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Essays on Gender and Health

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Abstract
The relationship between gender and health is complex. Although women live longer than men in almost every country throughout the world, women also tend to be sicker than men. While biological sex differences likely contribute to sex gaps in health, cross-national, historical, and life course variation suggest that social factors also play a role. This dissertation is composed of three chapters which examine social explanations for gender gaps in mortality and morbidity. The first chapter looks at the relationship between gender equality in the public sphere, and sex gaps in life expectancy throughout the world. I find that influence of gender equality on the sex gap in life expectancy depends on the level of economic development. The second chapter takes an historical perspective to examine the trend in the sex gap in depression in the United States between 1971 and 2008. In examining this trend, I find that the sex gap in depression has decreased over the past forty years, due to a decrease in depression among women that is primarily attributable to an increase in women's labor force participation and attachment. In the third chapter, I examine the relationship between gender, aging, and depression using longitudinal data for the population over age fifty in the United States. In doing so, I find that age does not increase depression until age 75, after which point depression increases for both sexes, but particularly for men, leading to a reversal in the sex gap in depression at the end of the lifespan. Furthermore, while the majority of the age effect on depression is explained by social and health changes, I conclude that there is a net effect of age per se on depression after age 75.

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This dissertation is dedicated to my Nana,

Judith Klubock Medalia

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through the process of completing my PhD. One message she reiterated when I felt overwhelmed with school was that “If it were easy to get a PhD, everyone would do it.” This message may sound simple, but has reminded me that it was OK that writing a dissertation was hard. It certainly was difficult to write this dissertation, but I am so glad that I saw it through to the end.

ABSTRACT

ESSAYS ON GENDER AND HEALTH

Carla Medalia

Jerry A. Jacobs

The relationship between gender and health is complex. Although women live longer than men in almost every country throughout the world, women also tend to be sicker than men. While biological sex differences likely contribute to sex gaps in health, cross-national, historical, and life course variation suggest that social factors also play a role. This dissertation is composed of three chapters which examine social explanations for gender gaps in mortality and morbidity. The first chapter looks at the relationship between gender equality in the public sphere, and sex gaps in life expectancy throughout the world. I find that influence of gender equality on the sex gap in life expectancy depends on the level of economic development. The second chapter takes an historical perspective to examine the trend in the sex gap in depression in the United States between 1971 and 2008. In examining this trend, I find that the sex gap in depression has decreased over the past forty years, due to a decrease in depression among women that is primarily attributable to an increase in women's labor force participation and attachment. In the third chapter, I examine the relationship between gender, aging, and depression using longitudinal data for the population over age fifty in the United States. In doing so, I find that age does not increase depression until age 75, after which point depression

increases for both sexes, but particularly for men, leading to a reversal in the sex gap in depression at the end of the lifespan. Furthermore, while the majority of the age effect on depression is explained by social and health changes, I conclude that there is a net effect of age *per se* on depression after age 75.

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CHAPTER 1: Gender equality, development, and cross-national sex gaps in life expectancy[1]

Carla Medalia and Virginia W. Chang[2]

Abstract

Female life expectancy exceeds male life expectancy in almost every country throughout the world. Nevertheless, cross-national variation in the sex gap suggests that social factors, such as gender equality, may directly affect or mediate an underlying biological component. In this paper, we examine the association between gender equality and the sex gap in mortality. Previous research has not addressed this question from an international perspective with countries at different levels of development. We examine 131 countries using a broad measure of national gender equality that is applicable in both Less Developed Countries (LDCs) and Highly Developed Countries (HDCs). We find that the influence of gender equality is conditional on level of development. While gender equality is associated with *divergence* between female and male life expectancies in LDCs, it is associated with *convergence* in HDCs. The relationship between gender equality and the sex gap in mortality in HDCs strongly relates to, but is not explained by,

[1] This paper was previously published: "Gender equality, development, and Cross-National Sex Gaps in Life Expectancy" by Carla Medalia and Virginia W. Chang (2011), in the *International Journal of Comparative Sociology*, Vol. 52, No. 5, pp. 371-389.

[2] This paper was coauthored by Virginia W. Chang, Assistant Professor of Medicine and Assistant Professor of Sociology at the University of Pennsylvania, Although the published paper was coauthored, the original idea for the paper, along with the research questions, were conceived solely by me. Furthermore, I researched and wrote the literature review, collected and cleaned all data, performed all analyses and wrote all drafts of this paper. Virginia's role as a coauthor was to advise, edit and revise the version of this paper which was published.

sex differences in lung cancer mortality. Finally, we find that divergence in LDCs is primarily driven by a strong positive association between gender equality and *female* life expectancy. In HDCs, convergence is potentially related to a weak negative association between gender equality and *female* life expectancy, though findings are not statistically significant.

Female life expectancy exceeds male life expectancy in almost every country throughout the world.[3] While females' higher life expectancy is partly attributable to biological factors, including hormonal differences (Bird and Rieker, 2008: 389), cross-national variation in the size of the sex gap suggests that the biological component is likely conditioned or directly affected by social factors. Gender equality, which refers to parity between women's and men's positions in society, is one social factor that may help explain cross-national variation in the sex gap in mortality.

Previous research offers insight into the association between gender equality and the sex gap in life expectancy, but is limited from a global perspective. First, cross-national research on gender equality and mortality, or the sex gap in mortality, is typically focused on either less developed countries (LDCs) or highly developed countries (HDCs). Second, the findings from studies in LDCs are not comparable to those in HDCs because researchers use different measures or proxies for gender equality in each setting. For example, studies in LDCs concentrate on educational, political, and

[3] According to WHO data from 2008, only Tonga and the Central African Republic had higher male life expectancies than female.

economic measures of gender equality, while studies in HDCs tend to examine sex differences in epidemiological risk factors, such as smoking and alcohol consumption rather than gender equality per se. Third, research in LDCs and HDCs are further differentiated by the mortality outcomes analyzed. While female or child mortality is the dependent variable in most LDC studies, sex differences in mortality are more often the focus in studies of HDCs.

Although research in LDCs and HDCs is not directly comparable, we believe there is preliminary evidence to suggest that the sex gap in mortality varies by level of gender equality across nations and, furthermore, that this relationship is conditional on level of development. For example, gender equality extends female life expectancy in LDCs (Aden et al., 1997), and the few studies which examine sex differences in life expectancy find a positive relationship between the sex gap and gender equality (Fuse and Crenshaw, 2006; Williamson and Boehmer, 1997). Gender equality is also related to the sex gap in HDCs. For example, as gender equality increases, women have adopted many of the same risky behaviors, such as smoking and drinking (McKee and Shkolnikov, 2001; Rogers et al., 2010; Smith, 2004). This trend may have led to a convergence in sex differences in life expectancy (Bird and Rieker, 2008; Bobak and Marmot, 1996; Crawley et al., 2008; Degenhardt et al., 2008; McKee and Shkolnikov, 2001; Morley and Hall, 2008). The sex gap also appears to be smaller where there is more gender equality in the public sphere (Backhans et al., 2007; Crawley et al., 2008; Helweg-Larsen and Juel, 2000), and may also be exacerbated by women experiencing

stress from work-family conflict (Schulz and Beach, 1999). While studies show that women's mortality in LDCs is lower where gender equality is higher, less is known about the nature of this relationship in HDCs. Moreover, it is unclear how male mortality is associated with gender equality at either level of development. Drawing on the literature, we hypothesize that the relationship between gender equality and sex differences in life expectancy is conditional on level of development. More specifically, we hypothesize that gender equality is associated with a divergence between men's and women's life expectancies in LDCs and a convergence in HDCs.

In this study, we examine the relationship between gender equality and the sex gap in mortality in 131 countries, including both HDCs and LDCs. To our knowledge, this is the first study to use a broad measure of gender equality to examine sex differences in mortality across a wide range of countries. We use common indicators of public sphere gender equality, including gender gaps in the economic, political and educational spheres, which are applicable across different levels of development. In contrast, epidemiological risk factors are specific to different causes of death, which vary cross-nationally and do not reflect the mortality experience in all countries (Link and Phelan, 1995). The analyses are divided into three separate sections. The first section examines the relationship between gender equality and the sex gap in five mortality outcomes, including three measures of adult mortality (life expectancy, healthy life expectancy [HALE], and adult probability of dying between ages 15 and 60) and two measures of youth mortality (infant and child mortality between ages 1 and 5). In the second section,

we explore the potential contribution of smoking to the sex gap in mortality by comparing sex differences in lung cancer mortality versus all other causes. In the third section, we examine the association of gender equality with male and female life expectancies as separate outcomes to better understand the patterns we observe with respect to sex gaps in mortality.

We find that greater gender equality is associated with *divergence* in life expectancy between the sexes in LDCs but *convergence* in HDCs. In LDCs, divergence is primarily driven by a strong positive association between gender equality and *female* life expectancy. In HDCs, convergence is possibly attributable to a negative association between gender equality and female mortality.

Theoretical Considerations

Mortality and gender research in LDCs

Gender equality in LDCs generally increases women's life expectancy, and some studies suggest that it contributes to divergence between men's and women's mortality. Gender equality has often been operationalized by factors such as levels of female labor force participation (LFP), female education, and reproductive health interventions.

Several studies show that the transition of women into the paid labor force increases female life expectancy relative to males (Baunach, 2003; Fuse and Crenshaw, 2006; Williamson and Boehmer, 1997). This relationship operates through several pathways. For example, spending time outside the home reduces women's exposure to the harmful indoor air pollution emitted from burning biomass fuel, which contributes to

women's excess morbidity and mortality in LDCs (Murray and Lopez, 2002). In addition, women's employment in the service sector enhances women's economic value and discourages female infanticide and neglect (Fuse and Crenshaw, 2006). Decreases in female mortality at young ages have a profound effect on increasing female life expectancy at birth (Preston et al., 2001; Shrestha, 2006).

Female education, through improved literacy, enrollment rates, and years completed, positively influences life expectancy for both sexes (Lee, 2000), and for women in particular (Williamson and Boehmer, 1997). Like employment, education increases daughters' economic value, thereby reducing parental preferences for sons and female's excess mortality at young ages (McNay, 2005). Education also contributes to increased female autonomy in the home. Exercised through decision making, more equitable divisions of household labor and increased age at marriage, female autonomy improves maternal and child health (J. Caldwell and Caldwell, 1993; Li, 2004). Caldwell's seminal study (1986) shows that the most important route to overall low mortality in poor countries is the increase in female autonomy.

Gender equality has also increased women's life expectancy through reproductive health interventions, such as the use of midwives during childbirth (Kabeer, 2005; Shaw, 2006). Midwives decrease both infant and maternal mortality (Frankenberg and Thomas, 2001), thereby, increasing female life expectancy (Williamson and Boehmer, 1997). Higher contraceptive prevalence (Shen and Williamson, 1997; Williamson and Boehmer, 1997) and lower fertility rates (Fuse and Crenshaw, 2006; Pillai and Gupta, 2006;

Williamson and Boehmer, 1997) also improve female life expectancy. Lastly, gender equality can improve women's mortality through increased access to other types of health services and improved nutritional well-being (Potter and Volpp, 1993).

The research summarized above has several limitations with respect our aim of comparing the relationship between gender equality and the sex gap in mortality cross-nationally in LDCs and HDCs. While some studies investigate *sex differences* in mortality (Baunach, 2003; Fuse and Crenshaw, 2006; Williamson and Boehmer, 1997), most of the studies described above examine only women's or child mortality. We cannot assume that increases in female life expectancy relate to divergence between the sexes because the same factors that increase female life expectancy may also improve male life expectancy. For example, maternal health and female education are positively associated with healthier sons and daughters, and the factors which increase female LFP and improve women's health and life expectancy may also benefit men. Another caveat with respect to LDCs is that studies that do examine sex differences typically use only a small number of LDCs and are therefore limited in generalizability (Baunach, 2003; Fuse and Crenshaw, 2006; Williamson and Boehmer, 1997).

Mortality and gender research in HDCs

In HDCs, the sex gap in mortality is often attributed to sex differences in epidemiological risk factors such as tobacco and alcohol use. Improvements in gender equality may lead women to adopt riskier behaviors and lifestyles previously associated with men (Bird and Rieker, 2008; Rogers et al., 2010). For example, increases in female smoking rates have

reduced the sex difference in mortality by 23 percent (Preston and Wang, 2006: 641). Increases in female smoking and alcohol consumption have also decreased men's excess heart disease mortality (Crawley et al., 2008). Another study finds that about three-quarters of the sex gap in mortality is due to sex differences in smoking and alcohol related causes of death, including ischemic heart disease, lung cancer and traumatic deaths (Wong et al., 2006). In Eastern Europe, where sex differences in life expectancy are generally considered to be large, the gap is narrowing as women's alcohol and tobacco consumption approaches men's (Bobak and Marmot, 1996; Degenhardt et al., 2008; McKee and Shkolnikov, 2001). While most studies explain convergence in the sex gap in mortality through increases in female smoking rates (Morley and Hall, 2008), decreases in male smoking-related mortality is also a factor (Zatonski et al., 2007).

Although most studies in HDCs use epidemiological risk factors which may be related to gender equality, a few studies explicitly examine broader measures of gender equality in conjunction with sex differences in mortality. For example, Pampel (2001, 2002) examines gender differences in smoking-related mortality using an index of gender equality. Although he did not find an association, the gender equality index used included the Total Fertility Rate (TFR) and divorce rate, factors which have not been identified as standard measures of gender equality and are not highly correlated with more general measures of gender equality (McNay, 2005). Two Scandinavian studies use more standard indicators of public sphere gender equality, such as female LFP, the proportion of parliamentary seats occupied by women, and the ratio of female-to-male

wages. One of these studies finds that gender equality, particularly equality in the division of labor and economic resources, is related to convergence in morbidity and mortality between the sexes (Backhans et al., 2007). While gender equality is negatively associated with mortality for both sexes, they conclude that convergence is attributable to a stronger negative association between gender equality and female mortality than with male mortality. Another study posits that as gender equality continues to increase in the future, and as men's and women's social positions become more similar, "further convergent trends in gender differences in mortality can be expected" (Helweg-Larsen and Juel, 2000: 220).

Gender equality is often associated with an increase in female LFP, which may have both positive and negative implications for health and mortality. On the one hand, the increase in women's LFP in the United States over the past 20 years has improved women's self-rated health (Schnittker, 2007), a finding corroborated by earlier research (Repetti et al., 1989; Ross and Mirowsky, 1995). Labor force participation may also reduce female mortality. A study analyzing Wisconsin death certificates from the 1970s found that death rates among women in the labor force were generally lower than those of housewives (Passannante and Nathanson, 1985). On the other hand, a decrease in the gendered specialization of household and labor market production may mean that both sexes, but especially women, are working a second shift (Hochschild, 1989). Work-family conflict is related to an increase in stress (Coverman, 1989), which could have a negative effect on mortality. Stress related to care-giving for an aging parent, for

example, has been found to increase the risk of mortality by as much as 63 percent (Schulz and Beach, 1999) compared with non-caregivers. This risk may be especially salient in the many HDCs that have female life expectancies of 80 or older. The negative impact of care-giving stress is particularly relevant for women, because daughters are much more likely to care for an aging parent than are sons (Wolf, 1994). Stress from other causes also contributes to an increase in female mortality. One study found that women who report high levels of stress are twice as likely to die from a stroke or coronary heart disease, and 1.5 times more likely to die from cardiovascular disease, compared with women who reported low stress (Iso et al., 2002). Finally, some research has shown that as women's presence in the labor market expands, they are more likely to exhibit the *coronary-prone behavior pattern*, also known as the "type A personality", which may mitigate sex differences in mortality caused by coronary heart disease (Crawley et al., 2008; Waldron, 1978). However, other research has questioned the relationship between the type A behavior pattern and health risks, and instead argued that underlying hostility levels are more important (Williams et al., 1980). Taken together, research on female labor force participation and mortality describes a complex relationship. Some studies find that female labor force participation positively benefits women's health and mortality, while others find that work-family conflict may exacerbate the negative association between stress and mortality. However, these studies do not suggest that this potential negative relationship outweighs the many other positive benefits of gender equality and women's labor force participation for women and for

society in general. Therefore, it remains unclear as to whether the relationship between gender equality and the sex gap in mortality in HDCs may operate through pathways other than risky behaviors such as smoking.

Data and Methods

The analysis is conducted in three parts, and the description of the variables, methods used, and results for each part will be described in turn. Although the mortality outcomes, provided by the World Health Organization World Health Report (2010), are available for 193 countries, the analytical sample includes 131 nations, including LDCs and HDCs (see Appendix 1.1). To distinguish between HDCs and LDCs, we use the Human Development Index (UN Human Development Report 2010). Of the original 193 countries, we lose 26 countries where HDI is not calculated due to missing data, leaving 167 countries. The average sex difference in life expectancy is not significantly different for these 26 countries than for the remaining 167. Finally gender equality is missing for an additional 36 of the remaining countries, 35 of which are LDCs, bringing the sample down to 131. Comparing the LDCs that are missing gender equality to those that are not, the average sex difference in life expectancy is one-tenth of a standard deviation lower among the missing gender equality countries. Thus, for missingness on gender equality to bias results towards a positive association between gender equality and the sex gap in life expectancy, gender equality would have to be higher in the non-sample LDCs, which is unlikely given that they are lower on HDI.

Gender equality and sex gaps in mortality

Mortality. We hypothesize that the association between gender equality and cross-national sex gaps in mortality is conditional on level of development. In this first part of the analysis, we consider five measures of sex gaps in mortality: the difference (in years) between females and males in (1) life expectancy at birth and (2) healthy life expectancy at birth (HALE); and the log of the sex ratios for (3) the adult probability of dying between the ages 15 and 60 ($_{45}q_{15}$), (4) the Infant Mortality Rate (IMR, $_1q_0$), and (5) the probability of a child of dying between the ages one and five ($_4q_1$). These data derive from national death registrations from 2007 (HALE) or 2008 that are compiled by the World Health Organization (WHO) (World Health Statistics 2010, 2010). For all measures, larger values indicate a female advantage, where sex differences are calculated by subtracting male from female values, and sex ratios are calculated by dividing male by female values.

We include the sex gap in the adult probability of dying between ages 15 and 60 in part to control for variation in the age pattern of mortality. Sex gaps in life expectancy derive from a combination of two factors – sex differences in age-specific mortality rates and the age pattern of mortality. The age pattern of mortality contributes to the sex gap in life expectancy through the quantity of deaths that occur at specific ages. For example, when deaths are more concentrated at older ages (a rectangular age pattern of mortality), the gains in life expectancy produced by declines in age-specific death rates are smaller.

Because women have a more rectangular age pattern of mortality than men, the sex differential in life expectancy could converge even if there were no change in sex differences in age-specific mortality rates. In a longitudinal study of high income countries, Glei and Horiuchi (2007) argue that differences in the age pattern of mortality between men and women may be more important to convergence in the sex gap in life expectancy than changes in age-specific mortality rates. To address this potential concern, we examine the sex gap in mortality for a limited age range. Specifically, we model the log of the sex ratio of the probability of an adult dying between the ages 15 and 60 ($_{45}q_{15}$). This measure is less sensitive to sex differences in the rectangular age pattern of mortality than is life expectancy at birth.

Gender equality. We measure gender equality in the public sphere using a modified version of the Gender Gap Index computed by the World Economic Forum (WEF) (Hausmann et al., 2010). The original variable measures the gap between women and men in terms of economic participation and opportunity, political empowerment, educational attainment, and health and survival. Our measure excludes gender gaps in health and survival because of its overlap with the dependent variables. Each of the three domains in this analysis reflects gender inequalities, captured by the ratio of female to male values, in multiple areas[4]. *Economic participation and opportunity* encompasses

[4] The WEF derives each component of the index from the following sources: the International Labour Organization *Key Indicators of the Labour Market* and *LABORSTA* Internet online database; the United Nations Development Programme *Human Development Report;* UNESCO Institute for Statistics *Education* Indicators, the World Bank's *World databank: World Development Indicators & Global Development*

four variables: the ratio of female to male labor force participation; wage equality between women and men for similar work; the sex ratio of legislators, senior officials and managers; and the sex ratio of professional and technical workers. *Educational attainment* encompasses four variables: sex ratios in a country's literacy rate, net primary and secondary enrollment rates, and gross tertiary enrollment rates. *Political empowerment* encompasses three variables: the sex ratio for parliamentary seats, the sex ratio at the ministerial level, and the ratio of the number of years with a female head of state or government over years with a male head. Each sub-index is calculated by averaging its variables after they have been normalized by their standard deviations.

To compute the gender equality score for each country, we averaged the scores for the three dimensions. A value of 100 in the gender equity index would indicate complete equality between males and females across the three domains, while a score of 0 would indicate complete inequality. The final measure ranges from 28.9 to 81.0, with an average score of 58.1 across all countries (see Appendix). Of the countries in the analysis, Yemen, Chad, and Pakistan have the lowest gender equality while the Scandinavian countries, including Finland, Norway and Iceland, have the highest gender equality. We also examine each of the three sub-indices separately.

Level of development. Each year, the United Nation (UN) publishes The Human Development Index (HDI) (*Human Development Report*, 2010), which measures and ranks countries by human development. In this study, we use the non-income version of

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Finance, The World Economic Forum *Executive Opinion Survey,* the Inter-Parliamentary Union *National Women in Parliaments* and *Women in Politics.*

the HDI, which combines indicators of population health (life expectancy) and education (mean and expected years of schooling). After carefully examining the ranked countries, we chose the non-income HDI as opposed to the income version, which also includes Gross National Income (GNI) per capita. Some countries that have very high GNIs are significantly lower on other previously mentioned aspects of human development (e.g., Qatar, the United Arab Emirates, and Brunei Darussalam). As such, using the income version of the HDI combines countries that are very different from one another. The countries with the highest HDI values include New Zealand, Australia, and Norway, and those with the lowest HDI values include Chad, Mozambique, and Burkina Faso. The UN ranks countries by their HDI value from highest to lowest human development (1 to 169), and then divides them into four categories of equal size with the following labels: very high, high, medium, and low human development. From this point forward, we refer to the countries with "very high" human development as HDCs, and other countries as LDCs. To assess how level of development modifies the association between gender equality and sex differences in life expectancy, we model an interaction between HDC and gender equality. Exploratory analysis shows that "very high" is the cut-point that is most salient for differences in the association of gender equality with sex differences in life expectancy.

One advantage to using the HDI as an indicator of development is that it includes life expectancy at birth for both sexes combined. The countries in this analysis vary widely in life expectancy, from a minimum of 42 years in Zimbabwe to a maximum of 83

in Japan. It is possible that the heterogeneous relationship between gender equality and the sex gap in life expectancy is driven by overall mortality levels in LDCs and HDCs. In countries where life expectancy is relatively low, there may be more room for life expectancy to be increased by factors such as gender equality. Because our measure of development includes life expectancy, it is unlikely that our results are driven by variation in overall levels of mortality.

Finally, models also control for the log of GNI per capita (Purchasing Power Parity, from the UN (*Human Development Report*, 2010)) to account for potential confounding from wealth.

Results

Table 1.1 shows descriptive statistics for all variables by level of development. Average sex gaps in mortality are larger in HDCs than LDCs, and life expectancies for both sexes are higher in HDCs. On average, HDCs are wealthier and have greater gender equality.

Regression results are presented in Table 1.2. Using Ordinary Least Squares (OLS), we regress each of the four sex gaps in mortality on gender equality, HDC status, the interaction between gender equality and HDC, and the log of GNI per capita. The main effect of gender equality in LDCs is represented by the first row of coefficients, and the estimated effect of gender equality in HDCs, computed as the sum of the main effect and interaction, is listed at the bottom of the table. To simplify the description of the results, we refer to a 10 point increase in gender equality when discussing associations with gender equality. Unless otherwise specified, results are significant at least at the

p<.05 level. In Models 1 and 2, the outcome variable is the sex difference in life expectancy. Model 1 includes gender equality, HDC, the interaction between gender equality and HDC, and the log of GNI per capita. The interaction term is negative and highly significant. Results show that a 10 point increase in gender equality is associated with a 1.5 year increase in the sex difference in life expectancy in LDCs and a weakly significant 1.1 year decrease in the sex gap in HDCs (p<.10). Therefore, the influence of gender equality on the sex gap in life expectancy appears to vary by level of development. In Model 2, we remove the interaction between gender equality and HDC. Comparing the R-squared parameters between Models 1 and 2 indicates that the interaction explains 36.5 percent of the overall variation in the sex gap in life expectancy.

The subsequent models in Table 1.2 show the regression of three additional sex gaps in mortality on the same explanatory variables included in Model 1. In Model 3, a 10 point increase in gender equality is associated with a 1.0 year increase in the sex difference in HALE in LDCs and a 1.1 year decrease in HDCs. The results shown in Model 4 indicate that gender equality is associated with divergence in the sex differential in the adult probability of dying in LDCs and convergence in HDCs. Specifically, a 10 point increase in gender equality contributes to a 10.3 percent increase in the sex ratio in adult mortality in LDCs, and a 18.0 percent decrease in the sex gap in HDCs. This suggests that the association we find between gender equality and the sex gap in mortality is not merely an artifact of the age pattern of mortality.

In contrast to the adult outcomes, we do not observe a statistically significant interaction between gender equality and HDC for either IMR or child mortality. The relationship between the log of the sex ratio in IMR and gender equality is not significant at either level of development, shown in Model 4. Finally, in Model 6, gender equality has a weak positive association with child mortality in LDCs, increasing the sex ratio by 4.1 percent for every 10 point increase in gender equality ($p<.10$), and a non-significant association in HDCs. In models excluding the interaction between gender equality and HDC for the child outcomes, gender equality is not significantly related to the sex ratio in IMR or youth mortality at either level of development (models not shown).

Figure 1.1 illustrates the relationship between gender equality and each of the four sex gaps in mortality described above. The regression lines are estimated from models which control for GNI per capita, and the scatter points are from observed data. In LDCs, the positive slopes of the regression lines for the three adult outcomes support the divergence hypothesis that gender equality is associated with an increase in the sex gap in life expectancy. In HDCs, the weaker but negative slopes of the regression lines are consistent with convergence between male and female life expectancies and healthy life expectancies in countries with greater gender equality. The relationship between gender equality and the sex gaps in the two youth mortality outcomes looks quite different. In Figure 1.1d, gender equality has almost no visible association with the log of the sex ratio in IMR at either level of development. We observe a weak slope of gender equality on the log of the sex ratio in the probability that a child dies between ages 1 and 5 in Figure

1.1e for both LDCs and HDCs. In summary, results for adults support the heterogeneous association between gender equality and sex gaps in mortality. In contrast to the sex gap in adult mortality, gender equality has a weaker relationship with the sex gap in youth mortality that is not dependent on level of development.

In Table 1.3, we examine the relationship between the sex gap in life expectancy with each of the three sub-indices of gender equality: economic participation and opportunity, educational attainment, and political empowerment. Results indicate that the overall pattern is consistent with the composite gender equality index. There is a positive association between each sub-index and the sex gap in life expectancy in LDCs, though the coefficient for political gender equality is not statistically significant. The interaction between HDC and gender inequality is negative for all three sub-indices. In HDCs, both political and economic gender equality are negatively related to the sex gap in life expectancy, though economic gender equality is not statistically significant. The only result that deviates from the composite gender equality results is educational gender equality, which while not statistically significant, has a positive association with the sex gap in life expectancy in HDCs. This result is not surprising given the very small amount of variation in educational gender equality among HDCs.

Effects of Smoking

Gender equality may lead to an increase in female smoking behaviors, especially in HDCs. Many studies have shown that increases in female smoking rates are associated with declining sex differences in mortality, both longitudinally and cross-nationally.

Indeed, gender equality may be related to the sex gap in mortality through its association with smoking behaviors. To consider this possibility, we examine the contribution of smoking through a comparison of sex gaps in mortality with and without lung cancer. While a simple adjustment for lagged smoking rates would be an alternate approach, lagged measures of smoking are not available for the majority of our sample. Lung cancer mortality is a commonly used method to estimate deaths attributable to smoking (Bird and Rieker, 2008; Ezzati and Lopez, 2003; Ezzati et al., 2008; Fenelon and Preston, Forthcoming; Peto et al., 1992; S. H. Preston et al., 2010). While smoking may lead to other causes of death, such as deaths from heart disease and other cancers, the vast majority of lung cancer deaths are attributable to smoking (Office of the Surgeon General, 2004). To assess whether gender equality is related to the sex gap in life expectancy above and beyond the association between smoking behaviors and lung cancer, we compare the Age Standardized Death Rate (ASDR) for lung cancer versus all other causes of death. By examining the causes of death other than lung cancer, also referred to as a "cause-deleted" or "associated single decrement" (Preston et al., 2001: 80), we ask what mortality would look like in the absence of lung cancer. This allows us to assess whether the negative effect of gender equality on the sex gap in mortality in HDCs is driven primarily by the relationship between gender equality and lung cancer, or if gender equality affects the sex gap in mortality through additional pathways. We use the ASDR as opposed to the sex gap in the adult probability of dying because the latter is not available by cause. The data derive from the WHO and refer to the year 2008

(*Global Burden of Disease*, 2010), and are available by sex and country[5]. The outcome variables in this part of the analysis are the log of the sex ratio of the ASDR (males/females) for all cause mortality, lung cancer mortality, and cause-deleted mortality (mortality in the absence of lung cancer).

The results summarized in Table 1.4 suggest that sex differences in smoking rates greatly contribute to, but cannot explain, convergence in the sex gap in mortality in HDCs. A ten point increase in gender equality is associated with a decrease in the sex ratio in the ASDR for all causes of mortality combined (7 percent) and for causes other than lung cancer (6 percent). The same ten point increase in gender equality cuts the sex ratio in the lung cancer ASDR almost in half, by 48.3 percent. Therefore, the interaction between gender inequality and development is three times larger for lung cancer mortality relative to that for all-causes and causes other than lung cancer, suggesting that lung cancer makes major contribution to the convergence of male and female life expectancies in HDC's. In LDCs, gender equality is positively associated with the sex ratio in the ASDR for all cause and cause-deleted mortality, but not related to the sex gap in lung cancer ASDR. These findings also support the notion that an association of gender equality with sex-related changes to smoking behaviors is more so a phenomenon in HDCs than LDCs.

[5] Because the cause-deleted ASDR is not directly observable, we calculate this outcome by multiplying the all cause ASDR by the proportion of deaths (ages 60 and over) that are not due to lung cancer. We restrict the proportion of deaths not due to lung cancer to ages 60 and over as opposed using the proportion for all ages combined to focus on the effects of smoking. By using ages 60 and older, we are more likely to remove deaths that are due to smoking than if we removed lung cancer deaths at earlier ages.

Explaining divergence and convergence in the sex gaps in life expectancy

To better understand why gender equality has a conditional relationship with the sex gap in life expectancy, we estimate the association between gender equality and male and female life expectancies as separate outcomes. When analyzing male and female life expectancies, we use the seemingly unrelated regression procedure (*sureg* in STATA) to account for any correlation in the error terms due to the fact that estimates come from the same sample of countries. In order for gender equality to contribute to divergence in LDCs, females have to benefit *more* from gender equality than males. On the other hand, convergence in HDCs is possible only if females benefit *less* from gender equality than males. A divergence (or convergence) in the sex gap can be attributed to a variety of underlying patterns with respect to the relationship between gender equality and female and male life expectancies (summarized in Table 1.5). For example, we could observe divergence in the sex gap if gender equality increases both female and male life expectancies but has a stronger effect for females than males (H1). Alternatively, gender equality could increase female life expectancy but have no effect on male life expectancy (H2) or even decrease male life expectancy (H3) in LDCs. We could also observe no relationship for females and a negative relationship for males (H4). Finally, gender equality could disadvantage both female and male life expectancy but be worse for males

(H5). Explanations for convergence are the opposite of (or mirror) those proposed for a divergence.

Data for male and female life expectancy come from the WHO World Statistics Report (2010). In addition to the covariates included in the previous analysis of sex gaps, we control for HIV prevalence among adults ages 15 to 49. HIV prevalence comes from the WHO (*World Health Organization*, 2009), and is missing for 13 countries, reducing the sample to 118. In prior models for sex gaps in mortality, its inclusion as a covariate did not modify our results so we excluded it from the final models to preserve the sample size[6].

Table 1.6 shows the results for the regression of female and male life expectancy, separately. In LDCs, we find that gender equality is positively related to life expectancy for both sexes. A 10 point increase in gender equality is associated with a 3.7 year increase in female life expectancy and a 1.4 year increase in male life expectancy ($p<.10$). These results support Hypothesis 1 to explain divergence in the sex gap in life expectancy: gender equality is positively related to life expectancy for both sexes but has a stronger positive effect on female life expectancy than male life expectancy.

In HDCs, we do not find statistically significant associations between gender equality and life expectancy for either sex, but the estimate is weakly negative for females and weakly positive for males. The interaction between gender equality and HDC is statistically significant for females, implying that there is a different relationship

[6] HIV prevalence has a strong negative association with both female and male life expectancies (r=-0.6 for both sexes), but a much weaker association with the sex gap in life expectancy (r=-.3)

between gender equality and female life expectancy in LDCs than in HDCs. Hence, though lacking statistical significance, we can speculate that convergence in HDCs may, to some extent, be driven by a negative association of gender equality with female life expectancy and a positive association with male life expectancy.

Discussion

In this paper, we find evidence of a heterogeneous relationship between gender equality and sex differences in life expectancy. In LDCs, gender equality is associated with divergence in the sex gap in life expectancy: as gender equality increases, women gain additional years of life over males. In HDCs, on the other hand, gender equality is associated with convergence in the sex gap in life expectancy. These patterns also describes the sex difference in healthy life expectancy and the adult probability of dying,

To understand why the association between gender equality and the sex gap in life expectancy is conditional on level of development, we analyzed male and female life expectancy separately. In doing so, we found that gender equality contributes to divergence in LDCs because gender equality has a stronger positive association with female life expectancy than with male life expectancy. Although researchers typically assume that the benefits of gender equality are greater for females than males, convergence in HDCs is only possible if males experience a net benefit. Though lacking statistical significance, our results suggest that convergence may attributable a negative association of gender equality with female life expectancy and a positive association with male life expectancy.

Why might gender equality differentially affect female life expectancy in LDCs vs. HDCs? A vast body of research has established that gender equality has numerous positive effects on women's quality of life and life expectancy, especially in settings where they are marginalized and disadvantaged. In this study, gender equality reflects three areas: economic participation and opportunities, educational attainment, and political empowerment. We separately examined each of these areas, and found that the pattern we found for gender equality as a whole is reflected in is parts. In LDCs, economic and educational gender equality showed a strong positive association with the sex gap in life expectancy. This finding is consistent with the literature on sex and mortality in LDCs that show that expansions in female educational and occupational opportunities improve female mortality outcomes (Baunach, 2003; Fuse and Crenshaw, 2006; Williamson and Boehmer, 1997). As education expands, health services improve, and labor market opportunities open to women, female autonomy increases and prior work shows reductions their mortality and increases life expectancy.

For HDCs, we found that composite gender equality, as well as political gender equality, was associated with a decrease in the sex gap in life expectancy, a finding which confirms the relationship observed in previous research (Helweg-Larsen and Juel, 2000). Political gender equality may increase women's access to the right to engage in risky behaviors already practiced by men, such as smoking and drinking (Bird and Rieker, 2008; Rogers et al., 2010). To further investigate the effects of smoking, we compared the sex gap in mortality for lung cancer to causes other than lung cancer. We found that

gender equality had a strong negative relationship to the sex gap in lung cancer mortality, a finding consistent with the large body of research on the effects of smoking on population health (Bobak, 2003; Degenhardt et al., 2008; McKee and Shkolnikov, 2001). This suggests that smoking behaviors have largely contributed to the convergence in the sex gap in life expectancy observed in HDCs. However, the analysis also showed that gender equality is negatively related to the sex gap in mortality from causes other than lung cancer. Therefore, we cannot exclude the possibility that gender equality is associated with the sex gap in mortality beyond its association with smoking. One potential mechanism is the increased stress women may face as a result of working in the labor force while simultaneously fulfilling care-giving responsibilities, such as was found (Schulz and Beach, 1999). Smoking could also contribute to convergence in ways that we were not able to examine in this study. In addition to lung cancer, smoking leads to other causes of death, such as deaths from other cancers, respiratory diseases, and cardiovascular diseases (Wong et al., 2006). The remaining association between gender equality and the sex gap in cause-deleted mortality could be driven by these other causes of death. Additional research is needed to see if the relationship between gender equality and the sex gap in mortality persists after all smoking-attributable effects are removed.

The results of this study raise questions regarding the relationship between gender equality and the sex gap in youth and infant mortality. While we observed a robust relationship between gender equality and the sex gap in mortality for adults, results are not as salient for the sex gap in youth and infant mortality. Gender equality has a weak

and relatively small positive association with the sex gap in child mortality in LDCs, and there is no observable association between gender equality and the sex difference in IMR at either level of development. These findings are consistent with the fact that many of the mechanisms through which gender equality affects mortality pertain to adults, such as through educational attainment, occupational opportunities, and health behaviors. However, previous studies have posited that gender equality may lead to divergence in the sex gap in youth mortality in LDCs through better and safer delivery, post-natal care, and reducing a preference for sons (Fuse and Crenshaw, 2006). Further research should examine why gender equality does not impact the sex gap in IMR and only weakly is related to the sex gap in youth mortality.

In this study, we find that gender equality is not significantly associated with male life expectancy in either LDCs or HDCs. Although some improvements in gender equality affect only female life expectancy (e.g., an increase in midwives reducing maternal mortality), other aspects of gender equality affect population health more broadly. Future research should focus attention on the relationship between gender equality and male mortality, a relationship that is much less understood than that between gender equality and female mortality.

A limitation of this study is that it uses cross-sectional data. The idea that gender equality first improves and then later mitigates women's mortality advantage over men implies that a process occurs over time. Therefore, a longitudinal perspective could

clarify how changes in gender equality are related to the changing relationship between male and female life expectancy.

Tables and Figures

Table 1.1. Descriptive statistics for LDCs and HDCs

	LDCs (n=89)				HDCs (n=42)			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Mortality								
Life expectancy at birth (both sexes)	66.213	9.107	42	78	78.667	3.074	71	83
Female life expectancy	68.517	9.855	42	81	81.571	2.401	76	86
Male life expectancy	64.056	8.536	42	78	75.690	3.751	66	80
Sex difference in life expectancy	4.461	2.861	0	13	5.881	2.098	2	12
Sex difference in HALE	2.584	2.285	-2	10	4.238	2.093	0	10
Sex ratio in adult probability of dying	1.580	0.479	1.005	3.387	2.000	0.418	1.368	2.964
Sex ratio in IMR	1.223	0.177	0.714	2.000	1.257	0.228	0.750	2.000
Sex ratio in child mortality	1.194	0.180	0.750	1.951	1.233	0.210	0.692	2.000
Sex ratio in all cause ASDR	1.392	0.233	0.905	2.135	1.636	0.225	1.185	2.214
Sex ratio in cause-deleted ASDR	1.375	0.222	0.905	2.118	1.566	0.203	1.185	2.063
Sex ratio in lung cancer ASDR	3.901	2.664	0.983	14.292	3.652	2.037	1.115	9.603
Predictors								
Gender equality index	55.486	7.236	28.943	69.723	63.752	6.810	50.860	80.960
GNI per capita (PPP in international $)	8710.404	12751.020	176.000	79426.000	29205.050	11161.430	12844.000	58810.000
Economic gender equality	0.609	0.127	0.195	0.879	0.687	0.082	0.497	0.831
Educational gender equality	0.928	0.101	0.509	1.000	0.993	0.013	0.938	1.000
Political gender equality	0.128	0.094	0.000	0.410	0.233	0.152	0.031	0.675
HIV prevalence (% of adults)	2.597	5.099	0.100	24.800	0.288	0.289	0.100	1.400

Note: Sex differences refer to Female-Male values while sex ratios refer to Male/Female values

Source: Mortality data from WHO; gender equality indices from the WEF; GNI per capita from the UN; and HIV prevalence from WHO

Table 1.2. Regression of sex differences in mortality on gender equality and level of development (n=131)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
	LE	LE	HALE	Adult Mortality	IMR	Youth Mortality
Gender Equality	0.150***	0.0803*	0.096**	0.010**	0.002	0.004+
	(0.035)	(0.032)	(0.031)	(0.003)	(0.002)	(0.002)
Gender Equality*HDC	-0.260***		-0.204***	-0.028***	0.001	-0.005
	(0.067)		(0.059)	(0.006)	(0.004)	(0.004)
HDC	0.881	-0.056	1.754**	0.179**	0.028	0.040
	(0.672)	-0.659	-0.589	-0.063	-0.044	-0.042
Log of GNI per capita	0.530*	0.524*	0.247	0.101***	0.000	0.006
	(0.227)	(0.239)	(0.199)	(0.021)	(0.015)	(0.014)
Constant	5.116***	4.929***	2.948***	0.494***	0.188***	0.173***
	(0.287)	(0.298)	(0.252)	(0.027)	(0.019)	(0.018)
Gender Equality in HDCs	-0.110+		-0.108*	-0.018***	0.003	-0.001
	(0.058)		(0.051)	(0.005)	(0.004)	(0.004)
R-sq	0.244	0.155	0.224	0.405	0.034	0.058

Note: Beta coefficients with standard errors in parentheses, + p<.10, * p<.05, ** p<.01, *** p<.001
Source: Mortality data from WHO; gender equality indices from the WEF; GNI per capita and HDC indicator from the UN

Table 1.3. Regression of the sub-indexes of gender equality on the sex gap in life expectancy (n=131)

	Model 1	Model 2	Model 3
	Economic Participation and Opportunity	Educational Attainment	Political Empowerment
Subindex	6.028**	16.17***	3.029
	(2.087)	(2.979)	(2.939)
Subindex*HDC	-10.35+	-10.76	-8.560*
	(5.652)	(29.540)	(4.020)
HDC	0.438	1.32	0.657
	(0.676)	(1.451)	(0.681)
Log of GNI per capita	0.692**	-0.205	0.705**
	(0.237)	(0.267)	(0.244)
Constant	4.951***	4.660***	4.918***
	(0.296)	(0.270)	(0.320)
Subindex in HDCs	-4.318	5.41	-5.531*
	(5.237)	(29.319)	(2.699)

Note: Beta coefficients with standard errors in parentheses, + p<.10, * p<.05, ** p<.01, *** p<.001, [a] p = .104

Source: Mortality data from WHO; gender equality indices from the WEF; GNI per capita and HDC indicator from the UN

Table 1.4. Analysis of the sex ratio in the ASDR (n = 128)

	Model 1	Model 2	Model 3
	All causes	Causes other than lung cancer	Lung cancer
Gender Equality	0.009***	0.008***	0.006
	(0.002)	(0.002)	(0.009)
Gender Equality*HDC	-0.0159***	-0.014***	-0.0539**
	(0.004)	(0.004)	(0.016)
HDC	0.184***	0.145***	0.265
	(0.041)	(0.039)	(0.163)
Log of GNI per capita	0.005	0.001	-0.002
	(0.014)	(0.013)	(0.055)
Constant	0.302*	0.319**	1.202*
	(0.118)	(0.114)	(0.475)
Gender Equality in HDCs	-0.007*	-0.006+	-0.048***
	(0.003)	(0.003)	(0.014)

Note: Beta coefficients with standard errors in parentheses, + p<.10, * p<.05, ** p<.01, *** p<.001

Source: Mortality data from WHO; gender equality indices from the WEF; GNI per capita and HDC indicator from the UN

Table 1.5. Hypotheses for conditional relationship between gender equality and sex gap in mortality

	Divergence in LDCs		Convergence in HDCs	
Hypothesis	Females	Males	Females	Males
1	**+**	+	+	**+**
2	**+**	null	null	**+**
3	**+**	-	-	**+**
4	null	**-**	**-**	null
5	-	**-**	**-**	-

Note: **Bold** signs indicate stronger relationship

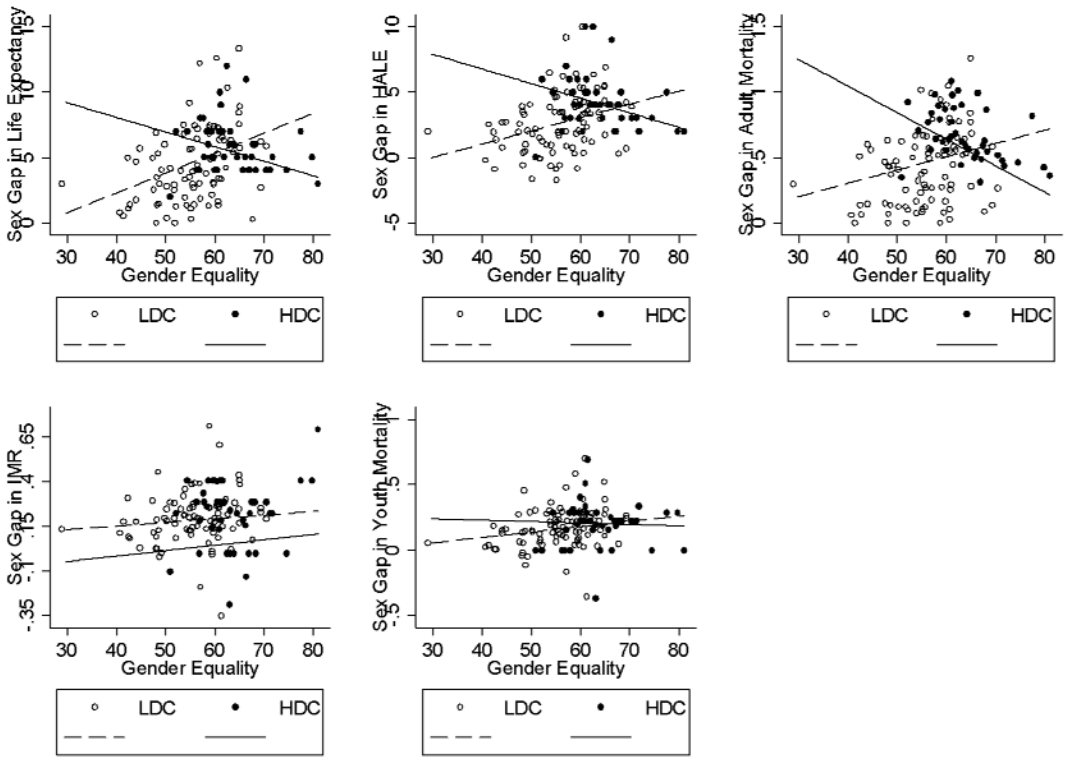
Table 1.6. Regression of male and female life expectancy, separately (n = 118)

	Model 1 Female LE	Model 2 Male LE
Gender Equality	.376***	.145*
	(0.073)	(0.073)
Gender Equality*HDC	-.441***	-0.087
	(0.122)	(0.121)
HDC	0.672	0.470
	(1.245)	(1.240)
HIV prevalence	-.990***	-.766***
	(0.098)	(0.097)
Log of GNI per capita	5.757***	5.191***
	(0.470)	(0.468)
Constant	73.114***	67.542***
	(0.551)	(0.548)
Gender Equality in HDCs	-0.065	0.058
	(0.099)	(0.099)

Note: Beta coefficients with standard errors in parentheses, + p<.10, * p<.05, ** p<.01, *** p<.001

Source: Mortality data from WHO; gender equality indices from the WEF; GNI per capita and HDC indicator from the UN; HIV prevalence from the WHO

Figure 1.1. Relationship between gender equality and sex gaps in mortality by level of development



Source: Mortality data from WHO; gender equality indices from the WEF; GNI per capita and HDC indicator from the UN

Appendix 1.1. 123 countries in analysis and gender equality score

28.94 Yemen	53.94 Malaysia	58.79 Viet Nam	62.93 Uganda
39.03 Chad	53.98 Maldives	58.86 Venezuela	**63.02 Barbados**
41.01 Pakistan	54.27 Mauritius	59.02 United Rep. of Tanzania	**63.14 Portugal**
43.19 Mali	**54.33 Japan**	59.05 Ukraine	63.16 Nicaragua
43.23 Côte d'Ivoire	54.40 Kenya	**59.31 Uruguay**	**63.18 Argentina**
43.63 Saudi Arabia	54.50 Belize	59.48 Thailand	63.27 Mongolia
44.21 Benin	54.99 Azerbaijan	59.72 Colombia	63.43 Costa Rica
44.52 Morocco	55.04 Mexico	**59.72 Greece**	**63.93 Luxembourg**
45.83 Turkey	55.29 El Salvador	59.74 Peru	64.28 Namibia
46.09 Egypt	55.99 Indonesia	59.82 Honduras	**64.48 Australia**
46.49 Syrian Arab Rep.	56.08 Brazil	59.85 Botswana	65.39 Trinidad and Tobago
46.72 Iran (Islamic Rep. of)	56.11 Tajikistan	59.87 Croatia	65.68 Mozambique
47.80 Ethiopia	56.13 Zimbabwe	**59.93 Singapore**	**65.68 Canada**
48.29 Jordan	**56.23 Cyprus**	60.32 Kyrgyzstan	**66.18 USA**
48.49 Algeria	56.51 Georgia	**60.44 Israel**	**66.40 Latvia**
48.71 Nigeria	**56.80 Malta**	60.47 Bulgaria	66.79 Sri Lanka
49.05 Qatar	56.84 Angola	60.77 China	**66.93 Netherlands**
49.08 Nepal	**57.01 Hungary**	**60.86 Chile**	**67.14 United Kingdom**
49.38 Mauritania	57.07 Madagascar	**60.99 Estonia**	**67.50 Belgium**
49.43 Cameroon	57.50 Bangladesh	**61.02 France**	**67.78 Germany**
49.89 Burkina Faso	57.51 Gambia	61.17 Jamaica	68.21 South Africa
50.52 Guatemala	57.61 Bolivia	61.18 Russian Federation	**68.21 Spain**
50.77 Fiji	57.68 Armenia	**61.20 Poland**	**68.36 Switzerland**
50.86 Bahrain	**57.72 Slovakia**	61.42 Kazakhstan	69.41 Philippines
51.02 India	57.78 Brunei Darussalam	61.44 TFYR Macedonia	69.72 Lesotho
51.47 Tunisia	**57.88 Italy**	**61.45 Slovenia**	**70.44 Denmark**
51.61 Zambia	57.95 Dominican Republic	61.76 Ecuador	**71.31 Ireland**
52.13 Republic of Korea	58.18 Ghana	61.79 Panama	**71.78 New Zealand**
52.21 Kuwait	58.19 Paraguay	61.90 Guyana	**74.55 Sweden**
52.95 Suriname	**58.43 Romania**	**61.93 Austria**	**77.48 Finland**
53.07 Senegal	58.45 Albania	62.39 Bahamas	**79.73 Norway**
53.25 United Arab Emirates	**58.69 Czech Republic**	**62.44 Lithuania**	**80.96 Iceland**
53.78 Cambodia	58.72 Malawi	62.82 Republic of Moldova	

Note: Sorted by gender equality; **bold** countries are HDCs

Source: Gender equality data from the WEF; HDC indicator from the UN

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CHAPTER 2: Historical changes in the gender gap in depression in the United States, 1971 to 2008

Abstract

Depression is a major public health concern that is more prevalent among women than men. Social factors have been shown to explain some of the sex gap. Furthermore, an earlier study concluded that the increase in women's employment between the 1950s and 1970s contributed to a decrease in the sex gap in depression. Since then, significant social changes have occurred in the realms of gender, work, and family. This paper updates the debate on sex and depression by investigating whether there have been changes in the sex gap in depression since 1970, and if so, what explains those trends? Using data from the National Health and Nutrition Examination Survey, I find that women are less depressed now than forty years ago, and as a result, that the sex gap in depression has decreased. The narrowing of the sex gap is attributable to the increase in female employment over this period.

Depression is a major public health concern, affecting approximately 6 to 17 percent of Americans over their lifetimes, depending on the study (Ronald C. Kessler 2006). According to the World Health Organization, depression is among the leading causes of disability worldwide and is the third leading contributor to the global burden of disease (World Health Organization 2008). However, the risk for depression is not uniformly distributed between the sexes. Research has consistently shown that women are more likely to experience depression than men (Clancy and Gove 1974; Gove and Tudor 1973;

L. Radloff 1975; Ronald C. Kessler et al. 1993; Ronald C. Kessler 2003; Bird and Rieker 2008). Although estimates of women's excess depression varies, community studies find that women are between 1.5 and 3 times more likely to be depressed than men (Ronald C. Kessler 2006). There are many explanations for the sex gap in depression, including biological and hormonal explanations, comorbidity between depression and other conditions and diseases, and social explanations, including education, employment status, marital status, parental status, income, poverty, and race, among others. While all of these factors are likely to play a role, social factors in particular may help to explain historical variation in the sex gap in depression. Research has shown that where men's and women's social roles are similar, their depression levels are also similar (John Mirowsky and Catherine E. Ross 2003; Ronald C. Kessler and McRae 1981).

One study examined the trend in the relationship between sex and depression between 1957 and 1976 (Ronald C. Kessler and McRae 1981). Given the "sex role hypothesis," which predicts that the relationship between sex and distress should decline as sex roles become more comparable, the authors hypothesized that the increase in women's labor force participation, the increase in women's educational attainment, and other changes in marital status and parental status would lead to a narrowing of the sex gap in psychological distress. The findings from this study indicate that although women had higher levels of distress in both years, the sex gap was larger in the 1950s than in the 1970s. In assessing the relevance of the sex role hypothesis in explaining this trend, the authors found that the increase in women's labor force participation explained 20 percent of the changing relationship between gender and distress. Labor force participation was

in fact the only compositional change to explain the decrease in sex gap in distress over this period.

Since 1976, there have been dramatic changes in the United States that have led to greater equality between men and women. For example, while educational attainment has increased for both sexes, this trend has been especially true for women. As women have entered the labor force in greater numbers, fertility rates have declined, and marriages have been postponed to older ages. Only a few studies have undertaken an historical perspective to examining the relationship between social changes and changes in the sex gap in depression (R.C. Kessler, K.A. McGonagle, et al. 1994; Ronald C. Kessler and McRae 1981; Klumb and Lampert 2004; Meertens, Scheepers, and Tax 2003). However, these studies either refer to an earlier period or have study design limitations in the methods or unit of analysis. As a result, we do not know what impact these social changes have had on the sex gap in depression since the 1970s. In short, we need an update on Kessler and McRae's social examination of the trend in the sex gap in depression (Ronald C. Kessler and McRae 1981).

In this paper, I document trends in depression over the past 40 years for men and for women. Furthermore, I investigate whether or not there have been changes in the sex gap in depression. If so, what explains those trends? In my analysis, I undertake a social perspective to understanding the changing relationship between sex and depression. Specifically, I examine the importance of changes in employment, marital status, poverty, and parental status on trends in depression.

In addition to the literature on sex and depression, this study fits into the body of research that examines the relationship between social changes and other dimensions of

public health. For example, research has shown that female employment has led to improvements in self-rated health among women, leading to a convergence in the sex gap in self-rated health (Schnittker 2007). As gender equality increases, women have adopted many of the same risky behaviors as men, such as smoking and drinking (Bird and Rieker 2008; Rogers et al. 2010; Smith 2004). Such increases in female smoking rates have reduced the sex difference in mortality by 23 percent (Preston and H. Wang 2006:641), and increases in female smoking and alcohol consumption have also decreased men's excess heart disease mortality (Crawley, Foley, and Shehan 2008).

To examine trends in the sex gap in depression, I use data from two waves of the National Health and Nutrition Examination Survey (NHANES): NHANES I, which was fielded between 1971 and 1975, and the 2005 to 2008 Continuous NHANES. I find that the sex gap in depression has decreased over this period, and that convergence in the sex gap is attributable to the decrease in depression among women. This historical change in the sex gap in depression could be explained by one or both of the following two factors. The relationship between social demographic characteristics and the risk of depression for men and/or women could have changed over this period. In addition, compositional changes in employment, education, marital status, and other attributes could be at play. I conclude that women's employment is responsible for the narrowing of the sex gap in depression because more women work now than did forty years ago and because employment is more protective against depression for women now than it once was.

Theoretical Considerations

Research on Gender and Depression

Depression is an important public health concern, affecting millions of Americans a year (Ronald C. Kessler 2006). Consistently, research has shown that women are more likely to have depression than men. Estimates of women's excess depression ranges between 1.5 to 3 times the rates of men (Bird and Rieker 2008; Ronald C. Kessler 2003; J. Mirowsky and C.E. Ross 1989; Van de Velde, Bracke, and Levecque 2010).

Why is there such a robust sex gap in the prevalence of depression? Before summarizing the explanations offered by the literature, it is important to address a factor that does *not* contribute to the sex gap. Research has found that the sex gap in depression reflects a real difference in health and is not attributable to differences in help-seeking behaviors or reporting (Bird and Rieker 2008; Veroff, Douvan, and Kulka 1981). Other research also indicates that there is no evidence for women and men labeling symptoms and addressing severity differently (Verbrugge 1985). Furthermore, the sex gap in depression is found in nationally representative surveys in addition to clinical settings.

Explanations used to explain the sex gap generally fall into four categories. One potential explanation for the gender difference in depression derives from whether the episode is the first onset of depression or a recurrence of depression. Research has shown that female's larger risks for depression and anxiety in childhood and adolescence puts them at risk later in life (Piccinelli and Wilkinson 2000). Kessler (2006) argues that while there is a significant gender difference in the risk of first onset, there are mixed results for the sex gap in recurring depressive episodes, often depending on the subject's history of depression. Due to limitations of data, I am unable to address the difference in

first onset and recurring episodes of depression. While the sex gap in the rates of depression may be due to a confluence of first onset and recurring episodes, this study's focus on historical change and the relationship between social demographic characteristics and the sex gap in depression should still be relevant.

The second explanation is that there are biological determinants and hormonal differences between men and women that contribute to the sex gap in depression. For example, some argue that genetic predisposition (Risch et al. 2009), immune function and the cardiovascular system (Bird and Rieker 2008; Hemingway and Marmot 1999), may interact with psychological processes. There is less consistent evidence for the role of hormones (Ronald C. Kessler 2006; Young and Korszun 2010). Furthermore, in a review of the literature on gender differences in depression, there was no evidence in for genetic and biological factors of the sex gap in depression (Piccinelli and Wilkinson 2000).

Third, comorbidity between depression and other diseases may explain part of the sex gap in depression. Research has established that certain conditions may exacerbate depressive symptoms. For example, empirical evidence finds that comorbidity between chronic pain and depression accounts for some of the sex gap in depression (Haley, Turner, and Romano 1985). Obesity, which is more common among adult women than men (Hedley et al. 2004) , is also strongly associated with risk of depression (Ma and Xiao 2009). There is also evidence for comorbidity with other psychiatric disorders; for example, with depression are more likely to have comorbid anxiety, while depressed men are more likely to have comorbid substance abuse or dependence (Bird and Rieker 2008; Breslau, Schultz, and Peterson 1995). In addition to diseases and conditions exacerbating depression, research also suggests that depression may affect health outcomes. For

example, one study found that depression increases the probability of reporting poor self rated health by 15 percent for both sexes, but that depression has a slightly larger effect on women's self-rated health than on men's (Case and Paxson 2005). Furthermore, another study found that sex differences in psychosocial factors likely contribute to the sex gap in non-fatal chronic disease and milder acute problems, but not to the sex gap in acute or serious conditions (Verbrugge 1985).

Finally, social explanations include demographic characteristics that make women more susceptible to experiencing stressful events or interpreting those events in such a way that leads to a depressive episode. It is likely that all of these explanations, including one's history of depression, biological factors, comorbid diseases and conditions, and social factors, work together to determine an individual's tendency toward depression. Although the other types of explanations may still be relevant to this topic, it is likely that the dramatic changes in social demographic characteristics over the past forty years are related to any change in the sex difference in depression.

Socio-demographic characteristics associated with depression

Age. Putting gender aside, the relationship between age and depression is complex and often contradictory (Jorm 2000). Empirical research has found evidence for all possible relationships between age and depression: some find that age is associated with an increased risk of depression (Luppa et al.; Newmann 1989; Sonnenberg et al. 2000); others find that depression decreases as people age (Bebbington et al. 1998; Cairney and Wade 2002; Christensen et al. 1999; Jorm 2000; Korten and Henderson 2000; Kroenke and Spitzer 1998; McGuire et al. 2009); research has found that the relationship between

age and depression is nonlinear, and that it follows either a U-shaped (Ronald C. Kessler et al. 1992; John Mirowsky 1996; John Mirowsky and Catherine E. Ross 1992) or inverse U-shaped (Newmann 1989) pattern; and finally, studies have concluded that there is no real trend in the relationship between age and depression, or that the relationship is too inconsistent to pin down (Djernes 2006; Glaesmer et al. 2011; van Grootheest et al. 1999).

In terms of the relationship between gender, age and depression, the story is just as unclear. One theoretical explanation for the sex gap in depression is that it is attributable to both the social and biological implications of the reproductive years. A few studies have shown that the sex gap in depression emerges during young adulthood and disappears after women go through menopause (Bebbington et al. 1998; Korten and Henderson 2000). Another possibility is that women are significantly more likely to experience depression than men at all ages (Case and Paxson 2005), and that the sex gap is constant over age (Cairney and Wade 2002; Hopcroft and Bradley 2007; Glaesmer et al. 2011; Ronald C. Kessler et al. 1992; Ronald C. Kessler and McRae 1981; McGuire et al. 2009; Sonnenberg et al. 2000; van Grootheest et al. 1999). However, other research suggests that the sex gap in depression increases as people age (Moen 1996; Luppa et al.).

Thus, there are many inconsistencies in the literature with respect to age and depression, and to sex gaps in depression as people age. Some of the reasons for these inconsistencies include how age is measured, the age range considered, and the depression outcome examined. One study concluded that the nonlinear age pattern in depression needs to be taken into account when examining sex gaps in depression,

particularly at the oldest ages (Medalia 2012). In this study, the sample population is between the ages of 25 and 74, and I control for age and age-squared to account for the non-linear association between age and depression.

Race. Depression is also associated with race, though findings are mixed. One study found that while whites are more likely to experience major depression than blacks, blacks are more likely to have depressive symptoms (Jackson and Williams 2006). Whites having greater rates of major depression than blacks is a consistent finding in the literature, and whites also appear to be at greater risk for major depression than Mexicans as well (Riolo et al. 2005). In terms of sex differences in depression, previous research has shown mixed findings by race. For example, a cross-national study found that the sex gap in depression was larger among Danes and American whites than among the Japanese (Oksuzyan et al. 2010). Another study found that while the sex gap in depression was present for whites, it was not statistically significant for blacks (Mezuk et al. 2010). In this study, I attempt to mitigate variation by race or ethnicity by controlling for a dummy variable indicating that the respondent is white. Unfortunately, race was measured as white/not white in the NHANES I, so this is the only possible race variable for historical comparison.

Poverty. Poverty has a strong positive association with depression. One study found that being in poverty doubles the risk of recurrent depressive episodes for both sexes, but that there were no significant gender differences in the effect of poverty on depression (Bruce, Takeuchi, and Leaf 1991). Other research focusing on women, find that women in poverty, and especially mothers, are more likely to be depressed than those not in poverty (Belle 1990; Belle and Doucet 2003; Kahn et al. 2000). However, yet

another study found that the positive association between poverty and depression was true only for whites, and not for Blacks or Mexicans (Riolo et al. 2005). I control for whether the respondent's family income falls below the poverty line in this study.

Marital status. There is a complex relationship between marital status and depression. Marital satisfaction reduces distress and improves well-being for both men and women (Coverman 1989). Typically, being married also protects both sexes from depression, but the effect may be particularly strong for men (Whisman, Weinstock, and Tolejko 2006). The sex difference in depression is also larger for married than unmarried people (Ronald C. Kessler 2006). There may be a more nuanced relationship for other categories of marital status, like divorce and widowhood. Unfortunately, I am unable to address this possibility in this study. There are too few widowed, separated, never-married and divorced individuals in NHANES I to treat them as separate categories. Therefore, I control for marital status as whether or not the respondent is married.

In addition to marital status affecting depression outcomes, another possibility is that depression affects marital status. There could be a selection effect of non-depressed people into marriage. For example, depressed people could be less likely to marry and more likely to divorce than non-depressed people. One way to rule out the possibility of reverse causation is to use longitudinal data as opposed to cross-sectional data (the latter is used in this study). Another way to reduce the implications of reverse causality is to focus on historical changes in depression. In this study, I examine the association between depression and marital status in 1971 and again in 2008. I also observe whether or not the association between depression and marital status has changed over this period. If there has been no change in the association between marital status and depression, but

marital status differences between 1971 and 2008 explain some of the change in the sex gap in depression, then it is likely that compositional changes in marital status are responsible. If this is the case, I can conclude that changes in the sex gap in depression that are attributable to marital status are due to marital status affecting depression and not the reversal.

Parental status. Most recent studies show that there is little difference in depression between parents and non-parents (Evenson and Simon 2005; Bures, Koropeckyj-Cox, and Loree 2009). However, in the past, there was a stronger relationship between parental status and depression. Radloff (1975; 1980) found that parents of both sexes, especially those with children younger than 6, had higher depression scores than non-parents. Another study found that being a parent is more emotionally disturbing than not being a parent in 1976 (Veroff et al. 1981). In this study, the measure of parental status that I include is whether or not the respondent has children under 18 living in the home. More detailed age measures of children are not available.

Education. Most studies find evidence that education is negatively associated with depression (Adler et al. 1994; Chen et al. 2005; Dohrenwend et al. 1992; Ronald C. Kessler, Katherine A. McGonagle, et al. 1994). The effect of education on depression may also be amplified over age. One study found that the education gradient in depression increased with age, explained by physical health problems among the low educated (Miech and Shanahan 2000). In this study, I control for age by using a dummy variable for having a Bachelor's Degree (BA).

Employment. At the individual level, there is a negative relationship between employment and depression – both men and women who work are less depressed than

those who do not. In a meta-analysis of 91 studies on work and women's well-being conducted in the 1980s and 1990s, Klumb and Lampert (2004) calculated that the average benefit of employment was a 60 percent reduction in women's depression. In an earlier study, using data from 1976, married women who worked outside the home were significantly less depressed than housewives. However, for their husbands, the effect was in the other direction – men whose wives worked were more likely to be depressed than those with housewives (Ronald C. Kessler and McRae 1982). The relationship between work and depression is most strongly supported by two explanations that describe unemployment as both cause and consequence of depression (Lennon 2006). First, depression acts as a barrier to employment; depressed people who do work are also more likely to take sick days. Second, there is strong evidence supporting the explanation that unemployment can cause depression.

This study does not specifically address the possibility of reverse causation in terms of employment. However, like the explanation provided for reverse causation and marital status, the design of this study, which examines historical trends, mitigates that possibility. Previous research has demonstrated that changes in the sex gap in labor force participation are related to changes in the sex gap in depression. For example, one study examined the trend in the relationship between sex and depression between 1957 and 1976 (Ronald C. Kessler and McRae 1981). They found that while women had higher levels of symptoms in both years, the sex gap was larger in the 1950s then in the 1970s. The authors attributed this change in the sex gap in distress to the increase in women's labor force participation over that period, which explains 20 percent of the changing relationship between gender and distress.

Objectives

This paper will attempt to answer three primary questions.

1. What was the relationship between sex and depression forty years ago, and what is it today? Has the sex gap in depression changed?

The second and third questions address the change in the sex gap in depression.

2. Has the relationship between socio-demographic characteristics and depression changed for men and/or women over the past forty years? What factors protected people from depression, and what factors augment the risk for depression? Are there the same factors associated with depression for men and women? At both points in time?
3. How do compositional changes affect trends in the sex difference in depression?

Data and Methods

The data used for this study come from multiple waves of the National Health and Examination Survey (NHANES). The NHANES is a large nationally representative survey that contains interview and examination components at the individual level, as well as household-level information. I use data from NHANES I (1971 to 1975) and the Continuous NHANES (2005 to 2008). The sample is restricted to those ages 25 to 74 for whom depression measures could be calculated.

Measuring Depression

Survey research on depression generally uses one of two types of depression instruments. On the one hand are surveys which ask respondents a relatively small number of questions (between 5 and 30) to determine depression severity and probable

Major Depression. Depression severity instruments include questions about the respondent's mood (including sadness and depression), somatic symptoms or "malaise" (such as energy level), social isolation (nobody likes me), and positive affect (enjoying life). These instruments are often used to understand the relationship between social factors and differences in depression between subgroups (Newmann 1989). On the other hand are diagnostics tools, which involve a much longer battery of specific questions pertaining to specific occurrences of depression throughout one's life. These instruments are often used to diagnose people with a specific disorder, such as Major Depressive Episode (MDE), according to the criteria established by the Diagnostic and Statistical Manual of Mental Disorders (DSM). Depending on which type of depression instrument is used, studies come to very different conclusions regarding the prevalence of depression in the population (Newmann 1989).

In performing this historical analysis, it is crucial that the indicators of depression I use are comparable to one another and belong to the same type of depression instruments. In this study, I use the former type of depression instrument described, which are based on questions to determine depressive severity and probable depression. NHANES I uses the Center for Epidemiologic Studies Depression Scale (CES-D), and the Continuous NHANES uses the Patient Health Questionnaire (PHQ-9). Both of these instruments have been demonstrated to perform as valid and reliable indicators of depression severity and are both highly predictive of medically diagnosed Major Depression. Studies that have compared the CES-D to the PHQ-9 found that the measures are highly correlated and when used in regressions on a variety of socio-demographic characteristics and other clinical depression measures, and that both

instruments produce similar and not statistically significantly different scores (Milette et al.). Another study also concluded that the PHQ-9 and CES-D measure the same concept, and that they are highly correlated (r=.83) (Dbouk, Arguedas, and Sheikh 2007).

While each wave uses a different survey instrument, they share many of the same questions as well as overall indicators of major depression. In this paper, I analyze two sets of outcome variables. First, I create a dichotomous variable that indicates probable major depression by using a cut-point on each scale. From this point forward, I will refer to this measure as "depression." Clinicians and other researchers typically use a cut-point on the scale to determine who is depressed and who is not. The cut-points used in this study are described below. Second, I examine each survey instrument as a complete, continuous variable (CES-D for NHANES I and the PHQ-9 for the Continuous NHANES). I will refer to this measures as "depressive severity," since it indicates the preponderance of depressive symptoms.

This is not the first study to use a historical perspective to examine sex differences in depression. A study by Kessler and McRae (1981) analyzed the trend in the sex gap in depression between 1957 and 1976, using five different surveys and four different depression instruments. Although there was cross-wave variation in questions and response categories, the authors argued that by analyzing scales, they could still study the relative changes in depression for men and women (Ronald C. Kessler and McRae 1981).

Survey Waves and Depression Outcomes

NHANES I was collected between 1971 and 1975. A subset of 3,059 adults between the ages of 25 and 74 received the Center for Epidemiologic Studies Depression Scale (CES-

D), created by the National Institute for Mental Health (NIMH). The CES-D consists of 20 items that ask the respondent how frequently during the past week he experienced a particular feeling or symptom associated with depression. Responses range from 0 to 3, where 0 indicates rarely or none of the time (less than 1 day), 1 is some or a little of the time (1 to 2 days), 2 is occasionally or a moderate amount of the time (3 to 4 days), and 3 is most or all of the time (5 to 7 days). The total instrument is therefore scored from 0 to 60, with 60 indicating the most severe depression. The scale is reliable, and has high internal consistency between the items (Chronbach's alpha usually around .85) (McDowell 2006). It is also considered a valid instrument for determining major depression, and it covers seven out of nine DSM IV symptoms of a Major Depressive Episode (McDowell 2006).

Four of the items on the CES-D are worded positively (e.g., "I enjoyed life"), while the remaining sixteen questions are worded in a negative direction (e.g., "I felt depressed"). Documentation for NHANES I urged caution when using the four positively worded items in the CES-D, because they were not always consistent with the negatively worded items. However, this is a common feature of the CES-D, and is part of its design. "Empirical evidence suggests that the positive items on the CES-D form a separate dimension, rather than being the inverse of the negative items" (McDowell 2006:350). While non-depressed individuals may experience some of the negative symptoms, it is thought that the depressed people would not experience the corresponding positive feelings. Therefore, I use the entire CES-D score for both the continuous and dichotomous outcome measures.

Various cut-points on the CES-D have been recommended to determine depression, ranging from 16 to 25 (Dbouk et al. 2007; Haringsma et al. 2004; Myers and Weissman 1980; Turk and Okifuji 1994; Wada et al. 2007; Watnick et al. 2005; Zonderman, Costa, and McCrae 1989). The selection of a cut-point is important for estimating the prevalence of depression in a population. Sixteen is the most commonly used cut-point, especially in clinical settings, "although a higher point may be beneficial in primary care settings to reduce the number of false positives" (McDowell 2006:352). This is true for a couple of reasons. In clinical settings, patients have already self-selected into seeing a mental health professional, so lower scores may still indicate depression. Secondly, the primary goal of using the CES-D in a clinical setting is to diagnose and potentially treat a patient. False positives would be preferable to false negatives, because misdiagnosing people who actually have major depression could be detrimental to their health. For the purposes of this study, however, a low cut-point would lead to an overestimation of depression, which could affect the conclusions I make with regard to historical changes in the sex gap in depression. I considered using several different cut-points, but after examining the cumulative distribution of each possible score, I selected 20 as the cut-point, which corresponded to 9.9 percent having depression. If I had used a cut-point of 16, 15.9 percent would have depression, which is much too high for a nationally representative population.

The Continuous NHANES was fielded between 2005 and 2008. The mental health module, the Patient Health Questionnaire (PHQ-9), was administered to 10,214 individuals between 18 and 85 years old. To facilitate comparison between survey waves, the sample was limited to the 7,622 people between ages 25 and 74. The PHQ-9

consists of 9 questions that ask the respondent how frequently they have been bothered by problems such as “little interest in doing things”, “feeling down, depressed, or hopeless”, or “feeling bad about yourself”. Responses to these 9 questions are scored from 0 to 3, where 0 is not at all, 1 is several days, 2 is more than half the days, and 3 is nearly every day. The score for each question is summed to create a total scale of 0 to 27, where 27 is the highest level of depression. The PHQ-9 includes a tenth question that asks about the difficulty these problems have caused, which, like in most non-clinical studies that use the measure, is not included in the scale. The questions on the PHQ-9 derive from the DSM-IV criteria for major depressive disorder (MDD); the instrument is therefore a valid indicator of major depression (Dbouk et al. 2007).

In this study, the cut-point selected for depression on the PHQ-9 was 10 on the scale from 0 to 27. This cut-point was selected because it is commonly used and a standard cut-point (Milette et al.). Previous research has found that when comparing the PHQ-9 and CES-D, the cut-point used to determine depression may matter for the prevalence of depression in the study (Dbouk et al. 2007; Milette et al.). Using higher cut-points on the PHQ-9 may lead to more agreement between the two measures (Dbouk et al. 2007).

The selection of cut-points in this study was determined after substantial consideration. Lower cut-points would result in higher levels of people having depression, while higher cut-points would result in lower levels of people having depression. Therefore, when comparing two different surveys, it is important that the cut-points accurately reflect as closely as possible depression levels at both points in time. That being said, while the selection of cut-points is particularly important for

determining absolute changes in depression over the past 40 years, it is less relevant to comparing relative changes in depression between men and women. Since the same cut-point is used within each survey for men and women, the sex gap in depression at either point in time, as well as the change in the sex gap over time, should not be driven by the particular cut-point used. One way to support this argument is to examine the distribution of depression scores for men and women using both surveys. Appendices 2.1 through 2.4 show that the distribution of scores is similar between females at both points in time and for males at both points in time. The primary difference in the distributions is that more men and women in 2008 report having zero symptoms of depression than in 1971, which are well below the cut-points. Furthermore, in addition to examining cut-points, I use a continuous depression severity score to analyze trends in the sex gap in depression over time. Using both of these outcome measures provides a sensitivity analysis to help overcome the use of different survey instruments in determining depression.

The two outcome measures of depression used in this study, depression and depressive severity, represent the two best options to analyze depression using different survey instruments. Another possible way to analyze depression was to examine specific questions across survey waves. This alternative was not feasible for two reasons. First, questions are worded differently and include different key words in each wave. For example, to register depressive affect, NHANES I asks respondents how often "I felt depressed," whereas the Continuous NHANES asks "I felt down, depressed, or hopeless." In terms of physiological symptoms of depression, NHANES I asks how often "My sleep was restless," whereas the Continuous NHANES asks if the respondent

had “Trouble sleeping or sleeping too much.” These are just a few examples to illustrate that while both survey instruments measure the same concept, the questions are not worded identically across surveys. Therefore, it would be impossible to accurately compare these specific questions to make conclusions regarding trends in the sex gap over time. The second reason I did not analyze specific questions is that taken separately, they do not measure depression. While each survey instrument was developed to measure depression when used as a whole, individual responses do not indicate depression. For example, someone could have trouble sleeping but experience no other symptoms of depression. If I compared these incompatible questions across waves I would only be able to generalize my results to *difficulty sleeping*, and not to depression, which is the goal of this paper.

Analysis

To recap, in this paper, I analyze two sets of outcome variables, both of which derive from the mental health instrument in the NHANES surveys: the CES-D and the PHQ-9. First, I analyze a dichotomous variable that indicates depression, based on a cut-point of the original score. The cut-points chosen were selected based on their applicability for the general population. For the CES-D, the cut-point was 20 on the original scale of 0 to 60, and for the PHQ-9, the cut-point chosen was 10 on the scale from 0 to 27. To analyze these dichotomous variables, I use logistic regression for survey analysis. Second, I examine both the CES-D and the PHQ-9 as a continuous variable. Although the response categories for both instruments are comparable and range from 0 to 3, the CES-D contains 20 questions while the PHQ-9 contains 9 questions. I rescaled the CES-D so

that both scales range between 0 and 27 so that the results can be interpreted. To do this, I used a linear transformation (see Equation 2.1).

Equation 2.1. $Score_{New} = {(Score_{Old} * 27)}/{60}$

Because the NHANES has a complex survey design, I use survey specific procedures to account for weights, and nesting within cluster and strata (National Health and Nutrition Examination Survey 1982, 2006, 2011b, 2011a).

Independent Variables

To examine sex differences in depression between 1971 and 2008, it is important to account for socio-demographic changes which may underlie any changes in the sex gap. In addition to the models that control for sex and survey year, the other independent variables include age and age-squared (to account for non-linear relationship between age and depression), race (measured as white or not white due to the limited race questions in the NHANES I), poverty (below 100 percent of the poverty threshold for each year), marital status (married or not), parental status (having children under the age of 18 in the home), educational attainment (BA or not), and employment status (currently has a job or not).

Most of these variables are measured the same way in each survey. However, an explicit indicator for parental status was not available in NHANES I. To generate parental status, I used the household roster (unfortunately, the ages of household members was not provided), and the relationship of the respondent to the head of household. A respondent was coded as being a parent if they were married and either the head of household or the spouse of the head and if the household contained more than 2

people, or if the respondent was the head, unmarried, and the household contained more than 1 person. They are coded as not being a parent when they live alone or with non-relatives, if they are the child or other relative. Additionally, a married adult who is the head or spouse of head in a household with two members was considered not a parent.

Methods

The results section is broken down into three parts to answer the three questions posed at the beginning of the paper. To recap, the first objective asks, *What was the relationship between sex and depression forty years ago, and what is it today? Has the sex gap in depression changed?* These questions are answered looking descriptively at the mean levels of depression and depressive symptoms by sex and year. The second objective is to examine the relationship between various social demographic characteristics and depression for men and women at both points in time. *Has the relationship between socio-demographic characteristics and depression changed for men and/or women over the past forty years? What factors protected people from depression, and what factors augment the risk for depression? Are the same factors associated with depression for men and women? At both points in time?* To address these questions, I separately examine depression and depressive severity for men and women by year (four analytical groups), adjusting for socio-demographic characteristics. The third objective is: *How do compositional changes affect the sex difference in depression?* To study compositional changes, I pool together both sexes and both years of data. I include female and survey year in the model, as well as the interaction between female and year. By adding in

control variables individually and then all together, I can examine what demographic shifts are responsible for the convergence in the sex gap I observe.

Results

In this paper, I examine the association between gender and depression in light of social changes that have occurred between 1971 and 2008. Figures 1 and 2 illustrate these demographic shifts for men and women. The average age of the population has increased by about 1 year for both sexes, but this difference is not statistically significant as the confidence intervals overlap. The percentage of the population that is white has decreased from about 89-90 percent to 72 percent for both sexes. In 1971, men ages 25 to 74 were more likely to have a BA than women, 17.8 percent versus 12.6 percent. In 2008, the percentage of the population with a BA has increased to 28.3 percent for males and 29.1 percent for females, resulting in a convergence and reversal in the sex gap in education. The percentage of the population that is currently married has decreased for both sexes over this period. In 1971, 85.0 percent of males were married, as were 72.3 percent of females. By 2008, 74.1 percent of males and only 67.0 percent of females were married. Thus, there was a decrease for both sexes, but a larger decrease in the proportion married among men than among women. Like being married, being a parent of children in the home is also less common in 2008 than it was in 1971. In 1971, 57 percent of both sexes had children living at home. By 2008, 42.9 percent of men and 45.3 percent of women were still parents. Having a job decreased slightly but significantly for men over this time period. In 1971, 82.9 percent of men had a job, and by 2008, 77.9 did. For women, there has been a massive increase in the percentage of

women with a job. In 1971, among women ages 25 to 74, 47.4 percent had a job. In 2008, 64.4 percent of women had a job. This shift decreased the sex gap in employment, but did not eliminate it, as men are still more likely to have a job. Finally, being in poverty has increased significantly for men, from 6.9 to 10.8 percent, but has not significantly increased for women. In summary, the largest socio-demographic shifts observed over this period include an increase in female employment, a decrease in the percentage of men and women who were parents and married, and a decrease in the percentage of the population who was white, though whites still represent the majority.

Objective 1

The first question this paper asks, *what were the levels of depression for men and women in 1971, and what are those levels in 2008? What about the sex gap in depression? T*o answer these questions, I compare the mean levels of major depression for men and women at both points in time. Figure 2.3 shows the means and 95 percent confidence intervals for the percentage of the population with major depression. A striking finding is that depression has become less prevalent among women, but has remained unchanged for men. In 1971, 13.7 percent of women had depression. In 2008, 8.9 percent of women were currently depressed. This is an absolute decrease of 4.8 percent, which translates into a 35.0 percent reduction in depression over these years. During the same period, men's average levels of depression decreased from 5.6 percent in 1971 to 5.1 percent in 2008. However, the confidence intervals overlap, so the decrease of 0.5 percent in the percent of depression among men is not statistically significant.

Change in the sex gap in depression is measured by combining the trends observed for men and women. Between 1971 and 2008, the sex gap in depression decreased from 8.1 percent to 3.8 percent. This is an absolute decrease of 4.3 percent, which means that over this 35 year period, the sex gap in depression was cut by more than half, specifically by 53.1 percent.

Figure 2.4 illustrates another way to examine change in the sex gap in depression. Here, logistic regressions were performed separately by year. In the null model, the only predictor variable is female. In the full model, all socio-demographic characteristics are included as covariates. In 1971, females were 2.7 times more likely to be currently depressed without controls, and 1.8 times more likely with controls. In 2008, women are 1.8 times more likely than men to have depression in the null model and 1.5 times more likely in the full model. In both the null and full models, women are more likely to have depression than men, and in both models, the sex gap decreases over time. However, the cumulative effect of socio-demographic controls had a larger impact in explaining the relationship between sex and depression in 1971 than in 2008. In 1971, the control variables explained 32.6 percent of the variation in the sex gap in depression. By 2008, the same socio-demographic controls explained only 14.1 percent of the variation in the sex gap in depression.

In addition to examining cut-points to represent having depression, I look at the sex gap in depressive severity, measured by the gap in the total depression scores seen in Figure 2.5. Depression severity scores range from 0 to 27. Men in 1971 had an average depression severity of 3.2, while in 2008, men's average severity score decreased to 2.3. This decrease of 0.8 points is statistically significant. For women, the average depression

severity score in 1971 was 4.4, and by 2008, their depression severity score significantly decreased to 3.4 points. The sex gap in depressive symptoms in 1971 was 1.3 points, and was 1.0 in 2008. Therefore, there was a slight decrease in the sex gap in depressive severity over this period, due to a decrease in depressive severity for both sexes but a larger decrease for women than men. As Figure 2.6 illustrates, however, the time trend in the sex gap in depressive severity appears to be completely explained by the inclusion of socio-demographic control variables in the model.

The answer to the question posed in the first objective is that while both sexes report lower levels of depressive severity now, only women are less likely to have depression in 2008 than in 1971. Furthermore, there is a significant decrease in the sex gap in depression, but there does not appear to be a decrease in the sex gap in depressive severity.

Objective 2

The second part of this paper is about the sex difference in the relationship between social characteristics and depression over time. *What was the relationship between sex, social factors and depression forty years ago, and what do those relationships look like today? Have these relationships changed over the past forty years?* In other words, this question tries to address the change in the sex gap in depression by asking if there have been changes in the 'causes' of depression over this period. Have certain social factors become either less or more important in predicting depression? To answer these questions, I look at the effects of social characteristics separately by sex and year, as

illustrated in Figure 2.7 and in Table 2.1 (depression), and in Figure 2.9 and in Table 2.2 (depressive severity).

Figure 2.7 show the odds ratios and 95 percent confidence intervals for the primary socio-demographic characteristics calculated from the full model where age, age-squared, the dummy variable for 'white,' as well as poverty, marital status, parental status, education, and employment status were also included in the model. Table 2.1 shows the beta coefficients, standard errors, and statistical significance for the same models. In models not shown, the social characteristics were added separately (along with controls for age and race). These results support the findings for the full models shown in Figure 2.7, with one exception: poverty had a larger effect on depression for both sexes and at both points in time when no other variables were included in the model than it does in the full model.

Figure 2.7 illustrates the finding that being in poverty is depressing for both men and women. The sex gap in the effect of poverty on depression is not significant at either point in time. Being in poverty approximately doubles the likelihood of being depressed for both sexes in 1971 and in 2008. The change over time in the effect of poverty on depression within each sex is not statistically significant.

As predicted, being married decreases the likelihood of having depression. Married women are between 47 and 45 percent less likely to be depressed than unmarried women in 1971 and 2008, respectively. Married men are 60 percent less likely to be depressed than unmarried men in 1971 and 41 percent less likely in 2008. However, there is no significant sex difference in the effect of marital status on depression at either

point in time. Furthermore, there is no significant change over time in the effect of marital status on depression for either sex, including for men.

Parental status has no significant relationship with depression for women in either 1971 or 2008. While not significant, the direction of the effect of motherhood on depression is positive in 1971 and negative in 2008. For men, being a parent has a positive effect on depression in 1971, but a negative effect on depression in 2008. Specifically, fathers were 83 percent more likely to be depressed than non-fathers in 1971, but were 31 percent less likely to be depressed than non-fathers in 2008. While the effect of being a father is significant in both waves, the *change* in the effect of fatherhood on depression is not as strong. Additional analyses (not shown) test the significance of the interaction between parent and year for men, which is significant at the $p<.10$ level. The effect of being a parent on depression is not significantly different for men and women within each wave. With respect to the time trend, there is no significant time trend in the effect of parental status for women, but the effect of being a father has flipped from exacerbating depression in 1971 to protecting against depression in 2008 for men.

Education is negatively associated with depression risk, as seen in the fact that having a BA protects against depression for both sexes and at both points in time. In 1971, having a bachelor's degree reduced depression by 74 percent for women and by 8 percent for males, though the effect of education on depression for males is not significant. Although this is big difference, the confidence intervals for men are particularly large for BA so the sex difference in 1971 is not statistically significant. In 2008, education reduced depression by 66 percent for women and by 62 percent for men;

the sex difference in the effect of education on depression in 2008 is also not significant. Furthermore, there is no significant time trend for either sex.

Finally, having a job is protective against depression for both sexes and at both points in time. In 1971, males with a job were 70 percent less likely to be depressed than unemployed men; in 2008, the protective effect of employment increased to 77 percent. The time trend for males is not significant, however. For females, on the other hand, there was a significant increase in the effect of having a job on depression between 1971 and 2008. In 1971, women with a job were 36 percent less likely to be depressed, but by 2008, they were 72 percent less likely to be depressed. To verify my results, I also analyzed these models when both waves of data were combined. In this analysis (not shown), I additionally included a variable for survey year and an interaction between job and year. The increase in the protective effect of having a job on depression is significant at the $p<.001$ level for females.

In this section, I asked whether there were any sex differences in the effects of social characteristics on depression at either point in time. Only one characteristic exhibited a sex gap: parental status has a stronger protective effect against depression for males than for females in 2008. In addition to sex differences, have been any changes in the effects of socio-demographic characteristics on having major depression for either men or women over time? The results show that there are two instances where there has been a change in the effects of social characteristics on depression. First, there was a significant change in the effect of being a parent for men, which went from exacerbating to protecting against depression over the past 40 years. Second, the effect of having a job is more protective against depression for women in 2008 than it was in 1971.

The relationship between social characteristics and depressive severity for males and females at both points in time is shown in Figure 2.8 and Table 2.2. There are no significant sex differences in the effect of social characteristics on depressive severity in either 1971 or 2008. Like the results for depression show, there are two cases where there is a time trend in the association between a social factor and depression. Being a parent protects males in 2008, whereas there was an insignificant positive effect of fatherhood on depressive severity in 1971. For females, the effect of having a job has become significantly more protective over time.

The relationship between social factors and depressive symptoms has remained relatively constant over time for both sexes. The two exceptions for both depression and depressive severity are parental status for males and employment status for females. However, given that the trend in the sex gap in depression was driven by trends in women's depression, it is unlikely that the change in the effect of fatherhood has contributed to the decrease in the sex gap in depression. On the other hand, it is possible that the change in employment status contributed to the trend in the sex gap in depression. In order to better understand the decrease in the sex gaps in depression and depressive severity, I examine compositional changes in the population in the next section.

Objective 3

The third question asks, *How do compositional changes affect the sex difference in depression?* For example, have women's greater educational attainment and increased labor force participation reduced the sex difference in depression? To answer this

question, data for both sexes and survey years was pooled and analyzed using logistic regression for survey analysis where the outcome is depression and regression where the outcome is depressive severity; the predictors include a dummy variable for female, survey year, and the interaction between female and year. By adding in the same socio-demographic characteristics described in the previous section, I examine whether or not there are changes in the level and significance of the interaction. In doing so, the compositional changes that are responsible for the decrease in the sex gap in depression between 1971 and 2008 are identified.

In Table 2.3, the beta coefficients, standard errors, and statistical significance when predicting depression are shown. Model 1 includes the dummy variables for female and year, the interaction female*year, age, age-squared, and the dummy for 'white'. Models 2 through 6 add each of the socio-demographic characteristics, being in poverty, married, having a BA, being a parent, and having a job, one at a time. Finally, Model 7 includes all variables together.

The first thing to notice in this table is that the coefficient for being female is positive and statistically significant at the $p<.001$ level for all of the models. Because this model also adjusts for year and the interaction female*year, the female coefficient can be interpreted as the sex gap in depression in 1971. Therefore, the fact that the variable female is statistically significant in all models implies that sex differences in social characteristics cannot completely explain the sex gap in depression in 1971. The second variable in the table is year, which can be interpreted as the change in the likelihood of a male being depressed between 1971 and 2008. The coefficient for year is significant and negative across all eight models which implies that men are less likely to be depressed in

2008 than they were in 1971, even controlling for changes in socio-demographic characteristics.

The third variable entered into the models is the interaction between female and year, which can be used to identify if there are changes in the sex gap in depression over time. The interaction is statistically significant in Models 1 through 5, but becomes insignificant in Models 6, which adjusts for employment status, and Model 7, the full model. This means that compositional changes in having a job can explain the significant decrease in the sex gap between 1971 and 2008. In order to better understand the change in the sex gap in depression, I compare the female*year coefficient from Model 1 to each of the following models and calculate the percentage of the change in the sex gap in depression that is explained by controlling for each socio-demographic characteristic.

Model 2 controls for being in poverty. Adjusting for changes in the percentage of men and women who are in poverty explains 11.1 percent of the trend in the sex gap in depression between 1971 and 2008. This finding makes sense given that poverty exacerbates depression, and that there was an increase in the percentage of males who were in poverty since 1971. The next model, Model 3, adjusts for changes in marital status over the period. Controlling for the percentage of the population who is currently married explains 10.1 percent of the decrease in the sex gap in depression since 1971. Recall that being married is protective against depression and that there has been a decline in marriage for both sexes, but particularly for males, since 1971. If there had not been a decrease in the proportion married, the decrease in the sex gap in depression over the past 40 years would have been slightly smaller.

In Model 4, changes in the percentage of the population with a BA explain 12.1 percent of the decrease in the sex gap in depression between 1971 and 2008. Over this period, there was an increase in educational attainment, particularly for women. Had educational attainment not increased, the decrease in the sex gap in depression would have been 12.1 percent smaller. Model 5 adjusts for parental status. Since 1971, there was a decrease in the percentage of men and women who had children living in the home from about 57 percent to about 45 percent in 2008. As shown in previous Figures and Tables, the relationship between depression and parental status for men and women at both points in time is confusing. It appeared as though being a parent may have increased depression in 1971 (though the effects were not significant for either sex), but that being a parent reduced the likelihood of depression in 2008 (significant only for men). That being said, controlling for parental status increases the time trend in the sex gap by 13.1 percent. Therefore, the change in the sex gap over the past 40 years would have been larger if there had not been a decrease in the proportion of men and women who are parents.

Employment status is adjusted for in Model 6. Controlling for changes in the proportion of the population with a job explains 66.7 percent of the decrease in the sex gap in depression between 1971 and 2008, and completely eliminates the statistical significance of the time trend. As shown in Figures 1 and 2, the percentage of men with a job decreased slightly since 1971, while the percentage of women with a job increased by over one-third. Furthermore, as shown in Figure 2.7, having a job protects people against depression, and there has been an increase in the protective effect for women over the period. Therefore, the increase in women's labor force participation, together with the

enhanced protection that women gain from employment today, has greatly diminished the sex gap in depression since 1971.

Finally, Model 7 includes all of the previously described social characteristics. Adjusting for all of these factors in the full model explains 87.9 percent of the trend in the sex gap in depression. Like in Model 6, the trend in the sex gap is no longer statistically significant once I control for changes in the composition of social characteristics for men and women. Therefore, the answer the third objective is that the decrease in the sex gap in depression between 1971 and 2008 is primarily attributable to the increase in female labor force participation over the past 40 years.

In addition to examining changes in the likelihood of having depression, I also analyze depressive severity in Table 2.4. Once again, the coefficient for being female is significant and positive across all models, indicating that women have higher levels of depressive severity than men in 1971. Second, the negative and significant year coefficient implies that there has been a decrease in depressive severity for men between 1971 and 2008. However, the year*female interaction is not statistically significant in any of the models. This result indicates that depressive severity has decreased for both men and women and that the sex gap in depressive severity has not changed significantly over the past forty years. Model 1 shows that in 1971, females' average depressive severity scores were 1.3 points higher than males'. In 2008, females' scores were 1.0 higher than males' on average. Between 1971 and 2008, male's average depressive symptoms scores decreased by 0.8 points. Therefore, although there was a 0.3 decrease in the sex gap between 1971 and 2008, the change in the sex gap in depression is not statistically significant. It is worth noting, however, that controlling for employment

status in Model 6 reduced female's excess depressive severity in 2008 to 0.8 points. None of the other socio-demographic characteristics have this large of an effect on changes in the sex gap in depressive severity. Therefore, while there has not been a statistically significant decline in the sex gap in depressive severity between 1971 and 2008, the observable decline is primarily attributable to compositional changes in women's employment.

Discussion

Depression is a major health problem that affects both sexes, but particularly women. Most research finds that women are between 1.5 and 3 times as likely as men to have depression. While biological sex differences likely contribute to the sex gap in depression, evidence that women's excess depression varies across subgroups, ages, countries, and over time suggests that social factors also play a role. In order to better understand the social factors that contribute to the sex gap in depression, this study examined trends in the sex gap in depression between 1971 and 2008. I asked whether there were trends in the sex gap in depression, and if so, why. In examining these trends, I found that there was a decrease in the sex gap in depression over the past 40 years. As illustrated in Figure 2.4, without controlling for any social characteristics, women in 1971 were 2.8 times more likely than men to have depression. By 2008, the sex gap was reduced and women were only 1.8 times more likely to be depressed than men.

Why did the sex gap in depression decrease? Because the sex gap in depression is a product of male and female depression levels, changes in the sex gap in depression can be understood by examining trends in depression for both sexes. In this study, I found

that 5.5 percent of men had depression in 1971, compared to 5.2 percent in 2008. This decrease in depression is small and not statistically significant. For women, on the other hand, 13.7 percent were depressed in 1971, but only 8.9 percent had depression in 2008. This means that over the past forty years, the percentage of women with depression was reduced by over one-third. Therefore, the decline in depression among women led to a narrowing of the sex gap in depression.

In addition to examining male and female trends, I examined the contribution of social factors to the trend in the sex gap in depression between 1971 and 2008. What role do changes in the sex differences in social characteristics play? As shown in Figure 2.5, I found that socio-demographic characteristics explained 35.0 percent of the sex gap in depression in 1971, but only 11.7 percent of the variation in the sex gap in depression in 2008. This suggests that the majority of the time trend in the sex gap in depression appears to be driven by sex differences in socio-demographic characteristics.

I argued that the change in the sex gap in depression could be due to one or both of the following factors. First, the relationship between socio-demographic characteristics and depression could have changed. I investigated this possible explanation for the trend in the sex gap in depression by separately analyzing depression for women and men in 1971 and in 2008. This explanation was largely unsupported by the data. Surprisingly, there has been little to no change in the majority of these relationships over time. As shown in Figure 2.7, there are only two cases where the relationship between a social factor and depression changed for either sex over the past forty years. The first example is that the effect of parental status on depression reversed for men between 1971 and 2008: fatherhood went from exacerbating to protecting against

depression. This change in the effect of fatherhood on depression was significant, but only marginally. Furthermore, recall that there has been no meaningful change in depression among men since 1971. Therefore, I conclude that the change in the effect of parental status on men's depression is not driving the decrease in the sex gap in depression. I also observed a change in the effect of employment status for women, where the protective effect of having a job grew stronger over the past forty years. Because the trend in the sex gap in depression was driven by a decrease in women's depression, it is possible that the increase in the protective effect of employment on depression could have contributed to a decrease in the sex gap between 1971 and 2008.

The second explanation is that compositional factors led to a decrease in the sex gap in depression. There were many dramatic changes in education, marital status, parental status, and employment status for both men and women over the past forty years. I found that the increase in female employment since 1971 explained the vast majority of the narrowing sex gap in depression. While other factors may contribute, changes in employment alone explain over two-thirds of the decrease in the sex gap in depression, rendering the time trend insignificant.

Ultimately, I conclude that female employment is responsible for the decrease in the sex gap in depression between 1971 and 2008 for two reasons. First, women's labor force participation increased dramatically, from 47 percent to 64 percent. This absolute change of 17 percent corresponds to a relative increase of over 36 percent in women's labor force participation. The second way that women's employment contributes to the narrowing of sex differences in depression is that employment is more protective against

depression today than it was forty years ago. Together, these two forces contributed to over a 50 percent reduction in the sex gap in depression between 1971 and 2008.

In addition to examining depression, I analyzed depression severity as a way to provide support for my empirical findings. When I look at depressive severity, a slightly different story emerges. Between 1971 and 2008, both men and women experienced an average decrease in depressive severity of about 1 point on a 27 point scale. Although the sex gap decreased slightly, the change over time was not significant. However, like for depression, I found that women's employment explains the change in the sex gap in depressive severity between 1971 and 2008.

The results from this study support previous research on time trends in the sex gap in depression. Earlier research found that between the 1950s and 1970s, sex differences in depression declined due to the increase in female labor force participation over that period (Ronald C. Kessler and McRae 1981). It is not surprising that increases in women's employment have reduced the disparity in depression between the sexes. As women have entered the workforce in increasing numbers, gender equality in the public sphere has improved. Other research has shown that gender equality leads to a diminished depressive symptoms in women (Chen et al. 2005). In addition to mental health outcomes, increases in women's employment has improved women's self-rated health (Schnittker 2007).

This paper used two survey instruments, the CES-D and PHQ-9 to estimate the prevalence of major depressive and severity of depressive symptoms. While these surveys are similar, they are not the same. To improve our understanding of the historical trend in the sex gap in depression, it would be beneficial to have nationally

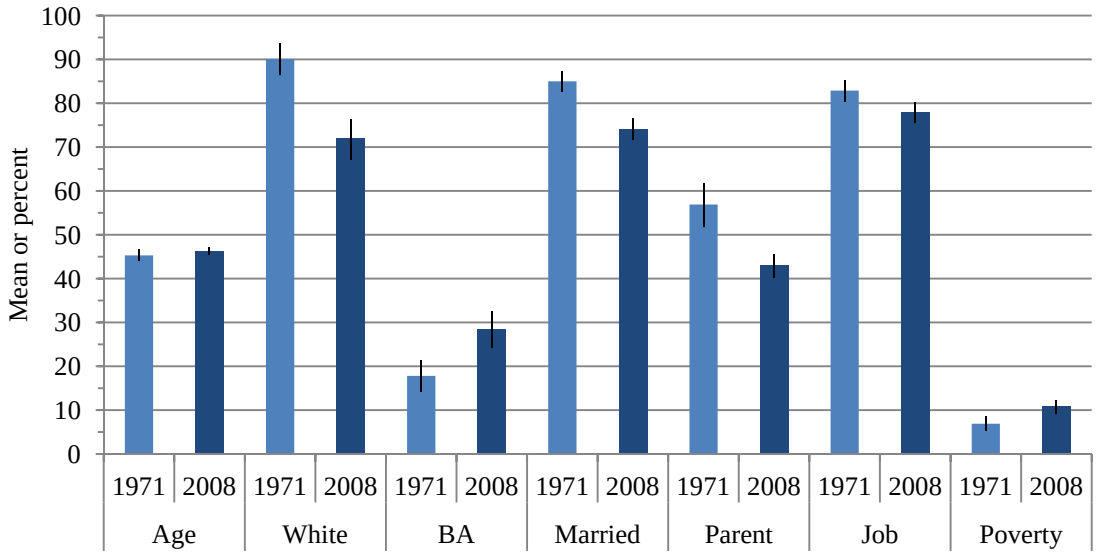
representative data for the same mental health instrument. At the time being, such data are not available. If new data becomes available that uses the CES-D, it would facilitate comparison to the data collected in the NHANES I.

This paper shows that the sex gap in depression has decreased between 1971 and 2008. Over this period, female labor force participation dramatically increased, which led to a subsequent decrease in the prevalence of depression for women. This is an important finding, and suggests that if women continue to increase their levels of employment, that the sex gap may be further diminished. However, there remains a sex gap in depression as well as a sex gap in employment. If the sex gap in employment was eliminated and an equal percentage of men and women were employed, what would happen to the sex gap in depression? Future research should address this question.

The sex gap in depression is smaller now than it once was, but it remains. Could any other socio-demographic factors not examined in this paper help to further reduce the gap? In addition to social explanations for sex differences in depression, biological factors and comorbidities with other diseases explain part of the gap. Ideally, research would be able to look at all of these explanations together, and to examine interactions between social factors and other types of explanations.

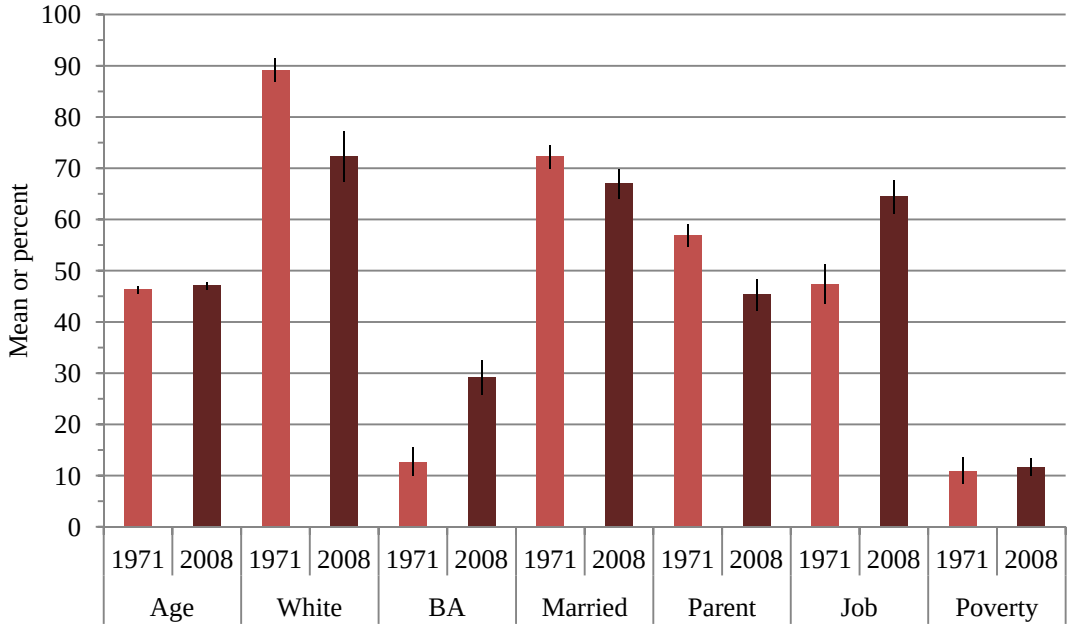
Tables and figures

Figure 2.1. Means and 95% confidence intervals for socio-demographic characteristics by year, males.



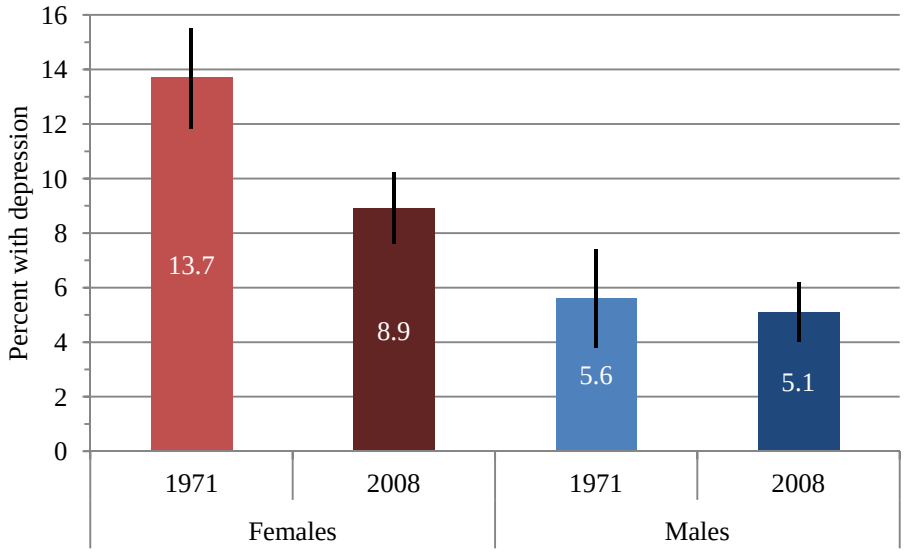
Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Figure 2.2. Means and 95% confidence intervals for socio-demographic characteristics by year, females.



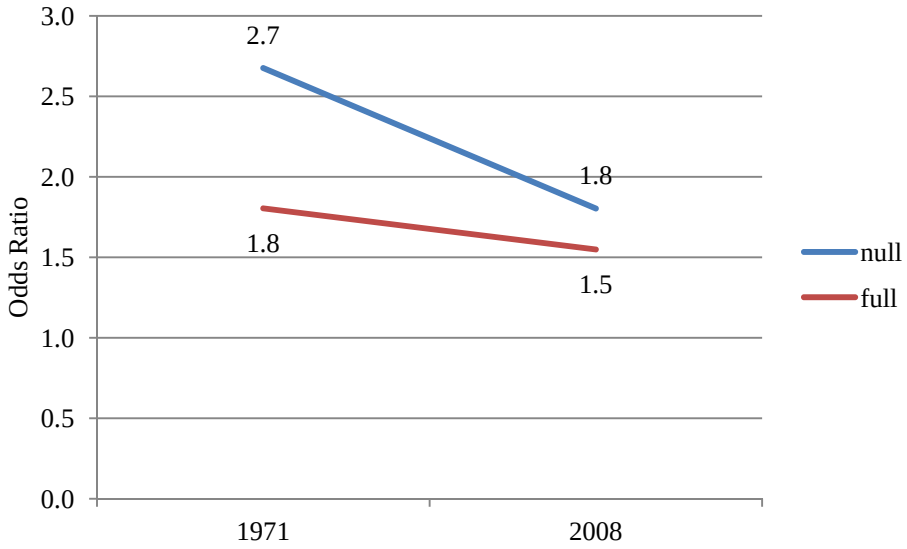
Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Figure 2.3. Objective 1: Percent with depression (and 95 % confidence intervals) by sex and year



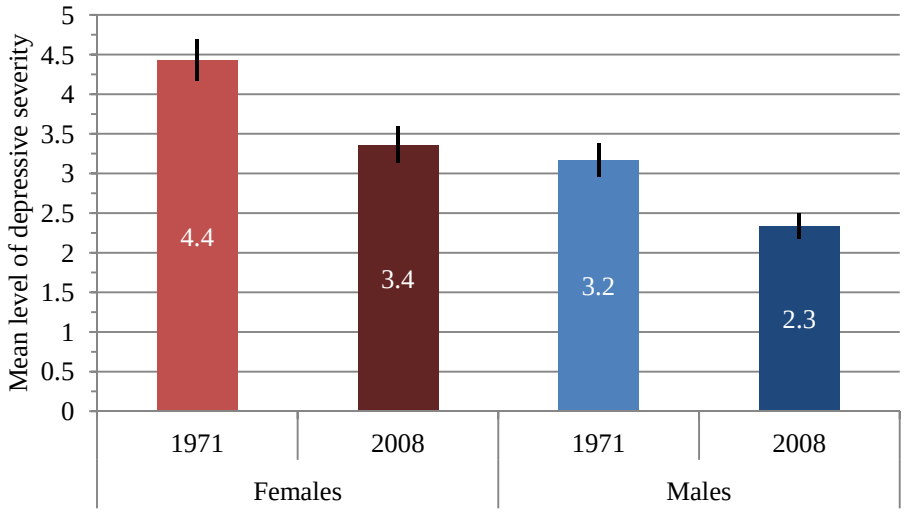
Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Figure 2.4. Predicted female odds ratios for logistic regression of depression, in models with and without control variables, by year



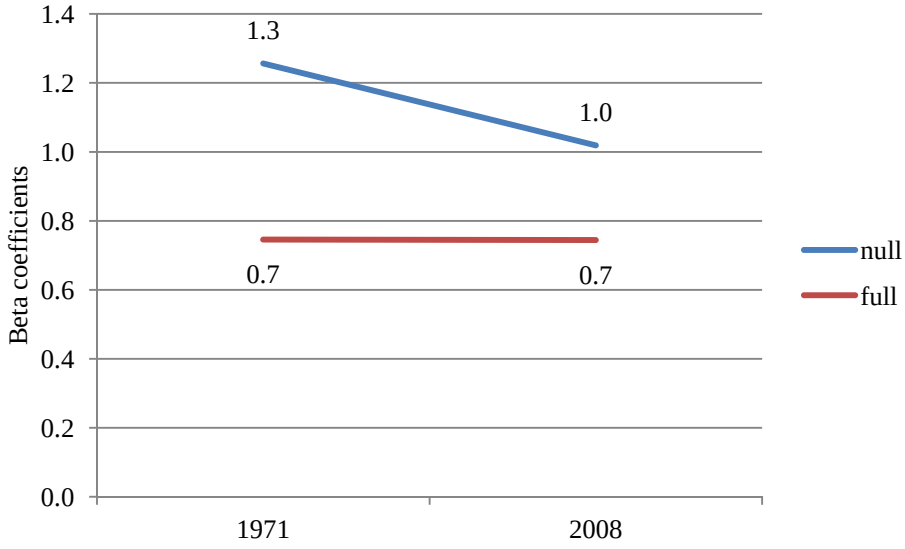
Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Figure 2.5. Objective 1: Mean levels of depressive severity (and 95 % confidence intervals) by sex and year



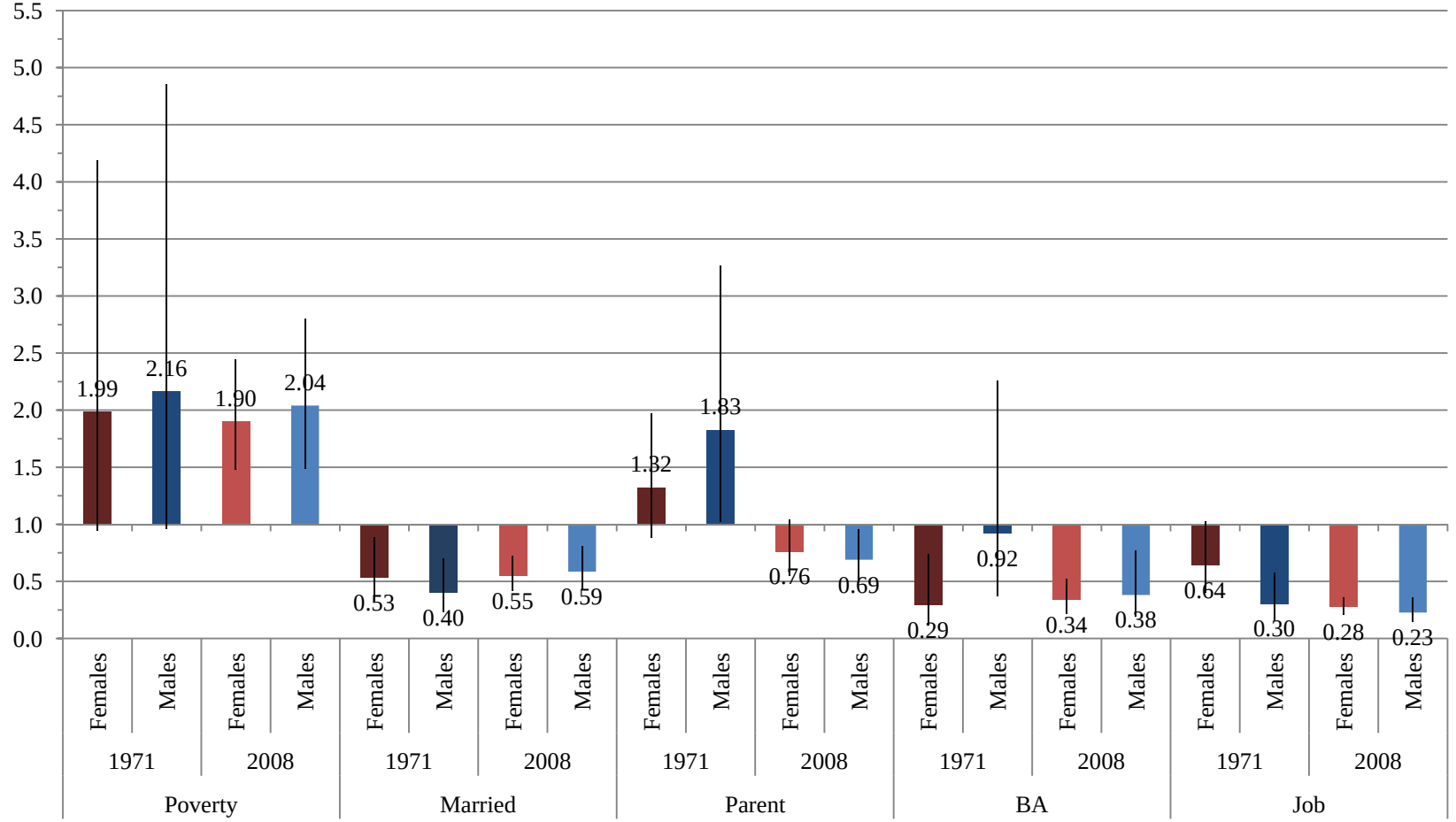
Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Figure 2.6. Female beta coefficients for regression of depressive severity, in models with and without control variables, by year



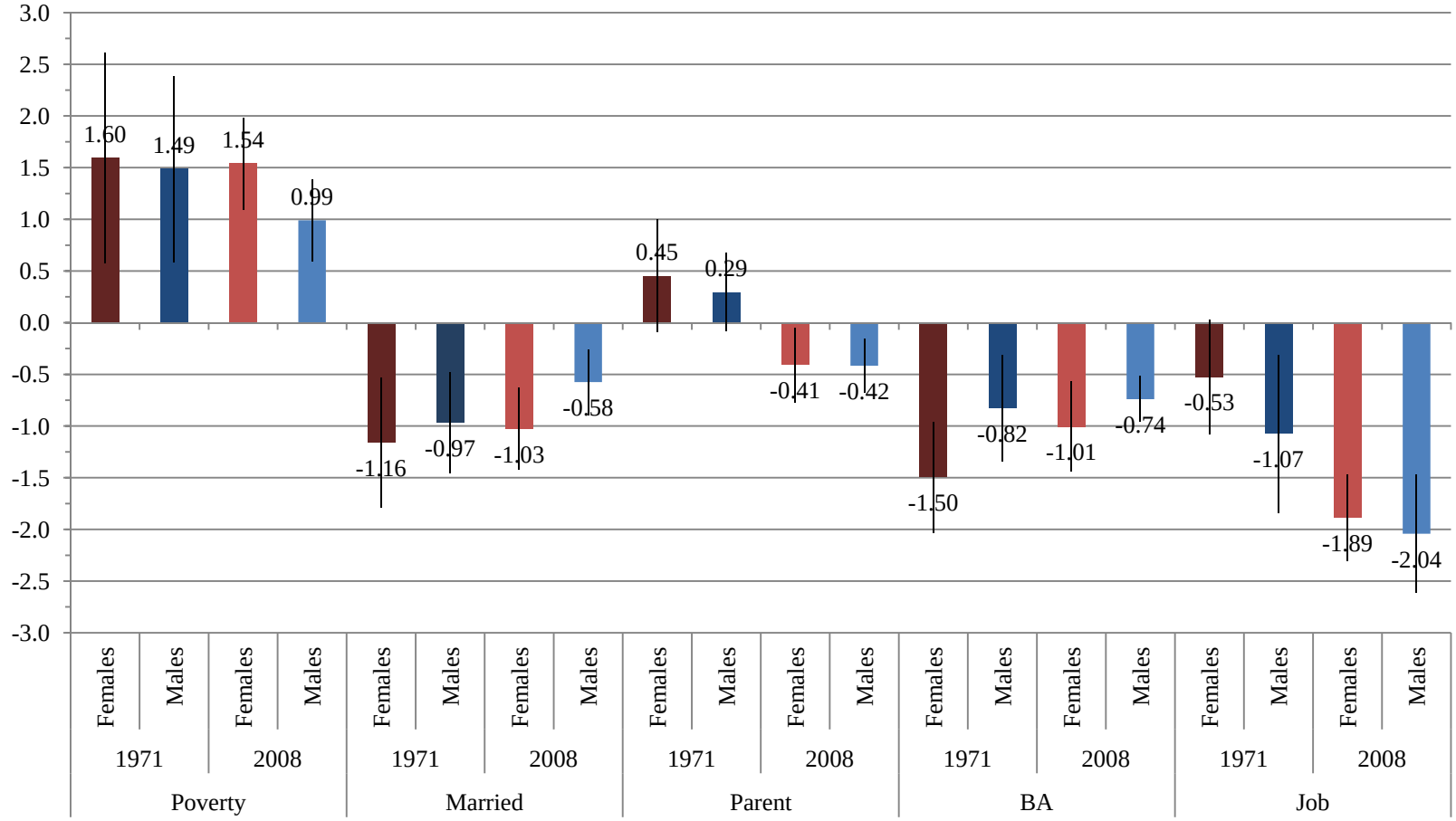
Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Figure 2.7. Objective 2: Odds ratios (and 95% confidence intervals) for logistic regression of depression on socio-demographic characteristics by sex and year



Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Figure 2.8. Objective 2: Beta coefficients (and 95% confidence intervals) for regression of depressive severity on socio-demographic characteristics by sex and year



Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Table 2.1. Objective 2: Beta coefficients and standard errors for logistic regression of depression on socio-demographic characteristics, separately by year and sex

	Male						Female					
	1971			2008			1971			2008		
	B	SE	Sig	B	SE	Sig	B	SE	Sig	B	SE	Sig
Intercept	-5.99	(2.09)	**	-6.02	(1.26)	***	-1.73	(0.94)	+	-5.12	(0.96)	***
Age	0.21	(0.10)	*	0.22	(0.05)	***	0.03	(0.05)		0.21	(0.05)	***
Age*Age	0.00	(0.00)	*	0.00	(0.00)	***	0.00	(0.00)		0.00	(0.00)	***
White	-0.49	(0.34)		-0.17	(0.18)		-0.11	(0.21)		0.04	(0.14)	
Poverty	0.77	(0.41)	+	0.71	(0.16)	***	0.69	(0.38)	+	0.64	(0.13)	***
Married	-0.92	(0.29)	**	-0.53	(0.16)	**	-0.63	(0.26)	*	-0.60	(0.14)	***
Parent	0.60	(0.30)	*	-0.37	(0.17)	*	0.28	(0.20)		-0.28	(0.16)	+
BA	-0.09	(0.46)		-0.97	(0.36)	**	-1.23	(0.47)	**	-1.08	(0.22)	***
Job	-1.19	(0.33)	***	-1.48	(0.23)	***	-0.45	(0.24)	+	-1.29	(0.14)	***

+ p<.10, * p<.05, ** p<.01, *** p<.001

Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Table 2.2. Objective 2: Beta coefficients, significance levels and standard errors for regression of depressive severity on socio-demographic characteristics, separately by year and sex

	Male						Female					
	1971			2008			1971			2008		
	B	SE	Sig	B	SE	Sig	B	SE	Sig	B	SE	Sig
Intercept	3.98	(0.69)	***	0.28	(0.54)		4.91	(1.28)	***	0.76	(0.91)	
Age	0.06	(0.04)		0.23	(0.03)	***	0.05	(0.05)		0.25	(0.04)	***
Age*Age	0.00	0.00		0.00	0.00	***	0.00	0.00		0.00	0.00	***
White	-0.33	(0.21)		0.13	(0.13)		-0.61	(0.41)		0.07	(0.17)	
Poverty	1.49	(0.45)	**	0.99	(0.19)	***	1.60	(0.51)	**	1.54	(0.22)	***
Married	-0.97	(0.25)	***	-0.58	(0.16)	***	-1.16	(0.32)	***	-1.03	(0.19)	***
Parent	0.29	(0.19)		-0.42	(0.13)	**	0.45	(0.27)		-0.41	(0.18)	*
BA	-0.82	(0.26)	**	-0.74	(0.11)	***	-1.50	(0.27)	***	-1.01	(0.21)	***
Job	-1.07	(0.39)	**	-2.04	(0.28)	***	-0.53	(0.28)	+	-1.89	(0.21)	***

+ p<.10, * p<.05, ** p<.01, *** p<.001

Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Table 2.3. Objective 3: Beta coefficients for logistic regression for predicting depression, pooled years and sexes (in two parts)

	1			2			3			4		
	B	SE	Sig	B	SE	Sig	B	SE	Sig	B	SE	Sig
Intercept	-4.11	(0.76)	***	-4.71	(0.69)	***	-4.11	(0.75)	***	-3.96	(0.76)	***
Female	0.40	(0.04)	***	0.38	(0.04)	***	0.36	(0.05)	***	0.39	(0.04)	***
Year	-0.20	(0.08)	**	-0.20	(0.07)	**	-0.23	(0.07)	**	-0.13	(0.08)	+
Year*Female	-0.10	(0.04)	*	-0.09	(0.04)	*	-0.09	(0.04)	*	-0.09	(0.04)	*
Age	0.09	(0.03)	**	0.10	(0.03)	**	0.11	(0.03)	**	0.09	(0.03)	**
Age*Age	0.00	0.00	**	0.00	0.00	**	0.00	0.00	**	0.00	0.00	**
White	-0.41	(0.10)	***	-0.22	(0.11)	*	-0.31	(0.10)	**	-0.32	(0.10)	**
Poverty				1.18	(0.15)	***						
Married							-0.70	(0.09)	***			
BA										-1.14	(0.21)	***
Parent												
Job												

Table 2.3. Continued

	5			6			7		
	B	SE	Sig	B	SE	Sig	B	SE	Sig
Intercept	-4.32	(0.60)	***	-4.06	(0.76)	***	-4.21	(0.68)	***
Female	0.41	(0.04)	***	0.25	(0.05)	***	0.23	(0.05)	***
Year	-0.20	(0.08)	**	-0.17	(0.08)	*	-0.17	(0.07)	*
Year*Female	-0.11	(0.04)	**	-0.03	(0.05)		-0.01	(0.05)	
Age	0.10	(0.03)	***	0.13	(0.04)	***	0.15	(0.03)	***
Age*Age	0.00	0.00	***	0.00	0.00	***	0.00	0.00	***
White	-0.41	(0.11)	***	-0.40	(0.10)	***	-0.12	(0.10)	
Poverty							0.71	(0.18)	***
Married							-0.67	(0.10)	***
BA							-0.90	(0.21)	***
Parent	-0.08	(0.08)					0.03	(0.09)	
Job				-1.15	(0.11)	***	-1.00	(0.12)	***

+ p<.10, * p<.05, ** p<.01, *** p<.001

Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Table 2.4. Objective 3: Beta coefficients and significance levels for regression for predicting depressive severity, pooled years and sexes (in two parts)

	1			2			3			4		
	B	SE	Sig	B	SE	Sig	B	SE	Sig	B	SE	Sig
Intercept	2.23	(0.52)	***	1.53	(0.54)	**	2.51	(0.50)	***	2.39	(0.51)	***
Female	1.26	(0.14)	***	1.18	(0.13)	***	1.12	(0.14)	***	1.20	(0.14)	***
Year	-0.93	(0.14)	***	-0.97	(0.14)	***	-1.04	(0.13)	***	-0.78	(0.14)	***
Year*Female	-0.23	(0.17)		-0.17	(0.16)		-0.17	(0.16)		-0.16	(0.16)	
Age	0.06	(0.02)	**	0.08	(0.02)	***	0.09	(0.02)	***	0.06	(0.02)	**
Age*Age	0.00	0.00	**	0.00	0.00	***	0.00	0.00	***	0.00	0.00	**
White	-0.50	(0.12)	***	-0.24	(0.12)	*	-0.37	(0.12)	**	-0.36	(0.11)	**
Poverty				2.11	(0.22)	***						
Married							-1.12	(0.11)	***			
BA										-1.25	(0.13)	***
Parent												
Job												

Table 2.4. Continued

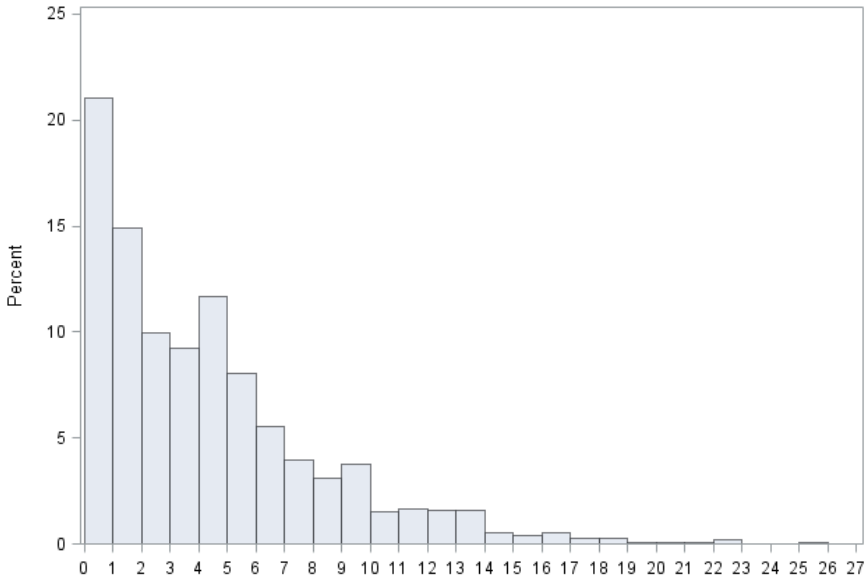
	5			6			7		
	B	SE	Sig	B	SE	Sig	B	SE	Sig
Intercept	2.05	(0.51)	***	2.53	(0.52)	***	2.38	(0.51)	***
Female	1.26	(0.14)	***	0.72	(0.15)	***	0.59	(0.15)	***
Year	-0.95	(0.14)	***	-1.01	(0.14)	***	-1.00	(0.13)	***
Year*Female	-0.23	(0.17)		0.11	(0.16)		0.20	(0.15)	
Age	0.08	(0.02)	***	0.13	(0.02)	***	0.15	(0.02)	***
Age*Age	0.00	0.00	***	0.00	0.00	***	0.00	0.00	***
White	-0.47	(0.12)	***	-0.45	(0.11)	***	-0.07	(0.11)	
Poverty							1.46	(0.21)	***
Married							-1.00	(0.10)	***
BA							-0.95	(0.12)	***
Parent	-0.17	(0.10)	+				-0.05	(0.10)	
Job				-1.58	(0.16)	***	-1.33	(0.15)	***

+ p<.10, * p<.05, ** p<.01, *** p<.001

Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

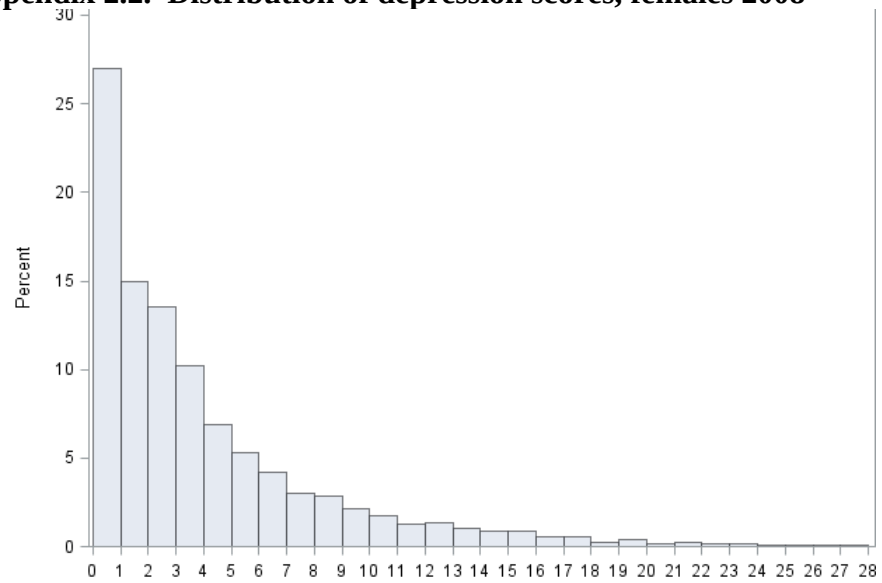
Appendix 2

Appendix 2.1. Distribution of depression scores, females 1971



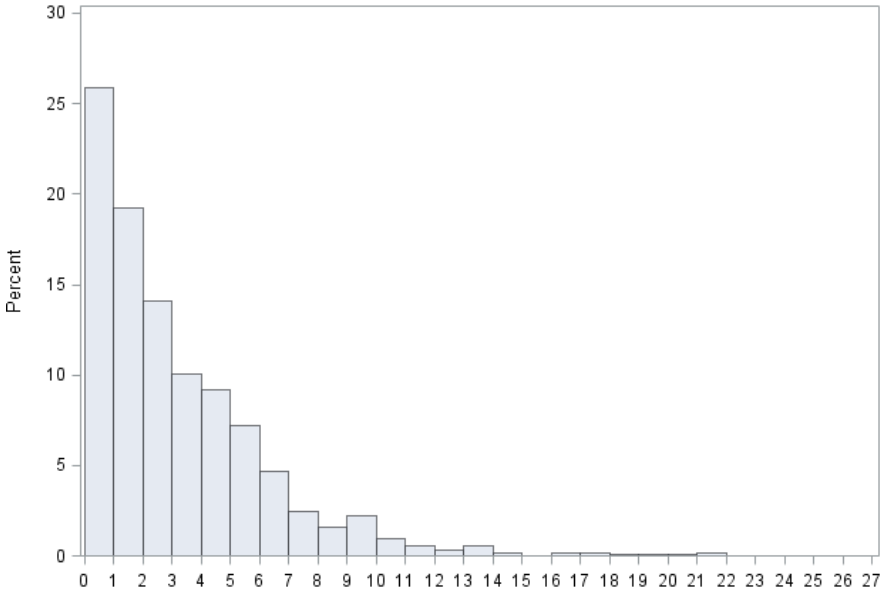
Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Appendix 2.2. Distribution of depression scores, females 2008



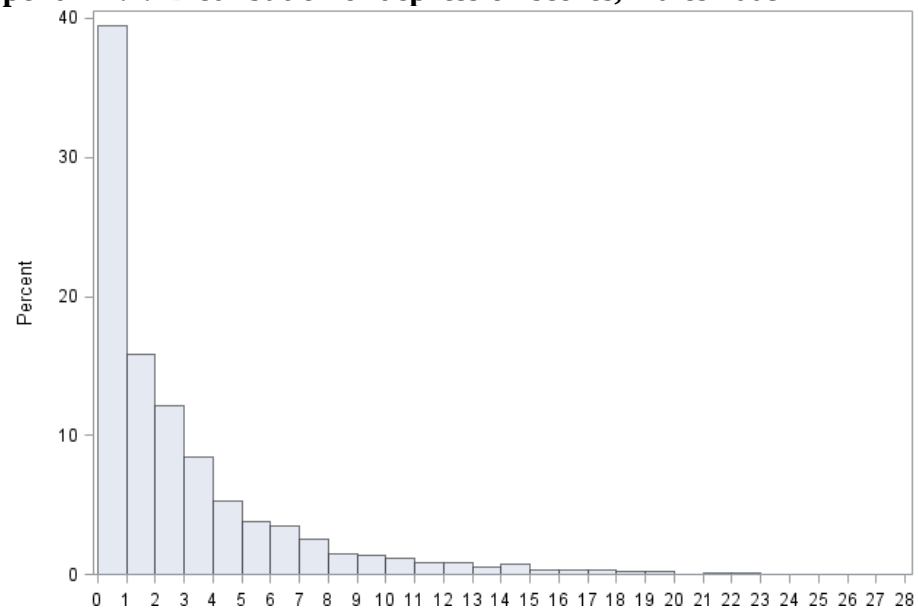
Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Appendix 2.3. Distribution of depression scores, males 1971



Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

Appendix 2.4. Distribution of depression scores, males 2008



Source: National Health and Nutrition Examination Survey (NHANES 1, 1971-1975; Continuous NHANES 2005-2008)

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CHAPTER 3: Aging, gender and depression

Is aging depressing? Popular belief, as well as a general consensus in the fields of gerontology and mental health, holds that aging is associated with an increased risk of depression (Newmann 1989). Most arguments for the positive association between age and depression pertain to the aging process: aging is usually associated with diminished physical and cognitive health, often comes with transitions from living with a partner to being widowed, living alone, and possibly living in a nursing home, retirement and reductions in economic stability. All of these factors are positively associated with depression, so it would make sense if aging led to an increase in depression.

In addition to this "gross" effect of the aging process, aging itself could be depressing: there could be a "net" effect of age that remains after adjusting for these other life transitions. For example, older age could be more depressing because people's social networks narrow as their peers die, and limited social support has been shown to be associated with increased depression among the elderly (La Gory and Fitpatrick 1992). Another part of the net age effect could include diminished cognitive function and increased dementia, which are also depressing (Wu, Schimmele, and Chappell 2012). Additional explanations for the net effect of age on depression may include changes in living situations, such as being institutionalized (Snowdon 2001; Valvanne et al. 1996), or lacking transportation (La Gory and Fitpatrick 1992). Depression among the elderly is also associated with comorbid anxiety (Gottfries 1998). While there are a variety of reasons for a net age effect, the goal of this paper is not to select among possible

mechanisms. Instead, I seek to establish whether there is a direct effect of aging net of other factors.

However, empirical research on aging and depression is inconclusive to say the least, and contradictory at worst. A few studies do find that depression increases with age (Luppa et al.; Sonnenberg et al. 2000), while others show the opposite – that depression actually decreases as people age (Bebbington et al. 1998; Cairney and Wade 2002; Christensen et al. 1999; Jorm 2000; Korten and Henderson 2000; Kroenke and Spitzer 1998; McGuire et al. 2009). Still other research shows that the relationship between age and depression is nonlinear, and that it follows either a U-shaped (Kessler et al. 1992; Mirowsky 1996; Mirowsky and Ross 1992) or inverse U-shaped (Newmann 1989) pattern. Finally, other studies find that there is no real relationship between age and depression, or that the relationship is too inconsistent to pin down (Djernes 2006; Glaesmer et al. 2011; van Grootheest et al. 1999).

Research is unclear on the relationship between age and depression for many reasons, including using small and unrepresentative data sets, operationalizing age in various ways, considering different age ranges, and measuring depression with diverse instruments. Even if all of these dissimilarities could be addressed, our understanding of the relationship between age and depression would remain uncertain for several reasons. First, the vast majority of research uses cross-sectional data as opposed to longitudinal data. Cross-sectional data allows for comparisons of different people at different ages, while longitudinal data can capture the effect of age itself on the same individual over

time. This is potentially problematic because some research suggests that there may be cohort differences in the relationship between age and depression (Bebbington 1996; Kessler et al. 1992; Luppa et al.; Newmann 1989). Second, research has not been able to disentangle the effect of the aging process from the potential effect of age *per se* on depression. This distinction between the gross effect of the aging process, which includes the association between age and diminished health, widowhood, and retirement, among other life changes, and the net effect of age itself on depression, is important for understanding how, and how much, caretakers can address depression among the elderly. Much of the research suggests that the increase in depression associated with age is actually attributable to decreases in health. Some research goes as far as saying that age, or "maturity", actually protects people from depression once controls for health changes are factored in (Djernes 2006; Mirowsky and Ross 1992; van Grootheest et al. 1999). However, because these assertions derive from cross-sectional data, they are inconclusive. We need to examine longitudinal data to fully understand the relationship between age and depression.

What about the role that gender plays in the relationship between age and depression? Research on gender and health has consistently found that women are more likely to be depressed than men. While part of the explanation may be biological, historical and cultural variation suggests that there is a social component to the sex gap in depression. Many social characteristics are related to an individual's risk of depression, including age, race, education, poverty, marital status, and employment status. Part of

the sex gap in depression is explained by sex differences in these risk and protective factors. Whether or not the sex gap in depression remains constant over the lifespan is a topic of much debate. Like the literature on aging and depression, there are many theoretical and empirical inconsistencies regarding the relationship between gender, age and depression.

One hypothesis is that the sex gap in depression is attributable to both the social and biological implications of the reproductive years. Some research has shown that the sex gap in depression emerges during young adulthood and disappears after women go through menopause (Bebbington et al. 1998; Korten and Henderson 2000). Another hypothesis is that the sex gap in depression increases as people age, because older women are at a greater risk of becoming widowed and falling into poverty than are older men (Moen 1996; Luppa et al.). Yet another hypothesis is that the sex gap in depression should remain constant over the life course, given the evidence that throughout their lives, women are consistently at a greater risk for depression (Cairney and Wade 2002; Hopcroft and Bradley 2007; Glaesmer et al. 2011; Kessler et al. 1992; McGuire et al. 2009; Sonnenberg et al. 2000; van Grootheest et al. 1999).

To summarize, research on aging, gender, and depression is contradictory and leaves us unable to fully understand these complex relationships. Do people become more or less depressed as they age? What explains the change in depression that occurs with age? Do changes in marital status, employment, and health explain the brunt of the change in depression? Or, does age *per se* have a direct effect on depression? What

happens to the sex gap in depression as people pass through their middle and elderly years? And finally, are there cohort differences in the age trend in depression? We do not know the answers to these questions because of data and methodological limitations of previous research. In this paper, I examine the relationship between gender, aging, and depression using longitudinal and nationally representative data from the Health and Retirement Study (HRS). In doing so, I find that age *per se* does not increase depression until age 75, after which point depression increases for both men and women. While social and health changes explain the majority of the increase in depression with age, I find that age itself has a net effect on depression levels. The sex gap in depression decreases after age 75 because the aging process has a stronger effect on men's depression than on women's. And finally, I find no support for the claim that the age trend in depression is due to cohort differences, which has been a major criticism of cross-sectional research. Instead, the measurement of age itself seems to be an important underlying explanation for the contradictory research on aging, gender and depression. A nonlinear measure of age, such as the age spline used in this study, more accurately represents the trend in depression over the middle to elderly years.

Theoretical Considerations

Aging and depression

As previously noted, empirical research on aging and depression is not only inconclusive, but also contradictory. The following discussion of the literature is summarized in Appendix 3.1. A few studies find that depression increases with age. For example, a

meta-analysis of studies that examine the relationship between age and gender on depression during latest life (ages 75 and older) found that late-life depression is common and often increases up to the very oldest ages (Luppa et al.). However, they note that this increase could be explained by an increase in risk factors and that age itself may not be the cause of the increase in depression (i.e., that there is no net age effect). In this meta-analysis, age is treated as a categorical variable, using five-year age increments. Another study, which examined Dutch adults between the ages of 55 and 85, also found an increase in depression for both sexes over age, using five-year age categories (Sonnenberg et al. 2000).

However, many more studies find that, contrary to popular belief, depression actually decreases as people age. For example, in another meta-analysis of the literature, Jorm (2009) found that aging *per se* reduces depression. This pattern was not initially evident, and only emerged after controlling for other risk factors. In other words, while the gross age effect was unclear, Jorm found a consistent negative relationship between depression and the net effect of age. In a study of Canadians ages 20 and older, the risk for major depressive episodes was found to decrease for both sexes over age (Cairney and Wade 2002). The study dichotomized age at 55; for both sexes, adults over age 55 were about 50 percent less likely to be depressed than adults under age 55. Another study, of adults aged 65 and older in the United States, dichotomized age at 75 (McGuire et al. 2009). They found that adults between ages 65 and 74 were more likely to be depressed than adults aged 75 or older, but did not specifically examine net versus gross age effects.

Other studies operationalize age differently. A study using an Australian sample and ten-year age categories found that age is negatively correlated with depression (Christensen et al. 1999). Another Australian study, which also measured age in ten-year age categories, also found a decrease in depressive symptoms at older ages (Korten and Henderson 2000). One criticism of this study is that they are missing elderly people who are institutionalized, who are most likely more depressed than those who are not institutionalized (Snowdon 2001).

Another common pattern is that age has a nonlinear association with depression. For example, in a study of US adults covering the age range 19 to 96, Kessler et al. (1992) found that depression followed a U-shaped pattern: depression was higher at age 25, lowest at age 50, and then higher around age 75. Mirowsky and Ross (1992) found similar results in their study of US ages 18 to 90. They argued that the age pattern is not a perfect U-shaped relationship: young adults are more depressed than middle aged adults, but the elderly are the most depressed. This study expands upon the analysis of age and depression by examining the trend in conjunction with other factors that contribute to depression, and conclude that being older is not in itself depressing.

Still other research finds that there is no real trend in the relationship between age and depression. For example, in a study of German elderly aged 60 to 85 and five-year age categories, there was no clear age pattern to depression for either men or women (Glaesmer et al. 2011). Two other studies, one of Italian elderly and another of Dutch elderly, found that there was no effect of age on the depression when controlling for other

variables (Minicuci et al. 2002; van Grootheest et al. 1999). In a meta-analysis of research on depression among Caucasian elderly populations, several trends were observed: some studies showed that age was positively associated with depression, others that the association was negative, and others found no trend with age (Djernes 2006).

So, what are we to make of the relationship between age and depression? Inconsistencies in the literature derive from several factors. First, the majority of studies on aging and depression focus on small community surveys or even clinical samples, so the findings are not necessarily generalizable to the general population. Second, the age range considered varies from study to study: some look at a wide range of ages, from 18 to 91 (thus having a small sample of elderly respondents), while others focus on the older adult population, for example, from ages 55 or 65 to 85. The conclusions we draw regarding the relationship between age and depression are likely to differ depending on if aging means comparing young adults to middle aged adults to the elderly, or if aging refers to passing through the last several decades of life. Third, age is operationalized differently, and often poorly, in many studies. In my review of the literature, I was surprised by how many studies treated age as a categorical variable (eight of the studies cited above) or a binary variable (three studies). Only five of the studies measured age using age and age-squared.

Putting age aside, a fourth reason for all of the disparities is the measurement of depression. Depression is often measured in two general ways: either as a summary score of depression severity, as in surveys like the Center for Epidemiological Studies

Depression Scale (CES-D) and the Patient Health Questionnaire-Nine (PHQ-9), or it is more formally diagnosed in a clinical way, with respect to the criteria specified by the Diagnostic and Statistical Manual of Mental Disorders (DSM), in surveys such as the Composite International Diagnostic Interview (CIDI). As it turns out, studies that use the former depression severity instrument find a very different relationship between depression and age than do studies that use the diagnostic measure of clinical depression (Newmann 1989).

In her review of research on depression and aging, Newmann (1989), Newmann describes two general trends in the relationship between age and depression: a U-shaped pattern and an inverse U-shaped pattern. She finds that studies that use measures of depression severity, such as the CES-D, often find a U-shaped relationship between age and depression. Studies that use diagnostic indicators of clinical depression, on the other hand, find an inverse U-shaped pattern. The operationalization of depression is important to studying the relationship between aging and depression. Proponents of depression severity scores are often interested in social factors associated with differences in depression between subgroups (Newmann 1989). She argues that the rise in depression toward the end of life may reflect the types of questions used in the CES-D. The CES-D incorporates four categories of questions, including depressive affect (feeling sad, depressed, or blue), somatic symptoms or "malaise" (lacking energy, could not get going, sleep problems), social isolation (nobody likes me), and positive affect (enjoying life). These dimensions may result in a potential age bias: "a number of investigators have

argued that composite scale scores may be disproportionately inflated among elderly persons as a consequence of various types of physical malaise that older persons commonly experience more than their younger counterparts" (Newmann 1989:161). However, several studies have investigated this claim, separating out the depressive affect and somatic symptoms questions in the CES-D and have concluded that there is no separate age pattern between these dimensions, and that somatic symptoms do not explain the trend in the relationship between age and depression that they observe (Kessler et al. 1992; Mirowsky and Ross 1992). If the disparity in the age pattern of depression is not attributable to somatic symptoms, what is it attributable to?

As previously noted, studies that use clinical diagnostic indicators of depressive disorders generally find an inverse U-shaped relationship between age and depression over the lifespan. In other words, they find that depression decreases during the elderly years. Newmann (1989) argues that this may be explained by why and how the CIDI is used to diagnose depression. Proponents of the diagnostic approach are trying to figure out who needs help from mental health professionals, and what kind of help they need. As a result, they aim to diagnose people with a specific disorder, such as Major Depressive Episode (MDE). According to the DSM, before someone is diagnosed with a MDE, a number of exclusionary criteria have to be ruled out so that the depression is not due to, for example, a physical illness or condition, medication, drugs or alcohol, or bereavement. These exclusionary criteria have been called into question because they may tend to produce underestimates of the prevalence of depression (Goldney, Fisher,

and Hawthorne 2004; Slade and Andrews 2002), especially in the elderly population since they are more likely to attribute their depression to physical illness (Knäuper and Wittchen 1994; Newmann 1989) or bereavement (Corruble et al. 2009). Note that not all studies that use the CIDI as a measure of depression use these exclusionary criteria.

Aging per se, or poor health associated with aging? Another question that remains regarding the relationship between aging and depression is does aging per se have an effect on depression, or does the effect of aging operate through its association with other life changes? Much of the research suggests that the increase in depression associated with age is actually attributable to diminished health. Some studies even argue that there is a protective net effect of age, or "maturity," on depression that becomes clear when you control for health changes (Djernes 2006; Mirowsky and Ross 1992; van Grootheest et al. 1999). For example, one study concludes that "With all the functional and social statuses adjusted, predicted depression drops throughout the lifetime. The residual decline in depression suggests an underlying benefit of maturity." (Mirowsky and Ross 1992:201). However, given that these studies use cross-sectional data, they may not be able to accurately disentangle the effects of aging and declining health on depression. Longitudinal data is better suited to answering this question, because it enables an examination of health changes and aging on depression outcomes.

Gender, aging and depression

What about the role that gender plays in the relationship between age and depression? Before answering that question, let me first summarize where research stands on gender

and depression in general. A predominant and consistent finding is that women are more likely to be depressed than men. While part of the sex gap explanation may be biological, historical and cultural variation suggests that there is a social component to the sex gap in depression. Many social characteristics are related to an individual's risk of depression, including employment status, marital status, education, and poverty, among others. Due to the fact that these characteristics are distributed differently between men and women, part of the sex gap in depression is explained by sex differences in these factors. Employment is probably the most notable social explanation for the sex gap in depression. Between the 1950s and 1970s, the increase in women's labor force participation explained 20 percent of the decreased sex gap in depression that was observed over that period (Kessler and McRae 1981). Between 1970 and the present, the additional increase in women's labor force participation explained 100 percent of the diminished sex gap in depression observed over the past 40 years (Medalia 2012). In addition to employment, women are less likely to be married, more likely to fall into poverty, and experience worse health than men, all risk factors for depression. Not only are women more likely to experience personal hardships, but they are also more susceptible to adverse events that occur within their social network, since they often have more extensive and stronger social ties to their networks (Kessler and McLeod 1984). Although most would agree that more women are exposed to these risks than are men, there is disagreement as to whether or not men and women experience these hardships differently. Some argue that women are doubly disadvantaged when it comes to these

undesirable life events: women are simultaneously more exposed to these hardships and also are more emotionally responsive to them (Kessler and McLeod 1984). However, other research finds that not being currently married (Sonnenberg et al. 2000; van Grootheest et al. 1999), or having a lower income (Sonnenberg et al. 2000), have a more profound effect on men's depression than on women's. Clearly, more research is needed to sort out the role that social factors play in determining the sex gap in depression.

Research is divided as to whether or not the sex gap in the risk of depression remains constant over the lifespan. One hypothesis is that the sex gap in depression is attributable to both the social and biological implications of the reproductive years. In a study of the British population ages 16 to 64, Bebbington et al. (1998) finds that women are more likely to be depressed than men before age 55, though there is some variation in the sex gap. After age 55, however, they find that men are more likely to be depressed than women. In other words, they find evidence not only for convergence in the sex gap, but also for a reversal. Additional research has found evidence for a convergence in the sex gap in depression over the lifespan (Korten and Henderson 2000). Retirement may also contribute to a decrease in the sex gap in depression as people age. Although it is changing, historically, men have been more attached to the labor force than women, so they are at greater risk of retiring than are women. Furthermore, retiring may trigger more depression in men than in women, since research shows that decreases in income have a stronger negative effect on men's depression than on women's (Sonnenberg et al.

2000). As a result, depression may increase more for men than women after retirement, leading to a narrowing of the sex gap in depression.

Another hypothesis is that the sex gap in depression increases as people age (Moen 1996). As people enter their elderly years, they often experience significant life changes that may put them at greater risk for depression. The elderly are more susceptible to becoming widowed and to falling into poverty. Gender is integrally related to these processes. Women are more likely to become widowed as their husbands die, since male life expectancy is lower than female life expectancy. Elderly women are also more likely to be in poverty as men, in part because of losing a spouse that may have supported them, but also because women tend to earn less and work less than men, and therefore have less savings to support them during old age. Thus, if the risk of depression does increase toward the end of life, these factors may contribute to a larger increase for women than for men, leading to further divergence in the sex gap in depression. Empirical support for this pattern is inconclusive, but in a meta-analysis of research on aging and depression, the majority of the community studies analyzed found evidence for an increase in the sex gap in depression as people passed through their elderly years (Luppa et al.).

Yet another hypothesis is that the sex gap in depression should remain constant over the life course. While it may be true that women are more at risk for becoming widowed and falling into poverty at old ages, they are also at a greater risk during their middle years, since, for example, they are less likely to be employed than men

(Mirowsky and Ross 1992). Indeed, several studies find no age trend in the sex gap in depression (Cairney and Wade 2002; Hopcroft and Bradley 2007; Glaesmer et al. 2011; Kessler and McRae 1981; Kessler et al. 1992; McGuire et al. 2009; Sonnenberg et al. 2000; van Grootheest et al. 1999). Ultimately, like the research on depression and aging, it is unclear what the relationship is between sex and depression as people age through their elderly years.

Potential contamination of age by cohort effects. Some research suggests there is a need to explore the role that birth cohort may play in the relationship between age and depression (Bebbington 1996; Kessler et al. 1992; Luppa et al.; Newmann 1989). For example, in a summary of the literature, Bebbington (1996) finds a consistent decline in depression with age in a number of studies, suggesting a cohort effect of increasing levels of, and possibly earlier onset of, depression. Other studies point out that the age effect they observe could be alternatively attributable to a cohort effect (Jorm 2000; Kessler et al. 1992), and that longitudinal data could help disentangle the perennial age-period-cohort problem.

Social status, health and depression among older populations. People of all ages are less likely to be depressed if they are married, employed, and in good health puts. There is less research on the effects of these social factors on depression specifically among older adults. However, the findings of this research are summarized here. One study found that the effect of no longer/not being married (compared to currently being married), was significantly greater for men than women – it increased men's risk of

depression by about 300 percent and women's risk by about 200 percent (Sonnenberg et al. 2000). Similarly, another study found that widowhood had a stronger association with men's depression than women's (van Grootheest et al. 1999). Having a lower income increased depression among both sexes (McGuire et al. 2009), but particularly for men (Sonnenberg et al. 2000). Being employed full-time was less depressing than other employment statuses, including part-time employment (Mirowsky and Ross 1992). Unsurprisingly, poor health, which encompasses self-rated health, chronic or physical illness, functional limitations, cognitive impairments, and disability, increases depression for both sexes (Djernes 2006; McGuire et al. 2009; Sonnenberg et al. 2000).

Research Questions

In this study, I ask five primary research questions.

1. How does the gross aging process affect depression severity? Is this process the same for men and women? Based on the literature, there are several possible relationships. Aging could be associated with both linear and nonlinear increases and decreases in depression, or there could be no observable trend over age.
2. How do other transitions, like changes in marital status, employment status, and levels of health, affect depression? Do these factors affect depression similarly for men and women?
3. Do these factors explain the effect of age on depression? Alternatively, does age have an effect on depression that is net of these other life changes? The literature

suggests that entire relationship between aging and depression may be explained by the association between age and other life transitions.

4. Are there any significant cohort differences in the age pattern of depression? The literature suggests that cohort differences may explain cross-sectional age patterns in depression.
5. Finally, what happens to the sex gap in depression as people age? Does the sex gap widen, shrink, or remain constant throughout the later years of adult life? Again, the literature is not clear on what to expect with respect to the relationship between age, sex, and depression.

Data and Methods

The data for this study derive from the Health and Retirement Study (HRS). The HRS is a longitudinal and nationally representative panel survey of Americans over the age of 50. The HRS data are often used to examine changes in labor force participation, marital status, and health changes among individuals ages 50 and older. The longitudinal design of the survey allows for analysis of the effect of aging on depression; as opposed to comparing different birth cohorts of individuals at different ages at one point in time, I follow individuals as they age through time. Among many other questions, the HRS surveys respondents about their income and work status, a variety of physical, mental and cognitive health measures. The data used in this study come from the eight survey waves collected every two years between 1994 (wave 2) and 2008 (wave 9). Wave 1 was

excluded because it does not include the variable of primary interest, the CES-D short form.

Cohorts

The HRS was collected for five birth cohorts, also shown in Table 3.1. The oldest cohort in the sample is the AHEAD cohort, who was born before 1924, and was originally part of another study before being subsumed under the HRS. The first wave of data available for the AHEAD cohort is from wave 3 (1996). The next cohort, CODA (Children of the Depression), were born between 1924 and 1930, and data is available on this cohort starting with wave 4 (1998). The HRS (born between 1931 and 1941), has data from the beginning, in wave 2 (1994). The WB (War Babies) cohort were born between 1942 and 1947, and they were included in the sample beginning with wave 4 (1998). Finally, the EBB (Early Baby Boomers) cohort was born between 1948 and 1953, and they were added to the sample more recently, beginning with wave 7 (2004).

Methods

The data used in this study are longitudinal, as there are up to eight observations per individual. In order to account for the fact that I observe repeated observations on individuals, and that the error terms are likely to be correlated, I use fixed effects regression methods. Fixed effects regression includes a dummy variable for each individual in the sample. As a result, the models estimate only within-individual change in depression over time. Fixed effects regression requires that all predictor variables included in the model must also be time-varying. These include factors such as age,

change in marital status, employment status, and health. With fixed effects, I am able to ask, "Does aging increase one's level of depression? Do life changes, such as retiring, becoming widowed, or falling into poor health augment depressive symptoms? Does age have a net effect on depression after adjusting for changes in marital status, employment status, and health?" In other words, fixed effects methods measure the effect of aging and other transitions on depression. Because this method only analyzes within-person variation, fixed effects methods also control for all time invariant characteristics of an individual, such as their personality, whether or not they experienced depression at a time before the observed study period, their education, race, and all other stable characteristics.

Depression

The depression measures on the HRS are a modified version of the Center for Epidemiological Studies Depression Scale (CES-D) (Radloff 1977). Following up the earlier discussion of the types of depression instruments used in surveys, the CES-D measures depression severity and was not designed as a clinical diagnostic tool. The original CES-D consists of 20 items that ask the respondent how frequently during the past week he or she experienced a particular feeling or symptom associated with depression. Respondents indicate how often they experienced a particular feeling in the previous week, with responses ranging from 0 to 3, where 0 indicates rarely or none of the time (less than 1 day), 1 is some or a little of the time (1 to 2 days), 2 is occasionally or a moderate amount of the time (3 to 4 days), and 3 is most or all of the time (5 to 7

days). The scale is reliable, and has high internal consistency between the items (Chronbach's alpha usually around .85) (McDowell 2006). The CES-D is also considered a valid instrument for determining major depression, and it covers seven out of nine DSM IV symptoms of a Major Depressive Episode (McDowell 2006).

The modified version of the CES-D used in the HRS includes eight of the original twenty CES-D questions. Another modification is that the HRS version of the CES-D worded the questions slightly differently from the original module, asking respondents to affirm or negate the presence of the feeling during "much of the week". This approach to scoring, called the "presence approach", has been determined to perform better than the alternative "persistence" approach method of dichotomizing the original CES-D categories (Perzynski and Townsend 2002). Although the original CES-D is not available, the modified module has the advantage that it is asked in the same exact way in every survey wave.

Independent variables

Age. When all survey waves and cohorts are combined, respondents are between age 51 and 115 years old[7]. However, due to the small sample size of respondents over the age of 95, age is top-coded at 95. Figure 3.1 illustrates the general trend between age and average depression levels for both sexes. The relationship between age and depression is nonlinear, but not in the way that previous research has suggested. Instead of a U-shaped

[7] In the regression models, age is divided by ten so that a one-unit increase in the dependent variable is associated with an additional decade of life.

or inverse U-shaped pattern, age has very little variation until age 75, after which depression increases. To account for this nonlinearity, I use a spline to divide the effects of age into two groups – the "middle-old" are between 51 and 75 years old, and the "oldest-old", who are 76 years old and older.

Sex. Sex is measured as a dummy variable for males and females. It is included in the analysis differently in different models. Most of the analysis is run separately by sex; however, at the end of the paper, sex is interacted with age in order to examine gender differences in the age pattern of depression.

Other social characteristics. In order to account for the association between aging and transitions into and out of other social statuses, I control for several individual characteristics in this study. Because of the nature of the analysis, I can only capture the effect of variables that change over the period of observation. Therefore, stable characteristics like race, ethnicity, and education are not included in the analysis. However, the fixed effects regression controls for these variables by comparing each individual to him or herself. Since I am interested in sex differences in the age trend in depression, I analyze most models separately by sex. In addition to age, the social demographic factors include the following variables: marital status, employment status, and health. Marital status is broken down into the following categories: currently married or living with a partner is the reference group, and effects are estimated for never being married, becoming separated or divorced, and becoming widowed. Employment status

includes being employed full time (the reference group), being employed part time, being partially retired, fully retired, not in the labor force, disabled, and unemployed.

Note that in addition to changes in marital status and employment status affecting depression, it is the reverse is also possible. Becoming depressed could erode the quality of one's relationship, leading to divorce; furthermore, evidence suggests that depression could cause people to withdraw from the labor force or take more sick days even if they're working (Lennon 2006). Since I observe respondents every two years, I am unable to determine whether reverse causation influences my findings. However, most research concludes that generally, changes in these social statuses are more likely to affect depression outcomes than the reverse.

Health. Because of the high correlation between depression and physical health, I will also control for health status. There are several ways to measure health status available in the HRS, including self-rated health, the number of Activities of Daily Living (ADLs) and Instrumental Activities of Daily Living (IADLs) the person has some difficulty with, and the number of chronic health conditions. While self-rated health is generally a good indicator of overall health status, since it is self-reported, it is strongly associated with depression. In this study, I measure health in the following three ways. First, the number of ADLs, including bathing, dressing, eating, getting into bed, and walking, with which the respondent experiences at least some difficulty (ranges from 0 to 5). Second, the number of IADLs, including using the phone, money, and handling medications, with which the respondent experiences at least some difficulty (ranges from

0 to 3). Third, number of chronic health conditions acquired since the last interview (ranges from 0 to 4)[8].

Findings

Descriptive results

Depression. In order to understand the relationship between aging and depression, I begin by graphically presenting mean CES-D scores by age and sex in Figure 3.1. This figure combines all cohorts and waves of data, so the effect of aging is potentially contaminated by period and cohort effects. In Figure 3.1, there is a clear nonlinear relationship between age and the mean level of depression for both males and females. Average depression severity remains level until about age 75 for both sexes. Between ages 51 and 75, the average depression level for males is 1.2, and 1.8 for females. Since there is no age trend in depression for either sex, the sex gap in depression for the middle-old is constant at around 0.42 points, meaning that females have an average depression score that is 50 percent higher than males in this age group. After age 75, an age trend emerges, and there is an increase in depression severity for both sexes for the oldest-old. Between ages 76 and 95, the average depression score is 1.7 for males and 2.0 for females. This implies that the rate of increase in the average depression score is faster for males than females: the rate of increase for males between these two age periods was

[8] In addition to the health outcomes examined in this study, additional health measures may also be useful to consider in future research. For example, specific types of diseases, such as hypertension, heart disease, and diabetes, may be particularly likely to affect depression outcomes.

40.8 percent and was 20.9 percent for females. At the very end of the lifespan, the observed data indicates a convergence in the sex gap in depression.

Social and health statuses. Before delving into the analysis, I describe the breakdown of marital status, employment status, and health, by sex and age group. Figure 3.2, which presents the proportion of the sample by marital status, shows there is a much larger decrease in the proportion of married females than males between the middle-old and oldest-old age groups. For the middle-old, 82 percent of males and 66 percent of females are currently married. For the oldest-old, 68 percent of males and only 27 percent of females are married. Corresponding to the decrease in the proportion of married individuals, there is a dramatic increase in the proportion of widows and widowers between these age groups. For the middle-old, 5 percent of males and 17 percent of females were widowed; for the oldest-old, 24 percent of males and 63 percent of females are widowed on average. This trend is probably a product of two factors. First, women are often married to men who are older then themselves. Second, life expectancy is longer for women than men. The other marital statuses included in Figure 3.6, divorced or separated and never married, do not change as dramatically between the age groups.

Figure 3.3, which depicts employment status differences by sex and age group, shows that there are also many changes in employment status between the 51 to 75 year olds and 76 to 95 year olds. The percentage of full time employed people decreases from 38 percent for males and 28 percent for females to 3 percent and 1 percent respectively.

The percentage of part-time workers also decreases between these age groups, from 4 percent (males) and 9 percent (females) to 1 percent for both sexes. In terms of retirement, the percentage of both sexes who are partially retired decreases between the age groups while the percentage of fully retired males and females increases. For the middle-old, 42 percent of males and 36 percent of females were retired. For the oldest-old, 88 percent of males and 71 percent of females were fully retired. The percentage of unemployed individuals was only one percent among the middle-old, while no one in the oldest-old group reported that they are unemployed. This makes sense given the national retirement age of 65. The two remaining categories reflect not being in the labor force due to disability and other reasons. The percentage of disabled, not working individuals is low for both sexes and age groups. An interesting gender pattern is observed for not in the labor force due to other reasons. While only 1 percent of males are in this category at both age groups, 15 percent of middle-old females and 23 percent of oldest-old females respond that they are not in the labor force for "other reasons." This is a subsuming category, but the gender disparity probably reflects the fact that women are more likely to consider themselves to be homemakers than are men.

Finally, Figure 3.4 illustrates age trends in health by sex. Females are more likely than males to have at least some difficulty with more ADLs and IADLs than males at both points in time. Not surprisingly, the percentage of both sexes who report difficulty with these tasks increases as people age. However, according to the data, there is little to

no gender gap in the number of new conditions reported, although this number also increases with age.

Question 1

How does the aging process affect depression? Is the gross relationship between aging and depression the same for males and females? To answer these questions, fixed effects regression of depression scores on age are modeled separately by sex. This model includes no additional control variables; therefore, it describes the gross association between age and depression. As a reminder, the effect of age is modeled separately for the two age groups, the middle-old (ages 51 to 75), and the oldest-old (ages 76 to 95). Results are included in Table 3.2 (Baseline Model), as well as depicted in Figure 3.5. As is shown in the figure, age has a slight positive effect on depression for middle-old males and females[9]. Between ages 51 and 75, depression increases by 0.09 points per decade for males, which amounts to 0.23 points over the 25 year age range. For females, depression increases by 0.11 points per decade, which amounts to 0.28 points over the 25 year age range. In terms of relative difference, this change is associated with a 10.2 percent increase in depression for males and 11.3 percent increase for females between

[9] In order to plot the predicted depression scores by age, I need an intercept. However, SAS, the program used to analyze the data in this paper, does not compute an intercept for fixed effects regression models. Other statistical packages, including STATA, do compute this statistic; the intercept is adopted from the random effects regression model. I follow this method and borrow the intercept for this figure from a random effects regression model where there are no predictor variables (null model).

age 51 and 75. Since the gross effect of age on depression is almost the same for both sexes, the sex gap remains constant for the middle-old, where females have higher depression scores than males.

Comparing the two age groups, Figure 3.5 shows that the gross association between age and depression is stronger for the oldest-old than for the middle-old. According to the baseline model in Table 3.2, per decade, age is associated with a 0.68 point increase in depression among oldest-old males and a 0.43 point increase in depression among oldest-old females. Between the ages of 76 and 95, depression increases by 1.36 points for males and 0.86 points for females. This absolute gross change corresponds to a 56.9 percent increase among oldest-old males and a 39.2 percent increase for females. Therefore, the gross effect of age on depression among the oldest-old is greater for males than for females. While the sample size at these oldest ages is relatively smaller, especially for men, these findings indicate that toward the very end of the life span, males experience higher depression levels than females.

Question 2

How do other factors affect depression? Is this the same for both sexes? Table 3.2 includes two models which show the results of the fixed effects regressions of CES-D on age (baseline) and all time-varying covariates together. As a reminder, the full model includes age (for both age groups), marital status, employment status, and health. In models not shown, the effects of changes in marital status, employment status, and health are very similar between models where the variables are entered separately or

simultaneously. I will now describe the effects of changes in social and health statuses on depression, reserving the discussion net age effects for the next results section. Marital status transitions have a slightly larger effect on depression severity for males than for females. Becoming divorced increases depression scores by 0.57 points for males and by 0.46 points for females. Widowhood increases depression by 0.72 points for males and 0.53 points for females. Therefore, being married is the most protective status for both sexes, and widowhood is slightly more depressing than divorce. A sex difference exists when considering the "never married" category, which has no effect on male's depression but increases female's depression by 0.60 points. While significant, the effect of being never married should be viewed critically, since a very small percentage of both sexes say they are "never married" – just 3.0 percent for each sex.

In terms of employment status, there is no significant difference in depression for either sex between being employed full time (the reference category) and two other statuses: being employed part time and being partially retired. However, when comparing full time employment to the remaining employment statuses, the protective effect of working becomes clear. Fully retiring increases depression by 0.13 points for both males and females; being unemployed increases depression by 0.40 points for males and 0.34 points for females; not working because of disability increases depression by 0.33 points for males and 0.47 points for females; and finally, not being in the labor force for other reasons increases depression by 0.30 points for males and 0.18 points for females. As previously mentioned, the association between employment and depression

could potentially be due to reverse causation, which cannot be differentiated in this study. However, taken together, fully retiring and unemployment affect male and female depression levels about the same, while not working due to disability affects females more than males and not working due to other reasons affects males more than females. In other words, there is heterogeneity in the impact of employment status transitions on depression for males and females.

In terms of health, it is not surprising that any health problems, whether it be experiencing some difficulty with ADLs, IADLs, or having an increasing number of new conditions, is more depressing than being in better health. As a reminder, in this dataset, ADLs range from 0 to 5; IADLs range from 0 to 3; and the number of new health conditions since the last interview ranges from 0 to 4. For males, having at least some difficulty with each additional ADL increases depression by 0.34 points, meaning that having some difficulty with 3 ADLs increases depression by 1.02 points. For females, each additional ADL increases depression by 0.28 points, and having difficulty with 3 ADLs increases depression by 0.84 points. Comparing the magnitude of the effects of having difficulties with ADLs to IADLs on depression, IADLs increase depression less than ADLs do for both sexes. Each additional IADL that the respondent says they experience at least some difficulty with increases depression by 0.18 points for males and 0.15 points for females. The effect of having new health conditions on depression is even smaller than the effect of IADLs: each additional new health condition increases depression by 0.09 points for males and 0.11 points for females. In sum, ADLs lead to

larger increases in depression than do IADLs or health conditions, and there is a slightly stronger relationship between health changes overall and male depression than with female depression.

Question 3

Do these factors explain the relationship between age and depression? Is there an effect of age on depression net of these other life transitions? As previously noted, many studies have hypothesized that depression should increase as people age, since aging is associated with diminished physical and cognitive health, becoming widowed, and no longer working, all factors associated with an increase in depression. Does the relationship between age and depression operate through these other pathways, or is there also a direct (net) effect of age on depression? In other words, how much of aging is due to age *per se* and not attributable to the correlation between age and other factors.

The results for the middle-old are shown in Table 3.2. In the baseline model, there is a very small positive gross effect of age on depression for males and females among the middle-old. When all variables are adjusted for in the full model, the net effect of age on depression becomes statistically insignificant for middle-old males. Therefore, there appears to be no net effect of age on depression among middle-old males. For middle-old females, on the other hand, adjusting for changes in social statuses and health contributes to a reversal in the effect of age. While the gross effect of age was positive, the net effect of age becomes slightly negative. This indicates that there may be

a slight protective net effect of age on depression among middle-old females after controlling for life transitions.

Although the gross age effect was very small for the middle-old, the gross effect of age on depression is larger for the oldest-old. As indicated in Figure 3.5 and the baseline model from Table 3.2, age has a positive gross association with depression for both sexes among the oldest-old. The full model in Table 3.2 shows that the net effect of age on depression remains significant after controlling for all covariates. How much of the gross age effect is explained by these life transitions? How much of the net age effect remains? To answer these questions, I compare age coefficients from the full model to the baseline model, and calculate the percentage of the gross age effect that is explained by adjusting for marital status changes, employment status changes, and health changes (see Equation 3.1).

Eq.3. 1 $$\frac{(\hat{D}^{B}_{95} - \hat{D}^{B}_{76}) - (\hat{D}^{F}_{95} - \hat{D}^{F}_{76})}{\hat{D}^{B}_{95} - \hat{D}^{B}_{76}}$$

When all variables are included in the model simultaneously, the association between age and depression is reduced by 62.5 percent for males and 80 percent for females. This means that 37.5 percent of the net age effect for males and 20 percent of the net age effect on depression for females remains unexplained. Therefore, age has a net effect on depression that is independent of changes in marital status, employment status, and health. For males, age increases depression by 0.03 points for every additional year after age 75, implying that aging 10 years leads to a predicted increase in

depression score of 0.30 points. For females older than age 75, depression increases by 0.02 points for every additional year, equivalent to 0.20 points over 10 years. While these effects are not very large, they do over the long run lead to increases in depression that are commensurate with or greater than the effects of changes in marital status, employment status, and health.

In this study, I examine both the gross effect of age, which includes changes in marital status, employment status, and health, as well as the net effect of age, which is the effect of age that remains after controlling for these other changes. What factors could be included in this net effect of age on depression? One possible explanation is that people could become more depressed as they age because they're friends are dying around them, and they feel increasingly alone. Decreases in cognitive function may also be associated with both age and depression. Moving into a nursing home or into assisted living may also be related to both age and depression. Another possibility is that proximity to death may be associated with both age and depression. In additional models, not shown, I also adjust for mortality by controlling for the wave before the respondent dies. In these analyses, the net age effect actually becomes slightly stronger for both males and females (and for both age groups), while part of the effect of health on depression is absorbed by proximate mortality.

Question 4

Do cohort differences explain the age pattern in depression? Some research indicates that there may be cohort differences in depression levels, and argues that the relationship

between age and depression cannot be distinguished from potential cohort effects using cross-sectional data. Since this study uses longitudinal data, it is better suited to addressing this problem. The data presented in Figures 6 and 7 show the observed average levels of depression by age and cohort for males and females, respectively. The pattern observed does not vary significantly by cohort. At a given age, cohort variation in the level of depression is small and not statistically significant. Therefore, I find no support for the claim that cohort differences in depression are driving the association between age and depression. Furthermore, there is no evidence of a cohort*age interaction on depression, unlike previous research has suggested.

Question 5

What explains the sex difference in the age trend in depression at the oldest ages?

Because the sex gap in depression remained constant over age for the middle-old, here, I focus on the convergence and reversal in the sex gap in depression among the oldest-old. In order to answer this question, males and females are examined together. In addition to age, an interaction between age and sex is included in the fixed effects regression to capture the change in the sex gap in depression as people age. Note that fixed effects regression prevents the inclusion of sex itself in the model since it is a stable characteristic; however, the interaction between a stable characteristic (sex) and time variant characteristic (age) is possible to model. Table 3.3 shows the effect of age on depression for males, the effect of age on depression for females, and the sex gap in the effect of age on depression, where female scores are subtracted from male scores. The

results are presented for five models, one that includes only age and the age*sex interaction, while subsequent models additionally control for marital status, employment status, health, and all variables combined. In this way, I am able to determine if the sex gap in the age trend in depression is attributable to other factors. In the first model, only age and the age*sex interaction are included. Each additional decade after age 75 contributes to a 0.82 point increase in depression scores for males and a 0.51 point increase for women. The sex gap in the gross effect of age on depression is -0.31 points per decade. Although the sex gap in the effect of age on depression is very small, it is statistically significant. In the second model, marital status is also included. While marital status explains some of the effect of age on depression for both sexes, it does not mediate the coefficient for the sex gap in the age effect, which remains almost constant at -0.29 points. The same is true for employment status, health, and the final model where all variables are combined. The factors which explain some of the gross age effect on depression for males and females do not explain the narrowing or reversal of the age gap in depression among the oldest-old.

Discussion

This study uses longitudinal data to examine the relationship between aging, gender, and depression among a nationally representative population of US adults over the age of 50. Given data and methodological limitations of previous research, it was unclear what I would find. The first conclusion this study demonstrates is that the relationship between the gross effect of the aging process and depression depends on how old someone is –

specifically, it is conditional on being younger or older than age 75. For adults between the ages of 51 and 75, age has very small positive association with depression. After age 75, the association between age and depression becomes much steeper. Therefore, there is a nonlinear relationship between age and depression. This finding is most similar to the conclusions reached by a small number of previous studies (Kessler et al. 1992; Mirowsky 1996; Mirowsky and Ross 1992; Newmann 1989). While the positive relationship between age and depression has been previously documented (Luppa et al.; Sonnenberg et al. 2000), the story is more complex than a straightforward linear relationship. The results of this study contradict the conclusions reached by studies which found that depression decreased with age, even among the elderly (Cairney and Wade 2002; Christensen et al. 1999; Kroenke and Spitzer 1998; McGuire et al. 2009), and those that found no relationship between age and depression (Glaesmer et al. 2011; van Grootheest et al. 1999).

In general, women have higher levels of depression than men. However, the sex gap in depression narrows, and eventually reverses, among adults over the age of 75. In my review of the literature, only one other study comes to the conclusion that the sex gap in depression should decrease over age (Korten and Henderson 2000). I conclude that the gross association of age and depression is stronger among elderly men than it is among elderly women. These results do not support the findings reached by studies which found no age trend in the sex gap in depression (Cairney and Wade 2002; Hopcroft and Bradley 2007; Glaesmer et al. 2011; Kessler and McRae 1981; Kessler et al. 1992; McGuire et al.

2009; Sonnenberg et al. 2000; van Grootheest et al. 1999). This study also does not support the hypothesis that the sex gap in depression is a product of the biological and social implications of the reproductive years (Bebbington et al. 1998). I find that the sex gap in depression decreases until well after menopause, and not around age 55. Finally, these results contradict the findings from studies that suggest that the sex gap in depression increases as people age (Luppa et al.; Moen 1996).

As people age, they may stop working, become divorced or widowed, and may experience diminished physical health. These transitions, which are simultaneously associated with aging and an increase in depression, completely explain the slight increase in depression that occurs as men age from 51 to 75. In fact, after controlling for these life changes, there appears to be a slight negative association between age *per se* and depression for women. Like previous research has suggested, there may be a beneficial effect of "maturity" in preventing depression (Djernes 2006; Mirowsky and Ross 1992; van Grootheest et al. 1999). However, the maturity benefit only goes so far. After age 75, there is a negative net effect of age on depression that remains for both sexes after adjusting for transitions in marital status, employment status, and health. The most important factor explaining the age effect among the elderly is health, which alone explains about half of the gross relationship between age and depression.

However, it should be taken into consideration that my focus on marital status, employment status, and health changes does not exhaust the possible changes that occur as people age. Other factors are not examined, such as how many friends are dying,

hospitalizations, and relocation to nursing homes. These factors are likely to exacerbate one's risk of depression, and may help to explain more of the effect of age on depression among. It is probable that the more factors you can control for, the more of the age effect that is explained. This is interesting, but somewhat beside the point. The fact is that changes in marital status, employment status, health, social ties, living situation, almost inevitably change as people age. They are in fact part of the aging process. The effect of aging on depression may be mitigated or postponed as people live longer and healthier, but it seems unlikely that the risk for depression will ever disappear completely for the very old. As a result, caretakers and healthcare providers should emphasize the recognition and treatment of depression in elderly loved ones and patients.

This study suggests that aging is more depressing for elderly men than for elderly women. Although women are on average more depressed than men for most of the lifespan, there may be a reversal in the sex gap among those over age 90. Why would men take aging harder than women? It is possible that men have a latent tendency toward depression that is suppressed by the protective influence of marriage, employment, and good health. When these benefits go away, they become more depressed. However, the negative effect of age on depression is not completely explained by these other life transitions. Almost 40 percent of the age effect on depression remains after adjusting for these factors. Due to small sample sizes of the very old, we cannot be completely confident in this estimate. Future research should examine depression among

nonagenarians and centenarians. However, it appears as though for both sexes, but particularly for men, it is important to monitor depression levels as people age.

The vast majority of research on aging and depression uses cross-sectional data. As a result, these studies compare depression among different cohorts, as opposed to observing the relationship between aging and depression for the same individuals. Previous research has suggested cross-sectional methods are not able to disentangle potential cohort differences in depression from the effects of age on depression. In this study, I use longitudinal data, following several cohorts of people as they age. This method allows me to measure the relationship between aging and depression for individuals. To further investigate the role that birth cohort may play, I separately examined the relationship between age and depression by cohort. I found that there were no differences in the age pattern of depression by cohort. As more data is collected by the Health and Retirement Study, it will be possible to follow more adults as they age into their elderly years. Future research should use this data to provide more information about potential cohort effects. However, the results from this study do not reaffirm the concern with cross-sectional studies that cohort effects contaminate the effect of age on depression. Instead, it appears as though the measurement of age is more important for the different conclusions reached by previous research with respect to the effect of age on depression.

One limitation of this study is that it only uses one measure of depression – the short form CES-D. Other measures of depression could be used, including more

diagnostic indicators such as the CIDI. It may be the case that the patterns observed here for levels of depression do not correspond to experiences of major depressive episodes. Additionally, this paper focuses on the population of adults ages 51 and older, which leaves questions regarding the relationship between age and depression at younger ages. Longitudinal data for younger adults would be helpful.

Ultimately, this study illustrates the importance of the measurement of age when studying depression among older adults. The nonlinear association between age and depression needs to be taken into account in future research.

Tables and Figures

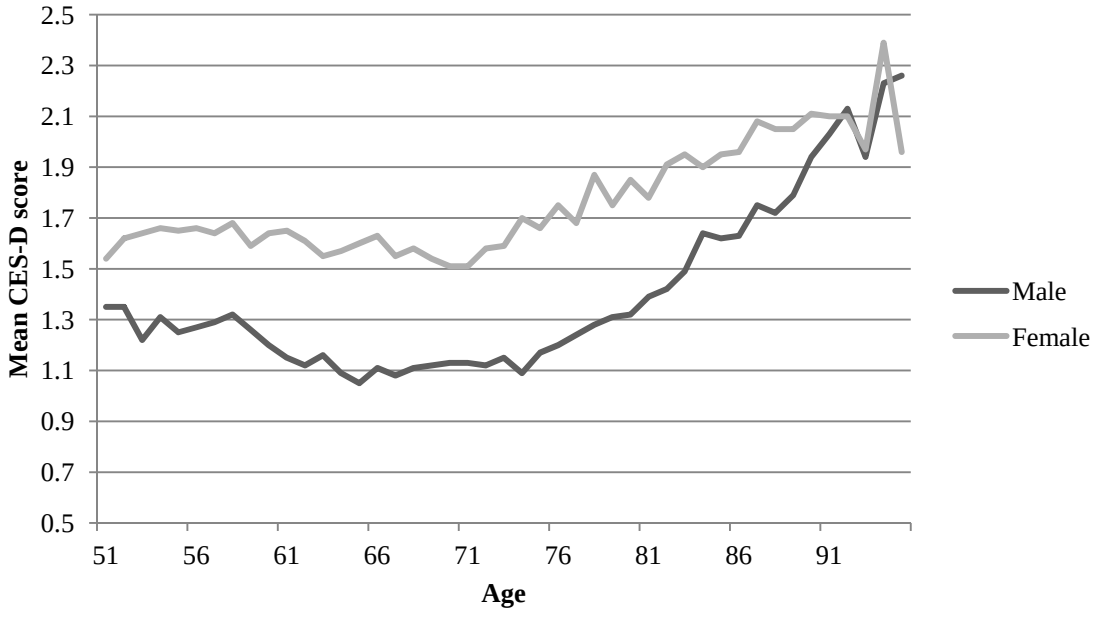
Table 3.1. Birth years and ages by cohort and survey wave

		AHEAD	CODA	HRS	WB	EBB
	Birth years	<1924	1924-1930	1931-1941	1942-1947	1947-1953
Wave	Survey Year					
2	1994			53-63		
3	1996	72-95*		55-65		
4	1998	75-95*	68-74	57-67	51-56	
5	2000	77-95*	70-76	59-69	53-58	
6	2002	79-95*	72-78	61-71	55-60	
7	2004	81-95*	74-80	63-73	57-62	51-56
8	2006	83-95*	76-82	65-75	59-64	53-58
9	2008	85-95*	78-84	67-77	61-66	55-60

*Note: due to the small sample size, respondents over the age of 95 are treated as being 95 years old.

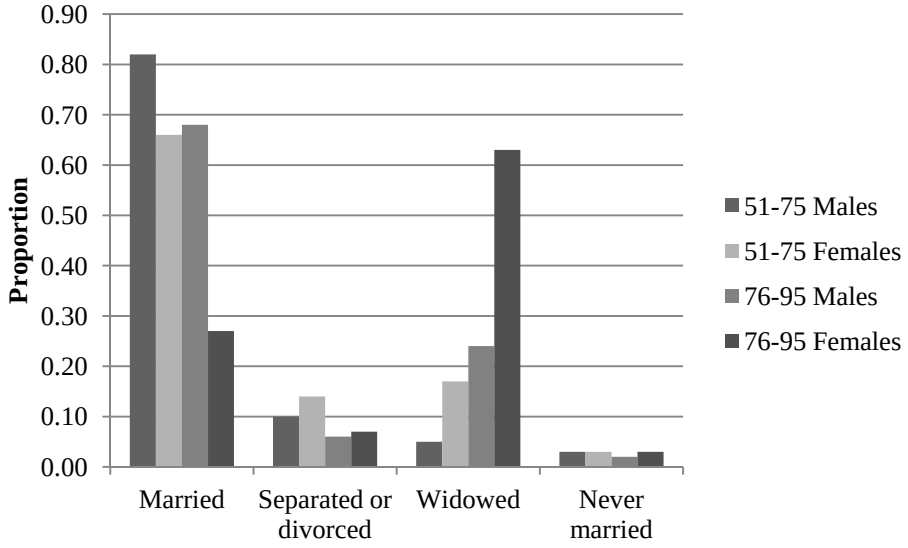
Source: Health and Retirement Survey

Figure 3.1. Average CES-D scores by age and sex (all cohorts and waves)



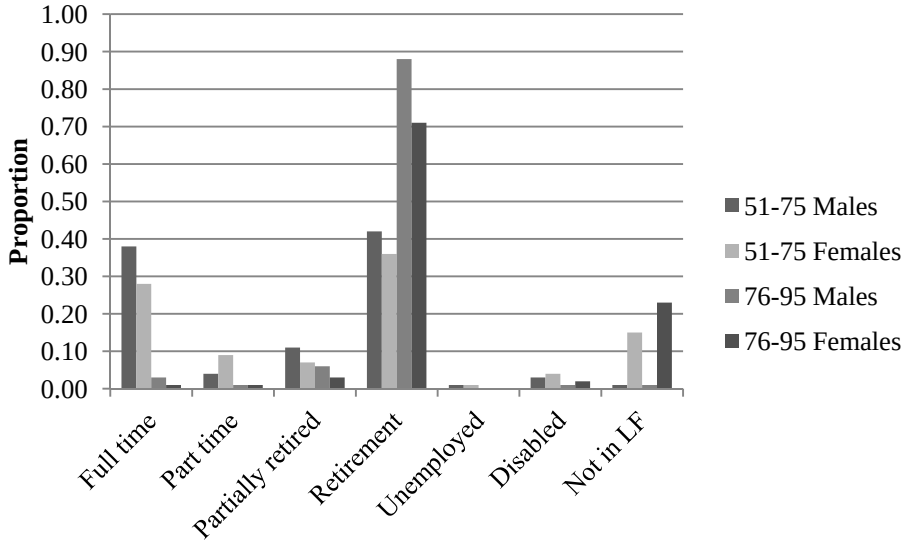
Source: Health and Retirement Survey

Figure 3.2. Marital status by sex and age group



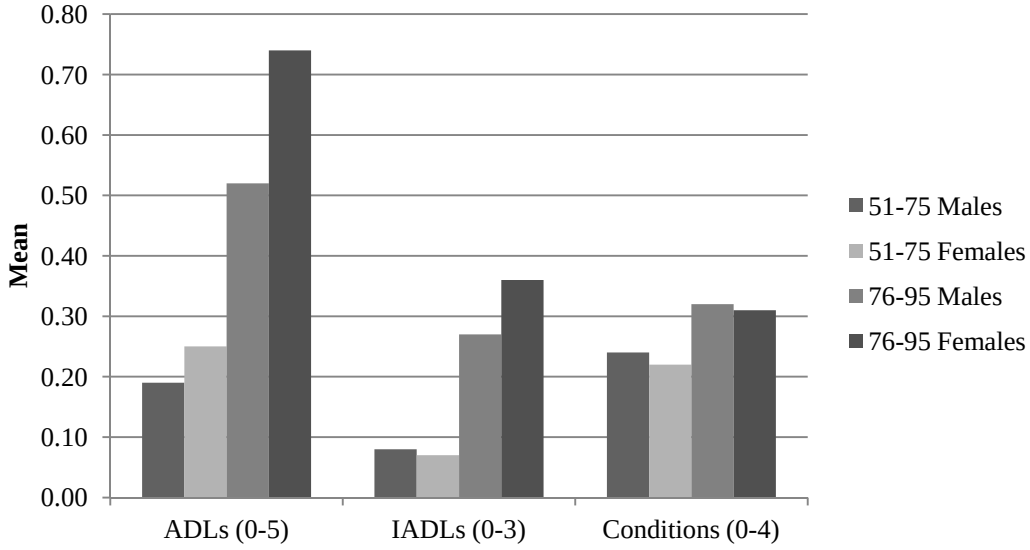
Source: Health and Retirement Survey

Figure 3.3. Employment status by sex and age group



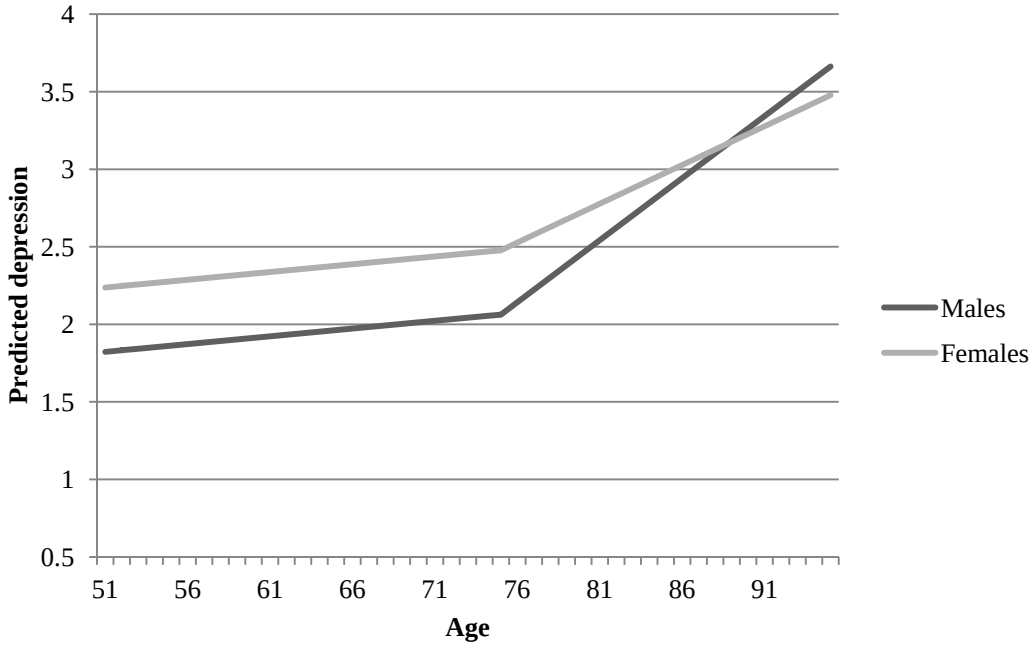
Source: Health and Retirement Survey

Figure 3.4. Health by sex and age group



Source: Health and Retirement Survey

Figure 3.5. Predicted CES-D score by sex and age, from fixed effects regression



Source: Health and Retirement Survey

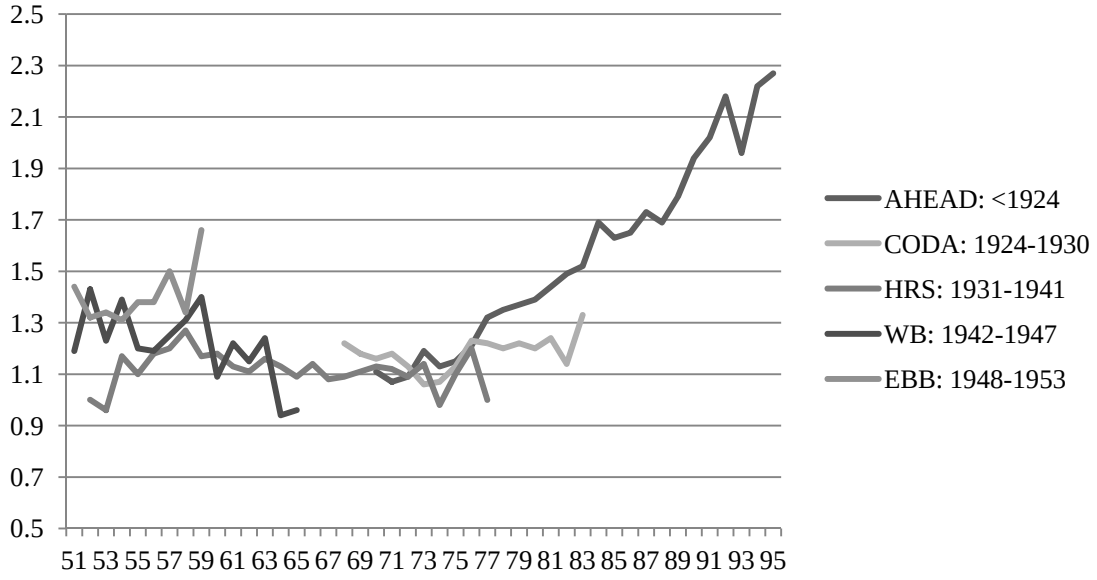
Table 3.2. Fixed effects regression by sex

	Baseline: age only, no controls						Full model: all variables					
	Male			Female			Male			Female		
	B	SE	Sig	B	SE	Sig	B	SE	Sig	B	SE	Sig
Age, in decades												
Age (51-75)	0.09	(0.02)	***	0.11	(0.01)	***	-0.03	(0.02)		-0.06	(0.02)	***
Age (76-95)	0.68	(0.04)	***	0.43	(0.03)	***	0.33	(0.04)	***	0.20	(0.04)	***
Marital status (ref=married)												
Divorced							0.57	(0.04)	***	0.46	(0.04)	***
Widowed							0.72	(0.04)	***	0.53	(0.03)	***
Never married							0.08	(0.15)		0.60	(0.11)	***
Employment status (ref=employed full time)												
Employed part time							0.01	(0.04)		0.01	(0.03)	
Partly retired							-0.02	(0.03)		-0.05	(0.03)	
Retired							0.13	(0.03)	***	0.13	(0.03)	***
Unemployed							0.4	(0.07)	***	0.34	(0.07)	***
Disabled							0.33	(0.06)	***	0.47	(0.05)	***
Not in LF							0.3	(0.09)	**	0.18	(0.03)	***
Health												
ADL							0.34	(0.01)	***	0.28	(0.01)	***
IADL							0.18	(0.02)	***	0.15	(0.02)	***
Number of conditions							0.09	(0.01)	***	0.11	(0.01)	***

Note: *=p<.05, **=p<.01, ***=p<.001

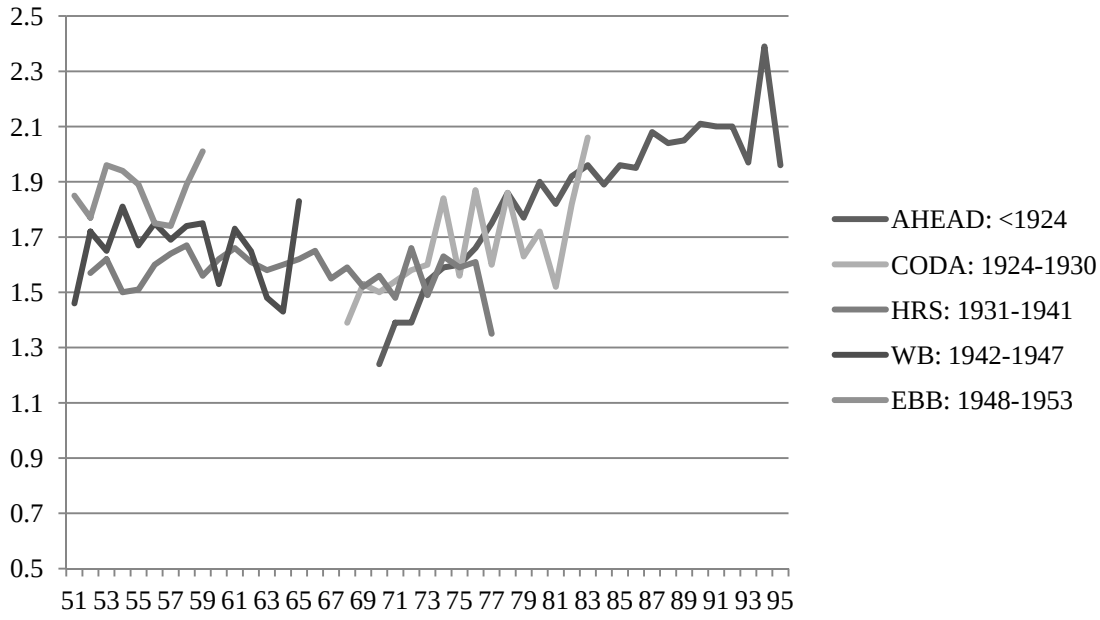
Source: Health and Retirement Survey

Figure 3.6. Average CES-D by cohort – Males



Source: Health and Retirement Survey

Figure 3.7. Average CES-D by cohort – Females



Source: Health and Retirement Survey

Table 3.3. Age*Sex interactions

	Age			Marital Status			Employment Status			Health			All variables		
	B	SE	Sig	B	SE	Sig	B	SE	Sig	B	SE	Sig	B	SE	Sig
Age, in decades (males)	0.82	(0.05)	***	0.67	(0.05)	***	0.78	(0.05)	***	0.58	(0.06)	***	0.41	(0.06)	***
Age*female	-0.31	(0.06)	***	-0.29	(0.06)	***	-0.28	(0.06)	***	-0.3	(0.07)	***	-0.27	(0.07)	***
Divorced				0.98	(0.08)	***							0.91	(0.08)	***
Widowed				0.58	(0.05)	***							0.56	(0.05)	***
Never married				1.10	(0.24)	***							1.14	(0.25)	***
Employed part time							0.04	(0.15)					-0.07	(0.17)	
Partly retired							0.18	(0.13)					0.16	(0.14)	
Retired							0.31	(0.12)	*				0.31	(0.13)	*
Unemployed							0.77	(0.60)					0.70	(0.59)	
Disabled							0.36	(0.18)	*				0.35	(0.18)	*
Not in LF							0.37	(0.13)	**				0.41	(0.14)	**
ADL										0.26	(0.02)	***	0.26	(0.02)	***
IADL										0.06	(0.03)	*	0.06	(0.03)	*
# of conditions										0.08	(0.02)	***	0.08	(0.02)	***
Age, in decades (females)	0.51			0.38			0.50			0.28			0.14		

Note: *=p<.05, **=p<.01, ***=p<.001

Source: Health and Retirement Survey

Appendix 3.1 Summary of literature on age, gender and depression

Paper	Type	Cou-ntry	Nat'l rep?	Dep var	Age range	Age measure	Gross age trend	Net age trend	Age trend in sex gap?
Bebbington et al. (1998)	X-S[1]	UK	No	CIS-R[6]	16-64	≥55, <55	↓ (F)[17]	Gross[24]	Reversal
Cairney and Wade (2002)	X-S	CA	Yes	CIDI-SF[7]	≥15	≥55, <55	↓[18]	Gross	—
Christensen et al. (1999)	X-S	AU	No	+	18-79	10-yr cat	↓	Gross	N/A
Djernes (2006)	M A[2]	+[4]	No	+	≥60	+	+	N/A[25]	N/A
Hopcroft and Bradley (2007)	X-S	+	Yes	1 Q[8]	≥18	A+Asq[15]	U[19]	None[26]	—
Glaesmer et al. (2011)	X-S	DE	Yes	PHQ-9[9]	60-85	5-yr cat	—[20]	N/A	—
Jorm (2000)	M A	+	No	+	30-65	+	~[21]	↓g[27]	N/A
Kessler et al. (1992)	X-S	US	Yes	CES-D[10]	19-96	A+Asq	U	N/A	—
Korten and Henderson (2000)	X-S	AU	Yes	CIDI[11]	18+	10-yr cat	↓	Gross	Converge
Kroenke and Spitzer (1998)	X-S	US	No	Auth.[12]	18-91	10-yr cat	↓	N/A	N/A
Luppa et al (Forthcoming)	M A	+	No	+	≥75	5-yr cat	↑	N/A	↑
McGuire et al. (2009)	X-S	US	Yes	PHQ-8[13]	≥65	≥75, <75	↓	N/A	—
Mirowsky (1996)	X-S[3]	US	Y/N[5]	CES-D	19-98	Log[16]	U	↓g	+
Mirowsky and Ross (1992)	X-S	US	Y/N	CES-D SF[14]	18-90	Log	U	↓g	N/A
Newmann (1989)	M A	US	No	+	+	+	U, Π[22]	N/A	N/A
Sonnenberg et al. (2000)	X-S	NL	Yes	CES-D	55-85	5-yr cat	↑	N/A	—
van Grootheest et al. (1999)	X-S	NL	No	CES-D	55-85	10-yr cat	↓ns[23]	None	—

See notes (next page)

Notes: [1] Cross-sectional; [2] Meta analysis; [3] Cross-sectional plus one longitudinal follow-up; [4] Indicates many or various outcomes, measures, etc.; [5] Indicates both because several surveys were used; [6] CIS-R: Revised Clinical Interview Schedule; [7] CIDI-SF: Composite International Diagnostic Interview Short Form; [8] Did you feel depressed or very unhappy?; [9] PHQ-9: Patient Health Questionnaire-9; [10] CES-D Center for Epidemiological Studies Depression Scale; [11] CIDI: Composite International Diagnostic Interview; [12] Author's own patient questionnaire; [13] Patient Health Questionnaire-8; [14] CES-D Short form; [15] Age and age-squared; [16] Falling component (ln(age-17) and rising component (age-18); [17] Decrease, only for females; [18] Decrease; [19] U-shaped curve; [20] No trend; [21] Inconsistent trends across several studies; [22] Two trends: a U-shaped trend (CES-D), and inverse U-shaped trend (diagnostic interviews); [23] Decrease, but not significant; [24] Net effect of age is same/similar to gross effect of age; [25] Not available/tested; [26] No net effect of age; [27] Net age effect remains but is smaller than gross effect.

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