for male beneficiaries and 7.25 to 8.40 for female beneficiaries.

DI beneficiaries who survived for a decade or longer on the rolls enjoyed greater life expectancy than at zero duration, although the gap with the general population remained substantial (Table 3 and lower bounds in Chart 12). For instance, at age 50, the number of expected years of premature death was 8.36–9.28 for men and 9.09–9.51 for women, depending on the study

Chart 12.
Difference between DI disabled-worker beneficiaries and the general population in period life expectancy by sex, age, and duration of DI entitlement, various periods 1991–2015



SOURCES: Bell and Miller (2005, Table 6); Zayatz (1999, Tables 12A and 12B); Zayatz (2005, 2011, 2015, Tables 9A and 9B); and Barrick-Funk (2020, Tables 9A and 9B).

Table 3.
Period life expectancy for the general population and for DI disabled-worker beneficiaries with less than 1 year and 10 or more years on the rolls, by sex, selected age, and study period

	Men					Women				
	Life expectancy [a]			Difference (years) between general population and DI beneficiaries with—		Life expectancy [a]			Difference (years) between general population and DI beneficiaries with—	
	General population	DI beneficiaries with—				General population	DI beneficiaries with—			
Study period		Zero duration	10+ years duration	Zero duration	10+ years duration		Zero duration	10+ years duration	Zero duration	10+ years duration
					Age 35					
1991–1995	74.74	58.29	63.36	16.45	11.38	80.45	65.51	67.59	14.94	12.86
1996–2000	75.83	60.16	63.50	15.67	12.33	80.72	65.83	67.58	14.89	13.14
2001–2005	76.49	61.85	64.03	14.64	12.46	80.87	66.75	68.06	14.12	12.81
2006–2010	77.56	63.29	64.86	14.27	12.70	81.68	67.86	68.92	13.82	12.76
2011–2015	78.18	63.94	65.79	14.24	12.39	82.20	68.04	69.65	14.16	12.55
					Age 50					
1991–1995	76.60	66.10	68.24	10.50	8.36	81.48	70.31	72.21	11.17	9.27
1996–2000	77.41	66.79	68.31	10.62	9.10	81.70	71.04	72.19	10.66	9.51
2001–2005	78.11	67.64	69.11	10.47	9.00	81.92	71.72	72.65	10.20	9.27
2006–2010	79.05	68.86	69.88	10.19	9.17	82.69	72.94	73.60	9.75	9.09
2011–2015	79.59	69.48	70.31	10.11	9.28	83.17	73.48	73.97	9.69	9.20
					Age 55					
1991–1995	77.49	69.06	70.42	8.43	7.07	82.09	72.44	74.07	9.65	8.02
1996–2000	78.22	69.55	70.41	8.67	7.81	82.26	73.15	74.11	9.11	8.15
2001–2005	78.97	70.53	71.22	8.44	7.75	82.48	73.83	74.50	8.65	7.98
2006–2010	79.91	71.60	72.05	8.31	7.86	83.26	74.97	75.44	8.29	7.82
2011–2015	80.42	72.15	72.40	8.27	8.02	83.75	75.55	75.78	8.20	7.97
					Age 60					
1991–1995	78.67	71.84	73.01	6.83	5.66	82.92	74.52	76.19	8.40	6.73
1996–2000	79.29	72.11	72.85	7.18	6.44	83.03	75.00	76.54	8.03	6.49
2001–2005	80.01	73.03	73.56	6.98	6.45	83.22	75.62	76.54	7.60	6.68
2006–2010	80.96	74.14	74.46	6.82	6.50	83.95	76.70	77.42	7.25	6.53
2011–2015	81.49	74.61	74.79	6.88	6.70	84.46	77.19	77.75	7.27	6.71

SOURCES: Author's calculations based on Bell and Miller (2005, Table 6); Zayatz (1999, Tables 12A and 12B); Zayatz (2005, 2011, 2015, Tables 9A and 9B); and Barrick-Funk (2020, Tables 9A and 9B).

a. For uniformity across ages and study periods, life expectancies are shown as expected length of life from birth.

period. Clearly, the mortality experience of DI beneficiaries at any age, study period, and duration on the disability rolls is one of severe reduction in life expectancy relative to the contemporary general population.

Recent Trends in Disability Awards

As discussed earlier, specific events, such as the widespread use of effective HIV medication and the legislative exclusions involving material drug and alcohol addiction, have helped to drive the observed decline in DI-beneficiary mortality from the early 1990s into the first half of the 2010s, particularly among younger men. Two broad distributional trends have likely further contributed to the mortality improvement of the DI-beneficiary population over time: the changing composition of the beneficiary population by diagnostic group and the growing role of medical-vocational considerations.

Differences in Diagnostic Composition

A recent report identifies the relative contribution of various impairments, injuries, and risk factors to U.S. morbidity and death in the period 1990–2010 (U.S. Burden of Disease Collaborators 2013). The most years of life lost to premature mortality in 2010 were attributed to ischemic heart disease, lung cancer,

stroke, chronic obstructive pulmonary disease, and road injury. On the other hand, the impairments that accounted for the most years lived with a disability in 2010 involved lower back pain, major depressive disorder, other musculoskeletal disorders, neck pain, and anxiety disorders.[26]

As shown in Chart 4, the number of DI awards with a mental disorder as the primary diagnosis rose rapidly in the late 1980s and the early 1990s, surpassing all other diagnostic groups, although their relative share has been declining since at least 2002. Given the peak onset ages of most mental disorders, this declining trend could continue as the median age of the population continues to rise. Likewise, awards involving primary diagnoses of musculoskeletal disorders began surpassing any other diagnostic group by the early 2000s and their share has increased rapidly since then.

DI beneficiaries entering the rolls with musculoskeletal and mental impairments have higher survival rates and are likely to enter the program earlier and stay longer than those with other disorders such as circulatory-system diseases or malignant cancers.[27] As a result, 63 percent of disabled-worker beneficiaries in current-payment status by 2019 had joined the DI rolls with either a mental or musculoskeletal-system primary diagnosis (SSA 2020, Chart 6). This shift in diagnostic composition has likely contributed to the mortality improvement of DI beneficiaries over time. SSA's actuarial studies do not provide period death rates by diagnostic group, except in the specific case of AIDS-related awards during 1992–1996 and 1997–2001 (Barrick and Zayatz 2005) and during 2001–2005 (Zayatz and Barrick 2012).

Raut (2017) used a competing-risks model to estimate DI beneficiary exit probabilities by reason for exit and selected primary diagnostic group, based on administrative data for 1980–2000 from SSA's Continuous Work History Sample.[28] He estimated that the cumulative probability of exit via recovery through the first 9 years on the rolls exceeded the probability of death only for the youngest age group (20–30) in his study (Raut 2017, Table 2). By comparison, Zayatz (2015, Tables K2 and K6) suggested that duration-adjusted recovery rates exceeded death rates for beneficiaries aged 20–34 during 1996–2010 and at ages 35–39 during 1996–2005.

In terms of broad diagnostic groups, Raut estimated that the cumulative probability of recovery through the first 9 years of entitlement exceeded the probability of death for only two categories: beneficiaries entitled at ages 20–40 with a mental disorder as the primary diagnosis and those entitled at ages 20–50 with a musculoskeletal-system primary diagnosis (Raut 2017, Table 4). Consistent with the results discussed earlier in this section, Raut found that mortality was highest at every age group among beneficiaries with malignant cancer, followed by those with circulatory impairments. Meanwhile, beneficiaries with musculoskeletal and mental impairment diagnoses had the lowest and second lowest probabilities of death, respectively.

Raut found that beneficiary mortality generally declined from the 1980s to the 1990s, except for young beneficiaries (aged 20–30) in either the mental impairment or "other remaining diagnosis" categories, for beneficiaries aged 31–40 with a musculoskeletal impairment, and for those aged 41–55 with a circulatory-system disorder (Raut 2017, Table 6). Because Raut's "other remaining diagnosis" category included infectious diseases, that result is consistent with the high mortality rates throughout the 1990s driven by AIDS-related deaths at young ages. The finding of increased mortality in the 1990s relative to the 1980s for young beneficiaries with mental and musculoskeletal impairments (and for middle-aged beneficiaries with a cardiovascular impairment), however, is surprising. As previously mentioned, no actuarial reports cover the mortality experience of DI beneficiaries in the 1980s. Thus, the net effect on mortality of the various legislative changes that took place throughout the 1980s is unclear.

The distributional shift in diagnostic categories among DI beneficiaries is open to multiple interpretations. Some observers view it as the result of more relaxed standards in the disability determination process after 1984. However, it is also possible that labor market conditions have prompted workers with certain impairments to apply for benefits, some of whom might otherwise have deferred applying until a few years later, perhaps under a different diagnostic category. Declining DI mortality rates during periods in which adjusted disability incidence rates are stable suggests a distributional shift in diagnoses toward less deadly impairments. According to Liebman (2015),

> although it is conceivable that medical progress has significantly reduced mortality for a wide range of conditions without improving functional capacity, it seems likely that a significant portion of the decline in mortality rates among DI recipients is the result of a change in the composition of the beneficiary population.

The dramatic improvements in mortality (Chart 10) and life expectancy (Chart 11) among the least longevous beneficiaries (those in their first year on the rolls) are consistent with a compositional shift toward less deadly impairments.

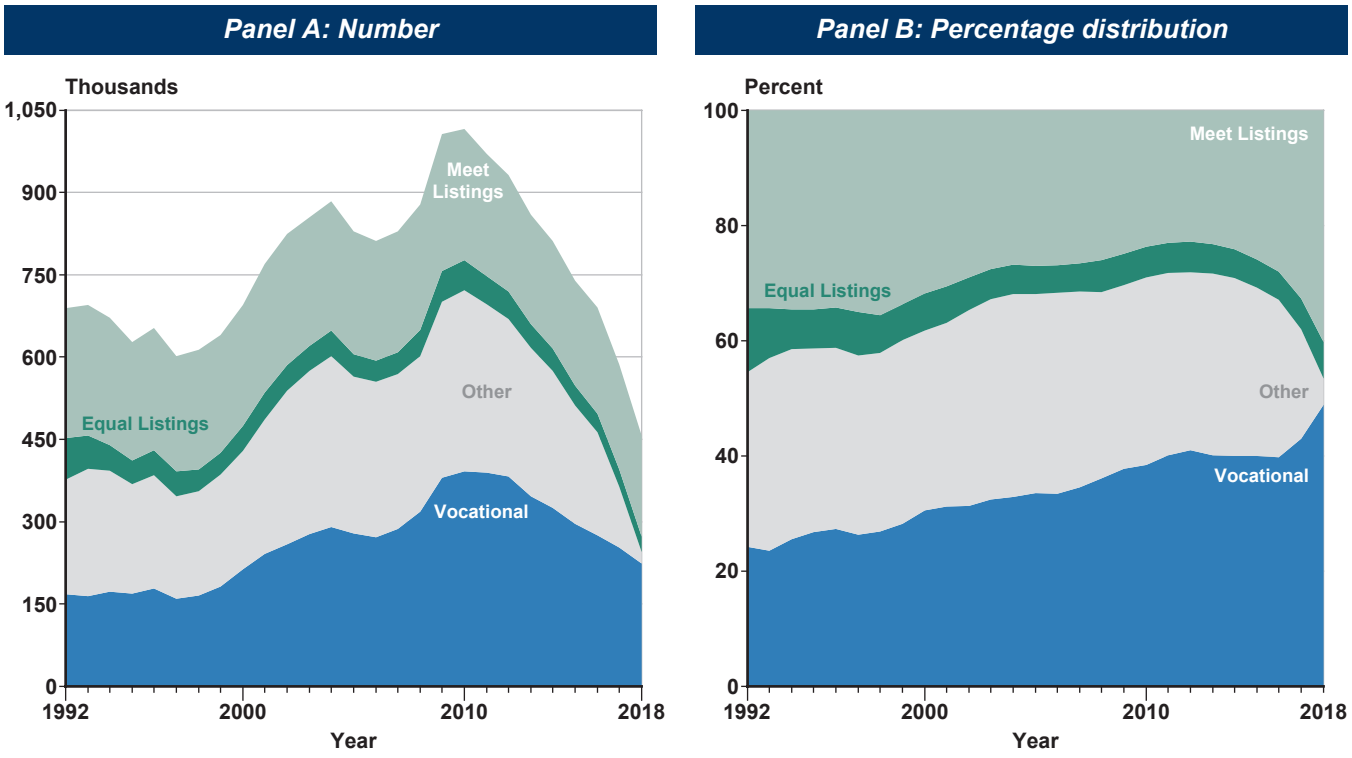
Shifts in the Composition of Vocational Awards

In recent decades, the share of awards based on medical factors alone has declined, lending greater prominence to medical-vocational considerations and the vocational grid. In 2010, 54.7 percent of adult DI allowances at the DDS level were based on medical-vocational considerations, as were 50.7 percent of SSI allowances (Wixon and Strand 2013, Tables 1 and 2). Although those figures provide an illuminating snapshot, they do not represent final decisions.[29]

Charts 13 and 14 respectively show the number and percentage distribution of final awards and final denials by year of application and reason for the decision for the period 1992–2018. The charts cover DI-only and concurrent DI/SSI disabled-worker applications and reflect the final adjudicative level of the disability determination.

Chart 13 illustrates important recent changes in the decisional basis of allowances. Specifically, the share of final awards involving vocational considerations increased from 24.3 percent in 1992 to 40.1 percent by 2015. The share rose further, to 48.9 percent, for 2018, the most recent year with available data—although subsequent final decisions on cases pending in 2018 will adjust that figure, most likely downward. Moreover, Chart 13 provides only a lower bound for the vocational-basis share of final allowances because the "other" category includes awards for which data on the basis of the determination were not available (this applies mostly to cases decided at the hearing level). Typically, a majority of these determinations are also vocational in nature.[30] Hence, as the share of allowances based strictly on the medical listings has been declining, a substantial majority of recent awards were based on the vocational grid. Furthermore, if one were to assume that all of the final awards in the "other" category in Chart 13 were vocational-based decisions, the upper-bound estimate of their share of final decisions would rise to 54.6 percent in 1992 and 69.2 percent by 2015.

Chart 13.
Number and percentage distribution of final DI disabled-worker awards, by basis of determination, application years 1992–2018



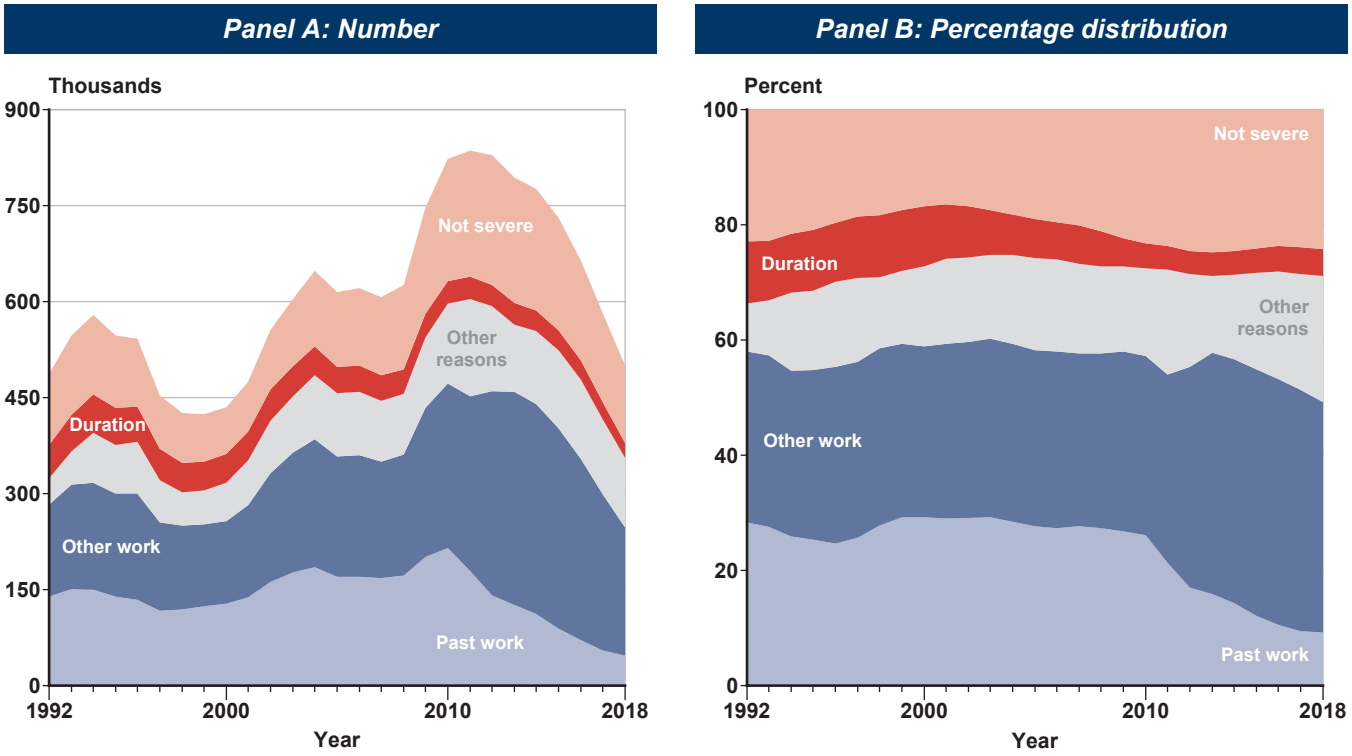
SOURCE: SSA (2020, Table 64).

Vocational considerations account for a majority of denials as well (Chart 14). More than half of final denials involve a finding of capacity to do either the applicant's past work or other work available in the national economy. Although the vocational-basis share of denials appears to have been stable in recent decades, its internal composition has shifted, as denials based on the capacity to do past work declined from 28.4 percent of final denials in 1992 to 12.2 percent of them in 2015. Notice that the decline in the share of denials based on capacity to do past work accelerated substantially after 2010, coinciding with the end of the Great Recession and a secular declining trend in awards (Chart 2). Because of the sequential nature of the disability determination process, claimants with applications denied for ability to do past work are generally deemed to have greater work capacity than those with denials for the ability to do any other work. Thus, the shrinking composition of "past-work" denials in panel B might suggest a pool of denied applicants with lower capacity for work than in previous decades, although there could be alternative explanations.

Vocational denials stand in contrast to those involving medical conditions that are deemed insufficiently severe or are expected to last less than 12 months, which also result in denial of benefits. In addition, the "other reasons" category includes cases denied at or above the hearing level for which data on the basis of determination were not available, as well as denials for various other reasons, such as return to substantial gainful activity, drug addiction or alcoholism, insufficient medical evidence, and failure to cooperate or follow prescribed treatment.

The distributional shift from medical toward vocational allowances remains puzzling. Focusing on initial DI determinations, Michaud, Nelson, and Wiczer (2018) found that workers' changing composition by age, education, and occupation could not explain this shift. Claimants aged 55–59 drive the growth in both applications and vocational-based allowances. The sheer size of the baby-boom cohort has led to a recent increase of that age group's share of workers (and, therefore, DI applicants), which would imply an increase in vocational-based allowances; yet its higher

Chart 14.
Number and percentage distribution of final DI disabled-worker denials, by basis of determination, application years 1992–2018



SOURCE: SSA (2020, Table 65).

educational attainment relative to prior cohorts has an offsetting effect. The authors note:

> Attainment of a high school degree lowers awards both through lower application rates and a higher rate of denial at the vocational stage. This is in line with the de jure objective of the vocational grid in the [DI] award process. The vocational grid also treats occupations in an interesting way. Workers in their 50s in service or production sectors drove the incidence of awards with vocational considerations, but they also contribute greatly to overall applications and awards at the medical stage.

It is plausible that the growth in the medical-vocational share of allowances has contributed to the improvement over time in DI mortality. However, the magnitude of that contribution is uncertain. Recall that panel A of Charts 7 and 8 shows the probability of death for DI beneficiaries during the first year of entitlement, by age, for men and women, respectively. As noted earlier, mortality during the first year of entitlement climbs rapidly as a function of age until about age 45 and then begins to flatten. This pattern appears for all subperiods covered in the actuarial studies, including the 1970s and early 1990s, when the vocational-based share of awards was much lower than it is today.[31] Notice in particular that mortality in many of the subperiods in the 1970s actually declined for men after about age 55 and for women after about age 50. In addition, the "dips" in mortality at the grid threshold ages 50 and 55 shift from imperceptible in the 1970s to moderate in size in the early 1990s and pronounced during the most recent period (2011–2015). This pattern seems consistent with the increasing share of awards attributable to vocational factors, as shown in Chart 13.

Clearly, claimants entering the rolls in recent decades at the 50 and 55 age thresholds experienced significantly lower mortality than their respective counterparts at ages 49 and 54. This suggests that a somewhat "healthier" population of new DI beneficiaries clusters at the vocational age thresholds and is consistent with the discontinuities often observed in the allowance rate at those ages.[32] For instance, in 2011–2015, the male probability of death at age 49 during the first year of DI entitlement was 0.062, while the corresponding probability at age 50 was substantially lower at 0.043. However, the probability of death at age 60 during the first year of entitlement was also similar to that at age 49 (0.062), highlighting the overall flattening of DI-beneficiary mortality at older ages. Notably, the lower mortality among those who entered the DI rolls at the 50 and 55 age thresholds persisted beyond the year of entitlement. For instance, the probability of death for a 52-year-old man 2 years after entering the DI rolls at age 50 during 2011–2015 (0.026) was lower than that of a 51-year-old male beneficiary 2 years after entitlement at age 49 (0.031; Chart 7, panel C).

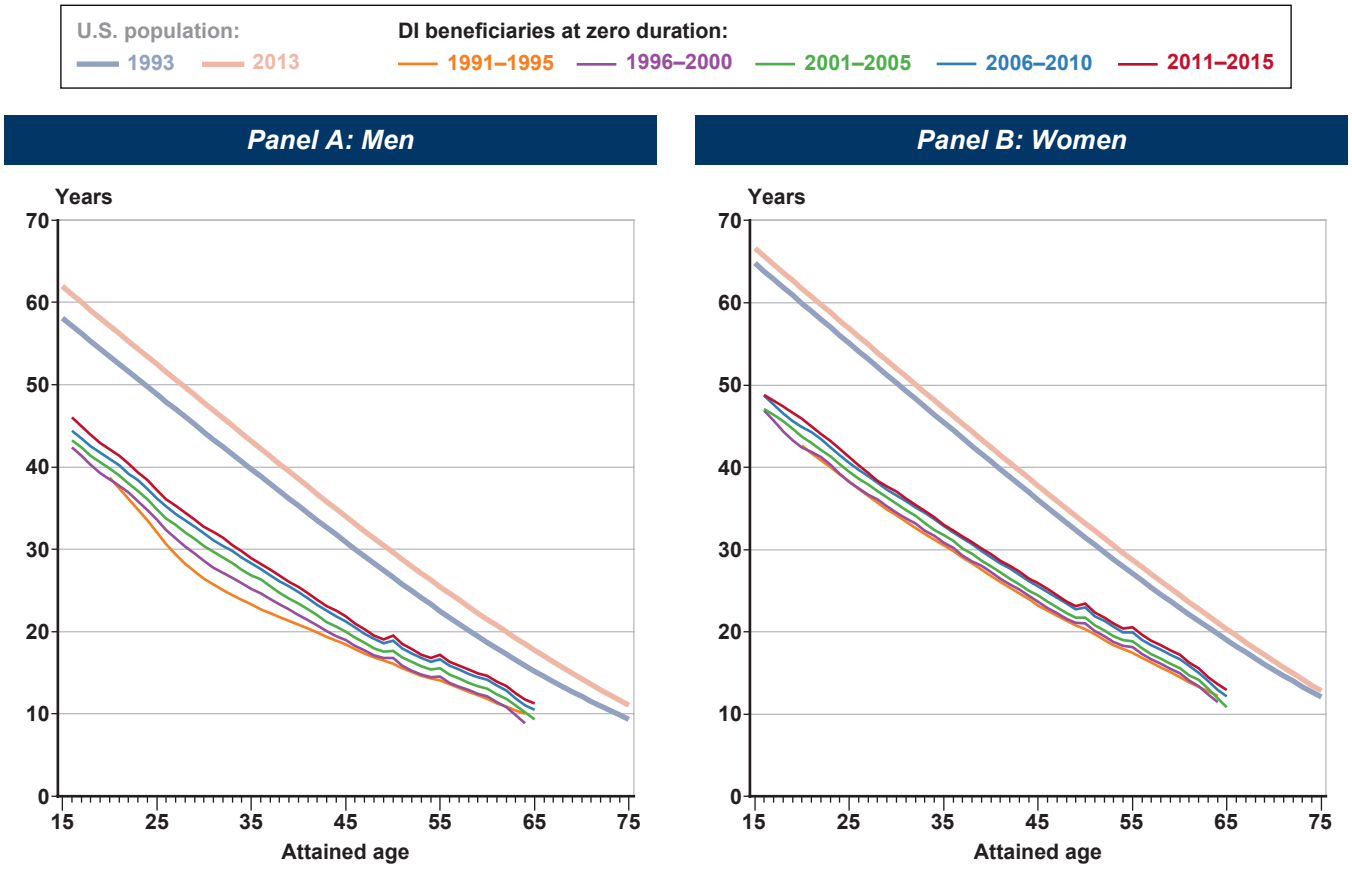
SSA follows a "borderline age policy" in implementing the medical-vocational rules.[33] In particular, suppose that a claimant will reach the next age category of the grid within 6 months of the date of adjudication and that such age, in conjunction with all other factors of the case, would result in a finding of disability, while current chronological age alone would result instead in a denial of benefits. Under very specific guidelines, a disability examiner is permitted to use the higher age and grant benefits. This practice is justified by administrative efficiency; it saves the cost and time of processing the same claim again in the near future, with the certain knowledge that it would result in an allowance.

Interestingly, although the likelihood of an allowance rises with the age thresholds of the vocational grid, claiming behavior does not cluster around those ages (Strand and Messel 2019, Figure 3). This suggests that applicants do not decide when to apply based on maximizing the chance of receiving benefits. In addition, the lower mortality rates around the vocational grid thresholds have a modest effect on period life expectancy.

Chart 15 shows period life expectancies as a function of age for the general population in 1993 and 2013 and for DI beneficiaries at zero duration in each of the five 5-year subperiods from 1991 to 2015, by sex. A man entering the DI rolls in 2011–2015 at age 50 had, during the first year of entitlement, a remaining life expectancy of 19.48 years, predictively outliving a 49-year-old DI beneficiary during the same period by one-half of a year and a 51-year-old by one full year. A linear extrapolation of expectancies at ages 49 and 51 suggests that the effect of the age-50 threshold in 2011–2015 was to increase male DI life expectancy by 0.72 years beyond what it would have been if 50 were not a specific age threshold. Similarly, the effect of the age-50 threshold for female beneficiaries during this period appears to equate to 0.77 added years of life.[34]

In conclusion, the observed flattening in DI mortality during the first year of entitlement beginning at about age 45 may be due to the use of vocational

Chart 15.
Period life expectancy for DI disabled-worker beneficiaries in the first year of entitlement and the general population, by age and sex, various periods 1991–2015



SOURCES: Bell and Miller (2005, Table 6); Zayatz (1999, Tables 12A and 12B); Zayatz (2005, 2011, 2015, Tables 9A and 9B); and Barrick-Funk (2020, Tables 9A and 9B).

considerations by disability examiners, whether informally prior to 1978 or formally after that. The increasingly pronounced discontinuities in mortality at the age thresholds of the vocational grid seem consistent with the growing share of awards decided based on vocational factors in recent decades. This development likely affected the mortality improvement of DI beneficiaries over time. Certainly, period life expectancy is higher at the age thresholds and their effect on mortality persists over multiple years of duration.

Mortality Trends in the General Population

From 1959 to 2013, U.S. period life expectancy at birth increased by almost a decade, from 69.9 to 78.9 years, but then declined for three consecutive years after 2014 (Woolf and Schoomaker 2019). Beginning in the 1980s, the rate of increase in U.S. life expectancy slowed relative to that of other developed countries, dipping below the average among Organisation of Economic Cooperation and Development nations by 1998. U.S. life expectancy at birth stopped increasing altogether in 2010, then declined in 2015, 2016, and 2017.[35] This reversal culminated a trend that began in the 1990s, when cause-specific mortality between ages 25 and 64 (midlife) began to rise.

Americans in midlife are experiencing a surge in deaths driven by the near-term effects of drug overdose, alcohol abuse, and suicide, often referred to as "deaths of despair" (Case and Deaton 2015, 2017, 2020). Mortality in midlife has also risen sharply for disorders associated with longer-term effects of drug and alcohol use, such as psychoactive substance use disorders, alcoholic liver disease, and liver cancer; and various organ system disorders, including hypertensive diseases, chronic obstructive pulmonary disease, diabetes, and obesity. Initially, the rising rate of deaths of despair was offset by simultaneous declines in other leading causes of death, such as traffic accidents,

ischemic heart disease, cancer, and HIV infection. However, by 2010, all-cause mortality at ages 25–64 began to rise, and by 2014, it was increasing across all racial groups (Woolf and Schoomaker 2019).

It is well established that mortality declines as earnings and educational attainment increase and that gains in longevity have disproportionately accrued to those with higher earnings (Bor, Cohen, and Galea 2017). The gaps in mortality and life expectancy by income and education widened during the period 1980–2014. Furthermore, although income inequality has been driven by disproportionate growth in incomes at the very top of the distribution, disparities in survival have been borne most acutely by the bottom half of the earnings distribution.

For various demographic groups, mortality has either been stagnant or increasing since the 1990s. For instance, Olshansky and others (2012) found that life expectancy in the 1990s declined for White people without a high school diploma, especially women. However, Bound and others (2015) cautioned that these findings are very sensitive to the substantial compositional changes in the educational attainment of the underlying population and that "focusing on mortality rates of those with less than a high school education over a twenty-year period means looking at a different, shrinking, and increasingly vulnerable segment of the population each year." Case and Deaton (2015, 2017) reported increased morbidity and all-cause mortality among non-Hispanic White 50- to 54-year-olds after 1998, driven by suicide and drug and alcohol abuse.[36] The disproportionate bulk of this mortality increase fell among those with a high school education or less.

Chetty and others (2016) estimated the difference in period life expectancy at age 40 between individuals in the top 1 percent and the bottom 1 percent of the income distribution to be 14.6 years for men and 10.1 years for women during 2001–2014. In that period, life expectancy at age 40 increased by 2.34 years for men and 2.91 years for women in the top 5 percent of the earnings distribution. For those in the bottom 5 percent of the income distribution, life expectancy increased only 0.32 years for men and 0.04 years for women.

Bor, Cohen, and Galea (2017) found that estimated survival gaps tend to be wider in studies that focus on changes in mortality across birth cohorts instead of changes across periods. This is because as cohort life expectancy rises for successive birth cohorts, period life expectancy discounts that increase by averaging across multiple cohorts.[37] The implication is that disparities in life expectancy over time mask potentially much wider gaps across generations. According to Waldron (2007),

> male Social Security–covered workers born in 1941 who had average relative earnings in the top half of the earnings distribution and who lived to age 60 would be expected to live 5.8 more years than their counterparts in the bottom half. In contrast, among male Social Security–covered workers born in 1912 who survived to age 60, those in the top half of the earnings distribution would be expected to live only 1.2 years more than those in the bottom half.

Medical breakthroughs in technology and improvement in care may extend disability-free life expectancy in the population (Chernew and others 2016). Ironically, those factors could also contribute to the widening gap in health and mortality by socioeconomic status, as they may disproportionately benefit those with higher earnings and educational attainment. For instance, as previously discussed, the widespread use of HAARTs in the mid-1990s is credited with drastically reducing mortality rates among DI beneficiaries with HIV. HAART demands strict patient compliance with a complex timing and sequence regimen for multiple drugs—as many as 24 pills per day. Failure to adhere to the regimen can result in resistance to the drugs. Goldman and Lakdawalla (2005) found growing disparities in tests of immune-system health among HAART users by educational attainment, implying differences in adherence to treatment.

The National Academies of Sciences, Engineering, and Medicine (2015) examined the effect of the growing mortality gap on the major federal entitlement programs (Medicare, Medicaid, OASI, DI, and SSI), documenting the distributional shift in government benefits resulting from the growing gap in mortality. The authors projected a cohort life-expectancy gap of almost a decade within a single generation among the richest and poorest 20 percent of Americans. In particular, life expectancy at age 50 is projected to remain unchanged for men in the poorest quintile and to decline for women in the two poorest quintiles.

In the context of DI, both applicants and beneficiaries have lower earnings and educational attainment, on average, than the general population. In particular, prior to disability onset, DI claimants disproportionately occupy the bottom half of the earnings distribution, especially among those reaching

a vocational-grid threshold age. After adjusting for age and sex, the difference in mean annual earnings in 2005 between the disability-insured population and DI applicants was $25,000 (Strand and Trenkamp 2015). Likewise, at least half of DI disabled-worker beneficiaries have no more than a high school diploma or equivalent, with other surveys indicating similar or higher proportions (Bailey and Hemmeter 2014; O'Leary, Walker, and Roessel 2015). By contrast, only 40.7 percent of the U.S. adult population had a high school education or less in 2016 (Census Bureau 2016, Table 1). Poterba, Venti, and Wise (2017) estimate that "a large component of the relationship between education and DI participation—more than one-third for men, and over two-thirds for women—can be attributed to the correlation of education with health, and of health with DI receipt."

Distributional differences in longevity among workers by earnings and educational attainment are wide and growing. Policymakers should therefore be cautious in extrapolating the characteristics of DI beneficiaries from the broader experience in the general population. Nondisabled Americans who are otherwise similar in socioeconomic status to DI applicants experience higher death rates, and mortality improvement that is far more modest, than the national average. Of course, in addition to lower earnings and lower educational attainment, DI beneficiaries (including those entering the rolls through decisions based on the vocational grid) also have medical impairments deemed to be severe by a disability examiner or an administrative law judge, accounting for much of the dramatic mortality gaps documented above.

Mortality, Morbidity, and Ability to Work

A seminal article by James F. Fries (1980) noted that a longer life may not necessarily mean a healthy one. As chronic disorders have replaced infectious diseases as the main cause of death at older ages, increasing life expectancy can become problematic as a measure of improvement in the general health of the population. As pointed out by Jagger and others (2015):

> Indeed, with a constant recovery rate, if the risk of dying diminishes more than the risk of becoming ill, the risk of being ill increases. In other words, the prevalence of chronic disease in the population can increase as a result of a lengthening of duration of survival if the decrease in fatality is not compensated for by an equivalent decrease in incidence.

Three alternative hypotheses have emerged for interpreting the phenomenon of populations with increases in both life expectancy and the prevalence of chronic disease. The first, morbidity compression, posits an increase in the share of disability-free life expectancy. The second, morbidity expansion, posits a decline in the share of disability-free life expectancy. Third, the so-called "dynamic equilibrium" hypothesis foresees the proportion of life spent free of disability remaining constant, as changes in life expectancy with and without disability offset each other. The evidence supporting these three hypotheses has been mixed and depends on the period and population under study, the chosen measures of health (disease, functioning, activities of daily living, and so on), and the methodology.[38]

Using data from the National Health Interview Survey, Crimmins, Zhang, and Saito (2016) estimated life expectancy for U.S. individuals with and without disabilities over the period 1970–2010. Using a much broader definition of disability ("any limitation of activity") than that of the DI program, the authors found that disability prevalence after 1980 increased for Americans younger than 65, but declined for those aged 65 or older. During working years (ages 20–64), life expectancy for disabled men and women increased 1.1 years and 1.6 years, respectively, while disability-free life expectancy increased by 0.9 years for men but declined by 0.6 years for women. Crimmins, Zhang, and Saito characterized the evolution of life expectancy over the 40-year period as one of dynamic equilibrium with some compression at older ages. However, the authors cautioned that "in sensitivity analyses, we examined the change over time in life expectancy assuming that the working ages were 20 to 70 years; the conclusions were similar to those we present for age 65 years. There is little evidence from this analysis of improving health in this age range that would support increasing the age at retirement."

Chernew and others (2016) used self-reported limitations in activities of daily living (ADLs) and instrumental ADLs from the Medicare Current Beneficiary Survey as measures of health condition. They found evidence of morbidity compression at ages 65 or older during 1991–2009. In particular, nondisabled life expectancy at age 65 increased by 1.8 years, while disabled life expectancy fell by 0.5 years. Furthermore, the authors attributed 63 percent of the improvement in nondisabled life expectancy to lower incidence of and improved functioning associated with cardiovascular impairments and vision problems.

Rutledge and others (2018) analyzed measures of self-reported health, work limitation, and restrictions in activities of daily living using Survey of Income and Program Participation results matched to administrative records from SSA. Focusing on DI and/or SSI claimants from 1989 to 2013, the authors found little difference over time in applicants' health status in the years before they applied, suggesting that the underlying health of DI and SSI claimants remained essentially unchanged over the period.

Using a health index based on the first principal component of 27 measures of disease, functional limitation, and medical care usage in the Health and Retirement Study, Heiss, Venti, and Wise (2015) compared the health trajectories of DI applicants and nonapplicants aged 50–65 over the period 1992–2010. By the time of application at ages 50–54, the health index of claimants was 31 percentile points lower than that of nonapplicants, suggesting large disparities in average health between the groups. Filers of allowed claims seemed to be in marginally better preapplication health than those who filed denied ones, although the former group suffered a much steeper decline in health in the year before and after application than the latter group. In the 12 years after application, the health status of beneficiaries remained unchanged, but it improved steadily for those whose claims had been rejected. However, this finding could be affected by mortality selection, if the filers of allowed and denied claims died at different rates. Heiss, Venti, and Wise note in particular the similarity in patterns of self-reported health and earnings trajectories for both allowed and denied claimants.

Based on data from the 2014 Survey of Income and Program Participation, Weaver (2020) compared a broad set of characteristics of the subpopulations who are allowed and denied disability benefits. Disproportionate shares of both the allowed and denied groups live in the South, lack a high school diploma, and are Black. For instance, Weaver estimates that 25.8 percent and 20.5 percent, respectively, of the allowed and denied populations are Black, compared with 11.6 percent of the general population. The estimated proportion of SSI recipients who are Black is 28.7 percent. Race and ethnicity are likely to be important, but often overlooked, components of the mortality experience of individuals with disabilities, given the substantial racial and ethnic differences in mortality documented for the general population.

According to Weaver (2020), denied claimants experience higher rates of poverty and material hardship than both the general and DI-beneficiary populations. In addition, despite having lower income and health insurance coverage rates than the general population, denied DI applicants experience significantly higher levels of health care use in the form of hospitalizations and visits to medical providers. Note that although both allowed and denied claimants have substantially poorer health than nonapplicants do, beneficiaries become eligible for cash benefits and health insurance from Medicare or Medicaid.[39] These facts raise the possibility that DI benefit receipt itself may subsequently affect health and mortality.

García-Gómez and Gielen (2017) analyzed the mortality effects of both stricter eligibility standards and reduced generosity in the Dutch disability insurance program. Changes enacted in the Netherlands in 1993 applied to beneficiaries younger than 45 and based eligibility on observable functional work limitations linked directly to a medical diagnosis. As a result, disability related to mental impairment became particularly hard to prove. In addition, occupational criteria were expanded, which effectively reduced benefit amounts. Exploiting the age discontinuity that the reforms introduced to the program, the authors derived causal estimates of the effects of decreased generosity of disability insurance on beneficiary mortality. García-Gómez and Gielen found that for women with low predisability earnings, a €1,000 reduction in annual benefits led to a 2.4 percentage point increase in the probability of death more than 10 years after the reform. On the other hand, mortality improved for male beneficiaries subjected to the more stringent disability standards. The authors hypothesized that the gender differences in the estimated effects are likely related to differences in earnings and diagnoses, as the prevalence of mental disability diagnoses is higher among women but they experience lower earnings.

For new DI beneficiaries in the period 1997–2009, Gelber, Moore, and Strand (2018) used the discontinuities in the benefit formula to derive local-area estimates of the causal effect of DI benefits on mortality during the first 4 years on the rolls. They found that DI benefits can substantially reduce mortality, particularly for the lowest-income beneficiaries: "At the lower bend point, where mean annual DI income is $8,543, we estimate that an increase of $1,000 in annual DI payments decreases beneficiaries' annual mortality rate by 0.26 percentage points." The authors observe that the magnitude of the annual-mortality elasticity of DI income is comparable to estimates found in other studies involving populations with

high mortality and low income, including old-age pensioners in Russia, U.S. Union Army veterans receiving pensions in the early 1900s, and elderly recipients of conditional cash transfers in Mexico.

Since the formal introduction of the vocational grid in 1978, workers in the general population and DI beneficiaries have both experienced longevity gains, particularly among beneficiaries during the first few years of entitlement. Yet the mortality gap between the two populations remains wide. For instance, as discussed earlier, period life expectancy at age 50 for a disabled-worker beneficiary during the 2011–2015 period was 9 to 10 years shorter than that for a 50-year-old in the general population (Table 3). Further, longevity gains among workers in the general population mask a great deal of heterogeneity in the distribution of those gains by earnings and educational attainment. Additionally, the extent to which long-term gains in life expectancy for DI beneficiaries are associated with improved residual functional capacity is unclear.

Note that the substantive concept in the statutory DI definition of disability is long-term inability to engage in substantial gainful activity caused by a physical or mental impairment. In other words, what matters is an applicant's long-term inability to work, independent of his or her odds of survival. In this context, the role of age as a vocational factor is sometimes confounded with the relationship between age and life expectancy. Age is a vocational factor under the assumption that older workers have greater difficulty adjusting to new work environments and learning new skills, not because older workers have fewer expected remaining years of life than younger ones. Thus, although chronological age might be a poor predictor of an individual's ability to work in the presence of a severe impairment, it raises the question: Do DI beneficiaries at older ages have greater residual capacity to work today than they did in the past? Estimates from Chen and van der Klaauw (2008) and Strand and Messel (2019) suggest that the work disincentives of receiving DI benefits may be much smaller for DI claimants with a vocational allowance than they are for other DI-beneficiary groups. According to Strand and Messel, an increase in the age thresholds of the vocational grid appears more likely to result in postponing DI beneficiary status via appeal and reapplication than to lead to labor-market reentry. In addition, the findings in Gelber, Moore, and Strand (2018) and García-Gómez and Gielen (2017) suggest that an increase in the age thresholds of the vocational grid could have a direct effect on mortality.

Mortality, morbidity, and ability to work are three distinct concepts that interact in complex ways. Although it is often assumed that higher morbidity inevitably leads to higher mortality and less capacity to work, the reality is nuanced. Declining mortality in a population does not necessarily mean better average health, and might actually contribute to higher prevalence of disease over time by increasing the number of years of potential exposure. Similarly, two individuals born in the same year could experience equally insurmountable obstacles to work, while facing very different medical diagnoses and mortality rates. Further, broad labor market trends can shift the set of skills required to find gainful employment in the national economy over time. Moreover, the ability to work of two people with comparable impairments, age, ethnicity/origin, cultural background, geography, educational attainment, work experience, transferable skills, earnings histories, and wealth can hinge on all sorts of external factors, including the level of support they are likely to receive from their social/family network.

Summary

Since the 1970s, SSA's OCACT has published mortality tables for DI beneficiaries encompassing various subperiods within the 1970s, the 1990s, and the 2000s, as well as for 2011–2015. In this article, I compare the mortality experiences of disabled-worker beneficiaries and the general population.

In general, any factor affecting entry into and exit from the disability program rolls can affect the mortality of disabled-worker beneficiaries. Such factors include:

1. macroeconomic variables, such as unemployment, labor force participation, and changes in part-time employment affecting insured status;
2. demographic factors, such as population growth or shifts in the age structure and gender composition of the insured population;
3. administrative factors involving staffing and the level of funding for CDRs and preeffectuation reviews;
4. legislative changes enacted by Congress and federal court rulings challenging SSA policy;
5. epidemiological events;
6. advancements in medical treatment or in technology that facilitate work; and

7. changes to certain program variables such as income replacement rates, the amount of earnings that defines substantial gainful activity, medical/vocational age thresholds that loosen eligibility requirements for older applicants, and even the FRA.

Mortality among DI beneficiaries, regardless of age, is highest during the first few years of entitlement (that is, receipt of benefits) and declines with the number of years one survives on the DI rolls. For this reason, I focus on two duration extremes: beneficiaries in their first year of entitlement (zero duration), and those who have received benefits for at least 10 years. These two duration categories provide upper- and lower-bound estimates of mortality for DI beneficiaries in various degrees of poor health. Notice, however, that the upper-bound mortality estimates may understate the true mortality experience at zero duration, because claimants who die during the 5-month waiting period fall outside the scope of measurement.

DI-beneficiary mortality for men and women aged 20–59 during the first year of entitlement improved at an often substantially higher average rate than did mortality in the general population throughout both the 1977–2015 period and the 1991–2015 subperiod. Mortality at zero duration also improved at a much faster rate than that of beneficiaries with at least 10 years on the rolls. As a result, the mortality gap between the most and least longevous DI beneficiaries has narrowed considerably over time. This finding appears consistent with a shift in the composition of DI beneficiaries toward those with less deadly primary diagnoses involving mental and musculoskeletal impairments. Notice, however, that because many factors affect the mortality of DI beneficiaries, improvement has occurred very unevenly. For instance, DI-beneficiary mortality in the first year of enrollment was lower in the early 1970s than in the latter part of the decade, which was contractionary by comparison, with steep declines in awards and frequent CDRs, which led to a sharp increase in exits for beneficiaries with mental impairments. Similarly, because of the AIDS epidemic, mortality for young male beneficiaries during the first 4 years of entitlement was substantially higher in 1991–1995 than it had been at any time during the 1970s. Other developments, such as the use of HAART to treat HIV and the policy change regarding applicants diagnosed with drug addiction and alcoholism, are credited with driving some of the rapid mortality improvement throughout the 2000s.

A comparison of mortality in the general and disabled populations reveals two broad patterns. First, at any given age and duration of entitlement for DI beneficiaries, mortality as a ratio to general-population mortality is higher for women than for men, indicating that the mortality gender gap is wider in the general population than it is among DI beneficiaries. Second, the DI-beneficiary to general-population mortality ratio for both men and women is highest at younger ages (mid-20s and 30s). Thus, in absolute terms (magnitude), older beneficiaries have higher mortality than younger ones and male beneficiaries have higher mortality than their female counterparts. However, in relative terms (compared with their reference group in the general population), female and young DI beneficiaries are worse off by a larger factor.

Another interesting pattern in the data for beneficiaries in the first year of entitlement involves the flattening of mortality as a function of age that occurs at about ages 45–50. One plausible explanation is the vocational grid. For the decade of the 1990s and particularly in the 2000s and 2011–2015, mortality appears to dip sharply around ages 50 and 55, corresponding to age thresholds in the vocational grid. The decline in mortality at the age thresholds has become more pronounced over time, which is consistent with the steady increase in the share of DI awards based on medical-vocational grounds. Similar discontinuities emerge for allowance rates at these ages, indicating that a somewhat "healthier" population of new DI beneficiaries clusters around the age thresholds. It is plausible that the growth in the medical-vocational share of allowances has contributed to the improvement over time in DI mortality. Nevertheless, a similar flattening of mortality at older ages is observed in the 1970s subperiods, suggesting that disability examiners may have used similar criteria informally prior to the formal introduction of the vocational-grid guidelines in 1978.

Despite gains in longevity among DI beneficiaries in recent decades, their experience at every age and duration on the disability rolls is one of severe mortality and reduced life expectancy relative to the general population. During the most recent study period (2011–2015), DI-beneficiary mortality in the first year of entitlement at age 50 exceeded general-population age-50 mortality by factors of 8.5 for men and 9.9 for women. Likewise, relative to the general population, period life expectancy for a DI beneficiary at age 50 and zero duration was 10.1 years shorter for men and 9.7 years shorter for women. Even for the beneficiaries who survived on the rolls for at least

10 years, mortality experience was closer to that of the general population a century earlier, before the existence of Social Security or the DI program, than to their general-population contemporaries. For example, after surviving on the DI rolls for a decade or more, mortality at age 50 in 2011–2015 was 3.9 times higher for men and 4.5 times higher for women than for their counterparts in the general population, and period life expectancy was shorter by at least 9 years.

Notes

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[1] SSA's Listing of Impairments "describes, for each major body system, impairments considered severe enough to prevent an individual from doing any gainful activity. Most of the listed impairments are permanent or expected to result in death, or the listing includes a specific statement of duration. For all other listings, the evidence must show that the impairment has lasted or is expected to last for a continuous period of at least 12 months" (SSA n.d.).

[2] Many studies have discussed factors affecting overall DI entry and exit trends. Examples include the nine SSA actuarial studies listed in the Introduction; Kearney (2005/2006); SSA (2006); and Puckett (2010).

[3] Notice that because of the time lag in processing new cases, the full effect of a legislative change in the disability program can take several years. For example, according to Schobel (1980), "the new eligibility of those under age 50 resulted in so many applications from persons disabled before 1960 that the gross incidence rate for 1961 was not exceeded for over ten years."

[4] For instance, Lindner, Burdick, and Meseguer (2017) found that "a higher unemployment rate is associated with a larger share of applicants with high work capacity whose applications are rejected earlier in the eligibility determination process. A substantial fraction of these initially rejected applicants are accepted into the program because of a successful appeal or re-application shortly after the initial application." Although the number of new awards generally increases during recessions, the fraction of applications allowed tends to decline. For example, Goss and others (2013) documented a strong inverse relationship between the total (final) allowance rate and the 2-year lagged unemployment rate. Applicants during recessions also tend to have higher earnings and struggle longer with their health prior to application (Coe and Rutledge 2013; Maestas, Mullen, and Strand 2015).

[5] For a summary description of the preeffectuation reviews and statistics on review volumes, see https://www.ssa.gov/open/data/preeffectuation-review-of-disability-determinations.html.

[6] Following enactment of the Social Security Act Amendments of 1980, SSA had reviewed 1.2 million beneficiaries by fall 1984 and terminated benefits for 490,000 of them, although around 200,000 had their benefits restored on appeal (Kearney 2005/2006).

[7] Prior to becoming an independent agency in 1995, SSA was part of the Department of Health and Human Services.

[8] Barrick and Zayatz (2005) provide a detailed account of AIDS-related mortality among DI disabled-worker beneficiaries and SSI adult recipients over the periods 1992–1996 and 1997–2001.

[9] According to Moore (2015), approximately 90 percent of about 100,000 affected DI beneficiaries applied to have their disability reclassified under a different diagnosis and about half of them succeeded.

[10] The two most common impairments in the endocrine, nutritional, and metabolic diseases diagnostic group were obesity and diabetes.

[11] For an assessment of DI application volumes and outcomes during the Great Recession, see Maestas, Mullen, and Strand (2015).

[12] Conversions from DI to OASI benefits are shown as DI program exits in Charts 1 and 3, reflecting their status from SSA's perspective—although "conversion" technically refers to a switch rather than a termination of benefits.

[13] Such discretionary switches are counted as "other" exits in Charts 1 and 3 and account for most of the exits in that category.

[14] The FRA for workers born in 1938 is 65 and 2 months, so although some of them did not attain FRA during 2003, most did.

[15] Ruffing (2014) analyzes findings from various studies of DI enrollment growth.

[16] Chart 4 shows awards by the impairment category of the primary diagnosis. By contrast, Meseguer (2018) measured multimorbidity (the simultaneous expression of multiple disorders in the same person) among initial claimants, as partly reflected in the secondary diagnosis codes in administrative data from SSA.

[17] "Select period" should not be confused with "study period."

[18] Additionally, the actuarial methodology for treating the exposure to death in the more recent studies differs slightly from that of the earlier ones.

[19] All estimates of general-population mortality in this article are from OCACT (Bell and Miller 2015). The Human Mortality Database (HMD), a collaborative research initiative, provides an alternative publicly available source of U.S. general population mortality from as early as 1933 (https://mortality.org). The HMD mortality estimates tend to be lower for older ages than those from OCACT. Conversely, the HMD estimates of life expectancy

are generally higher. OCACT uses data on the Medicare-enrolled population aged 65 or older as its source for death counts and population exposed. By contrast, the HMD draws its raw data from state-reported deaths and census population estimates (Goss and others 2015). Barbieri (2018) found that the discrepancies between the HMD and SSA mortality estimates cannot be explained by methodological differences and are due to differences in the data sources.

[20] For a review of factors that led to the increase in life expectancy, see Johnson (2021).

[21] Except for Kelley and Lopez (1984), the earlier actuarial studies follow beneficiaries only to duration t=5+.

[22] Because the SSA actuarial studies tend to use 5-year study periods, I pick the midpoint of a given period for comparisons with general-population statistics. For example, 2013 is the midpoint of the 2011–2015 actuarial study period. The mortality rate for a 76-year-old man in the general population in 2013 was 0.0403. By contrast, the mortality rate facing a 50-year-old male DI beneficiary at zero duration in the period 2011–2015 was 0.0427.

[23] More specifically, from the 1991–1995 to the 2011–2015 study periods.

[24] Note that the general population also includes all DI beneficiaries in current-payment status as a subpopulation. Their exclusion from the general population estimates would yield an even bigger gap in contemporaneous mortality between the two groups.

[25] Only the five most recent actuarial studies, spanning the period 1991–2015, feature life-expectancy tables.

[26] Notably, in 2010, diabetes ranked eighth in years lived with disability and seventh in years of life lost to premature mortality.

[27] Mental impairments tend to have early ages of onset (Meseguer 2018). For instance, the likelihood of a primary or secondary DDS diagnosis among 2009 applicants involving an affective/mood disorder peaks at ages 26–36, while for a schizophrenia diagnosis, the likelihood declines monotonically as a function of age. Incidence probabilities for musculoskeletal disorders generally peak at older ages than do those for mental diagnoses (for example, ages 46–56 for a disorder of the back). On the other hand, the incidence probabilities of a circulatory-system diagnosis such as cardiomyopathy, or of malignant neoplasms such as lung cancer, increase monotonically with age. Hence, because mental and musculoskeletal impairments have higher survival probabilities and are more predominant at younger ages than cancers and cardiovascular disorders, they make a greater contribution to the stock of DI beneficiaries over time.

[28] Raut's methodology, data source, and study period differ markedly from those of the OCACT studies. Specifically, Raut's exit-probability estimates are based on a random sample of 157,237 disabled-worker beneficiaries spanning two decades. The actuarial studies cover the entire population of DI worker beneficiaries (in 2014, for example, encompassing more than 14.5 million records) and typically focus on 5-year study periods.

[29] Wixon and Strand's tables provide a useful benchmark for researchers working with the administrative regulation basis codes that identify the steps of the sequential disability determination process. In addition, and by design because of the transactional nature of the administrative data files on which they are based, the tables contain duplicates (that is, multiple records for a single claimant moving through the initial and reconsideration stages).

[30] Vocational allowances also have a medical component. In particular, if an applicant has one or multiple medical conditions that are deemed to be severe but fail to meet or equal the criteria in SSA's official Listing of Impairments, then vocational considerations become a decisional factor. On the other hand, applications with a medical decision may await a final nonmedical decision or be subsequently denied for nonmedical reasons.

[31] Although SSA did not introduce the medical-vocational guidelines until 1978 (and the grid has remained largely unchanged since then), disability adjudicators had informally been considering age and other factors in making disability determinations since 1960 (Strand and Messel 2019).

[32] Allowance rates at various adjudicative levels often jump sharply when applicants reach a vocational age threshold, suggesting a greater likelihood of an allowance (see, for example, Meseguer 2013, Charts 5 and 7).

[33] For a description of the policy, see https://www.ssa.gov/OP_Home/hallex/I-02/I-2-2-42.html and https://secure.ssa.gov/poms.nsf/lnx/0425015006.

[34] The effect of the vocational age thresholds on cohort life expectancy would be more pronounced because the improved mortality effect persists over multiple years of duration on the rolls.

[35] The decline reversed in 2018, as life expectancy at birth increased by 0.1 year to 78.7.

[36] Gelman and Auerbach (2016) comment on potential aggregation bias in Case and Deaton (2015).

[37] Cohort life expectancy follows the mortality experience over time of individuals grouped by birth year. Period life expectancy follows the mortality of individuals of different birth cohorts in a given year.

[38] Jagger and others (2015) compare the experiences of 14 European Union member countries with increasing life expectancies and chronic disabilities prevalence.

[39] DI beneficiaries are entitled to Medicare benefits after 2 years on the rolls, while SSI recipients receive Medicaid benefits immediately in most states.

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