Chapter 13: Work, Occupation, Income, and Mortality*

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ABSTRACT

Work is a central feature in the stratification of society because it sorts individuals into more or less prestigious occupations; exposes workers to salubrious, dangerous, or stressful environments; and provides earnings that, if adequate, can be converted into wealth, housing, and additional education. Thus, it seems intuitive that work, earnings, and occupations would be associated with broader life chances, including the attainment of long and healthy lives. Our chapter has four major sections. First, we discuss the theoretical and methodological challenges regarding the myriad and multidirectional relationships among work, income, and occupation on one hand, and health and mortality on the other hand. Second, we review some of the major theoretical and empirical findings that link work, income, and occupation to individual mortality in more developed countries. Third, we describe how work, occupation, and income impact mortality in less developed countries where work and social safety net conditions may be quite different than in more developed countries. Finally, we discuss some of the aggregate, historical, and comparative research that links work and income to mortality. Throughout the chapter, we note how gender and the life course shape the relationship between work and mortality.

Work is a key indicator of the productive capacity of populations, and many individuals work for a majority of their adult lives. Classical sociological thought has emphasized the importance of work for integrating individuals into the broader social order and fostering mutual dependence among those who specialize in different occupations (Durkheim 1933), allowing workers to express their creativity through their productive efforts (Marx 1957), or offering individuals the promise of insight into their destination in the afterlife (Weber 1958). Work is central to the stratification of society because it facilitates social interactions with co-workers, customers, and other business contacts, sorts workers into occupational statuses, exposes employees to specific working conditions, and provides earnings (Friedmann and Havighurst 1954; Hauser and Warren 1997; Kasl and Jones 2000). Earnings, in turn, may be converted into other material resources, including savings, housing, and other forms of wealth, and occupational status is considered so fundamental for individuals and society that it is often used as the primary indicator of a person's social status. Given the importance of work in society, it seems intuitive that it would be linked to the distribution of other valued outcomes, such as long and healthy lives. Importantly, not all jobs promote health, and some are outright dangerous. Some estimates suggest that there were up to 1.3 million work-related fatalities in the world in 1990, primarily from work-related accidents or exposure to noxious agents (Driscoll et al. 2005; Murray and Lopez 1996; Takala 1999). Thus, our chapter is devoted to understanding the relationship between mortality and work, occupation, income, and related material resources.

Our chapter is comprised of four substantive sections. The first section engages with a persistent concern of researchers: is employment, occupation, or material resources causally related to mortality? This is a topic of theoretical importance to researchers who attempt to untangle the reciprocal relationships between health and different measures of socioeconomic

status (SES) over the life course and by gender. Researchers have also devised numerous methodological strategies in an attempt to determine the circumstances under which work, occupation, and material resources are most clearly linked to health and subsequent mortality outcomes, and to understand the direction and magnitude of these associations. The reciprocal relationship between various indicators of SES and health and mortality outcomes is a theme that we touch on throughout all sections of our chapter, but given the centrality of causal concerns in contemporary research, we devote a section to this specifically.

The second section focuses on individual and family dimensions of work, occupation, and material resources and their connections to mortality in more developed countries (MDCs). Throughout this and other sections of the chapter, we will emphasize the theoretical distinctions among work, occupation, and material resources (Duncan et al. 2002; Galobardes et al. 2006), and their connections to mortality. Education is closely tied to work opportunities, occupational mobility, and income and wealth, and also has independent relationships with mortality, as described in Chapter 5 of this Handbook. We present empirical findings that illustrate and support the key substantive issues, rather than providing an exhaustive literature review.

The third section focuses on the relationships between individual and family dimensions of work, occupation, and material resources, and adult mortality in less developed countries (LDCs). Some theoretical and methodological concerns are similar for MDCs and LDCs, but the social and economic contexts of LDCs have important implications for the relationships among work, material resources, and mortality. For example, LDCs often have more limited public health infrastructures than MDCs, so life-saving medical care may be unavailable for purchase regardless of the economic resources available. Further, the character of work in LDCs may be very different from work in MDCs in ways that can impact mortality: there are fewer legal

protections for workers, less regulation to ensure safe work environments, and the most common occupations may include subsistence farming or, more recently, jobs in manufacturing, which confer different risks for health and survival than the service sector and administrative jobs that are more common in MDCs.

Throughout the first three sections, we frequently return to the importance of gender and life course for shaping the relationship between mortality and work, occupations, and material resources. Gender is important because it structures participation in the labor force, the occupations held, and the remuneration received. In some societies, or in some historical periods, men may spend more of their lives in the formal workforce, and women's disproportionate efforts in caring for the home or other family members, or their participation in part-time work may be undercounted (Buvinic, Giuffrida, and Glassman 2002; Sullivan 2006). For example, between 1940 and 2007 the percent of U.S. women who worked outside the home (or "for pay") steadily increased from 28% to about 59%, although women remain more likely than men to take time out of the labor force to care for children or ailing parents (Smith and Bachu 1999; U.S. Census Bureau 2007). Perhaps as a result of their weaker attachment to the labor force, the relationship between various socioeconomic characteristics and health or mortality are weaker for women than for men (Macintyre and Hunt 1997).

With regard to the life course, both men and women often transition into and out of the labor force multiple times as they complete or return to school, experience spells of unemployment or disability, take time to care for children or other family members, or retire one or more times (Pavalko and Smith 1999). Each of those transitions, the time that individuals spend in each state, and the trajectories workers experience within their careers can have important implications for mortality (Hayward et al. 1989; Pavalko, Elder, and Clipp 1993).

The fourth section turns to research on the relationships between societal patterns of work, income, and material resources and mortality, often within a comparative or historical framework. Inequality and cycles of unemployment and economic growth can leave their mark not only on the survival of individuals, but also on the mortality experiences of populations. This section also describes some of the implications of globalization for mortality, especially the movement of low skill, low wage, and unsafe jobs from MDCs to LDCs.

Due to the limitations of extant data, prior research has often examined health outcomes other than mortality, but that are associated with survival (e.g., morbidity, mental health, medical conditions, and self rated health). Mortality is unique in that it marks the irreversible exit from a population and reflects the culmination of a lifetime of work, occupational, and material conditions. Our discussion focuses on the theoretical connections between work, occupations, and income and various health and mortality outcomes, and where possible, we emphasize studies that specifically examine mortality. We draw on theory and research from demography, sociology, economics, social epidemiology, and occupational epidemiology.

Empirical Relationships: Work, Occupations, Income, and Mortality among U.S. Adults

Before we discuss major findings from the empirical literature, we present some numbers to provide a sense of the magnitude of the relationships among employment status, occupational status, material resources, and overall mortality. For most of this exercise, we use data from the 1990 Family Resources Supplement to the National Health Interview Survey (NHIS), linked to prospective mortality in the National Death Index through 2002 (National Center for Health Statistics 1992, 2007). Gompertz proportional hazard models estimated the risk of death between the respondent's age at interview and their age of death or their age at the end of the follow-up

period in 2002 (Korn, Graubard, and Midthune 1997). Gompertz models capture the exponentially increasing risk of death as adults age. The models also adjust for race/ethnicity, sex, foreign born status, marital status, and education. We include each employment status, occupational status, and income variable separately, rather than simultaneously, to provide a sense of the gross relationship between each measure and prospective mortality in a nationally representative sample of adults aged 18 and older. We also present models that are stratified by sex and broad age groups at baseline. Our models are not designed to test the theoretical frameworks described below, but instead highlight many of the measures that are commonly used and their relationships with mortality.

Employment Status

Table 1 presents the results for three sets of employment status variables. In the first column, the first set of variables shows that compared to those who are employed at the time of survey, those who are unemployed have 35% higher risks of death, and those who are not in the labor force and not looking for work have 60% higher risks of death over the follow-up period. The next set of variables distinguishes among those who usually work full time (35 or more hours per week) and those who usually work part time (1 and 34 hours per week). Compared to those who work full time, adults who work part time have 30% higher risks of death, those who are unemployed have 52% higher risks of death, and those who are not in the labor force have 72% higher risks of death over the follow-up period. The third set of variables finds no difference in the risk of death between those who are employed at a job and those who are self-employed.

(Table 1 about here)

The next two columns estimate these relationships separately by gender and show that

working part time, being unemployed, or not participating in the labor force is associated with higher risks of death for males than for females, potentially because it is more common for males to serve as the primary breadwinners in families and select out of the labor force only if their health is quite poor, whereas women have weaker attachments to the labor force. The final three columns show that the relationship between employment status and mortality weakens after age 65. However, even adults aged 65 or older have increased risks of death if they are not in the labor force, potentially because they are in poor health and are unable to work.

Occupational Status

Table 2 presents the relationship between occupational status and mortality. We examine six different occupational status indices (discussed in more detail in the following sections). The indices include the Hauser and Warren (1997) socioeconomic index, the Siegel (1971) prestige score, the Nakao and Treas (1994) prestige score, the Nam-Powers-Boyd occupational status score (Nam and Boyd 2004), an occupational earnings score that indicates the percentage of workers who are in occupations that have lower median incomes than those in the respondent's own occupation, and an occupational education score that indicates the percentage of people in the occupational category who had completed one or more years of college. Except for the Hauser and Warren socioeconomic index, all of the scores were calculated by staff at the Integrated Public Use Microdata Series (Ruggles et al. 2009), and were then merged into the NHIS based on the 3 digit 1990 Census Occupational Codes. Those who are not in the labor force do not report an occupation. Thus, we standardize the occupational status indices to have a mean of 0 and a standard deviation of 1, and code those who are not in the labor force as 0. Then we include a dummy variable to indicate those individuals who are not in the labor force.

(Table 2 about here)

The first column of Table 2 shows that a one standard deviation increase in any of the occupational status indices we examine is associated with a 10% to 11% lower risk of death over the follow-up period. The next two columns show that the inverse association between the occupational status scores and overall mortality is generally stronger for men than for women. The final three columns show that the inverse relationships among the occupational status scores and mortality are strongest among those aged 18 to 44 at baseline, and weaken with age until none of the scores are significantly associated with mortality among adults aged 65 and older at baseline. Although prior research emphasizes differences in the measurement and conceptual purpose of each index (Mutchler and Poston 1983; Nam 2000), our (quite simple) models show that each has a similar relationship with mortality. Future work could more systematically explore whether different dimensions of occupational status or prestige confer different survival advantages.

Given important differences among occupations in working conditions and their links with specific causes of death, Table 3 presents the relationship between selected causes of death and some major occupational groups and specific occupations, based on data from the U.S. National Occupational Mortality Surveillance (NOMS) System (National Institute for Occupational Safety and Health 2009). The NOMS System uses data from death certificates that include occupation and industry information from twenty-eight states that have participated in the project for two or more years from 1984 through 1998. The NOMS database does not provide information on length of employment or estimates of workplace exposures, but it includes information on numerous recent deaths and has broad geographic coverage. The proportionate mortality ratios (PMRs) indicate whether the age- standardized proportion of

deaths from a specific cause of death for a particular occupation is higher (i.e., PMR>100) or lower (i.e., PMR<100) than expected. For example, deaths from cancers of the trachea, bronchus, and lung are significantly lower than expected among males in executive, administrative and managerial occupations overall, but are not different from the expected levels for business managers.

(Table 3 about here)

Table 3 shows several noteworthy patterns. First, men in white collar positions generally have lower than expected mortality from most of these causes, with the exception of higher than expected mortality from heart diseases among men in technical, sales, and administrative support occupations. By contrast, women in executive, administrative, and managerial occupations, and in technical, sales, and administrative support occupations have higher than expected mortality from lung and related cancers and COPD—causes affected by smoking, which may have been more common among higher status women who were dying over the period considered here.

Second, while external causes of death due to injury and poisoning are inexplicably higher than expected for women in many occupations, for women and men they are particularly high in farming, forestry, and fishing occupations and in blue collar occupations like extractive work (e.g., mining) and in jobs that involve a high risk of traffic accidents (e.g., truck drivers). Third, there are remarkably strong associations between extractive occupations and deaths from pneumoconioses and lung diseases like silicosis (PMR=973), due to the external agents that are frequently inhaled in mining work.

Income and Material Resources

Table 4 returns to the NHIS data and presents results for overall mortality and material resources.

Individual and family income are the sum of the income from sources including jobs, self employment, social security/railroad retirement, retirement accounts, interest bearing accounts, dividends, and other sources. Income from self employment or dividends can be negative if individuals take a loss at their businesses or on their investments. Thus, we code our income variables for analysis by bottom-coding individual and family income to ensure that there are no negative values, dividing by $10,000, and taking the natural log. We also include a dichotomous variable to indicate whether individuals (or any family members, in the case of family income) reported negative income values from self employment or dividends. Although persistent income losses may be disadvantageous, short term losses may be less problematic if the ownership of a business or investments is associated with reduced mortality.

(Table 4 about here)

The first column of Table 4 shows that each $10,000 increase in logged individual income is associated with 3% lower risk of mortality over the follow-up period. Individuals who have any negative income have 38% lower risk of death than those without negative income. Family income has a similar inverse relationship with the risk of death. We also examine a family income equivalence measure that adjusts the family income variable for the purchasing power of different size families, as described by Van der Gaag and Smolensky (1982), and again find an inverse relationship between family income and mortality.

The income portfolios capture the income diversification of individuals or households (Krueger et al. 2003). The individual income portfolio is the sum of the number of income sources an individual has received from jobs, self employment, social security/railroad retirement, other pensions, interest, dividends, and other income. The family income portfolio includes the number of sources of income from all family members, divided by the number of

family members. The individual income portfolio indicates that each additional source of income is associated with 13% lower risks of death over the follow-up period. The family income portfolio shows that each additional source of income per family member is associated with a 10% lower risk of death over the follow-up period. The next two columns show that the relationships between each measure and mortality are modestly weaker for women than for men. The final three columns show that the relationship between material resources and mortality weakens with age.

CAUSAL, RECIPROCAL, AND SPURIOUS RELATIONSHIPS

Theoretical Concerns

Nearly all research that examines relationships between overall or cause-specific mortality and employment or work conditions, occupational exposures or prestige, or income and material resources grapples with the difficulty of establishing causal connections among those variables in the population of interest. Education is unique among the commonly used indicators of SES, as is described in Chapter 5. Because education is usually determined early in life before the onset of age-related poor health and does not change with age, it has a more clearly established causal effect on mortality, although the mechanisms that link education to mortality are incompletely understood (Link 2008; Lleras-Muney 2005; Mirowsky and Ross 2003). By contrast, work, occupation, and material resources may change multiple times over the life course, and are likely to be more sensitive to the influence of underlying (and potentially unobserved) health conditions (Kitagawa and Hauser 1973; Smith 1999).

There are clear theoretical reasons to suspect a causal connection leading from better work conditions, higher status occupations, and higher incomes to longer lives. Indeed, this is the

primary focus of this chapter, so we will not belabor the point here. Nevertheless, individuals with higher incomes can afford to live in safer housing in safer neighborhoods, purchase more nutritious foods or access to gyms or other recreational facilities, and buy better healthcare; high quality jobs may be safe, interesting, and relatively free of stress; and higher status occupations can offer greater prestige that one can use to command resources that promote health. All of these factors could plausibly lead to better health and longer lives.

In contrast, although mortality is the last event that individuals will ever experience, placing it clearly after a lifetime of exposure to work and material conditions, it remains possible that those who are sickly or disabled may be less able to work, more likely to lose their jobs or to move into lower status occupations if they are working, less likely to earn high incomes, and ultimately, more likely to die (Smith 1999). For example, the inverse association between household wealth and the risk of death among older adults (Bond Huie et al. 2003) could be explained by the need for sickly individuals to spend down their assets to qualify for long term care through the Medicaid program (Smith 1999). Haas (2006) has demonstrated that poor health in early life is associated with reduced earnings in later life.

What remains most likely, however, is that there are reciprocal relationships between health and work, income, and occupation (Mulatu and Schooler 2002; Mullahy and Robert 2008), and that the predominant direction of that relationship (i.e., from health to SES, or from SES to health) varies over the life course and across social circumstances. At younger ages, relatively few adults are too disabled to work, and instead, those who are not working are often attending school, at home caring for young children, or, less frequently, participating in underground economies that may offer greater rewards than the formal labor market (Subramanian and Kawachi 2003). In mid- and late-life, however, early life conditions may

begin to exact their toll on the ability of individuals to maintain fully active lives, which may result in greater disability, lower incomes, and increased risks of death (Haas 2006; Hayward and Gorman 2004; also see Chapter 4). Further, over the life course, individuals may experience bouts of illness that reduce their socioeconomic position, and some individuals may be better able to recover their health and socioeconomic standing than others.

The role of gender in selection into the labor force, certain occupations, and earning at the highest levels changes over time and varies across birth cohorts. In prior decades in MDCs, when relatively fewer women worked outside the household, women who did hold full time jobs outside of the home in high status occupations were a very select group. More recently and in most parts of the world, women are commonly spending part or all of their adult lives in the paid labor force, although they remain more likely than men to leave the labor force to care for children or elderly dependents (Buvinic et al. 2002; Heymann, Fischer, and Engelman 2003). Little research has systematically examined how changes in the employment of women across cohorts might shape the relationship between work, occupation, material resources, and health and mortality outcomes among women, men, and their families.

Finally, an alternate hypothesis warrants mention. Work, occupation, and material resources may have spurious relationships with mortality outcomes in some circumstances. For example, unobserved genetic or environmental factors that are associated with employment or occupational status attainment (Guo 2006; Nielsen 2006) may also account for differential mortality by employment or occupational status. Importantly, the unobserved factors need not be genetic. Cultural capital—or the underlying tastes and preferences that convey a person's status (Bourdieu 1984, 1986)—may shape educational and occupational prospects, as well as health behaviors that have established connections to mortality (Pampel 2006; Stempel 2005). Although

cultural capital theories are commonly linked to education, Bourdieu's (1984) emphasis on the cultivation of cultural capital within families suggests that interventions that target increases in educational attainment (e.g., mandatory schooling laws) may do little to shape the underlying tastes for high status work or healthy behaviors.

Methodological Concerns

There are multiple strategies for attempting to address causal concerns. First, researchers can try to find socioeconomic measures that are less sensitive to individuals' bouts of poor health. For example, family income or one-time income transfers from family members may be less sensitive to personal health than individual earnings (Kitagawa and Hauser 1973). However, this approach can be problematic if unhealthy individuals (e.g., smokers) tend to live together, resulting in poor health and lower earnings among all family members, or if families non-randomly provide transfers or bequests based on the health of recipients (McGarry and Schoeni 1995). Second, some researchers use instrumental variables or fixed-effects methods, or attempt to find natural experiments to exploit plausibly-exogenous variation in socioeconomic resources that result from policies or plant closings, to account for the impact of unobserved factors on the relationship between socioeconomic indicators and mortality (Glied and Lleras-Muney 2008; Krueger et al. 2004; Strully 2009).

Third, some researchers attempt to directly model reciprocal relationships between health and work, occupation, and material resources. Moore and Hayward (1990) focus on changes in occupation and find that the least healthy individuals appear to leave physically demanding occupations like farming that they hold through midlife and move into clerical positions in later life. The mixing of career clerks with those who moved from farming to clerical work in later life

inflates the mortality rate for clerical occupations, and deflates the rate for farmers. Finally, researchers can make stronger causal claims when they identify causal pathways—such as from shift work, to sleep loss, to accident mortality, or from work-related crystalline silica exposure to silicosis mortality. But the biological, behavioral, and psychosocial links between many social factors and specific causes of death are seldom observed in the available data.

The remaining sections of the chapter emphasize the theoretical reasons and empirical support for the influence of work, occupation, and material resources on health and mortality outcomes. Throughout the chapter we will note where the reciprocal relationships between SES and health or mortality outcomes are most apparent, or indicate where there is scant firm evidence to support causal connections in either direction.

INDIVIDUAL AND FAMILY LEVEL: MORE DEVELOPED COUNTRIES (MDCs)

Work and Employment

In industrialized societies, work, or employment, is often defined as effort that is spent in the paid-labor force in exchange for wages or a salary. Of course, Sullivan (2006) points out that this definition of "work" is imprecise. Not all work is done for pay in the near term (e.g., farmers may only accrue earnings if they have a successful crop that sells for a profit at the end of the growing season), yields financial remuneration, and takes place outside the home (e.g., housework or carework). In LDCs, much work can be informal and inconsistent. Because a detailed examination of informal economies and household production are beyond the scope of this chapter (but see Becker 1981; Sullivan 2006), we will focus our attention on participation in the paid labor force. This generally includes people who are employed and those who are unemployed but looking for work, while others are classified as not in the labor force and not

looking for work because they are retired, attending school, homemakers, or disabled. Research has documented higher mortality among those who are unemployed or not in the labor force but who are of working age, compared to working-aged adults who are employed (Rogers, Hummer, and Nam 2000; Sorlie and Rogot 1990), potentially due to the benefits of work itself, or because the least healthy individuals may be most likely to be unemployed or to exit the labor force.

Mortality risk and health also vary considerably among those who are employed, and several bodies of research seek to identify the mechanisms that link work conditions to mortality. The "job strain model" focuses on the survival consequences of workplace demands and the ability of workers to meet those demands: Figure 1 shows the hypothesized relationships (adopted from Karasek 1979; see also Theorell 2000). Jobs that place high demands on workers, but that offer workers little control over their work conditions and limited ability to meet those demands tend to be associated with higher risks of death, especially from cardiovascular disease (Johnson et al. 1996; Kivimäki et al. 2002) and suicide (Tsutsumi et al. 2007). But not all research has confirmed the impact of job strain (the combination of high demands and low control) on coronary heart disease or mortality (de Lange et al. 2003; Eaker et al. 2004), and some find that "passive" jobs marked by low demands and low control may be linked to excess mortality (Amick et al. 2002). Further, some research finds that social support in the workplace is directly associated with improved cardiovascular health or buffers workers from the harm of high job strain (Kawakami et al. 2000), but others find no effect of work-related social support on mortality (Astrand, Hanson, and Isacsson 1989). Ambiguous findings in the job strain literature may result from differences across studies in control variables or the time between measuring job conditions and assessing mortality (Theorell 2000).

(Figure 1 about here)

The "effort-reward imbalance (ERI) model" provides another common perspective for examining the health and mortality consequences of the fit between workers and their jobs. The ERI model characterizes jobs on two dimensions: effort and reward (Siegrist 1996; van Vegchel et al. 2005). The effort dimension indicates the job-related obligations required of the employee. The reward dimension captures money, esteem, job security, and other opportunities that are conferred to the employee through the job. In addition to the characteristics of the job itself, workers who exhibit "overcommitment" will be less likely than others to leave jobs that are marked by an imbalance between efforts and rewards due to their intrinsic need for approval and esteem, in combination with high levels of ambition (Siegrist 1996; van Vegchel et al. 2005). The theory predicts that workers who exhibit overcommitment and who work in jobs that require high effort but that offer few rewards should have increased levels of stress; higher levels of smoking, drinking, and other behaviors that are often undertaken in response to stress; and thus, increased risks of death. Empirical studies have generally found that the effort-reward imbalance is associated with worse self-rated health, higher levels of smoking and alcohol consumption, and a greater incidence of cardiovascular disease incidence and mortality (Bosma et al. 1998; Kivimäki et al. 2002; van Vegchel et al. 2005), although the model typically fits better for men than for women (Niedhammer et al. 2004). Research on the importance of overcommitment, however, is less often studied and the extant results are inconclusive (van Vegchel et al. 2005).

Other research has examined how different types of employment contracts may lead to variations in mortality among employed people. "Standard" employment contracts imply full-time work, typically on a fixed schedule, with the expectation of continued employment, and at the employer's place of business under the employer's direction (Kalleberg 2000). In contrast, nonstandard work encompasses alternate employment relationships that may include on-call

work and day labor, temporary-help agency employment, employment with contract companies or independent contracting, other self-employment, and part-time employment in otherwise "conventional" jobs (Kalleberg, Reskin, and Hudson 2000).

Some researchers have hypothesized that nonstandard employment contracts are linked to increased adult mortality because such jobs often lack access to health insurance coverage, retirement benefits, and unemployment insurance coverage in the United States, they provide less on-the-job training and managerial oversight of occupational safety and health, and they involve employment insecurity (Price and Burgard 2008; Quinlan, Mayhew, and Bohle 2001). For example, self-employed individuals may have worse health than those who are employed by others because self-employment can be fraught with uncertainty due to market fluctuations and the risk of losing personal assets (Jamal 2007; Lewin-Epstein and Yuchtman-Yaar 1991). Because self-employed workers may have to rely on their own savings and cannot count on employer contributions to pension programs, self-employed workers tend to work longer, retire later, and die more quickly after they retire (Hayward and Grady 1990).

There is tremendous variety among nonstandard contracts and in their health consequences across occupations, industries, and societies. Some studies have found no difference in the health of nonstandard workers and their counterparts with standard contracts, possibly because of different labor policies across employment sectors, or differential selection of persons into nonstandard contracts based on their age, gender, preferences for terms of employment, and baseline health (Artazcoz et al. 2005; Virtanen et al. 2006). In contrast, the risk of traumatic and fatal occupational injuries was higher among temporary workers in Spain than among their standard contract counterparts (Benavides et al. 2006), and temporary workers in Finland had higher all-cause mortality and higher mortality from alcohol-related causes and from

smoking-related cancers than their standard contract counterparts (Kivimaki et al. 2003).

Work schedules are also associated with health outcomes that are closely linked to mortality. Working late, long, or rotating shifts is associated with shorter sleep durations and higher rates of automobile and workplace accidents among truck drivers and medical workers (Lockley et al. 2004; Pack et al. 2006), and increased risk of myocardial infarction (Liu and Tanaka 2002). Epidemiological research has also linked late-night work and prolonged exposure to light at night to hormonal changes that result in increased risks of breast cancer (Davis, Mirick, and Stevens 2001; Schernhammer et al. 2001), a leading cause of cancer mortality among women. Overtime hours have been associated with poorer perceived health, more work-related injuries and illnesses, and even increased mortality for U.S. workers (Caruso et al. 2004). In post-industrial economies, however, overtime work is increasingly performed by highly-educated professionals, so future research is needed to understand if and how they are affected by longer work hours in the context of generally healthy working conditions.

Importantly, employment transitions can have implications for health. Involuntary job loss has been linked to downturns in physical and mental health (Burgard, Brand, and House 2007) and can increase stress due to the loss of an important social role and reduced income. The increased stress associated with unemployment can, in turn, lead to higher levels of smoking, excess drinking, and increases in biomarkers (e.g., inflammation, cholesterol) that indicate worse cardiovascular health (Dooley, Fielding, and Levi 1996). Further, job loss can mean the loss of healthcare coverage and decreased access to preventive healthcare services in the United States, where insurance coverage is frequently tied to an employer. Even individuals who lose their jobs but are quickly re-employed have a greater incidence of medical conditions than those who are continuously employed (Strully 2009).

Transitions into and out of, or within the labor force can have important implications for health over the life course. Intuitively, job loss or a lack of employment could impact mortality differently depending on whether an individual has just completed a college degree and not yet started a new career and become self-sufficient, is middle aged and has a family to support, or is near retirement and has been working for years in a physically demanding occupation (Kasl and Jones 2000). Spending more time in the labor force is generally associated with better health (Pavalko and Smith 1999), but men who move through a series of unrelated jobs, or who make progress early in their career but were not promoted later in their careers, have increased risks of death compared to men who work in the same job over time or who are promoted throughout their careers (Pavalko et al. 1993). Participation in the labor force is also associated with better health among women, and having children or spending time doing housework does not appear to greatly diminish those benefits (Pavalko and Smith 1999; Schnittker 2007).

Occupations and Occupational Status

Research on occupations or occupational status and mortality typically focuses either on work-related exposures and harmful environments, or on social status aspects of occupation. A substantial body of research examines the connections between particular occupations or occupational exposures and specific health outcomes. Work that entails exposure to toxic chemicals, the use of unsafe machinery or work environments, or that requires intense physical effort may be associated with increased risks of mortality. For example, exposure to fine particles of crystalline silica when mining, working with stone, or sandblasting can increase the risk of silicosis-related mortality (Bang et al. 2008), and asbestos exposure can increase the risk of lung cancer (Yano et al. 2001). Some occupations are physically demanding and lead to

increased rates of disability and mortality. Longer exposures to more physically demanding occupations are associated with increased risks of mortality, regardless of the most recent occupation held (Moore and Hayward 1990). Nonetheless, not all work-related physical activity is harmful to health. Some physically strenuous work may promote cardiovascular health and reduce the risk of cardiovascular disease mortality (Morris et al. 1966; Paffenbarger and Hale 1975). Declining levels of physical activity in the workplace in recent decades are a major contributor to the total declines in physical activity among U.S. adults (Brownson, Boehmer, and Like 2005), and sedentary lifestyles are associated with greater risks of morbidity and mortality.

A second line of research conceptualizes occupation as an indicator of SES or prestige. Because adults in industrialized societies typically spend long hours in the labor force and derive central aspects of their identities from their work, occupational status is often considered a key indicator of an individual's status in society. Indeed, those who work in higher status occupations as indicated by standard occupational indices or military or government rank live longer than those in lower status positions (Marmot 2004; Rogers et al. 2000; Seltzer and Jablon 1977). Adjusting for income and education reduces but does not eliminate the impact of occupational status on mortality in the United States (Rogers et al. 2000), although that association is less persistent for other health outcomes in more homogeneous samples (Miech and Hauser 2001).

Marmot (2004) focuses on the status dimensions of occupation in the Whitehall study of British civil servants. Because all British civil servants have access to high quality healthcare and other social benefits, and because an occupational status gradient in mortality persists even among the Whitehall respondents, all of whom have fairly high levels of income, Marmot argues that status itself drives the relationship between occupational class and mortality. Specifically, he suggests that individuals compare themselves unfavorably to others in higher status positions,

which leads to higher levels of stress and higher levels of drinking and smoking in response to that stress (see also Wilkinson 2006).

Marmot's (2004) findings are consistent with research on the importance of subjectively reported social status on health and mortality outcomes even after adjusting for objective indicators of SES (Adler et al. 2000). But it remains possible that unmeasured material resources, perhaps from earlier in life, may drive both current occupational status, perceptions of status relative to others, and health and mortality outcomes (MacLeod et al. 2005). Some researchers have focused on mortality within very specific and high status occupations. For example, Major League baseball players can expect to live longer than those in the general U.S. population (Saint Onge, Rogers, and Krueger 2008), although their survival advantage may come from the selection of only the healthiest individuals into baseball careers (Saint Onge, Rogers, and Krueger 2007). Similarly, boosts in prestige—such when actors and actresses win an Academy Award—are associated with increased survival (Redelmeier and Singh 2001), although errors in statistical analysis might account for those results (Sylvestre, Huszti, and Hanley 2006). In sum, the causal effect of occupational prestige on mortality remains ambiguous.

Occupational status also has important implications for the retirement process and subsequent mortality. Men typically retire from the labor force multiple times, and men who work in occupations that are marked by low status, low earnings, and few opportunities for advancement tend to spend more years working after they initially retire, and spend a greater share of their working lives in post-retirement jobs (Hayward, Grady, and McLaughlin 1988). Further, workers in physically demanding jobs with little intellectual complexity are more likely to become disabled and to retire, and to die sooner after retiring than workers in higher status occupations (Hayward et al. 1989). Prior research typically finds that retirement may not lead to

worse health in general, but poor health may often precipitate retirement (Kasl and Jones 2000).

While evidence suggests a link between occupation and survival, it can be difficult to measure and operationalize occupational status for several reasons. Occupation can change over the life course, making it difficult to compare studies using occupation in early life at the beginning of the career to studies that use occupation in later life that is closer to retirement. Additionally, occupational status may be more variable among younger workers who have not yet established themselves in a single career, and among older workers who may have retired from their primary occupation but who continue to work in new fields (Moore and Hayward 1990). Characterizing an individual's occupation can be especially difficult for women, who tend to move in and out of the labor force more frequently than men to care for children or elderly parents (Kitagawa and Hauser 1973; Martikainen 1995; Pavalko and Smith 1999), although this sex difference is becoming less pronounced in recent cohorts (Schnittker 2007).

There is no single standard method for measuring occupational status, nor is there a consensus about whether the various indices have similar relationships with mortality. Various occupational status indices have been devised, each with a different focus: the Duncan (1961) Socioeconomic Index of all Occupations links information about average education and income of incumbents to an indicator of prestige; the Nam-Powers-Boyd (2004) Occupational Status Scale emphasizes occupation-specific differences in earnings and education; and Siegel's (1971) Occupational Prestige Scores are derived solely from prestige-based survey items (see Miller and Salkind 2002; Nam 2000). Jencks and colleagues (1988) raise numerous criticisms of standard occupational status indices that fail to account for the substantial heterogeneity within occupations, and instead devise an index of job desirability that incorporates both pecuniary (e.g., earnings) and non-pecuniary (e.g., work hours, job stability, whether individuals get dirty

at work, frequency of supervision, and repetitive tasks) aspects of jobs. Gender differences may be greater for measures of occupational status than of occupational prestige (Mutchler and Poston 1983). Indeed, Hauser and Warren (1997) note the difficulty of creating occupational status indices that are adequate for both men and women, and that capture something more than education within and across generations.

In terms of mortality, we are aware of no studies that compare these indices in terms of their impact on overall or cause-specific mortality, nor that theorize why some scales should be more important than others for predicting mortality. Some research has documented links between mortality and single measures of occupational status; Rogers and colleagues (2000) find that Nam-Powers-Boyd occupational status scores are inversely associated with the risk of death. Our simple models in Table 2 show that the indices have similar associations with mortality, but future research that examines these relationships more systematically would offer greater insight into the most salient dimensions of occupational status for survival.

Finally, there are limitations associated with both self-reported and objective data on occupation-specific or workplace stress, insecurity, exposure to noise, injuries, fatalities, and exposures to noxious substances (Jencks et al. 1988; Theorell 2000). Objective reports from employers of the number of workplace injuries or temporary workers, or expert raters' observations of working conditions in specific occupations are costly to collect and quickly become outdated because working conditions can change quickly over time. Self-reports are more sensitive to workers' actual experiences because conditions vary considerably even within the same occupation, and because workers also have different levels of coping resources, social support, and sense of control. But self-reports are vulnerable to bias if some workers are pessimistic and report negatively about both their job characteristics and their well-being,

creating a spurious association between the two. Objective data avoid this problem of spurious association, but provide only a rough estimate of conditions that may be important for mortality and that are experienced by the many different workers in a given occupation.

Income and Related Material Resources

Work provides earnings that are a major component of household income and that contribute to other material resources, including retirement accounts, savings, and home ownership. We distinguish between material resources that are fluid and that are available to spend immediately (e.g., earnings), and accumulated material resources that may be more difficult to liquidate but that may nevertheless promote longevity (e.g., housing, retirement accounts, financial assets).

Fluid resources like earnings can be used immediately to promote health and reduce the risk of death by paying for medications and medical care, aiding smoking cessation efforts, or purchasing more nutritious foods and gym memberships. Higher levels of income are generally associated with lower risks of death, although that relationship is weaker at higher levels of income than at lower levels (Rogers et al. 2000). Income from a variety of sources (self-employment, jobs, interest, dividends) each promote longer lives, but income from jobs and self-employment are especially important for reducing mortality among working-aged adults (Krueger et al. 2003; McDonough et al. 1999). Although income from self-employment may be more volatile than income from jobs, the amount of income from each source has the same inverse relationship with the risk of death (Krueger et al. 2003). But not all income is associated with lower risks of death. McDonough and colleagues (1999) find that women have lower risks of death when their husbands have high earnings, although men have increased risks of death when their wives have high earnings, potentially because sickly men rely on the higher earnings

of their wives, or because high earning wives may violate traditional gender roles.

Some research suggests that access to Medicare and Social Security may weaken the link between income and mortality at the older ages by providing access to medical care and diminishing income inequality among older adults (House et al. 1990). But others find that the equalizing forces of the Social Security program on income at the oldest ages are modest compared to the immense disparities in the accrual of private pensions and asset income over the life course (Crystal and Shea 1990). Although the relationship between income and mortality weakens with age, adults who are 75 years or older who receive income from multiple sources have lower risks of death than those with fewer income sources, even after adjusting for the total amount of income received, because their income may be more stable if any single source should falter (Krueger et al. 2003). Moreover, recent research suggests that the selective mortality of adults with low levels of education and earnings before they reach the oldest ages may partially account for the smaller socioeconomic gradient in mortality at the oldest ages (Dupre 2007).

Wealth, or accumulated material resources, has important implications for mortality. Home ownership is a primary source of wealth for many U.S. families (Oliver and Shapiro 1997), with a smaller share of households holding stocks, bonds, mutual funds, and personal retirement accounts. Wealth is particularly important when viewed in a life course framework because it tends to accumulate with age, and as such, is a stronger predictor of mortality outcomes among older adults than is income, which often declines as older adults exit the labor force (Bond Huie et al. 2003).

Historical research from the eighteenth and nineteenth centuries in England suggests, however, that wealth was not associated with mortality in that era, possibly because excess food consumption, tobacco use, and sedentary lifestyles were more common among the aristocracy,

merchants, and professionals, than among the laborers (Razzell and Spence 2006). By 1865 in Providence Rhode Island, however, a clear mortality gradient was apparent; individuals who paid taxes (because they had higher incomes) had lower mortality rates than those who did not pay taxes (Chapin 1924). Thus, the income and wealth gradient in mortality may have appeared only at the end of the nineteenth century. Other research focuses on why the inverse relationship between material resources and mortality may continue to increase in contemporary societies (Glied and Lleras-Muney 2008; Phelan et al. 2004).

In contrast to holding wealth, being in poverty suggests severe material deprivation. Although a small but not insubstantial share of the U.S. population may be in poverty at any given time, up to 30% of household heads in the Panel Study of Income Dynamics experienced some form of poverty between 1967 and 1982, and about 11% were in poverty throughout that period (McDonough, Sacker, and Wiggins 2005). Compared to men, women are more likely to live in poverty because they are more likely to be the unmarried heads of households with dependent children, to have lower levels of education (at least among older cohorts of women), and to earn lower incomes. Being in poverty is associated with increased risks of death among both men and women (Zick and Smith 1991). Although the risk of death increases with the number of spells of poverty, the first time that individuals move into poverty is especially harmful, perhaps because individuals may be able to adapt to repeated spells or longer durations of poverty (Oh 2001). There is some evidence that redistributive policies that target individuals in economic need can promote survival. Compared to those who are estimated to be eligible but who did not participate in the Food Stamp program, those who participate in the program have significantly lower risks of death after adjusting for unobserved factors, possibly because the program ensures adequate nutrition and allows the family to allocate monetary resources to other

areas that promote health (Krueger et al. 2004).

INDIVIDUAL AND FAMILY LEVEL: LESS DEVELOPED COUNTRIES (LDCs)

Work and Employment

More than 80% of workers live in the developing world, and while they face some of the same mortality risks related to employment, occupation, and income as individuals in MDCs, their work circumstances are also unique (Rosenstock, Cullen, and Fingerhut 2005). Although there is considerable variation across societies and regions, LDCs often have a substantial share of their workforce—70% or more in some cases—engaged in the agricultural sector (World Bank 2003). Further, many adults in LDCs are engaged in informal work that occurs in households or on the streets and that is completely unregulated for occupational health and safety risks. The close integration of subsistence agriculture and informal home-based production into the household context blurs the separation between work and home that is more apparent in MDCs, and can make it difficult to identify injuries and deaths that are specifically work-related (Driscoll et al. 2005; Rosenstock et al. 2005). Further, work-related exposures, whether due to pesticides used for farming or to lead used to make batteries in home workshops, can directly impact the health and mortality of both the worker and other family members (Rosenstock et al. 2005).

Vulnerable social groups are often more likely to work in the informal economy (Giuffrida, Iunes, and Savedoff 2002) and with nonstandard contracts (Kalleberg et al. 2000), but the situation is perhaps even more evident in LDCs than in MDCs. Child labor is rare but still exists in MDCs; 96% of child laborers live in LDCs, with up to one in three children under the age of 15 working in some regions of the world (Facchini et al. 2003). Children routinely do dangerous work that exposes them to serious injury and hazardous chemicals. For example,

children work in charcoal production in Brazil and manufacture fireworks in Guatemala and Columbia (Giuffrida et al. 2002; Salazar 1998). Adverse conditions may be particularly damaging to the health of children who are still undergoing physical development, and can add to the cumulative burden of workplace dangers they face over the life course. Women are more likely than men to work in the low paying informal economy, where they are often overlooked by labor unions or public health services (Buvinic et al. 2002; Toyota 2006), and they experience dangerous occupational exposures during pregnancy and ergonomic challenges when using production equipment that was designed for male workers (Loewenson 2001). Internal and international migrants who work in LDCs and even MDCs are often relegated to low paying and risky work in the informal economy (Toyota 2006).

Formal investment in occupational health and safety (OHS) is lower and enforcement of regulations to protect workers or compensate them for workplace accidents or illness covers a smaller share of the population in LDCs than in wealthier nations. OHS regulations are typically not very stringent or only apply to certain types of employers in many countries that are still undergoing industrialization (Giuffrida et al. 2002; Yu et al. 1999), and the large informal sector is largely unregulated. For example, a study of auto body shops in Sonora, Mexico, found outdated equipment and technology for mitigating exposure to hazardous chemicals, and little awareness of environmental and occupational health and safety (Velazquez et al. 2008). Small businesses that employ only a handful of workers are plentiful in developing countries, and they are less able to invest in the OHS infrastructure than larger businesses that can spread the costs over larger numbers of workers (Giuffrida et al. 2002). Many business owners have limited capital to invest in improving conditions for workers or for the residents in surrounding communities that may also be affected by toxic emissions.

Governments in poorer countries have limited data collection systems in place to evaluate work-related injuries or mortality, few resources to enforce any existing health and safety regulations, and few scientists or bureaucrats to influence decision-makers (Nuwayhid 2004). Further, many individuals who retire from paid work in LDCs cannot expect the same pension benefits or income and health support programs that many MDCs provide, because LDCs often lack the financial resources, motivation, or infrastructure to offer these benefits (Willmore 2006), and because large fractions of the population work in the informal economy and do not pay into social security or pension programs (van Ginneken 1999).

Occupations

Workers in lower-income societies are exposed to both the "classic" dangerous occupational exposures, resulting in outcomes including accidental injuries and fatalities, and exposure to silicosis and lead poisoning, but increasingly they also face risks that are prevalent in higher income countries, such as high job strain (Rosenstock et al. 2005). The globalization of production means that may dangerous occupations and working conditions are moving from MDCs to LDCs, where workers will accept lower wages and where OHS regulations are weaker (Loewenson 2001). In LDCs, for example, workers in export processing zones may have workplaces characterized by high levels of machine-related accidents, dust, noise, and exposure to toxic chemicals (Denman, Cedillo, and Harlow 2003). These workplaces also enforce unrealistic production quotas, productivity incentives, and unregulated overtime, resulting in jobs that place high demands on workers who have little ability to control their circumstances (International Labour Organization 1988).

Certain occupations in LDCs have been the target of extensive study. In African nations

with high rates of HIV/AIDS, truck drivers show very high rates of infection with the disease because they are highly mobile and spend a great deal of time away from their families and communities. These working conditions and the wide availability of commercial sex workers along major transport routes mean that they are much more likely than those in other occupations to engage in high risk sexual encounters and to contract sexually transmitted infections, including HIV/AIDS (Ramjee and Gouws 2002). Similarly, men who migrate long distances to work in mining centers in Southern Africa have high rates of contracting HIV/AIDS due to long spells spent away from family, residence in single-sex hostels, and the ready availability of commercial sex workers (Lurie et al. 2003). Those male workers, their spouses, and the sex workers the men visit have increased risk of HIV/AIDS infection and mortality in these contexts.

The high level of exposure to pesticides and the resulting morbidity and mortality among agricultural workers in LDCs has also been studied extensively. Some estimates suggest that 99% of all deaths from acute pesticide poisoning occur in LDCs, even though those countries use only 20% of the world's pesticides (Christiani and Wang 2003). The meaning of pesticide-related deaths may be unclear because they can result from work-related exposure, accidental exposure in the home if improperly stored, or intentional ingestion in suicide attempts (Litchfield 2005). Agricultural workers also have high rates of injuries that are related to their work.

Income, Remittances, and Material Resources

On one hand, individuals in LDCs may be well poised to convert relatively low levels of material resources into survival gains, because many causes of death in LDCs result from the deprivation of basic resources. Incremental increases in income can facilitate the purchase of additional calories and nutrients that will greatly improve even adult health and survival. On the other hand,

the scant availability of basic medical, occupational safety and health, and social welfare infrastructure means that individuals in LDCs may be less able to convert their income into survival than adults in MDCs. Weaker social safety-nets, a poorer public health infrastructure, few medical facilities, and underfinanced or inexistent pension or healthcare programs may leave families responsible for the care of sick and elderly adults. Because formal safety-nets are lacking, parents may invest their earnings and wealth in the education and employment prospects of their children as a method for ensuring their own health and material wellbeing in later life.

Although adult children in LDCs sometimes migrate for school or marriage, they most often migrate within the country or internationally to find better paying jobs (Knodel and Saengtienchai 2007). Consistent with the idea that migration decisions are made with the interests of all family members in mind (Massey 1990), adults whose children migrate intra- or internationally for work typically have improved survival compared to adults whose children did not migrate, even after adjusting for baseline health and the propensity to have migrant children (Kuhn 2006; Kuhn, Everett, and Silvey 2010). This effect is strongest when focusing on migrant sons in countries where sons and their wives are expected to provide the primary source of support for parents. Part of the salubrious effect of having migrant children is mediated by the higher education and greater earning potential of migrant children, which suggests that children's remittances may be important for parents' health (Kuhn 2006; Zimmer et al. 2007).

Nevertheless, it is often difficult to measure income in communities where many households are engaged in subsistence agriculture or home-based production, where remittances and earnings may be irregular, or where the ownership of durable goods rather than cash reserves may be more important indicators of economic wellbeing. Indeed, it is difficult to identify the impact of children's remittances on parents' mortality in many surveys, given that children who

migrate for work may only sporadically send money to their parents, but they may buy them gifts, like cellular phones, property, and automobiles, and only make large cash transfers when parents have acute healthcare needs (Knodel and Saengtienchai 2007; Kuhn 2006). Other researchers have collected information on expenditures on basic necessities, such as food and housing, and have created asset indices of ownership of durable goods. For example, Filmer and Pritchett (2001) developed an asset index based on ownership of consumer durables (e.g., radio, bicycle) and housing characteristics (e.g., presence of piped water in the home). However, ownership of assets may confer different survival benefits than the availability of income, depending on the families' abilities to convert those assets into health.

Measurement Issues in Less Developed Countries

Data quality is especially problematic in LDCs. Due to gaps in vital statistics records and errors in recording information about the cause of death, it can be difficult to ascertain who died and why. In any country, there are two kinds of occupational mortality: acute accidents or outcomes that are linked to immediate work conditions, and mortality from diseases that have a long latency period and that are more difficult to establish as specifically caused by work or a particular occupation (Driscoll et al. 2005). In both MDCs and LDCs, it is difficult to assess the impact of work on diseases or causes of death that have long latency periods, and this is even more difficult in LDCs that lack adequate record keeping systems on employment, occupational exposures, and overall and cause-specific mortality. Moreover, workplace injuries and accident-related mortality may be undercounted in LDCs where there are few regulatory agencies that ensure the accurate reporting of work-related deaths (Concha-Barrientos et al. 2005).

An illustrative example is the underreporting of fatal and nonfatal accidents involving

pesticides in LDCs. Estimates suggest that only 10% to 20% of pesticide-related exposures are reported appropriately, and that only 5% of fatal cases are appropriately reported (London and Bailie 2001). Underreporting of occupational fatalities in agricultural work and in rural areas more generally may be particularly severe. A study of the Western Cape region of South Africa found that occupational fatalities in rural areas were underreported by 85% (Schierhout, Midgley, and Myers 1997). Large farm owners in South Africa exercise a great deal of control over their workers who are isolated from transportation and information because they live and work on the farms. Under these conditions, and because it is up to the farm owner to be informed about regulations and to report fatalities, many agriculture-related deaths are missed. Further, worker deaths and injuries in construction and manufacturing industries in rapidly industrializing areas of China may be substantial but are routinely underreported, especially for those working in the growing private sector rather than in state owned enterprises (Yu et al. 1999).

AGGREGATE AND COMPARATIVE RESEARCH

Global Labor Relationships and Mortality

The job characteristics that shape the mortality experiences of a population change as economies transition from predominantly agricultural to industrial and post-industrial modes of production. The relative importance of physical and environmental hazards at work declines as fewer individuals hold agricultural and manufacturing jobs, while the importance of psychosocial stressors rises as the dominance of the service sector grows. Wealthier countries that transition toward service-based economies often “export” physically and environmentally hazardous jobs to nations with fewer regulations and more workers willing to perform these jobs for relatively low pay. The global competition for manufacturing means that employers may cut wages and

LDCs may enact weak OHS standards in an effort to attract jobs, which may result in stressful and unsafe working conditions (Denman et al. 2003). Increasing globalization also means that psychosocial stressors, notably perceived job insecurity, may rise for workers in wealthier countries. This is true even for higher status workers, whose job security falls as technological innovation and the push for enhanced flexibility and competitiveness lead to organizational restructuring and layoffs (Cappelli et al. 1997). Even in the United States, where unemployment is often much lower than in other MDCs, both low and high status workers lose their jobs relatively often, even if many subsequently become re-employed quickly (Strully 2009).

The consequences of social inequalities in the distribution of "good" jobs and material resources are also heavily influenced by societal contexts. Many Western European nations provide relatively generous social safety nets and have high levels of unionization, providing protection for workers from across the social spectrum. The United States provides fewer institutionalized supports for workers, especially those in "bad" jobs. Low and middle income countries generally have even less support available for workers in risky occupations, or for those working informally or in subsistence agriculture. Indeed, a weaker public health infrastructure and limited access to adequate nutrition can exacerbate the harms of the more dangerous jobs that are more common in many LDCs.

Macroeconomic Growth and Unemployment

A society's level of economic development—or the growth of their economy—has also been linked to longer lives, although the importance of economic growth may have been more important in pre-industrial and industrializing societies than in contemporary MDCs (Preston 1976; Sen 2001). Adequate material resources in a population can be used to improve sanitation

and the public health infrastructure, eradicate or ameliorate the harmful effects of parasites and infectious diseases, and improve the human capital of the population through education (Cutler and Lleras-Muney 2008; Cutler and Miller 2005). Indeed, Omran's (1971) description of the epidemiologic transition from high to low mortality regimes in Western societies specifically invoked the importance of economic development, given that the advent of modern antibiotics and immunizations, and large scale improvements in water treatment, occurred after the most dramatic declines in mortality already took place.

In MCDs more recently, however, the connection between economic growth and mortality is less clear. A series of papers by Brenner suggested that macroeconomic recessions lead to increased mortality, especially for vulnerable populations (Brenner 1971, 1979). Long term economic growth may promote survival by reducing poverty, allowing greater investments in medical or workplace technologies that directly aim to improve health, and fostering stronger social support programs such as Social Security and Medicare (Brenner 2005). Thus, Brenner (2005) suggests that long term economic growth and low levels of unemployment should promote longevity, although he notes that in the short term, economic growth may result in companies investing in new technologies which may foster workplace competition, require employees to learn new skills, and increase stress-related mortality.

In contrast, although there is clear evidence that unemployment is harmful for individuals who have lost their jobs, some research at the aggregate level suggests that unemployment rates are inversely associated with mortality at least for some causes of death and in countries with social welfare programs that buffer individuals from the immediate harms of unemployment. Adult mortality from traffic accidents, coronary heart disease, and cirrhosis appears counter-cyclical and increases when the economy improves (Granados 2008; Ruhm 2007).

Various mechanisms might account for the inverse relationship between unemployment rates and some causes of death. For example, people may have more time for sleep and exercise if they are unemployed or have reduced hours, and they may reduce unhealthy behaviors such as consuming alcohol and other substances because they have less income. Even individuals who are employed may be less willing to undertake unhealthy behaviors that may lead to job loss in an uncertain economic climate (Catalano et al. 1993). But Ruhm (2007) discounts the importance of health behaviors, especially given that mortality declines as much among those who are aged 65 or older (and who already have time for exercise and sleep), as among working aged adults. He posits that a sluggish economy may impact the mortality of adults of all ages by reducing air pollution and traffic congestion, or fostering social support as younger family members spend less time working. Further, and somewhat inexplicably, some evidence suggests that fewer individuals receive medical treatments including coronary artery bypass grafting or coronary angiography when the economy is strong (Ruhm 2007). In contrast, deaths from other causes, including suicide, diabetes, and hypertension are pro-cyclical and increase as the economy declines (Granados 2008; Kammerling and O'Connor 1993).

Another factor that may weaken the link between economic growth and mortality includes the widespread availability and affordability of cigarettes and calorie dense but nutritionally poor foods. So-called “diseases of affluence,” including obesity, diabetes, high cholesterol, hypertension, and heart disease may increase with economic growth, especially in low and middle income countries (Brandt 2007; Ezzati et al. 2005). The economic development that accompanied major declines in fertility and mortality, also leads to increases in nutrition. But MDCs, and more recently, LDCs have become increasingly reliant on processed foods that have relatively high levels of fat and sugar, and that facilitate the rise of obesity (Cutler, Glaeser,

and Shapiro 2003; Popkin 1993). Similarly, the global diffusion of cigarette smoking—spurred by growing affluence around the world—has contributed to increasing levels of heart disease and lung cancer (Brandt 2007; Pampel 2007). These increases in obesity and smoking are particularly harmful in LDCs where there are few resources to treat chronic diseases and where individuals may simultaneously remain at an elevated risk of infectious diseases.

Income Inequality

Some researchers have examined the relationships between economic inequality within populations and individual or aggregate mortality experiences (Lynch et al. 2004; Ross et al. 2000; Wilkinson 1997; Wilkinson and Pickett 2006). At least some research finds that among countries at comparable levels of development, more inequitable nations have higher mortality, regardless of the measure of inequality used in the analyses (Kawachi and Kennedy 1997). Thus, the question arises about why the inequality of a population would matter for longevity, even after adjusting for individual socioeconomic factors or the level of economic development, and even in populations where even the poorest should have access to basic material and social resources, such as healthcare or a reasonable government safety net.

Three mechanisms have been posited that link economic inequality to population health and mortality outcomes. First, economic inequality might undermine the development or maintenance of social capital, as indicated by trust among citizens, norms of reciprocity, and strong civic organizations (Kawachi et al. 1997). Not only might those factors directly influence health (Kawachi and Berkman 2000), but they may make it harder to achieve effective political solutions to problems associated with population health and wellbeing. Second and concomitantly, economic inequality may undermine support for the development of human

capital through high quality public education, a strong social safety-net, affordable access to healthcare, and an equitable distribution of public resources (Lynch et al. 2000). The immensely different resources of high and low status individuals in very inequitable societies can make it hard for policy makers to achieve a consensus about the benefits of social programs that are supported by taxes on the most wealthy but primarily benefit the least wealthy (Kawachi and Kennedy 1999). Third, inequality may lead to increased mortality due to the psychosocial stress experienced by low status individuals. In highly unequal societies, low status individuals may make social comparisons—whether in terms of ownership of high status items, access to the most elite institutions, or opportunities for success—in which they always appear to be failing. In turn, adverse social comparisons can lead to a sense of relative deprivation, increased levels of psychosocial stress, worse health behaviors such as drinking and smoking as individuals seek to cope with that stress, and, ultimately, increased mortality (Wilkinson 2006).

Evidence for the relationship between economic inequality and mortality, however, is somewhat mixed. Although some studies find that income inequality and mortality or other adverse health indicators are positively associated, others have found null or even inverse relationships (Deaton and Paxson 2001; Mansyur et al. 2008; Subramanian and Kawachi 2004; Wilkinson and Pickett 2006). Wilkinson and Pickett (2006) suggest that many of the null or inverse relationships emerged in data from the 1980s and 1990s when there were rapid increases in both inequality and longevity in many countries, a finding that is consistent with results from Deaton and Paxson (2001). However, in subsequent research, Deaton and Paxson (2004) show that changes in mortality poorly track changes in income inequality, which undermines a clear connection between income inequality and mortality in their data. Rather, they suggest that declines in mortality appear to be driven by technological advances—a finding supported by

others (Glied and Lleras-Muney 2008). Interestingly, some research documents that the inverse association between personal income and mortality is stronger as the level of income inequality in a population increases (Mansyur et al. 2008), possibly because high incomes in unequal societies lead to favorable social comparisons (Deaton and Paxson 2001).

CONCLUSION AND FUTURE DIRECTIONS

Work, occupation, and material resources are clearly important for survival in both MDCs and LDCs, although their relationships with mortality are not always straightforward. Some jobs and occupations promote long and healthy lives, whereas others expose workers to dangerous and stressful conditions. Further, there are important differences across countries—such as the availability of public safety nets and OHS regulations—that shape the relationship between work and mortality. Based on the wealth of important research findings that we describe above, we have identified several areas that future work might explore.

First, much research in MDCs focuses solely on the work, occupation, and income of an individual, without providing sophisticated insight into how decisions about work and the allocation of income are shaped by family members in ways that might impact health and mortality. Marriage and family relationships have persistent relationships with mortality, but the complex relationships among family, work or income, and mortality are under-theorized and under-studied. A few notable exceptions focus on gender differences in the impact of spousal earnings or time in the labor force on personal health or mortality (McDonough et al. 1999; Stolzenberg 2001), but many questions remain. Research from LDCs has more directly focused on the nexus of work, family, and health. Perhaps because of the lack of social and healthcare safety nets, families in LDCs might play a more central role in determining who should attend

school or migrate for work, to maximize the wellbeing of all family members (Kuhn 2006).

Second, comparative research could more directly examine the global flows of both work and workers, and their implications for mortality. The movement of relatively low skill migrants from LDCs into MDCs for low paying jobs that cannot be outsourced (e.g., agriculture, construction), and the flow of highly skilled immigrants (e.g., doctors) from LDCs into MDCs for improved opportunities might have important implications for the spread of infectious diseases (Tatem, Rogers, and Hay 2006), the stress associated with job uncertainty as outsourcing increases (Strully 2009), and the dearth of physicians who can provide adequate healthcare in LDCs (Ahmad 2005). The global flow of both workers and jobs might be particularly acute for workers at certain stages of their life course or by gender. Indeed, men are more likely than women to migrate internationally for work, where they may have fewer workplace protections than native born workers. Further, older workers in MDCs may be in jobs that are more likely to be outsourced (e.g., manufacturing) and may be less able to find new jobs and to benefit from additional education. Research that considers the increasingly global economy may reveal important patterns in the impact of moving jobs and workers on mortality in both the sending and receiving countries.

Third, our chapter draws together research from demography, sociology, social epidemiology, and occupational epidemiology. The distinct orientations of each body of research are clear. Occupational epidemiology emphasizes the relationship between workplace exposures to noxious agents and social stressors to clinical health and mortality outcomes, such as mortality from silicosis and myocardial infarction. In contrast, the sociological and demographic research more often focuses on life course and gender issues in the progression through jobs or occupations, emphasizes the importance of status rather than occupational exposures, and

examines overall mortality. Future research in each field might benefit by recognizing the strengths of research in other areas to more clearly understand the mechanisms that link work, occupations, and material resources to overall and cause-specific mortality.

Finally, future research should continue to collect more extensive and accurate data. Data limitations are especially pressing in LDCs where the quality of vital statistics data may be questionable and where data about workplace exposures and stressors may be particularly difficult to collect given that many individuals work in informal or unregulated jobs. In both MDCs and LDCs, extensive data collection efforts are required to establish the workplace fatalities that occur after long latency periods. Further, there are limited data that link work and occupation to mortality through specific psychosocial, behavioral, and biological pathways, especially in low income countries.

Our chapter also highlights the many ways that policy might impact the relationship between work, occupation, income, and mortality. For example, policies and interventions could target workplaces and their owners by designing laws and encouraging the implementation of technologies that limit exposure to noxious agents, reduce the need for repetitive motions and heavy lifting, and provide training to workers and managers to facilitate stress-free environments. Alternately, social policies could target the population more holistically, without focusing narrowly on the circumstances of employment. Re-distributive policies, such government mandated healthcare, social security, and income redistribution may directly impact the mortality of all individuals, regardless of whether they are employed for pay, thereby having a greater impact on population health (Link and Phelan 2005). Nevertheless, work, occupation, and material resources are central features in the broader stratification of society, and it seems likely that they will continue to be linked to life chances, including survival.

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Figure 1: Job Strain Model and the Hypothesized Impact on Mortality

Job Control \ Job Demands	Low	High
Low	Passive Job (midrange mortality)	High Strain Job (highest mortality)
High	Low Strain Job (lowest mortality)	Active Job (midrange mortality)

Source: Adopted from Karasek 1979, p. 288

Table 1: Gompertz Proportional Hazard Ratios for the Relationship between Employment Status and Overall Mortality, US Adults Aged 18 and Older, 1990-2002.[a,b]

	All adults	Males	Females	Aged 18-44	Aged 45-64	Aged 65+
Employed	ref.	ref.	ref.	ref.	ref.	ref.
Unemployed	1.35***	1.51***	1.05	1.40	1.30*	1.11
Not in the labor force	1.60***	1.66***	1.50***	1.82***	1.85***	1.33***
Employed full time	ref.	ref.	ref.	ref.	ref.	ref.
Employed part time	1.30***	1.35***	1.23*	1.26***	1.41***	1.09
Unemployed	1.52***	1.71***	1.18	1.52**	1.61***	0.90
Not in the labor force	1.72***	1.78***	1.62***	1.92***	1.96***	1.38***
Employed at a job	ref.	ref.	ref.	ref.	ref.	ref.
Self-employed	0.96	0.99	0.88*	0.97	0.86	1.01
Unemployed	1.42***	1.61***	1.08	1.46*	1.47***	0.86
Not in the labor force	1.56***	1.63***	1.46***	1.83***	1.78***	1.32***

Note: * p<.05; ** p<.01; *** p<.001 (two-tailed tests)

[a]Data come from the 1990 Family Resources Supplement to the National Health Interview Survey, and the Linked Mortality Files.

[b]Each set of employment status variables comes from a separate model. All models also adjust for age, sex, race/ethnicity, foreign born status, marital status, and education.

Table 2: Gompertz Proportional Hazard Ratios for the Relationship Between Standardized Occupation Scores and Overall Mortality, US Adults Aged 18 and Older, 1990-2002.[a,b]

	All adults	Males	Females	Aged 18-44	Aged 45-64	Aged 65+
Hauser-Warren socioeconmic index	0.90***	0.87***	0.96*	0.85***	0.95***	0.98
Not in the labor force	1.62***	1.65***	1.56***	1.86***	1.86***	1.36***
Siegel prestige score	0.89***	0.88***	0.92**	0.85***	0.92***	0.99
Not in the labor force	1.63***	1.66***	1.57***	1.85***	1.88***	1.36***
Nakao and Treas prestige score	0.89***	0.87***	0.93*	0.85***	0.93***	0.98
Not in the labor force	1.63***	1.67***	1.57***	1.85***	1.88***	1.36***
Nam-Powers-Boyd occupational status score	0.89***	0.85***	0.95*	0.83***	0.93***	1.00
Not in the labor force	1.63***	1.65***	1.58***	1.88***	1.88***	1.36***
Occupation earnings score	0.90***	0.87***	0.96	0.86***	0.91***	1.03
Not in the labor force	1.62***	1.62***	1.58***	1.84***	1.87***	1.35***
Occupation education score	0.90***	0.88***	0.95***	0.83***	0.98***	0.97
Not in the labor force	1.63***	1.67***	1.56***	1.87***	1.87***	1.36***

Note: * p<.05; ** p<.01; *** p<.001 (two-tailed tests)

[a]Data come from the 1990 Family Resources Supplement to the National Health Interview Survey, and the Linked Mortality Files.

[b]Each occupational status variable comes from a separate model. All models also adjust for age, sex, race/ethnicity, foreign born status, marital status, and education.

Table 3: Proportionate Mortality Ratios (PMR) for White Males (M) and Females (F) Aged 15 and Older for Selected Usual Occupations, 1984-1998.[a,b]

	Cancers of the Trachea, Bronchus and Lung		Heart Disease		Chronic Obstructive Pulmonary Disease (COPD)		Pneumoco-nioses & Lung Diseases due to External Agent		External Causes of Injury and Poisoning	
	M	F	M	F	M	F	M	F	M	F
Executive, Administrative & Managerial	97*	131*	99*	89*	82*	110*	71*	94	89*	104*
Business Managers	100	130*	99*	90*	81*	109*	70*	91	92*	106*
Professional Specialty	76*	91*	97*	92*	68*	90*	70*	97	93*	114*
Teachers	63*	76*	98*	92*	57*	74*	69*	101	93*	111*
Technical, Sales and Admin. Support	95*	113*	101*	93*	87*	106*	72*	97	91*	103*
Admin. Support, Incl. Clerical	95*	111*	102*	91*	90*	108*	76*	101	82*	99*
Service Occupations	101	113*	102*	101*	103*	108*	81*	94*	92*	108*
Janitors & Cleaners	105*	109*	102*	110*	107*	86*	93	--	99	111*
Farming, Forestry & Fishing	82*	92*	103*	99	102*	96	68*	--	127*	141*
Farm Workers	79*	111	96*	98	135*	--	72*	--	131*	161*
Precision Production, Craft & Repair	113*	116*	98*	99*	110*	104	161*	101	108*	110*
Extractive Occupations	112*	--	97*	102	134*	--	973*	--	110*	173*
Operators, Fabricators & Laborers	108*	104*	101*	103*	114*	98*	96*	102	105*	105*
Truck Drivers	118*	118	101*	95	125*	122	75*	--	106*	157*
Homemakers	73*	92*	103	103*	86*	98*	--	98*	72*	94*

Notes: * $p<.05$ (two-tailed tests)

[a]Data come from the National Occupational Mortality Surveillance System.

[b]The PMR indicates whether the age-standardized proportion of deaths from a specific cause of death for a particular occupation or industry

appears to be higher (above 100) or lower (below 100) than the expected proportion for a particular occupation or industry. PMRs not calculated for cells with small numbers of deaths.

Table 4: Gompertz Proportional Hazard Ratios for the Relationship between Individual and Family Income and Income Portfolios, and Overall Mortality, US Adults Aged 18 and Older, 1990-2002.[a,b]

	All adults	Males	Females	Aged 18-44	Aged 45-64	Aged 65+
Individual income, divided by $10,000, logged	0.97***	0.96***	0.98***	0.97***	0.96***	0.99*
Any negative individual income	0.62***	0.65*	0.50	0.63*	0.48	1.08
Family income, divided by $10,000, logged	0.97***	0.96***	0.97***	0.96***	0.97**	0.99
Any negative family income	0.94	0.78***	1.21	0.65	0.96	1.26***
Family income equivalence, divided by $10,000, logged	0.97***	0.96***	0.97***	0.96***	0.96**	0.98
Any negative family income	0.94	0.77***	1.20	0.65	0.96	1.26***
Individual income portfolio	0.87***	0.86***	0.89***	0.70***	0.74***	0.94***
Family income portfolio	0.90***	0.89***	0.90***	0.74***	0.76***	0.95***

Notes: * p<.05; ** p<.01; *** p<.001 (two-tailed tests)

[a]Data come from the 1990 Family Resources Supplement to the National Health Interview Survey, and the Linked Mortality Files.

[b]Each income or income portfolio variable comes from a separate model. All models also adjust for age, sex, race/ethnicity, foreign born status, marital status, and education.