Putting "Work" Back in Working-Aged Mortality: Employment Status, Occupation, and Cause-Specific Mortality among Contemporary Working-Aged U.S. Adults

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Introduction

Mortality rates are increasing among working-age U.S. adults. Efforts to understand this trend have become increasingly prominent in scientific and lay discourses on major public health challenges facing the country. The past decade has also seen an outpouring of research documenting vast and widening disparities in working-aged (i.e., 25-64) mortality between the highest and lowest educated members of society (Case and Deaton 2015; Masters et al. 2012; Miech et al. 2011; Montez and Zajacova 2013; Sasson 2016b). These studies document a 10-15 year life expectancy gap between those at opposing ends on the education distribution (Hummer and Hernandez 2013; Sasson 2016b); they also specify the causes of death that account for these disparities (Ho 2017; Miech et al. 2011; Sasson 2016a). In addition to persistent disparities among leading causes such as heart disease and cancer, external causes like alcohol-related disease, suicide, and drug poisonings have accounted for an increasing proportion of mortality in this age range (Case and Deaton 2015; Masters et al. 2017; Woolf et al. 2018), with the latter almost entirely responsible for an overall reduction in U.S. life expectancy over the past three years (Xu et al. 2018).

Yet a focus on education as the sole socioeconomic determinant does not align with the contemporary narrative of U.S. working-age mortality. While the majority of aforementioned research relies on education as a proxy for socioeconomic status (SES), popular or 'lay' outlets continue to frame this as a "working-class" crisis, using imagery that emphasizes how the most afflicted groups are blue-collar and/or unemployed workers in parts of the country where manual labor sustains (or once sustained) the economy (Alexander 2017; Quinones 2015). Though

acknowledging the role of lower educational attainment, many news reports[1] frame rising working-aged mortality as indicative of "the collapse of the white working-class" (Bendix 2017) or by stipulating that "America's working-class is a dying breed" (Meyerson 2015). While neither the Case and Deaton (2015) paper, nor subsequent government reports (Xu et al. 2018) ever include the term "working-class", its repeated use as shorthand for working adults employed in non-'white-collar' occupations speaks to the significance of *work* as an important dimension of SES that often gets short shrift in studies of U.S. adult mortality.

Most importantly, the framing of recent mortality trends as a "working-class" issue reaffirms the salience of occupations as a strong signal of individuals' position and *identity* in the social hierarchy of the U.S., shaping life circumstances and, in turn, health. More than an issue of semantics, this working-class mortality narrative reflects individuals' having similar "life chances" based on their social position (Elo 2009; Krueger and Burgard 2011), and the extent to which occupations embody certain lifestyles and social circumstances that influence health (Cockerham 2005). But occupations also reflect how larger socioeconomic and political forces create shared vulnerability within a group (Burgard and Lin 2013). With the decline in secure, well-paying non-white collar jobs, recent scholarship has emphasized the rapid growth of the "precariat" (Standing 2011); that is, an increasing proportion of American workers find themselves in "precarious jobs" with minimal financial and social security, perpetual employment instability, and poor workplace conditions (Kalleberg 2011). In turn, hyperbolic expressions like "death of the working-class" capture the disproportionate impact of layoffs and

[1] Based on a review of news and magazine articles referencing "working-class mortality" published between November 2015 (when the Case and Deaton 2015 paper was released) through September 2018, obtained from ProQuest and limited to the US News-stream.

instability on working-class occupations in recent years (Case and Deaton 2015; Evangelist and Bernhardt 2014; Kalleberg and Von Wachter 2017).

Thus, extant evidence and the ongoing narrative of working-class mortality points towards the need for a broader definition of SES than is suggested on the basis of education alone, especially in identifying working-age Americans at the highest risk for premature mortality across a broad set of leading and emergent causes. Consequently, the goals of this paper are twofold. First, using large-scale, nationally-representative survey data, we estimate disparities in cause-specific mortality risk across individuals' occupational groups and employment status, with a particular emphasis on "emergent" causes of death (e.g., poisoning) among working-aged adults in occupational categories characterized by high levels of precariousness. Critically, we leverage our data to estimate these risks before and *after* accounting for educational attainment, while assessing gender differences in the associations. Second, we then use evidence of these disparities to discuss the significance of occupation for health and mortality; namely one that establishes occupation as more than downstream of education, and instead emphasizes the unique mortality risks associated with certain types of occupations in the contemporary U.S.

Background

Occupations and "Life Chances"

Individuals' occupations have been and continue to be a central component of sociological research on defining and measuring SES, serving as the backbone for early social thought on "class" and individuals' place in the social hierarchy (Elo 2009; Krueger and Burgard 2011). Indeed, recent scholarship has capitalized upon the Weberian notion of shared "life chances" in

emphasizing the blurred lines among the material/economic, sociocultural, and political dimensions of work and occupations as a distinct form of social stratification (Eidlin 2015). Increasing polarization of society on the basis of shared occupational interests and "life chances" is of particular salience to recent working-class struggles in the U.S., and consistent with the research by Kalleberg and others documenting the growing sector of the working-age population trapped in unstable, uncertain and/or insecure "precarious" jobs (Kalleberg 2009; Kalleberg 2011; Standing 2011; Vallas and Prener 2012) – a group disproportionately affected by globalization in recent decades, and the rapid transition towards a knowledge-based economy.

Central to this literature, and vital to improving our understanding of *who* among the working-aged is most at risk for poor health, is that precarity has come to be a defining feature of *multiple* occupational sectors (Kalleberg 2009; Kalleberg 2011; Vallas and Prener 2012). As 'blue-collar' and manual labor jobs (e.g., manufacturing, extraction, agriculture) declined in their stability, availability, and wages/benefits, lower-quality service sector jobs – notably those reflecting "the privatization of activities… previously done mainly in the household (e.g., child care, cleaning, home healthcare, and cooking)" (Kalleberg 2009: p.5) – have become an increasingly prominent sector of the labor market. Ongoing research and Bureau of Labor of Statistics (BLS) estimates suggest relatively low-skill and often precarious jobs (with respect to instability, danger, and low material and psychosocial rewards) in the food, healthcare, and other service industries, as well as private and commercial transportation, are only likely to increase in coming decades (BLS 2018; Kalleberg 2009; Kalleberg and Vallas 2017), as the "artificial" consequence of willful policy-making designed to promote a "low-wage, high-unemployment" labor model (Madrick 2012). In turn, the increasing economic, social, and political marginalization of this group has contributed to a rising sense of social injustice and stigma within particularly vulnerable

occupational sectors (Standing 2012), coupled with increased distress and loss of meaning attributable to the difficulty in "construct[ing] a rational life plan or career narrative" (Kalleberg and Vallas 2017: 17). Thus, in extending "life chances" to the study of health, a shared vulnerability or risk among similarly-employed individuals influences not only the *quality* of their life but also its *quantity* when it comes to longevity and premature mortality.

Occupations, Employment, and Health

Occupation has a well-established legacy as a social determinant of health across multiple psychosocial and physical outcomes (see Burgard and Lin 2013; Clougherty et al. 2010; Krueger and Burgard 2011 for extensive reviews). Though research on hazardous workplace conditions and worker characteristics is a central aspect of occupational epidemiologic research (Checkoway et al. 2004), the decline in workplace-related accidents and mortality in past decades has encouraged researchers to place greater emphasis on one's job as a source of psychosocial trauma and stress (Pfeffer 2018). For instance, Marmot's foundational Whitehall studies providing a vivid illustration of how occupational hierarchies in the workplace – and the resultant disparities in decision-making, autonomy, and self-mastery – are manifest as occupational gradients in mortality (Marmot 2005; Marmot et al. 1997). Indicative of how the environment – in this case, a shared occupational environment – operates through psychosocial mechanisms to "get under the skin", increase stress, and thereby influence physical health (Matthews and Gallo 2011), the cumulative toll of workplace-induced trauma on individuals' health is a mainstay in leading models of occupational health. Proponents of "job strain" argue that chronic exposure to a high-demand, low-control work environment leads to a host of negative physical and mental health effects (Karasek 1979), including increased risk of cardiovascular disease and mortality (Kuper et al. 2003; von Bonsdorff et al. 2012). Relatedly,

and likely working in conjunction with job strain (De Jonge et al. 2000), "effort-reward imbalance" suggests that a sustained disparity between one's effort at work and the recognition/compensation one receives is yet another source of increased risk for stress-related health issues (Siegrist 2016; van Vegchel et al. 2005).

Despite the considerable evidence of work as a social determinant of health, large-scale and nationally-representative research on the significance of occupations for U.S. population health is scant. Work, however, is a central determinant of one's standing in U.S. society, and the *absence* of work – i.e., both the short-term and chronic unemployment symptomatic of growing precarity in the contemporary labor market (Kalleberg 2009) – is associated with poor health and premature mortality. Most instrumentally, work-derived income allows one to "buy" better health (Krueger and Burgard 2011), and the majority of working-aged adults obtain health insurance through their employer (Burgard and Lin 2013; Goh et al. 2015). Beyond these essential benefits, work is a salubrious institution that informs individuals' meaning and self-worth, which are vital for positive mental and physical health (Burgard and Lin 2013; Dave et al. 2006; Montez et al. 2014). Relatedly, research consistently finds rapid health declines following job loss (Brand 2015; Burgard et al. 2007; Strully 2009); even among job-holding individuals in occupations where job loss is rampant, perpetual exposure to and threat of layoffs is associated with worse physical and mental health (Grunberg et al. 2001; Modrek et al. 2015).

Beyond this employed-unemployed dichotomy, occupations reflect distinct pathways in their impact on health, suggesting that they are more than a proxy for education in explaining U.S. mortality disparities (Christ et al. 2012; Fletcher 2012; Gueorguieva et al. 2009; Rogers et al. 2000). Cumulative "wear-and-tear" associated with physically demanding and stressful jobs is a prominent finding among research on older adults (Fletcher 2012), while other studies focus on

the psychosocial impact of occupations as a measure of social status. For example, Fujishiro et al. (2010) find significant associations between occupational prestige and disparities in self-rated health, with stress exposure and poor mental health as hypothesized mechanisms. However, evidence on prestige and mortality disparities is mixed (Gregorio et al. 1997). While Christ et al. (2012) find that a 10-point increase in prestige is commensurate with an additional year of education in reducing mortality risk, similar to earlier results (Rogers et al. 2000), Johnson et al. (1999) find that prestige does not help explain U.S. mortality disparities after accounting for both education and income. Critically, the totality of this research underscores the complexity of occupations' importance for mortality, and why a more holistic conceptualization of occupation is warranted in health research (Lynch and Kaplan 2000; Moore and Hayward 1990).

Occupations and Cause-Specific Mortality

Epidemiologic analyses often map specific occupations to specific causes of death in an effort to identify the most "at-risk" occupations (Checkoway et al. 2004). For instance, adults in physically *dangerous* occupations, such as construction, transportation, and agriculture, are at increased risk of unintentional injuries (e.g., falls, motor vehicle-related, fires: Birdsey et al. 2015; Biswas et al. 2017; Bureau of Labor Statistics 2017). Relatedly, cumulative exposure to harmful substances in these occupations is associated with elevated risk of respiratory disease deaths, rare cancers, and neurodegenerative conditions (Colditz and Wei 2012; De Matteis et al. 2017; Park et al. 2005). Even the timing and/or regularity of one's work schedule has a biophysiological impact on health; occupations with atypical work schedules/shifts, such as manual labor and service, have greater cancer, cardiovascular, and other chronic disease mortality risk, owing to an enduring state of physical stress and inflammation (Åkerstedt et al. 2004; Knutsson 2003; Wang et al. 2011). Though invaluable, a downside of this research is that

a fine-grained focus on specific occupations and causes of death obscures larger patterns of cause-specific mortality risks across the occupational categories most represented among working-age adults. Nevertheless, these studies demonstrate that myriad socioenvironmental risk factors are concentrated among non-'white-collar', precarious occupations.

Beyond biophysiological risk, and of particular salience to the rise in "deaths of despair" (i.e., suicides, drug overdoses, and alcohol-related), recent sociological, demographic, and social psychological research instead emphasizes harmful behaviors deployed as a coping mechanism "to numb the psychological pain of an unhealthy workplace" (Pfeffer 2018: 51). Research on suicide shows that medical professionals, farmers, and manual laborers all have among the highest rates (Agerbo et al. 2007; Roberts et al. 2013). Namely, the subjective nature of job-related stress may have a similar impact among individuals in occupations with a high degree of responsibility and accountability (e.g., those in professional/specialized positions), as well as those with low autonomy, control, and job security (e.g., service and manual labor) (Stack 2001). *Physical* pain is key as well; increased opioid prescriptions in response to workplace injuries often trigger prolonged addictions (Bernacki et al. 2012; National Safety Council 2015), which may explain the higher proportions of overdose-related deaths among construction and other manual labor jobs (Morano et al. 2018). Indeed, many have argued that differential exposure to psychological and physiological "distress" contributes to occupational variation in cause-specific mortality (Agerbo et al. 2007; Roberts et al. 2013), especially in linking precarious occupations to despair-related deaths (Pfeffer 2018). However, few studies have examined these causes of death (McLean 2016; Monnat 2016), let alone with individual-level survey data; thus distinguishing occupational versus other sociodemographic disparities – most notably education – remains both a conceptual and empirical challenge.

Hypotheses

The emerging narrative of working-age and *working-class* mortality in the U.S., together with extant research on occupational and employment-related disparities in mortality, points to the need to better understand U.S. working-aged mortality disparities. Specifically, the considerable psychosocial and physical health risks encountered by adults in occupations characterized by high levels of precarity suggests that (1) *individuals employed in the growing sector of "working-class"* (service, agricultural, manual, and transport) *occupations will have significantly elevated mortality risk relative to their "white-collar" professional counterparts*; likewise, *individuals who are unemployed and those not in the labor force will be at elevated risk compared to those currently working*. Further, these disparities will be (2) *especially pronounced among causes of death that most closely reflect the unique psychosocial and physical health risks associated with "working-class" jobs* – namely heart disease, lung cancer, and accidental poisoning – relative to suicides and more non-preventable causes of death such as accidents, uncommon cancers, and other rare or hard-to-treat conditions.

Additionally, (3) controlling for *education,* as a source of selection into employment and occupations, *will attenuate these occupational mortality risks*; however, the distinct impact of work on health noted in past literature suggests that a significant association will persist – especially for the aforementioned set of "working-class" jobs. Finally, while we expect (4) *similar occupation and employment disparities for women and men,* gender differences in workplace environments and returns to employment (Clougherty et al. 2011; Mandel 2018) – especially for highly-educated female professionals – are thought to explain the weaker SES-mortality relationship for women relative to men (Ross et al. 2012; Zajacova 2006).

Consequently, *we assess the possibility that women will have a less pronounced occupational gradient in mortality than men.*

Data and Methods

Data come from the National Health Interview Survey (NHIS), which is a nationally-representative survey that links individuals' occupations and employment status with follow-up mortality records. Though NHIS data annually survey tens of thousands of respondents, our goals necessitate a number of restrictions to the analytic sample. First, we only use data from working-age adults, defined as ages 25-64 at time of survey, to capture the majority of adults having completed their education and entered the workforce. Second, NHIS randomly chooses a single "sample adult" per household to complete a more detailed questionnaire, including verbatim responses for usual occupation converted to a standardized occupational code by Census specialists. While these codes have changed over time, IPUMS, which provides the harmonized NHIS data used in this analysis, has standardized these codes to the 1995 Standard Occupational Classifications (Blewett et al. 2018). Finally, we limit the analytic sample to survey data from 1997-2014 linked with mortality data through 2015 because NHIS data prior to 1997 do not include critical employment status data, such as the category of "never worked." Detailed cause of death data are only available through a restricted-use agreement with the National Center for Health Statistics; thus analyses were conducted at a Federal Restricted Data Center, with a final sample of 368,396 adults and 22,527 deaths during the follow-up.

Measures

We drew upon extant literature on precarious labor (Kalleberg 2009; Kalleberg 2011), as well occupational categories in past research along with Census subheadings for occupations, to define nine categories suitable for cause-specific mortality analyses (see Table A1 in Appendix for detailed occupational composition). Professional/specialized occupations (e.g., managers and administrators, educators) account for about one-third of adults; nearly a quarter are in the skilled service sector (e.g., administrative support, sales); about 15% are in manual labor (e.g., construction, mining, machine operation) and service occupations (e.g., food, cleaning, personal, health), respectively. Transport (e.g., motor vehicle/equipment operators) accounts for 6% of occupations, and about 2% of adults are in protective services, farming/fishing/forestry (abbreviated as "Farming" in tables and subsequent discussion), or report having no occupation, respectively. Finally, 4% report having never worked. We also include an indicator for individuals' employment status, categorized as working, unemployed, or not in the labor force. With the exception of those who never worked, the majority of adults report an occupation regardless of current employment; given research on the cumulative effects of occupations, even among those not working (Fletcher 2012), we assign those individuals to their report of usual occupation.

Detailed cause of death data are based on standardized International Classification of Disease codes. In order to maintain adequate sample sizes for analysis – such as relatively uncommon causes of death among specific occupations – we categorize deaths into 10 different groups, representing 'emerging' causes of death underlying recent trends, as well as other leading causes among working-age adults. We include a 'low-preventability' category – i.e., especially hard-to-treat and/or relatively unpredictable deaths (e.g., brain, ovarian, pancreatic, and stomach cancer; neurological diseases) – to see whether they exhibit less occupational variation in mortality, as

seen with education (Miech et al. 2011; Phelan et al. 2004). Ultimately, 689 deaths were from alcoholic liver disease (2.9%), 498 from accidental poisoning (2.3%), 577 from suicide (2.8%), 5969 from cardiovascular diseases (26.0%), 1850 from lung cancer (8.5%), 2249 from other cancers (10.0%), 988 from low-preventability causes (4.4%), 2022 from non-poisoning accidents (9.4%), 219 from homicide (0.9%), and 7466 from other diseases and residual causes (32.7%).

Finally, we account for individuals' gender, race/ethnicity (measured as non-Hispanic White, non-Hispanic Black, Hispanic, and Other) and foreign-born status. A subset of models includes individual-level educational attainment – measured as less than high school, high school or equivalent, some college or associates degree, and college degree or greater – to estimate the association between occupation, employment status, and mortality net of education.

Methods

We created a multiply-imputed data set to account for missingness by estimating a series of chained equations to assign values for missing items based on observed correlations among all variables in the data. The addition of "never worked" as an occupational category is critical as it prevents the assignment of an occupation to *currently* non-working adults who have *never* worked. Based on the size of our data, and 14% missingness on occupation, we use 10 iterations to ensure stable estimates (White et al. 2011).

We then run gender-stratified separate Cox proportional hazard models to obtain estimates of relative mortality risk for different occupations (with professional/specialized as the reference) and employment status (with employed as the reference) for all-cause mortality and then by cause of death, while adjusting for race/ethnicity and nativity. Specifically, individuals aged 25 through 64 at time of survey are followed for survival status until: (1) their death, (2) their 65th

birthday, or (3) the end of 2015. An exact measure of attained age, based on birth and death/censoring date, is the underlying time metric per recommendations for survival analyses with data like NHIS (Thiébaut and Bénichou 2004). We use survey weights to account for complex survey design across different years and ineligibility for mortality follow-up.

Pursuant of our study goals and hypotheses, we first examine the relationship between employment status, occupations and: (1) all-cause mortality; (2) "emerging causes", including alcoholic liver disease, accidental poisonings, and suicide; (3) "leading chronic conditions", including heart disease, lung cancer, and other types of cancer (excluding those under "low-preventability"); and finally (4) "other" leading causes, which includes low-preventability, accidents, homicides, and any remaining, uncategorized deaths. We then adjust for educational attainment to see whether and how cause-specific mortality risks change.

Results

Descriptive

The sociodemographic composition of our sample is similar to that of the U.S. as a whole. As seen in Table 1, the mean age is 43.5, and just under half of the sample is male (49.0%). About 70% are non-Hispanic white, 12% non-Hispanic black, 13% Hispanic, and 4% represent other race/ethnic groups, comparable to the 2010 Census. The percent foreign-born, 17%, is consistent with Bureau of Labor Statistics (BLS) estimates for working-age adults, as is the educational composition. As a check on the representativeness of our occupation variable, we compared the percent of working-age adults in each group to BLS estimates for major occupations in 2005 (i.e., the midpoint for our data). With the exception of some occupational coding differences, our

occupational distribution was very similar. Finally, approximately three-quarters of our sample is working at time of survey, while 4% are unemployed and 21% are not in the labor force. The percent unemployed is consistent with BLS estimates, while the percent working and not in the labor force are 10 points higher and lower, respectively. This discrepancy is likely due to the inclusion of adults ages 20+ in BLS estimates, many of whom are still in school, in contrast with our age range of 25-64.

[Table 1]

Next, in Tables 2 through 5, we test our hypotheses in examining the associations between employment, occupation, and mortality risks for different causes of death. In all tables, hazard ratios for employment status and occupation are presented before and after adjusting for individuals' educational attainment (as seen in Figures 1-4, to help visualize observed patterns). For parsimony, we do not show hazard ratios for race/ethnicity, foreign-born status, and educational attainment; they are available on request.

All-Cause Mortality

We begin by looking at the relationship between occupation and employment and all-cause mortality. Table 2 shows that adults in professional/specialized occupations have considerably lower mortality risk than their counterparts in all other occupational groups and, despite gender differences in the labor force, the magnitude of the increased risk associated with these other occupations is nearly identical for women and men. Immediately apparent, and consistent with our first hypothesis, is the nearly *twofold* risk for women in service (HR=1.81, $p<0.01$), farming (HR=1.73, $p<0.01$), manual labor (HR=1.81, $p<0.01$), and transport occupations (HR=1.97, $p<0.01$), as well the 70% greater risk among never employed adults, with comparable estimates

for men. The mortality risks associated with unemployment and not being in the labor force are also considerable, and comparable across genders. There is an approximately 45-50% greater risk of mortality for unemployed adults relative to those currently working, and not being in the labor force is associated with especially high mortality risk – twice the risk for women (HR=2.08, $p<0.01$) and two-and-a-half times the risk for men (HR=2.46, $p<0.01$).

[Table 2]

In line with our third hypothesis, accounting for educational attainment *attenuates*, but does not eliminate, the higher risks of mortality associated with employment status and occupation; there is also considerable variation in this attenuation across occupations (as seen in Figure 1). For instance, the attenuation of mortality risk associated with unemployment and not being in the labor force is quite small, and similar for both women and men. However, women appear to have a less "consistent" occupational gradient, net of education. The mortality risk associated with skilled service, protective, farming occupations, as well as having no occupation, is no longer significantly different after accounting for education among women; service, blue collar, and transport workers, and women who have never worked, continue to have 24 to 42% higher all-cause mortality risk net of education. Conversely, when accounting for education among men, only protective services and those with no occupation are no longer at higher mortality risk compared to professional/specialized occupations. Similar to women, men in service, manual labor, and transport occupations, and among those having never worked, have anywhere from 22 to 35% higher mortality risk; farming also stands out as particularly risky for men (HR=1.40, $p<0.01$). Part of the difference may be attributable to small sample sizes for women in certain occupations, as the overall pattern of occupation-associated mortality risk is unchanged and approaches statistical significance, as is also the case for men. However, it is clear that our fourth

hypothesis is largely supported, as for both genders being unemployed or not in the labor force, as well as belonging to more traditionally 'working-class' occupations – namely, service, manual labor, and transport – is associated with consistently elevated mortality risk.

[Figure 1]

Emerging Causes of Death

The next set of analyses examines mortality risks for 'emerging' causes of death – poisonings, alcoholic liver disease, and suicide -- linked to recent increases in U.S. working-age mortality. However, as seen in Table 3, the variation in mortality risks associated with these causes across employment and occupation status suggests a more complicated interaction between adults' place in the contemporary workforce and mortality risk from these "despair deaths".

With respect to alcoholic liver disease mortality, farming occupations are the clear standout among women, associated with a five times greater risk of death relative to professional/specialized occupations (HR=5.06, $p<0.01$), and only a twofold increase among men. Even after accounting for education, the risk is still fourfold higher for women (HR=3.77, $p<0.01$). Service-related occupations are associated with a nearly two-and-a-half times greater risk relative to the professional/specialized group for both men and women; accounting for education attenuates this risk similarly for both genders (HR~1.83, $p<0.05$). Manual labor jobs are associated with a twofold higher risk among men, though not after controlling for education. Furthermore, employment status continues to be a key source of risk, with minimal attenuation from education. For both genders, unemployment is associated with over a twofold increase in risk (HR=2.26, $p<0.05$ for women; HR=2.38, $p<0.01$ for men), though not being the labor force is associated with greater risk for men than women. While associated with double the risk for the

women (HR=2.08, p<0.01), not being in the labor force is associated with *triple* the mortality risk among men (HR=3.28, p<0.01).

[Table 3]

Accidental poisonings also show considerable variation across occupations and by employment status. Consistent with the second hypothesis, there is a three-and-a-half to four times greater risk of accidental poisoning mortality among women in service (HR=3.75, p<0.01), manual labor (HR=3.43, p<0.01), and transport occupations (HR-3.86, p<0.01) relative to professional/specialized occupations, and an elevated risk among those never employed (HR=2.49, p<0.05). For men, all but protective service occupations are associated with a greater risk of poisoning mortality, with the highest risks for those in farming (HR=3.47, p<0.01), transport (HR=2.88, p<0.01), and manual labor occupations (HR=2.59, p<0.01). Somewhat contrary to our fourth hypothesis, no occupational group is associated with higher mortality net of education among men, while occupational differences are more pronounced among women; indeed, net of education, women in service, manual, and transport occupations continue to be associated with a nearly threefold higher risk of mortality. The association between not being in the labor force and risk of accidental poisoning death is especially dramatic, with threefold greater risk for women (p<0.01), and an almost *six* times greater risk for men (p<0.01). Unemployment is also associated with higher mortality from accidental poisoning, with a higher relative risk among women than men (HR=2.89, p<0.01 vs. HR=1.55, n.s.).

Finally, in contrast to both alcoholic liver disease and accidental poisonings, mortality risk from suicides exhibits relatively little variation across occupations, shown in Figure 2. While occupation-specific sample sizes pose a challenge for this cause of death, results are consistent with our second hypothesis and past research showing a lack of clear patterns in the types of

occupations at greatest risk for suicide mortality. For women, only manual labor jobs are at elevated risk relative to professional/specialized occupations (HR=2.51, $p<0.01$), while there are no significant associations among men. Unemployment and not being in the labor force, however, are each associated with far greater suicide risk. Specifically, unemployment is associated with a nearly fourfold increase for women (HR=3.77, $p<0.01$) compared to about double the risk for men (HR=1.72, $p<0.05$), while the risk associated with not being in the labor force is similar for both genders (HR=1.81, $p<0.01$ for women; HR=2.11, $p<0.01$ for men). Accounting for education marginally attenuates these associations among men and, contrary to our third hypothesis, instead contributes to a marginal *increase* in the strength of the associations for women.

[Figure 2]

Leading Causes of Death

Though alcoholic liver disease, accidental poisoning, and suicide mortality have increased in recent years, heart disease and cancer continue to be the leading causes of death among working-age adults. Similar to all-cause mortality, nearly all occupations are at a higher risk of heart disease mortality relative to those in professional/specialized occupations, with the only exception being protective and farming jobs and women with no occupation (Table 4). As expected, the greatest risks are observed among service (HR=1.92, $p<0.01$ for women; HR=1.71, $p<0.01$ for men), manual labor (HR=1.92, $p<0.01$ for women; HR=1.66, $p<0.01$ for men), and transport jobs (HR=1.84, $p<0.01$ for women; HR=1.91, $p<0.01$ for men), as well as those never employed (HR=1.89, $p<0.01$ for women; HR=1.90, $p<0.01$ for men). Even skilled service professions are at greater risk (HR~1.4, $p<0.01$), and farming occupations are at especially elevated risk among men (HR=2.15, $p<0.01$). Accounting for education has a considerable

attenuating effect on heart disease mortality risk; while overall patterns remain similar, only service and manual labor jobs are at significantly elevated mortality risk (HR~1.3, $p<0.05$) among women. These disparities are more pronounced among men, as all but protective service occupations and those with no occupation continue to have significantly elevated mortality risk. Both unemployment and not being in the labor force are associated with greater mortality risk as well, with comparable associations for men and women (HR~1.75, $p<0.01$ for unemployment; HR~2.3, $p<0.01$ for not in labor force).

[Table 4]

In contrast to heart disease, lung cancer mortality risk varies considerably by gender. While women in service (HR=1.68, $p<0.01$), manual labor (HR=1.56, $p<0.05$), and transport (HR=2.01, $p<0.05$) occupations are at greater risk, these associations are completely attenuated when accounting for education. In fact, women in skilled service occupations actually have a 25% *lower* risk of lung cancer mortality net of education (HR=0.75, $p<0.05$). For men, however, lung cancer mortality risk is far higher overall and greatest among service (HR=2.66, $p<0.01$), farming (HR=2.95, $p<0.01$), manual labor (HR=2.48, $p<0.01$), and transport occupations (HR=2.83, $p<0.01$), as well as those never employed (HR=2.21, $p<0.01$). Our first and second hypotheses continue to be supported, as education attenuates mortality risk for all occupations, while service, farming, manual labor, and transport jobs continue to be associated with an approximately 50% higher risk. For employment status, not being in the labor force is associated with 70% greater risk of lung cancer mortality ($p<0.01$).

Finally, the grouping of other types of cancers exhibit the least overall occupational variation in mortality risk (as seen in Figure 3). Only manual labor and transport jobs are associated with greater risk among women, though these associations are entirely attenuated by education.

Among men, farming, manual labor and transport occupations exhibit the highest initial risk, only farming remains significant when accounting for education (HR=1.55, $p<0.05$). However, the association between not being in the labor force and lung cancer mortality is elevated for both women and men (HR~1.55, $p<0.01$). Unemployment is associated with higher risk only among men (HR=1.58, $p<0.05$).

[Figure 3]

Other Causes of Death

In this last section, we briefly examine the remaining four categories of mortality (Table 5), beginning with "low-preventability" deaths which typically exhibit a shallower SES-mortality gradient. However, while occupational variation for low-preventability deaths is lower than for other causes, we find that working-class occupations continue to exhibit elevated mortality risk – contrary to our second hypothesis. For women, skilled service (HR=1.61, $p<0.05$), service (HR=2.47, $p<0.01$), and manual labor (HR=2.13, $p<0.05$) occupations, as well as those never employed, are at greatest risk; for men, service (HR=1.71, $p<0.05$), farming (HR=2.71, $p<0.01$), manual labor (HR=1.58, $p<0.01$), and transport occupations (HR=1.90, $p<0.01$) are at highest risk. Education attenuates these associations for both women and men, such that only service occupations remain at a significantly elevated risk among women (HR=1.85, $p<0.05$), compared to farming (HR=2.10, $p<0.01$) and transport occupations (HR=1.51, $p<0.01$) for men. Net of education, unemployment and not being in the labor force are associated with a two- and one-and-a-half times greater risk, respectively, for women, while only not being in the labor force is significant for men (HR=1.82, $p<0.05$).

[Table 5]

Accident-related mortality risk varies by occupation as well. Among women, all but protective service occupations are associated with higher mortality risk, especially in service (HR=1.64, $p<0.01$), farming (HR=2.34, $p<0.05$), and transport occupations (HR=1.90, $p<0.05$). Men, on the other hand, exhibit almost no occupational variation in accident mortality, as only manual labor jobs are at significantly elevated risk (HR=1.25, $p<0.05$). Contrary to our third hypothesis, educational attainment almost entirely accounts for these initial associations, such that only service occupations remain at greater risk for women (HR=1.37, $p<0.05$). Occupational variation in accident mortality is us almost entirely nonexistent net of education, as clearly seen in Figure 4. By contrast, the association between not being in the labor force and accident mortality risk remains significant (HR=1.25, $p<0.05$ for women; HR=1.86, $p<0.01$ for men).

[Figure 4]

Estimating homicide mortality risks proves especially difficult in our sample, as only a total of 219 working-age adults experience a homicide death in this time period, primarily among men. This is reflected in the very large confidence intervals for homicide risk for women, as well as the lack of data for protective and farming occupations. Nevertheless, we observe significantly elevated risk of homicide for farming (HR=2.90, $p<0.05$), manual labor (HR=2.24, $p<0.05$), and especially transport (HR=3.46, $p<0.01$) occupations. The risks associated with unemployment (HR=2.13, $p<0.05$) and not being in the labor force (HR=3.16, $p<0.01$) are considerable as well. However, accounting for education, only not being in the labor force remains significant (HR=3.17, $p<0.01$).

The last category consists of the remaining causes of death that do not neatly fit into the aforementioned categories but account for a substantial proportion of deaths. While there is no 'core' etiology for these causes of death, we clearly observe that specific occupational groups –

especially those considered "working-class" – consistently exhibit the highest mortality risk relative to professional/specialized occupations. Initially, all but those listing no occupation are at significantly greater risk of mortality, with an approximately twofold higher risk among service, manual labor, and transport occupations, as well as those never employed ($p<0.01$). Farming occupations are also at greater risk among men (HR=1.71, $p<0.01$). In support of the second, third, and fourth hypotheses, education has a uniform attenuating effect on all of these estimates, but service, manual labor, and farming occupations, as well as having never been employed, continue to be associated with significantly elevated risk for both women (HR~1.5, $p<0.01$) and men (HR~1.4, $p<0.01$). Interestingly, skilled service occupations are also at greater risk among men (HR=1.27, $p<0.01$). Not being in the labor force is associated with ~2.7 times greater mortality risk for women and men ($p<0.01$), while unemployment is only significant among women (HR=1.45, $p<0.01$).

Discussion and Conclusion

With recent increases in U.S. mortality concentrated among specific causes of death and working-aged adults, the present study examined occupation and employment status disparities in mortality risk. On the one hand, our analyses lend empirical support to the presupposition that 'working-class' Americans, namely manual labor workers and/or those not actively employed, are at significantly elevated risk of mortality across a broad range of leading and emerging causes of death, even after accounting for education. However, we find that elevated mortality risk is not limited to this occupational sector, but instead encompasses a broader set of categories with high concentrations of precarious jobs -- characterized by physical labor, unsafe conditions, a lack of autonomy, and low 'rewards.' Adults in service and transport occupations – constituting

a large and growing proportion of the labor force – are at significantly elevated risk as well, sometimes exceeding that of manual labor workers. Depending on the cause of death, farming and even skilled service workers are also at higher risk than manual laborers, along with those having never been employed.

The magnitude of occupation-specific mortality risk varies somewhat by cause of death, but overall patterns are remarkably consistent. Individuals in manual labor, service, and transport occupations generally have 75 to 100% higher mortality risk than their professional/specialized counterparts, though these mortality risk increases are two or even threefold for specific causes like alcoholic liver disease and accidental poisonings. In some cases, mortality risks among service and/or transport workers exceed those of adults in manual labor jobs, such as alcoholic liver disease, heart disease, homicide, and other/residual mortality. Accounting for educational attainment typically halves the mortality risk associated with a given occupation, but the general pattern of elevated risks remains unchanged. Importantly, certain causes of death show relatively little occupational variation in mortality, such as suicide, for which contemporary mortality risk is not confined to a particular group. The relatively uniformity in the occupation-specific suicide risk more closely resembles the gradients observed for more 'non-preventable' causes like non-lung cancers, low-preventability conditions, and accidents, rather than "despair deaths" like alcoholic liver disease and accidental poisoning. The only exception are women in manual labor jobs, which may be associated with increased workplace stress and/or discrimination linked to working in a traditionally male-dominated field (Evans and Steptoe 2002).

Despite gender differences in workforce experiences and the relationship between SES and mortality, the associations between occupations and cause-specific mortality risk are relatively consistent when comparing women and men. Occupation-specific all-cause, heart disease, and

other/residual mortality risks are nearly identical for both women and men, as are the attenuating effects of education. Though there are some notable exceptions – such as women in farming occupations having elevated alcoholic liver disease mortality risk, and women in service and manual labor jobs being at higher risk of accidental poisoning mortality net of education – we generally observe the same set of working-class occupations contributing to elevated risk of cause-specific mortality across genders.

Finally, our results clearly show that individuals' employment status cannot be ignored in the contemporary discussion of working-aged mortality. The most consistent predictor of increased mortality across all causes was not being the labor force, with a two to threefold greater risk than being currently employed (and as much as five to six-fold in the case of accidental poisoning among men). We acknowledge that health selection is an issue underlying this relationship; however, for some causes, like alcoholic liver disease and poisoning, these health selection processes are plausibly linked to individuals' occupations, as occupation-induced stress or injury may lead to harmful behaviors that contribute to both exit from the labor force and premature death. Similarly, unemployment is often associated with a higher mortality risk than any single occupation, especially for accidental poisoning and suicide mortality among women, and alcoholic liver disease among men. Most importantly, both unemployment and not being in the labor force appear to be an 'equal opportunity' source of risk because unemployment is harmful for all individuals, regardless of their educational background.

Prior to discussing the implications of these results, we acknowledge a few important limitations of the study and how they may be addressed in future research on employment, occupation, and mortality. First and foremost, while we use more precise occupational categories than most survey-based studies, we are constrained by data limitations as to how narrowly we can specify

individual or smaller groups of occupations. Past research has shown fine-grained occupational variation in all-cause mortality (Johnson et al. 1999; Sorlie et al. 1995); this study represents an initial attempt to assess this relationship in recent years, but with more time NHIS data may allow for greater specification of occupations, and to examine trends over time. Secondly, our measure of occupation is obtained at survey, and we cannot guarantee that individuals remain in a given employment status or occupational group throughout the follow-up period. On the one hand, research shows that individuals tend to stay in a primary occupational category throughout the course of their lives – especially in the U.S., where occupational mobility is shrinking (Rytina 2000) – such that one's first job has an extended impact on health (Fletcher 2012). However, job mobility, and its impact on health, is important as well (Moore and Hayward 1990). Most longitudinal data sets lack the sample sizes for estimating occupational disparities across different causes of death; such data would be ideal to study this question in greater depth. Finally, more comprehensive data on other aspects of individuals' workplace experiences, exposures, and rewards[2] would allow us to compare how psychosocial, biophysiological, and material sources of risk influence cause-specific mortality.

These limitations aside, our results highlight the importance of occupation and employment for the discourse on disparities in U.S. working-aged mortality. While both the research on and actual growth of precarious labor in the U.S. have moved in tandem over past decades, only recently have scholars considered health-related consequences of this fundamental shift in the labor force (Benach et al. 2014; Scott-Marshall and Tompa 2011; Tompa et al. 2007). This turn in the literature is critical, as a workplace-focused understanding of the relationship between

[2] For instance, we ran additional analyses with a crude indicator of individuals' income-to-needs as a potential measure of occupational "rewards"; as expected, its inclusion attenuated some but not all risk estimates, and largely served to increase variation.

occupation and health is incomplete, or too proximate, without acknowledging the more distal and social forces acting on occupations and, in turn, health (Benach and Muntaner 2007). Our research underscores the diversity of ways in which we might characterize occupations as exhibiting signs of precariousness, inclusive of job stability, autonomy, rights and protection, income and benefits, work-role status, social support, and exposure to hazards, all of which, in turn, influence health through physical, stress, and material deprivation pathways (Tompa et al. 2007). Consequently, we can and should conceptualize precarious labor – inclusive of the semi-perpetual unemployment and revolving participation in the labor force that characterizes certain occupations – as affecting health through a variety of direct and indirect mechanisms (Facey and Eakin 2010).

In light of this emerging research, our study is innovative in underscoring how the association between employment precarity and mortality is manifest in different causes of death. Many of the working-class occupations we examine project little to no growth in coming years – such as the bulk of manual labor manufacturing/production jobs, as well as farming – and have experienced a marked decline in quality over recent decades. The loss of the social and economic stability these jobs once offered, primarily due to outsourcing and decreasing union power in advocating for workers' rights (Kalleberg 2011; Standing 2011), is plausibly linked to the status loss and "despair" that is hypothesized to underlie recent increases in mortality. As the precariousness of manual labor and farming jobs has increased across a broad range of indicators, workers' elevated risks of alcoholic liver disease, accidental poisoning, and, among women, suicide, might be a consequence of increased stress and negative coping behaviors (Tompa et al. 2007). Conversely, a number of high-risk occupations are more stable or even growing in terms of availability, such as service jobs in the health care and food industries and

various types of transportation (BLS 2018). However, these jobs are *already* characterized by the above-described precariousness that has only more recently impacted manual labor occupations. Even though service and transport occupations are in higher demand, workers face uncertain and unstable work conditions; these jobs often have no long-term employment contracts, are largely un-unionized, and similarly lack opportunities for advancement, contributing to job dissatisfaction and frequent job changes (Kalleberg 2011; Pfeffer 2018). Again, it is plausible that these psychosocially poor working conditions would translate into increased mortality risk from alcoholic liver disease and accidental poisoning.

However, the harmful effects of these "bad jobs" in manual labor, service, transport, and farming industries are not confined to emerging causes of death. Using a broad definition of precariousness, physical hazards associated with occupations such as unsafe conditions and exposures and/or workplace practices, coupled with poor health due to material deprivation and stress in the form of low wages, a lack of health insurance, low autonomy, and irregular work schedules, likely compound increasing working-aged mortality risk. Indeed, these pathways are evident across the consistently elevated risks of mortality for working-class adults across the diverse set of causes of death in our analyses. As no form of employment has a "monopoly on precariousness" (Tompa et al. 2007: 216), higher mortality risk across multiple working-class occupations reflects unhealthy workplace environments according to a number of dimensions.

Unfortunately, most attempts at improving workers' health, such as wellness programs and rewards for 'good' health behaviors, are only a proximate-level solution to occupational disparities in health and mortality (Pfeffer 2018). These initiatives largely target physical health outcomes (Goetzel et al. 2014; Mattke et al. 2013), ignoring their more distal psychosocial determinants. Certainly, successful programs should be a staple of employer-led initiatives to

improve employees' health and reduce mortality risk; however, we contend that a more fundamental, policy-level shift is necessary, with a focus on the kinds of structural-level policies that hold workplaces accountable for the "socialization or externalization of the private costs of operating an unhealthy workplace" (Pfeffer 2018: 205), counteract various dimensions of precariousness in the workplace (Moen et al. 2016), and promote a holistic understanding of employee health that captures the *full* spectrum of risks associated with one's work.

Overall, our results clearly warrant increased attention on workplaces as important sources of mortality risk for large segments of the working-age population. Reducing disparities in workplace stressors, conditions, and exposures would mitigate the extent to which "good" versus "bad jobs" (i.e., precarious occupations) lead to good versus bad health, even independent of one's educational background. Undoubtedly, extant educational disparities in mortality continue to make increasing educational attainment among U.S. adults a priority (Hummer and Hernandez 2013); however, whether or not education guarantees placement into "good jobs" – and thus guarantees good "life chances" – remains an important population health concern. Certain working-class sectors, such as service, transport, and some subset of manual jobs, are growing and will require new workers regardless of their educational background. One can imagine a scenario in which an ever-increasing mismatch between individuals' education and their occupational responsibilities exacerbates the already harmful psychosocial consequences associated with having a "bad" and unfulfilling job (Burris 1983; Groot and Van Den Brink 2000). And while these occupations may become increasingly precarious owing to broader U.S. socioeconomic and political trends, the health and wellbeing of their workers cannot be undermined by continuing to promote workplace practices and conditions that denote a lack of investment in the women and men that comprise the workforce.

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Tables

Table 1

Description of Overall Sample
(Ages 25-64; NHIS 1997-2015)

Demographics	
Age (mean)	43.5
Male	49.0%
White	70.2%
Black	11.9%
Hispanic	13.4%
Other	4.4%
Foreign born	16.9%
Education	
<HS	13.4%
HS	27.4%
Some college	29.2%
BA+	30.0%
Decedent	5.5%
Cause of death	
Alc. Liver	2.9%
Poisoning	2.3%
Suicide	2.8%
Heart	26.0%
Lung cancer	8.5%
Other cancers	10.0%
Low-preventability	4.4%
Accidents	9.4%
Homicide	0.9%
Other/residual	32.7%
Occupation	
Professional/specialized	31.3%
Skilled service	24.0%
Protective	2.1%
Service	12.0%
Farming	1.8%
Manual	16.4%
Transport	6.1%
No occupation	2.2%
Never employed	4.0%
Employment	
Working	75.2%
Unemployed	3.9%
Not in labor force	21.0%

Notes:
N = 368,396.
Distributions based on NHIS survey weights.

Table 2

All-Cause Mortality Risk, U.S. Adults (25-64): NHIS 1997-2015

	Females						Males					
	Occupation			Occupation + Education			Occupation			Occupation + Education		
	HR	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*	
Occupation												
Professional/specialized (ref.)												
Skilled service	**1.32**	1.22	1.42	1.08	0.99	1.17	**1.41**	1.30	1.54	**1.20**	1.10	1.32
Protective	**1.40**	1.11	1.77	1.15	0.90	1.46	**1.30**	1.12	1.50	1.09	0.94	1.27
Service	**1.81**	1.65	1.98	**1.33**	1.20	1.47	**1.83**	1.67	2.02	**1.35**	1.22	1.49
Farming	**1.73**	1.29	2.32	1.25	0.92	1.68	**2.01**	1.78	2.27	**1.40**	1.23	1.60
Manual	**1.81**	1.62	2.02	**1.32**	1.17	1.48	**1.68**	1.57	1.79	**1.22**	1.13	1.32
Transport	**1.97**	1.63	2.37	**1.42**	1.17	1.73	**1.89**	1.75	2.04	**1.35**	1.24	1.48
No occupation	1.24	1.01	1.53	1.02	0.82	1.26	**1.32**	1.13	1.53	1.08	0.93	1.26
Never employed	**1.71**	1.53	1.92	**1.24**	1.10	1.40	**1.76**	1.49	2.08	**1.27**	1.06	1.51
Employment												
Working (ref.)												
Unemployed	**1.50**	1.30	1.73	**1.46**	1.26	1.68	**1.44**	1.29	1.62	**1.41**	1.26	1.58
Not in labor force	**2.08**	1.97	2.21	**2.01**	1.90	2.13	**2.46**	2.33	2.59	**2.33**	2.21	2.46

Notes:

N = 368,396 w/ 22,527 deaths.

All analyses weighted, and adjusted for race/ethnicity and nativity.

Bold indicates p<0.01; Underline indicates p<0.05.

Table 3

Mortality Risk from 'Emerging' Causes, U.S. Adults (25-64): NHIS 1997-2015

Females

	Alcoholic Liver Disease						Accidental Poisoning						Suicide					
	Occupation			Occupation + Education			Occupation			Occupation + Education			Occupation			Occupation + Education		
	HR	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*	
Occupation																		
Professional/specialized (ref.)																		
Skilled service	1.26	0.73	2.18	1.07	0.59	1.95	1.67	0.91	3.05	1.37	0.75	2.49	1.47	0.88	2.44	1.48	0.86	2.57
Protective	1.48	0.40	5.51	1.27	0.34	4.75	2.12	0.32	14.20	1.76	0.27	11.54	0.86	0.12	6.39	0.87	0.12	6.56
Service	**2.36**	1.42	3.94	1.82	1.01	3.29	**3.75**	2.18	6.43	**2.88**	1.68	4.95	0.98	0.48	1.97	1.03	0.47	2.26
Farming	**5.06**	1.91	13.39	**3.77**	1.39	10.19	-	-	-	-	-	-	-	-	-	-	-	-
Manual	1.91	0.93	3.90	1.46	0.67	3.20	**3.43**	1.65	7.12	**2.63**	1.27	5.47	**2.51**	1.25	5.04	**2.72**	1.28	5.77
Transport	2.00	0.79	5.06	1.53	0.58	4.01	**3.86**	1.56	9.53	2.95	1.18	7.36	-	-	-	-	-	-
No occupation	2.14	0.81	5.69	1.82	0.66	5.04	0.61	0.06	6.29	0.52	0.05	5.20	1.53	0.52	4.50	1.58	0.54	4.61
Never employed	1.46	0.74	2.89	1.11	0.52	2.36	2.49	1.24	5.03	1.94	0.97	3.87	1.10	0.46	2.64	1.20	0.47	3.06
Employment																		
Working (ref.)																		
Unemployed	2.26	1.05	4.87	2.19	1.01	4.73	**2.89**	1.51	5.55	**2.79**	1.45	5.35	**3.77**	1.98	7.20	**3.80**	1.99	7.26
Not in labor force	**2.08**	1.49	2.88	**2.00**	1.44	2.78	**3.34**	2.32	4.79	**3.27**	2.27	4.72	**1.81**	1.17	2.80	**1.83**	1.19	2.82

Males

	Alcoholic Liver Disease						Accidental Poisoning						Suicide					
	Occupation			Occupation + Education			Occupation			Occupation + Education			Occupation			Occupation + Education		
	HR	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*	
Occupation																		
Professional/specialized (ref.)																		
Skilled service	1.57	1.01	2.44	1.34	0.83	2.16	2.00	1.12	3.58	1.47	0.84	2.57	1.26	0.86	1.85	1.17	0.79	1.72
Protective	1.37	0.67	2.80	1.16	0.56	2.39	1.96	0.78	4.97	1.41	0.56	3.53	1.22	0.59	2.51	1.12	0.53	2.37
Service	**2.49**	1.50	4.14	1.84	1.06	3.19	2.16	1.05	4.43	1.26	0.61	2.61	1.44	0.87	2.38	1.27	0.76	2.14
Farming	2.10	1.10	4.03	1.46	0.72	2.94	**3.47**	1.51	7.95	1.88	0.80	4.43	1.30	0.67	2.53	1.15	0.59	2.27
Manual	**2.04**	1.42	2.94	1.50	0.98	2.28	**2.59**	1.54	4.36	1.48	0.87	2.51	1.31	0.94	1.82	1.15	0.78	1.68
Transport	1.63	0.91	2.91	1.17	0.62	2.23	**2.88**	1.52	5.48	1.59	0.81	3.10	1.44	0.92	2.24	1.26	0.79	2.01
No occupation	1.99	0.90	4.37	1.63	0.74	3.59	1.70	0.59	4.83	1.16	0.41	3.31	1.13	0.47	2.73	1.05	0.44	2.50
Never employed	1.56	0.73	3.34	1.12	0.51	2.46	1.55	0.61	3.98	0.87	0.34	2.24	0.64	0.15	2.66	0.57	0.14	2.40
Employment																		
Working (ref.)																		
Unemployed	**2.38**	1.29	4.38	**2.31**	1.25	4.26	1.55	0.78	3.08	1.45	0.72	2.89	1.72	1.06	2.80	1.71	1.05	2.78
Not in labor force	**3.28**	2.49	4.33	**3.08**	2.33	4.07	**5.81**	4.07	8.29	**5.26**	3.70	7.50	**2.11**	1.51	2.96	**2.09**	1.49	2.93

Notes:

N = 368,396 w/ 1764 deaths.

All analyses weighted, and adjusted for race/ethnicity and nativity.

Bold indicates p<0.01; Underline indicates p<0.05.

Table 4

Mortality Risk from 'Leading' Causes, U.S. Adults (25-64): NHIS 1997-2015

Females

	Heart Disease						Lung Cancer						Other Cancer					
	Occupation			Occupation + Education			Occupation			Occupation + Education			Occupation			Occupation + Education		
	HR	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*	
Occupation																		
Professional/specialized (ref.)																		
Skilled service	**1.41**	1.19	1.66	1.07	0.89	1.29	1.05	0.83	1.31	0.75	0.59	0.95	1.14	0.94	1.40	1.00	0.80	1.24
Protective	1.44	0.91	2.30	1.10	0.69	1.76	1.04	0.45	2.39	0.74	0.32	1.70	1.04	0.48	2.27	0.91	0.42	1.99
Service	**1.92**	1.60	2.30	1.31	1.07	1.61	**1.68**	1.32	2.13	0.98	0.75	1.28	1.24	1.00	1.55	1.01	0.79	1.29
Farming	1.55	0.92	2.62	1.05	0.61	1.79	1.45	0.50	4.20	0.84	0.29	2.48	1.55	0.78	3.06	1.24	0.62	2.50
Manual	**1.92**	1.53	2.40	1.30	1.01	1.66	1.56	1.09	2.23	0.89	0.61	1.31	1.38	1.04	1.83	1.11	0.82	1.50
Transport	**1.84**	1.33	2.54	1.24	0.88	1.74	2.01	1.16	3.50	1.15	0.65	2.02	1.87	1.15	3.04	1.50	0.90	2.50
No occupation	1.02	0.67	1.55	0.78	0.51	1.20	0.88	0.44	1.78	0.62	0.30	1.27	0.96	0.58	1.57	0.84	0.51	1.39
Never employed	**1.89**	1.48	2.42	1.29	0.98	1.69	1.24	0.84	1.84	0.71	0.47	1.06	1.40	0.99	1.99	1.13	0.78	1.66
Employment																		
Working (ref.)																		
Unemployed	**1.73**	1.25	2.38	**1.67**	1.21	2.31	1.09	0.54	2.20	1.05	0.52	2.11	0.81	0.54	1.23	0.80	0.53	1.20
Not in labor force	**2.27**	2.02	2.55	**2.19**	1.94	2.46	**1.74**	1.46	2.07	**1.62**	1.36	1.94	**1.59**	1.34	1.89	**1.56**	1.31	1.85

Males

	Heart Disease						Lung Cancer						Other Cancer					
	Occupation			Occupation + Education			Occupation			Occupation + Education			Occupation			Occupation + Education		
	HR	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*	
Occupation																		
Professional/specialized (ref.)																		
Skilled service	**1.42**	1.22	1.65	1.21	1.03	1.41	1.31	0.95	1.79	0.97	0.70	1.34	1.32	1.04	1.68	1.17	0.90	1.51
Protective	1.38	1.07	1.79	1.16	0.89	1.51	1.58	0.97	2.58	1.15	0.70	1.88	0.92	0.56	1.53	0.80	0.48	1.35
Service	**1.71**	1.43	2.05	1.25	1.03	1.52	**2.66**	1.87	3.79	1.54	1.06	2.25	1.32	0.92	1.88	1.03	0.69	1.52
Farming	**2.15**	1.73	2.67	**1.49**	1.19	1.87	**2.95**	1.90	4.58	1.62	1.02	2.56	**2.05**	1.38	3.06	1.55	1.01	2.39
Manual	**1.66**	1.46	1.89	1.21	1.04	1.40	**2.48**	1.94	3.17	1.42	1.07	1.89	**1.46**	1.18	1.80	1.13	0.87	1.47
Transport	**1.91**	1.66	2.20	**1.36**	1.16	1.60	**2.83**	2.10	3.80	**1.57**	1.13	2.18	**1.75**	1.34	2.28	1.34	0.98	1.81
No occupation	1.43	1.07	1.91	1.18	0.87	1.59	1.65	0.95	2.85	1.16	0.66	2.06	0.87	0.47	1.62	0.75	0.40	1.39
Never employed	**1.90**	1.42	2.54	1.35	1.00	1.83	**2.21**	1.26	3.85	1.24	0.70	2.19	1.71	0.95	3.10	1.32	0.71	2.45
Employment																		
Working (ref.)																		
Unemployed	**1.83**	1.50	2.22	**1.78**	1.46	2.17	1.26	0.78	2.05	1.24	0.76	2.01	1.60	1.11	2.31	1.58	1.09	2.28
Not in labor force	**2.50**	2.27	2.75	**2.35**	2.14	2.59	**1.79**	1.50	2.12	**1.64**	1.38	1.95	**1.60**	1.34	1.91	**1.54**	1.29	1.83

Notes:

N = 368,396 w/ 10,068 deaths.

All analyses weighted, and adjusted for race/ethnicity and nativity.

Bold indicates p<0.01; Underline indicates p<0.05.

Table 5

Mortality Risk from Other Causes, U.S. Adults (25-64): NHIS 1997-2015

Females

	Low-Preventability						Accidents						Homicide						Other/Residual					
	Occupation			Occupation + Education			Occupation			Occupation + Education			Occupation			Occupation + Education			Occupation			Occupation + Education		
	HR	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*	
Occupation																								
Professional/specialized (ref.)																								
Skilled service	1.61	1.02	2.56	1.33	0.80	2.21	**1.37**	1.10	1.70	1.24	0.97	1.58	1.08	0.41	2.87	0.68	0.27	1.69	**1.39**	1.21	1.59	1.15	0.99	1.33
Protective	1.69	0.36	7.98	1.40	0.29	6.73	1.18	0.50	2.80	1.06	0.45	2.52	-	-	-	-	-	-	1.60	1.08	2.37	1.33	0.89	1.98
Service	**2.47**	1.58	3.88	1.85	1.12	3.06	**1.64**	1.27	2.12	1.37	1.02	1.84	2.15	0.83	5.56	1.15	0.46	2.85	**1.96**	1.68	2.30	**1.44**	1.20	1.73
Farming	3.51	0.99	12.38	2.54	0.71	9.16	2.34	1.18	4.67	1.92	0.96	3.87	-	-	-	-	-	-	1.60	0.99	2.58	1.14	0.70	1.86
Manual	2.13	1.16	3.90	1.58	0.84	2.98	1.41	1.00	1.99	1.16	0.81	1.67	1.25	0.28	5.54	0.65	0.14	2.91	**2.03**	1.68	2.45	**1.48**	1.20	1.82
Transport	1.80	0.72	4.50	1.33	0.51	3.46	1.90	1.15	3.13	1.57	0.93	2.64	1.14	0.19	6.87	0.59	0.10	3.60	**2.10**	1.60	2.76	**1.52**	1.14	2.01
No occupation	1.63	0.57	4.61	1.37	0.48	3.91	1.87	1.05	3.30	1.67	0.94	2.96	2.21	0.29	16.78	1.43	0.19	10.86	1.34	0.96	1.86	1.09	0.78	1.54
Never employed	2.18	1.21	3.94	1.62	0.85	3.11	1.51	1.04	2.19	1.24	0.84	1.82	2.97	0.80	11.00	1.65	0.47	5.82	**1.92**	1.61	2.29	**1.38**	1.14	1.67
Employment																								
Working (ref.)																								
Unemployed	2.16	1.20	3.89	2.08	1.15	3.73	1.43	0.95	2.14	1.40	0.94	2.10	0.28	0.05	1.41	0.26	0.05	1.32	**1.49**	1.17	1.90	**1.45**	1.13	1.85
Not in labor force	1.52	1.09	2.11	1.46	1.05	2.03	**1.28**	1.06	1.54	1.25	1.04	1.50	1.63	0.77	3.47	1.57	0.74	3.34	**2.64**	2.40	2.91	**2.54**	2.31	2.80

Males

	Low-Preventability						Accidents						Homicide						Other/Residual					
	Occupation			Occupation + Education			Occupation			Occupation + Education			Occupation			Occupation + Education			Occupation			Occupation + Education		
	HR	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*		*HR*	*95% CI*	
Occupation																								
Professional/specialized (ref.)																								
Skilled service	1.31	0.92	1.87	1.16	0.79	1.70	1.20	0.93	1.56	1.12	0.86	1.46	2.44	0.99	5.98	1.96	0.72	5.36	**1.52**	1.32	1.74	**1.27**	1.10	1.47
Protective	1.35	0.66	2.75	1.17	0.57	2.39	1.13	0.72	1.78	1.05	0.66	1.65	0.85	0.16	4.57	0.69	0.12	4.01	1.31	1.00	1.71	1.09	0.83	1.43
Service	1.71	1.12	2.62	1.38	0.85	2.24	1.26	0.91	1.75	1.07	0.75	1.52	1.58	0.63	3.97	0.96	0.33	2.82	**2.16**	1.83	2.55	**1.57**	1.31	1.87
Farming	**2.71**	1.76	4.18	**2.10**	1.28	3.43	1.39	0.84	2.30	1.15	0.68	1.96	2.90	1.10	7.63	1.51	0.47	4.90	**1.71**	1.36	2.14	1.18	0.93	1.49
Manual	**1.68**	1.27	2.22	1.34	0.94	1.92	1.25	1.00	1.55	1.06	0.82	1.37	2.24	1.06	4.74	1.35	0.51	3.57	**1.70**	1.50	1.91	**1.22**	1.06	1.39
Transport	**1.90**	1.35	2.66	1.51	1.00	2.28	1.20	0.90	1.60	1.00	0.72	1.38	**3.46**	1.46	8.20	2.02	0.71	5.79	**1.95**	1.68	2.27	**1.37**	1.16	1.62
No occupation	0.95	0.48	1.87	0.83	0.42	1.65	1.22	0.77	1.93	1.10	0.69	1.76	2.81	0.77	10.25	1.95	0.44	8.58	1.25	0.92	1.70	1.02	0.74	1.39
Never employed	1.32	0.62	2.80	1.06	0.49	2.33	1.27	0.72	2.25	1.07	0.60	1.91	0.72	0.07	7.23	0.42	0.04	4.44	**2.00**	1.58	2.53	**1.42**	1.12	1.81
Employment																								
Working (ref.)																								
Unemployed	0.96	0.57	1.64	0.94	0.55	1.61	1.04	0.65	1.67	1.03	0.65	1.65	2.13	1.04	4.36	1.98	0.97	4.07	1.17	0.94	1.47	1.15	0.91	1.44
Not in labor force	**1.89**	1.45	2.45	**1.82**	1.39	2.37	**1.91**	1.59	2.29	**1.86**	1.55	2.24	**3.50**	1.97	6.21	**3.17**	1.74	5.77	**3.02**	2.75	3.31	**2.86**	2.61	3.14

Notes:

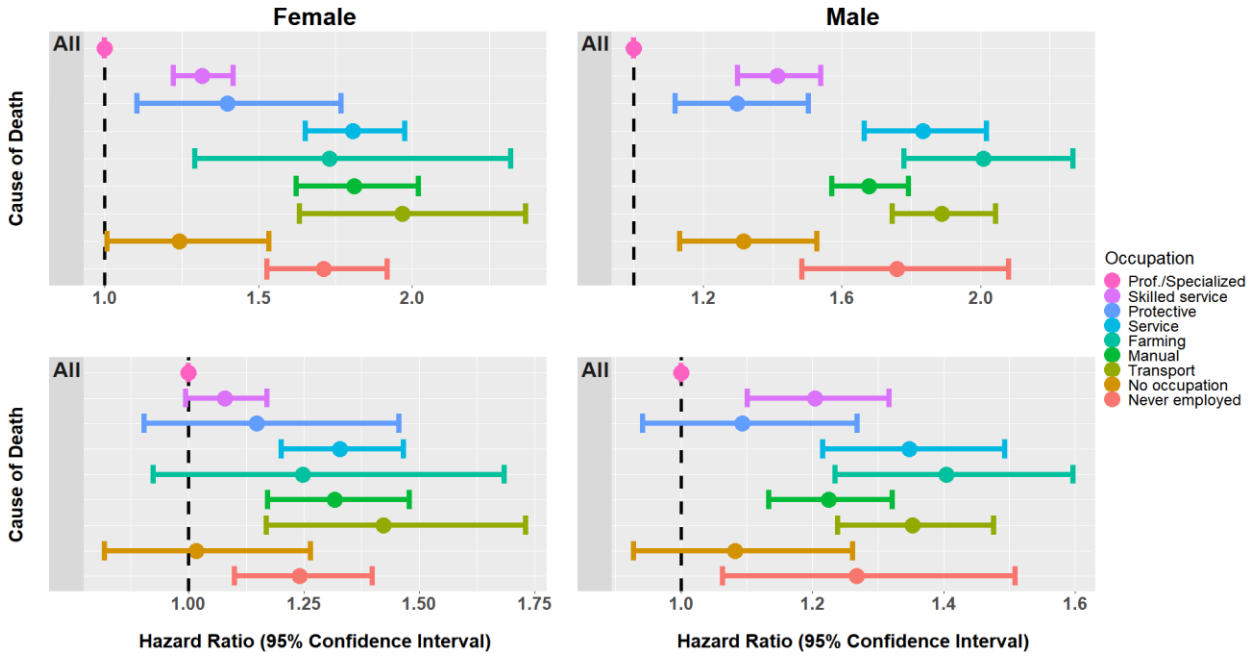
N = 368,396 w/ 10,695 deaths.

All analyses weighted, and adjusted for race/ethnicity and nativity.

Bold indicates p<0.01; Underline indicates p<0.05.

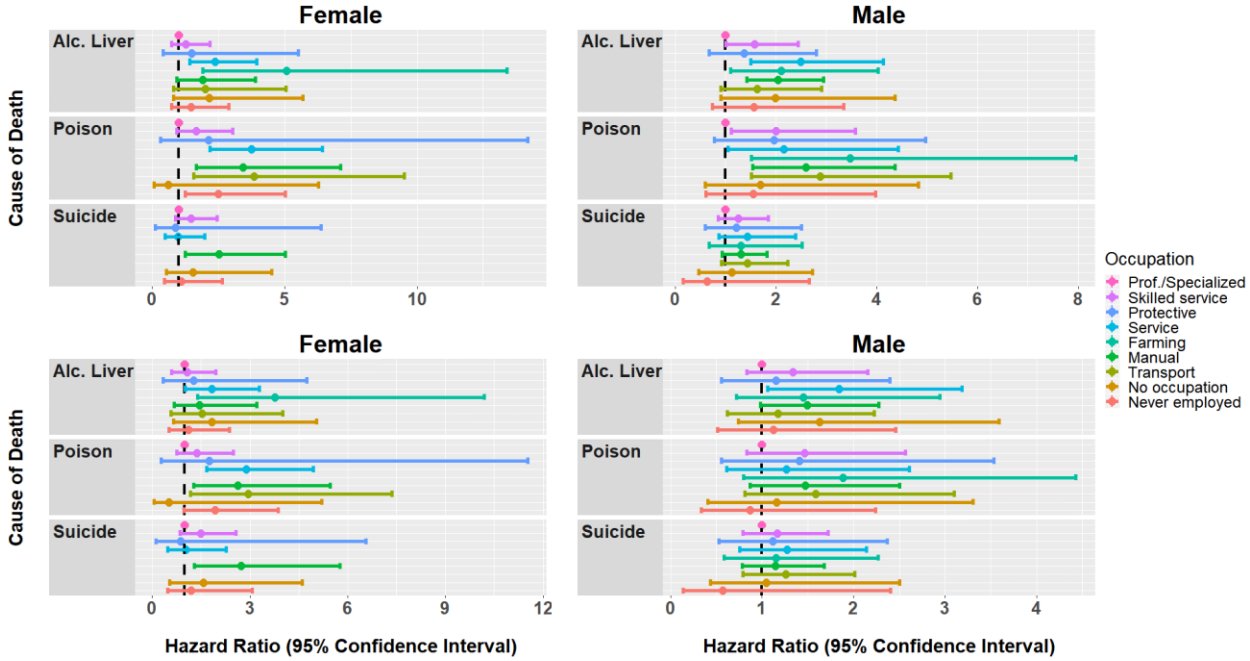
Figures

Figure 1: All-Cause Mortality, Pre- and Post-adjustment for Education



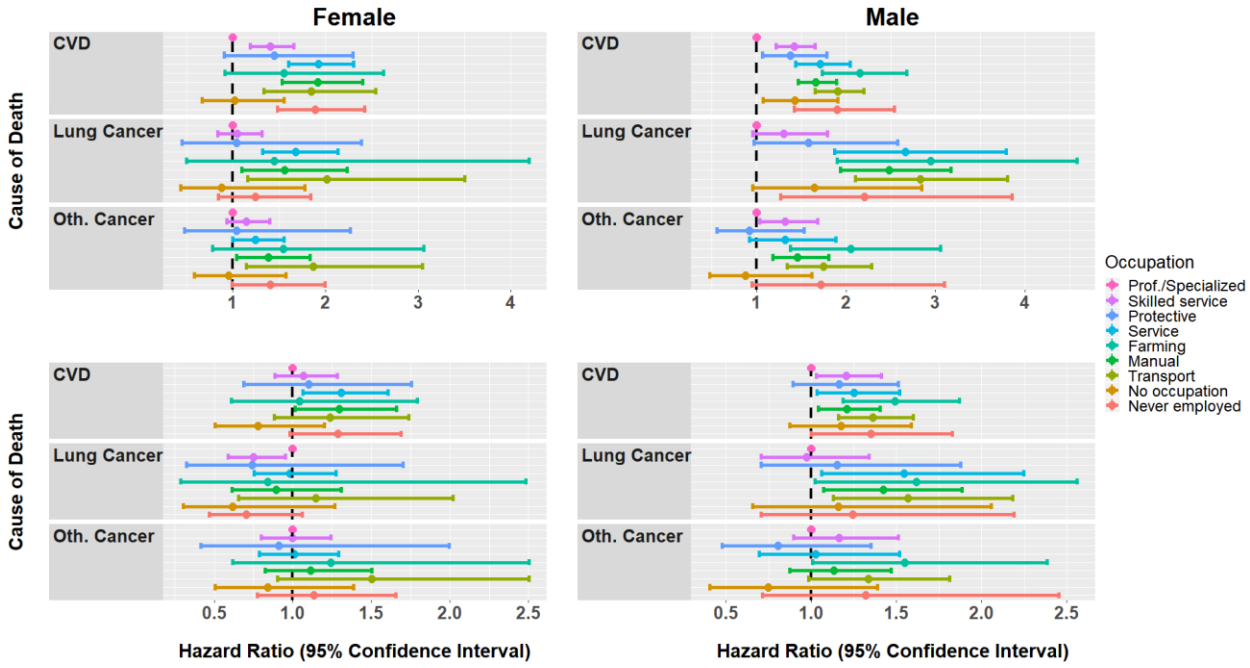
Note: Top panel is pre-adjustment for education. Bottom panel is post-adjustment for education.

Figure 2: Emerging Causes of Mortality, Pre- and Post-adjustment for Education



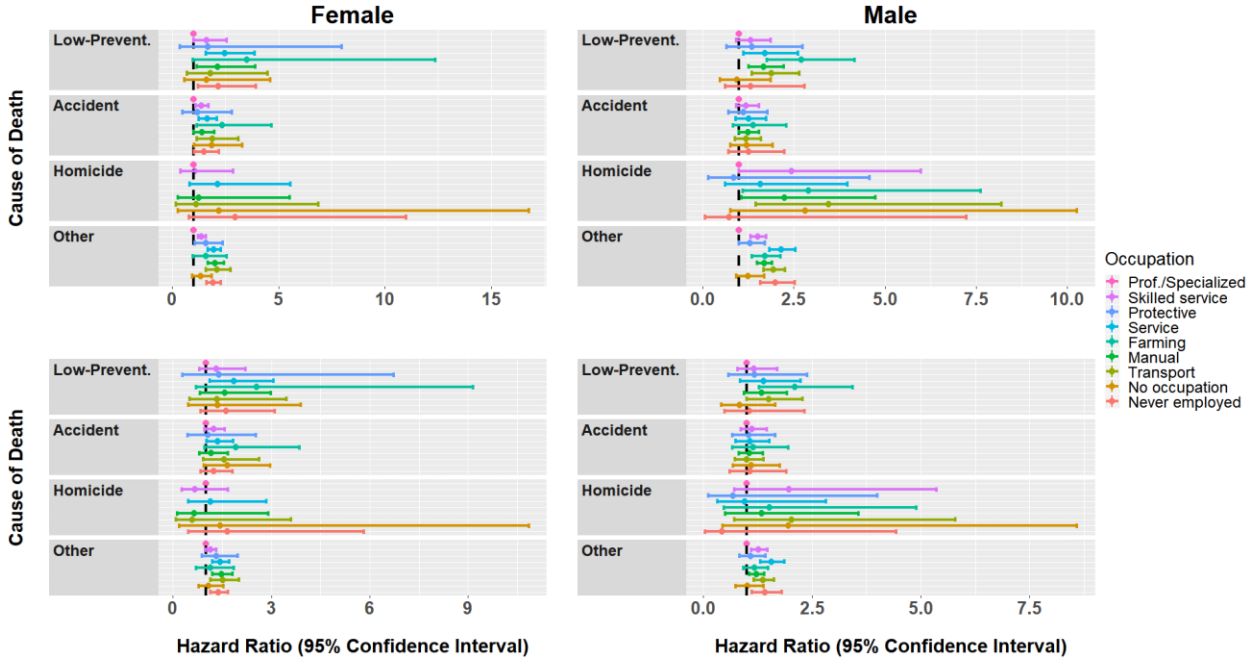
Note: Top panel is pre-adjustment for education. Bottom panel is post-adjustment for education.

Figure 3: Leading Causes of Mortality, Pre- and Post-adjustment for Education



Note: Top panel is pre-adjustment for education. Bottom panel is post-adjustment for education.

Figure 4: Other Causes of Mortality, Pre- and Post-adjustment for Education



Note: Top panel is pre-adjustment for education. Bottom panel is post-adjustment for education.

Appendix

Table A1

Distribution of Specific Occupations within Occupation Groups (Ages 25-64; NHIS 1997-2015)

Professional/specialized (31%)	
Managers and administrators, except public administration	27%
Teachers, librarians and counselors	19%
Management related occupations	13%
Natural, mathematical, and computer scientists	9%
Health diagnosing occupations	8%
Other professional specialty occupations	8%
Writers, artists, entertainers and athletes	6%
Engineers	4%
Officials and administrators, public administration	3%
Health assessment and treating occupations	3%
Architects and surveyors	1%
Skilled service (24%)	
Other administrative support	29%
Other sales	20%
Supervisors and proprietors	12%
Stenos, typists, secretaries, receptionist	9%
Mail carriers, baggagemen, teleg. messengers	8%
Financial records processing occupations	8%
Sales representatives, commodities and finance	8%
Technologists, technicians except health	6%
Computer equipment operators	0%
Protective (2%)	
Police and firefighters	58%
Other protective service occupations	32%
Military	10%
Service (12%)	
Food service	33%
Cleaning and building service	26%
Personal service	22%
Health service	18%
Private household workers	1%
Farming (2%)	
Farm workers and other agricultural workers	81%
Farmers and farm managers	12%
Forestry and fishing occupations	7%
Manual (16%)	
Construction and extractive trades	32%
Machine operators and tenderers, except precision	27%
Mechanics and repairers	22%
Precision production occupations	10%
Fabricators, assemblers, inspectors, and samplers	9%
Transport (6%)	
Motor vehicle operators	49%
Material moving equipment operators	32%
Freight, stock and material handlers	12%
Other transportation, except motor vehicles	4%
Construction laborers	3%
No occupation (2%)	
Unknown-refused	75%
Unknown-not ascertained	19%
Unknown-don't know	6%

Notes:

N = 368,396.

Distributions based on NHIS survey weights; additional 4% report having never worked.