



# Changes in the depression gender gap from 1992 to 2014: Cohort effects and mediation by gendered social position

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## ABSTRACT

The depression gap (i.e., higher rates of depression among women than men) represents an important mental health disparity in the US. Differences in gendered social position (i.e., the roles, responsibilities, and opportunities available to women and men), which have been changing since the mid-20th Century may contribute to this gender gap. The present study examined the evidence for a changing depression gap across birth cohorts and tested the extent to which any changes over time were mediated by changes in relative social position between women and men. Data were from the National Longitudinal Surveys. The depression gap was defined as differences in mean CESD scores for women vs. men. The analytic sample included 13,666 respondents interviewed from 1992 to 2014. Hierarchical mixed models estimated the magnitude of the gender depression gap over time, its association with 10-year birth cohort (range: 1957–1994), and whether any variation was mediated by ratios among women relative to men of obtaining a college degree, being employed full-time, and the average number of hours spent doing housework per week, three indicators of gendered social position. There was a linear decrease in the depression gap by 0.18 points across birth cohort (95% CI =  $-0.26, -0.10$ ). The results of the mediation analysis estimated that an increasing ratio of college degree attainment mediated 39% of the gender depression gap across cohorts (95% CI =  $0.18, 0.78$ ). There was no evidence of mediation due to changing employment or housework ratios. These findings partially support the hypothesis that the depression gap is changing over time and is meaningfully related to the social environment. Understanding the social causes of the depression gap can illuminate the fundamental processes through which depression disparities may be perpetuated or attenuated over time and may aid in the identification of strategies to reduce them.

## 1. Introduction

### 1.1. Depression, the gender depression gap, and social stress theory

Major depressive disorder is a persistent state of low mood and apathy that can affect the thoughts, behavior, feelings, and sense of well-being (American Psychiatric Association, 2013). Compared with men, women are more likely to develop major depression (Kessler et al., 1993; Robins, 1991) and depressive symptoms (Nolen-Hoeksema et al., 1999; Salk et al., 2017) throughout the world (hereafter referred to as the depression gap), though some evidence suggests that the gap may be changing over time (Kessler et al., 1994a; Kessler and McRae, 1981; Mojtabai et al., 2016).

In studying the causes of the depression gap, many approaches have tested whether known causes of inter-individual variation in depression

are more prevalent among women than men. In other words, if the prevalence of a known cause of depression (e.g., childhood adversity (Kessler et al., 1997)) is higher among women than men, then that exposure may explain the depression gap. Biological (Angold and Worthman, 1993) and social stress (Horwitz, 2013) mechanisms have been explored to explain the gap, with the most robust evidence to date supporting social stress. Social stress theory focuses on ways that group differences in social position may act as an upstream determinant of stress and the depression gap (Horwitz, 2013). The theory posits that social categories, such as race, sexual orientation, and gender, confer access to resources and advantages differentially based on member's relative position within each category (Lynch, 2000). In other words, social position directly influences the likelihood of experiencing stressors and may determine the availability of resources to respond to stress (Pearlin et al., 1981).

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Women have historically experienced a disadvantaged social position compared with men (Aneshensel et al., 2013). Although women and men have similar levels of exposure to general life stressors, the stressful events to which women are exposed are more likely to cause depression, partially because women have fewer resources to respond to stress (Wheaton, 1980), and are more likely to use coping strategies that increase risk for depression (e.g., rumination; Nolen-Hoeksema, 1991, 1987).

In part, gendered social positions are created and reinforced by gender norms (Acker, 1990; Connell, 2003), which are socially acceptable behaviors defined for individuals in a given social and historical context (Rose, 2010). Gender norms are influential from an early age (Connell, 2014; Risman, 2004; Risman and Davis, 2013), as individuals learn, shape, and respond to a normative set of beliefs regarding the nature and appropriate behavior of women and men (Lorber, 1994). Part of this socialization includes the roles that are traditionally expected of women and men. In the United States, contemporary notions of “traditional gender roles” were first formalized during the industrial revolution, and dictate that men obtain a formal education then enter the paid workforce, while women provide unpaid domestic labor, primarily in the form of housework and childcare (Rose, 2010). Traditional gender roles reinforce women's disadvantaged social position relative to men, as the gendered division of paid and unpaid labor restricts the opportunities of women to attain an education and engage in the labor market (Connell, 2003). Thus, the divisions or relative composition of these roles among women and men may serve as indicators of gendered social position.

Gendered social position may influence depression risk through both absolute and relative disadvantage (Marmot, 2003). In absolute terms, gender roles determine access to personal (i.e., not shared within a partnership) socioeconomic resources (England, 2017; Lorant et al., 2003) (e.g., income) and psychosocial resources, such as self-complexity (Rafaeli-Mor and Steinberg, 2002) and self-esteem (Glass and Fujimoto, 1994). These resources reduce exposure to stressors (Persson et al., 2009), and also mitigate the effects of stressors (Brydon et al., 2004) in ways that influence the risk of depression (Aneshensel et al., 2013). At a relative level, gendered social position reflects the unequal distribution of power, authority, and opportunity between men and women (Connell, 2003). This is exemplified by the gendered wage gap, which quantifies the extent to which men and women with equal effort or qualifications are differentially rewarded in the workplace (Platt et al., 2016). Distinct from the effects of absolute resource acquisition, these relative inequalities represent an additional source of depression risk, by reinforcing gender differences in the opportunity to attain equal social position in the division of workplace and domestic roles (Belle and Doucet, 2003; Gove, 1972).

### 1.2. Changes in women's social position may influence the depression gap over time

Over the past 50 years, education and employment opportunities have become increasingly available to women, coinciding with changes in gender norms. Women surpassed men in earning a college degree in the early 1990's (Goldin et al., 2006). Since 1955, employment rates among working-age women nearly doubled to 70% (Lee and Mather, 2008), and today, women are nearly as likely to be employed as men (England, 2017). The time women spend on housework has also decreased (Bianchi et al., 2000), part of a suite of changes in women's domestic roles – women also increased birth control use (Goldin and Katz, 2000), waited longer to marry (Vespa, 2017), had fewer children (Rosenzweig and Schultz, 1985), and had children at later ages (Martin et al., 2013). Based on social stress theory, changes in these indicators of gendered social position (education, employment, housework) should predict decreases in women's risk of depression, thereby narrowing the depression gap over time.

Changes in the depression gap over time can be characterized as a

birth cohort effect, capturing the cumulative effects of exposure to specific historical conditions from birth onward (Ryder, 1985). The cumulative nature of these effects means that the experience of gender socialization during childhood and adolescence has long-term implications for depression. Historical changes in these conditions, evidenced by changing gendered social position, may yield different cumulative effects for depression across cohorts.

There is some evidence that the depression gap has changed; however, evidence is limited and inconsistent. Early retrospective studies of DSM-III depression reported inconsistent results across cohorts born from 1905 to 1965; some showed that the depression gap was narrowing (Weissman et al., 1993), and some showed it was stable (Kessler et al., 1994a). Evidence of narrowing depression symptom levels have been reported in longitudinal (Kessler and McRae, 1981; Murphy, 1986; Srole L and Fischer A, 1980) and repeated cross-sectional (Mojtabai et al., 2016) studies of more recently born adults. One meta-analysis of symptoms reported a decrease in Children's Depression Inventory scores across 1964–1988 birth cohorts, though this study was limited to childhood depression (Twenge and Nolen-Hoeksema, 2002). Another narrative review of studies of children and adolescents reported that internalizing symptoms were increasing among girls and boys (Bor et al., 2014). Neither review reported whether changes over time differed between boys and girls. A meta-analysis of depressive symptoms among women and men ages 12–70+ reported that gender differences increased from 1991 to 2014, though the authors did not specifically examine cohort trends (Salk et al., 2017).

Overall evidence regarding the degree and nature of changes in the depression gap over time is inconclusive, in part due to four limitations. First, individual studies of cohort effects often rely on retrospective reporting of symptoms, which may introduce recall bias. Second, follow-up periods in longitudinal studies are often too short to identify temporal trends in depression. Third, studies do not always report changes in depression levels separately for male and female respondents. Reporting the gap without stratified estimates may obscure important trends, and thus limit the ability to study potential sources of the changes underlying the depression gap. Changing gendered social positions may decrease women's depression, while potentially increasing (Springer et al., 2019) or decreasing (Bird, 1999) men's depression at the same time, influencing the magnitude and variation in the depression gap. Fourth, less attention has been paid to gender differences in levels of depression symptoms, compared with the gender gap in diagnostic depression. Examining cohort effects in gender differences in symptom-based assessments of depression may shed important light on gender patterns in sub-threshold levels of depression, which can cause significant impairment (Lewinsohn et al., 2000), and also increase the probability of progression to major depression (Shankman et al., 2009).

To address the above limitations, we investigated the temporal trends in the gender differences in depression symptoms in a large prospective sample, representing several sequential birth cohorts. We hypothesized that: 1) the depression gap has been decreasing across birth cohorts, 2) changes were due to decreasing depression rates among women, and 3) decreasing depression rates were mediated primarily by increasing education and employment rates among women compared with men, as well as increasing equity in the division of housework between men and women.

## 2. Methods

### 2.1. Sample

Data were from two of the National Longitudinal Surveys (NLS), ongoing prospective surveys of employment, education, domestic labor, and health of American adolescents and adults. Detailed information for each survey has been previously published (Center for Human Resource Research, 2017, 2007). NLS data are processed and cleaned by the

Bureau of Labor Statistics, which maintains a publicly available repository of data and documentation (Bureau of Labor Statistics, 2018). The source population, birth year range, interview waves, sample sizes, gender distributions, and attrition rates of the study sample are summarized in Supplementary Table 1. The NLS surveys were combined to create a single analytic sample of respondents interviewed biennially from 1992 to 2014, the period when depression symptoms were asked of both men and women.

## 2.2. Multiple imputation

In the combined dataset, 15% of outcome responses were missing. To minimize this loss of information, missing outcome data were multiply imputed and combined with corrected standard errors (Rubin, 2004). Ten imputation models were run, using the following variables: gender, age, birth year, and all valid outcome data. Imputed model estimates were compared to unimputed estimates in order to examine the robustness of analytic models to the degree of missing data. In total, the final dataset included 13,666 respondents at baseline with an average of 3.7 observations over the study period (47,646 person-years).

## 2.3. Measures

### 2.3.1. Independent variables

The primary independent variables were the respondent's gender (male/female) and their birth year, grouped into four a priori defined 10-year periods to create successive birth cohorts from 1955 to 1994. There were no respondents for birth years 1955–56 and 1966–71. Overall, birth cohorts included the following years (0 = 1957–1964; 1 = 1965, 1972–1974; 2 = 1975–1984; 3 = 1985–1994). This general categorization is conventional in demographic research and distinguishes cohorts roughly according to historically meaningful groups, including “Baby Boomers”, “Generation X”, “Generation Y”, and “Millennials” (Yang, 2007). Indeed, these groups were partially defined by the changes in the gendered social environment that are examined in the present analysis (i.e., college completion, employment, and domestic labor) (Dimock, 2019). The person-years of observation for each birth cohort overall and stratified by gender are detailed in Supplementary Table 2. Together, gender and birth cohort were used to estimate cohort effects on the depression gap.

## 2.4. Dependent variables

### 2.4.1. Center for Epidemiologic Studies Depression scale

The primary dependent variable was the 7-item Center for Epidemiologic Studies Depression (CESD) symptom score (Cole et al., 2004). The CESD records how often over the past two weeks individuals experienced symptoms associated with depression, such as restless sleep, poor appetite, and feeling lonely (score range: 0–21, higher scores indicate more symptomatology) (Radloff, 1977). A CESD score of 8 or higher represents high-CESD symptoms (Vilagut et al., 2016). As an instrument to identify individuals with probable depression, the 7-item CESD has demonstrated high internal consistency (Levine, 2013), good sensitivity, specificity, and construct validity (Cseh, 2008) in community samples (Carleton et al., 2013) for different age groups (Lewinsohn et al., 1997; Roberts et al., 1990), and genders (Cole et al., 2000). The depression gap was operationalized as both differences in CESD scores between women and men, and the risk difference of high-CESD scores for women minus men. In both forms, the depression gap was defined as a derived group-variable which did not vary within each cohort in a given year, and a positive difference indicated women's higher scores.

## 2.5. Mediators

Three variables were considered as indicators of relative gendered

social position: the ratio of women to men with a college degree or more (i.e., *college ratio*), the ratio of women to men with full-time employment (i.e., *employment ratio*), and the ratio of hours of daily housework reported by women vs. men (i.e., *housework ratio*). Variables were defined at the cohort level and did not vary within each cohort in a given year. Each cohort-level indicator was operationalized in relative terms in order to highlight changes over time as increasing or decreasing gender parity in gendered social position. Further, indicators were defined at the population-level as they represent indicators of the overall context of gendered social position at a given historical time-point. For example, the ratio of college completion captures to some extent the equality of opportunity for women to attain a higher education, rather than the individual-level rates of college completion. We hypothesized that this relative effect would be related to changes in the depression gap. Mediator data were incorporated from external nationally-representative data. College ratio data were incorporated from the US Census Current Population Survey (CPS) annual historical data (Census, n.d.). Employment ratio data were also incorporated from the US Census CPS historical data (Census, n.d.), based on average annual labor force participation rate among noninstitutionalized civilian adults age 20 or older. Housework ratio data were incorporated from a series of harmonized studies that measured time-use decennially from 1965 to 1995 and annually from 2003 to 2018 (Fisher et al., 2015). Housework included activities such as cooking, cleaning, yard work, and shopping, but not time spent providing child care, in order to apply to respondents without children in the analysis.

In each cohort, members were assigned the value of each mediator that was extant in the population when they were 20 years old. For example, education level for the 1955–64 birth cohort corresponded to the ratio of women to men who earned a college degree from 1975 to 1985. This range was chosen to represent the time when college, employment, and housework statuses were most salient for individuals, while also maximizing the range of overlap in ages across cohorts.

## 2.6. Confounding variables

Conceptually no variables met criteria for confounding of the relationship between cohort and depression or gender and depression (i.e., no exogenous causes of gender). We also considered confounders of the mediator-outcome relationship, such as exogenous macro-economic trends. To control for these sources of confounding and estimate a valid indirect effect, the mediation models were adjusted for annual unemployment (defined as the proportion of the population actively seeking current employment) and marriage percentages. Models were also adjusted for respondent age, the mean age within each cohort, to account for inter-cohort age differences (Yang and Land, 2016), and the gender-specific average level of each mediator (e.g., the numerator and denominator of each ratio measure). This was done to isolate the relative effect of each mediator (i.e., the ratio), net of the absolute effect. The employment ratio mediation model was also adjusted for the gender-specific average weekly number of hours of paid work. The Directed Acyclic Graph depicting the causal structure underlying the analytical model can be found in Supplementary Figure 1.

## 2.7. Analysis

### 2.7.1. Descriptive analysis

The distributions of the study variables were summarized as means and standard deviations (SD) for continuous variables and percentages of categorical variables. Distributions were calculated for the overall sample, stratified by gender, and further stratified by 10-year birth cohort.

## 2.8. Hierarchical mixed modeling

We estimated the magnitude of the gender depression gap over

time, and its relationship with birth cohort and education, employment, and housework ratios with a series of hierarchical mixed models. These models accounted for the nested structure of the data, and also allowed for the specification of random effects, to account for the proportion of total variation that is due to within-cohort depression gap estimates over time, separately from the variation in the between-cohort depression gap estimates (Jager et al., 2013). These models rely on the same assumptions of standard linear models (Keyes et al., 2010). To determine the functional form of CESD scores over time, we tested up to 3rd order polynomial age terms to determine the best-fitting model using ANOVA. The analysis was then implemented in three sequential steps. First, we examined the overall depression gap (i.e., gender differences in CESD scores). Second, we tested whether the depression gap differed across cohorts. Third, we tested whether education, employment, and housework ratios mediated the depression gap across cohorts. Separate models were estimated for each mediator.

Separate models estimated continuous CESD scores using linear models and binary high-CESD symptoms outcome using log-binomial models. Birth cohort was first considered as a set of indicator variables, to examine the linearity of changes in CESD scores between cohorts. All continuous variables were centered to facilitate interpretation (Miyazaki and Raudenbush, 2000). Model fit was assessed using log likelihood and Bayesian information criterion (BIC) statistics (Jager et al., 2013). Random intercepts and random slopes were estimated and included if they explained more than 10% of the total model variance (Tom et al., 1999).

### 2.9. Mediation

To implement the mediation analysis, we first tested for additive statistical interaction between cohort and each mediator, to determine the method needed to estimate a valid indirect effect (VanderWeele, 2015). Next, we specified a mediator model to estimate the conditional distribution of the mediator given the exposure, and an outcome model to estimate the conditional distribution of the outcome given the exposure, mediator, and observed confounders. Each model's estimated parameters were used to decompose the direct and indirect parameter estimates in the total mediation model (Imai et al., 2010). This approach estimates standard errors using quasi-Bayesian Monte Carlo methods based on normal approximation, to construct 95% confidence intervals around both the direct and indirect parameter estimates and the proportion of the total effect that was mediated (Imai et al., 2010).

All statistical analyses were conducted in R (version 3.5.1) (R Core Team, 2013). All hierarchical linear models were implemented using the “lme4” package (Bates et al., 2007), multiple imputation was implemented with “merTools” (Knowles and Frederick, 2016) and “amelia” (Honaker et al., 2011) packages, and mediation models were implemented using the “mediation” package (Tingley et al., 2014) using a maximum likelihood estimator robust to non-normality (Jager et al., 2013).

## 3. Results

### 3.1. Descriptive

Descriptive statistics, overall and stratified by gender, are presented in Table 1. Compared with men, women reported higher CESD scores and a higher prevalence of high-CESD symptoms. Overall the proportions with a college degree or more were similar between women and men, while women were less likely to be employed. On average, women did nearly three times more housework than men. Men reported working twice as many hours of paid work than women. There were no gender differences in the annual percent unemployed and married.

Gender differences in study variables comparing women vs. men, further stratified by birth cohort are presented in Supplementary Table 3. Gender differences narrowed across cohorts in both CESD

scores (1955: 4.38 vs. 3.24; 1985: 4.44 vs. 3.85), and the prevalence of high-CESD symptoms (1955: 20% vs. 12%; 1985: 17% vs. 13%). The ratio of women to men who earned a college degree changed from minority women in the 1955–64 cohort (21% vs. 26%) to majority women in the 1985–94 cohort (38% vs. 29%). Gender differences in full-time employment narrowed across cohorts, due to increases in employment rates among women (41%–55%) and decreases among men (80%–68%). Housework ratios also narrowed, due to declining time spent by women (25.0–16.6 h per week) and increasing time spent by men (6.9–9.1 h per week).

### 3.2. Hierarchical mixed models

#### 3.2.1. Main effects

Based on a priori criteria, the best-fitting model contained quadratic and cubic age terms, ( $\chi^2 = 7.13$ , p-value = 0.008) and included random intercepts, which accounted for 33–36% of the total variance in each model (model-fitting details are provided in Supplementary Table 4). Table 2 presents the estimated changes in CESD scores across cohort in model 1, and changes in the gender depression gap across cohort in models 2 and 3. In model 1, CESD scores decreased across more recently born cohorts (CESD difference =  $-0.15$ ; 95% CI =  $-0.2, -0.09$ ); across all cohorts, women's CESD scores were 0.96 points higher than men's (95% CI =  $0.86, 1.06$ ). In model 2, compared with the 1955–64 cohort, the gender gap decreased in the 1965–74 cohort, (CESD difference =  $-0.25$ ; 95% CI =  $-0.76, 0.26$ ), however, the confidence interval included the null value, consistent with no differences between these two groups. The gap was 0.36 points lower in the 1975–84 cohort (95% CI =  $-0.63, -0.10$ ), and 0.54 points lower in the 1985–94 cohort (95% CI =  $-0.79, -0.28$ ). These coefficients approximated a linear decrease, therefore, subsequent analyses assumed linear changes in the gender depression gap across cohorts. In model 3, assuming a linear change, the gender depression gap narrowed by 0.18 points in each birth cohort (95% CI =  $-0.26, -0.10$ ).

Cohort effects in CESD scores among gender-stratified models are presented in Table 3 and visually in Supplementary Figure 2. Among women, CESD scores decreased by 0.41 points across cohorts (95% CI =  $-0.63, -0.19$ ), while among men, there was a 0.05-point decrease (95% CI =  $-0.08, -0.02$ ). When compared to the dataset with no imputation, results were not meaningfully different in magnitude of the model estimates, although standard errors were slightly smaller overall (results not shown).

In the analysis estimating the gender gap in high-CESD symptoms, findings were generally similar to the models estimating CESD score differences. The risk of high-CESD symptoms decreased across cohorts overall (see Supplementary Table 5), among both women (RD =  $-0.32$ ; 95% CI =  $-0.42, -0.23$ ) and men (RD =  $-0.17$ ; 95% CI =  $-0.27, -0.08$ ) (see Supplementary Table 6).

#### 3.2.2. Mediation analysis

There was no evidence of additive interaction between the exposure and each mediator, indicating the indirect effects were equal across all levels of the mediator. Table 4 details the results of mediation of the gender depression gap across cohorts by three indicators of gendered social position (measured as ratios comparing women to men). In Model 1, an increasing ratio of college degree attainment (i.e., as women became more likely to earn a college degree than men) mediated 39% of the gender depression gap across cohorts (95% CI = 18, 78%) (i.e.,  $(-0.18 \text{ to } -0.07)/-0.18$ ). In Model 2, the female to male employment ratio did not mediate the gender depression gap across cohorts, nor did the female to male housework ratio (Model 3).

## 4. Discussion

This study leveraged change over time to test whether changes in women's social position relative to men influenced the gender

**Table 1**  
Descriptive Statistics of analytic variables averaged across cohorts, in the total sample and stratified by gender.

	Total		Men	Women
	%; Mean (SD)	Range	Mean (SD)	Mean (SD)
Birth year	1972 (12.2)	[1957, 94]	1972 (12.19)	1973 (12.17)
CESD score	4.09 (4.0)	[0, 21]	3.63 (3.69)	4.57 (4.24)
High CESD score	0.17 (0.37)	[0, 1]	0.13 (0.34)	0.2 (0.4)
% College degree or more †	28%	[8%, 42%]	27%	28%
College ratio*	0.98 (0.21)	[1.31, 0.76]		
% FT employed†	63%	[32%, 86%]	72%	54%
FT Employed ratio*	0.93 (0.4)	[1.77, 0.57]		
Housework hrs/wk ‡	14.1 (7.56)	[4.4, 34.5]	8.1 (1.92)	20.3 (6.11)
Housework ratio*	2.94 (2.62)	[1.8, 3.6]		
Paid work hrs/week**	31.2 (10.3)	[17.1, 47.8]	40.8 (4.07)	21.4 (2.62)
% Unemployed	6%	[4%, 10%]	6%	5%
% Married	58%	[52%, 68%]	58%	55%

FT = full-time; \*Ratio comparing women to men; \*\*Among employed persons; † source: Current Population Survey historical data; ‡ source: 1965-66 Americans' Use of Time Study; 1975-76 Time Use in Economic and Social Accounts, 1985 Americans' Use of Time, 1995 Electric Power Research Institute (EPRI) Study; 2003–2008 American Time Use Study.

**Table 2**  
Hierarchical mixed model results estimating CESD score differences for birth cohort, gender, and their interaction.

	Model 1*	Model 2*	Model 3*
<i>CESD score difference (95% CI)</i>			
<b>Fixed Effects</b>			
Intercept	3.76 (3.36, 4.17)	3.48 (3.06, 3.91)	3.54 (3.13, 3.96)
Cohort (ref = 1955)	-0.15 (-0.2, -0.09)	-0.09 (-0.14, -0.05)	-0.10 (-0.14, -0.05)
Gender (ref = men)	0.96 (0.86, 1.06)	1.10 (0.98, 1.24)	1.14 (1.0, 1.29)
Cohort x gender (ref = 1955)†			
1965–74		-0.25 (-0.76, 0.26)	
1975–84		-0.36 (-0.63, -0.1)	
1985–94		-0.54 (-0.79, -0.28)	
Cohort x gender (ref = 1955)			-0.18 (-0.26, -0.1)
<b>Random effects variance</b>			
Intercept	5.48	5.43	5.46
Residual	10.3	10.3	10.3
<b>Fit statistics</b>			
BIC	236575	236598	236568
Log Likelihood	-118239	-118230	-118231

Note: all continuous variables are mean centered; \*adjusted for age polynomials and cohort mean age; †modeled as indicator variables.

**Table 3**  
Hierarchical mixed model results estimating CESD score differences for birth cohort, stratified by gender.

	Women*	Men*
<i>CESD score difference (95% CI)</i>		
<b>Fixed effects</b>		
Intercept	5.03 (4.74, 5.32)	3.91 (3.67, 4.15)
Cohort (ref = 1955)	-0.41 (-0.63, -0.19)	-0.05 (-0.08, -0.02)
<b>Random-effects variance</b>		
Individual intercept	6.68	4.3
Residual	11.42	9.22
<b>Fit statistics</b>		
BIC	130756	129079
Log likelihood	-65343	-64504

Note: all continuous variables are mean centered; \*adjusted for age polynomials and cohort mean age.

depression gap. There were four central findings: 1) the gender depression gap decreased by an average of 0.18 points between each 10-year birth cohort from 1955 to 1994; 2) the decreasing pattern in the gender depression gap was due primarily to decreasing depression symptoms among women; 3) women's social position relative to men—indicated by college completion, employment rates, and the division of housework—improved across cohorts; 4) changes in female-to-male education ratios explained more than one-third of the observed changes in the gender depression gap.

To our knowledge, this is the first cohort analysis of the adult depression gap in among those born after 1975 in the US. Previous studies are based on samples with cohorts born from 1905 to 1975, which are substantially earlier than the 1955–1994 cohorts represented in the present study. Among them, some reported similar trends of a narrowing gender depression gap among younger cohorts (Kessler and McRae, 1981). In the Epidemiologic Catchment Area study, gender differences in DSM-III depression risk decreased across 1905–1965 birth cohorts (Wickramaratne et al., 1989). In contrast, the National Comorbidity Study Replication found no evidence of change in the gender gap in DSM-III-R depression across 1936–1975 birth cohorts (Kessler et al., 1994a). Using longitudinal data from the Americans' Changing Lives study, Yang and Lee reported that the depression gap increased across cohorts born in 1915–1955 (Yang and Lee, 2009). A repeated cross-sectional study reported a narrowing depression gap from 2005 to 2014, among young adults ages 18–25 (Mojtabai et al., 2016). Compared with much of the existing literature, the findings of this study describe trends in gendered social position among more recently born cohorts through the end of the 20th Century.

Alongside the narrowing gender depression gap, gender ratios in college degree attainment, employment, and the division of housework also narrowed or changed direction in the case of college degree attainment, highlighting three meaningful trends in the improvement of women's social position. The college ratio reversed from majority male in the 1955 cohort to majority female in the 1975 and 1985 cohorts, driven by a near doubling in women's college completion rates, from

**Table 4**

Hierarchical mixed model results estimating the mediation of the gender gap in CESD scores across cohorts by indicators of gendered social position.

	Model 1	Model 2	Model 3
<b>Fixed Effects parameters</b>	<i>CESD score difference (95% CI)</i>		
Intercept	3.63 (3.26, 3.99)	5.93 (3.25, 8.61)	6.92 (4.94, 8.9)
Cohort (ref = 1955)	-0.49 (-0.66, -0.32)	-0.47 (-0.75, -0.19)	-0.47 (-0.77, -0.17)
Gender	1.11 (0.98, 1.24)	1.11 (0.97, 1.24)	1.02 (0.82, 1.23)
Gender x cohort	-0.11 (-0.18, -0.04)	-0.26 (-0.34, -0.18)	-0.20 (-0.31, -0.09)
College ratio*	-0.13 (-0.21, -0.05)		
FT Employed ratio*†		0.42 (-0.60, 1.44)	
Housework ratio*			-0.03 (-0.15, 0.10)
<b>Mediation analysis</b>			
Avg. mediated effect	-0.07 (-0.1, -0.04)	0.08 (-0.04, 0.22)	0.02 (-0.13, 0.17)
% mediated	0.39 (0.18, 0.78)	-0.45 (-1.54, 0.26)	-0.11 (-0.26, 0.04)
<b>Random-effects variance</b>			
Individual intercept	4.95	5.37	5.39
Residual	9.82	10.18	10.22
<b>Fit statistics</b>			
BIC	138036	234429	232961
Log likelihood	-68952	-117145	-116406

Note: FT = full-time; all models adjusted for age polynomials and cohort mean age; \*The ratio of base rates comparing women to men; †Adjusted for number of hours worked per week.

21% to 38%. The employment ratio narrowed due both to increases in employment among women and to decreases among men. Despite this, women in the youngest cohort were still less likely to be employed than men. The decreasing housework ratio across cohorts was mostly due to women doing less housework, rather than men doing more. Levels among men increased from the 1955–1965 cohorts but remained relatively stable thereafter. The amount of unpaid work decreased overall, replaced by both technological improvements that reduce labor demand (Sayer, 2010), and by paid domestic workers (Bianchi et al., 2006, 2000). Therefore, while women's share of housework has decreased, the trend toward equity has not come from substantial increases in housework by men.

Changes in women's social position relative to men—specifically gender ratios of college completion—mediated changes in the gender depression gap among women. Increases in women's college completion, relative to men, mediated 39% of the gender gap in depression symptoms across cohorts. The findings in the present study were robust to the adjustment in the base rates for each mediator, and mediation of cohort differences was specific to women's depression scores in stratified models. Results suggest that women may gain additional mental health benefits due to an increasing parity in gendered social position, distinct from the benefits afforded by absolute increases in women's socio-economic status. This highlights the importance of relative measures of social position between men and women (Connell, 2003). The results of the mediation analysis in this study suggest that gender parity in education attainment may contribute to the observed reductions in the depression gap in more recent cohorts. This finding is supported by previous research that has shown that parity in educational attainment between men and women signals a more equal opportunity structure (Diprete and Buchmann, 2006), which may act to decrease the depression gap through social stress pathways (Mirowsky and Ross, 1998).

In contrast, changes in employment ratios did not mediate the CESD cohort effects. While employment opportunities expanded for women, a gap in the employment ratio remained. This gap highlights one of many persistent barriers to equal participation in the labor market (England, 2017). In addition, job characteristics differ by gender. Women are more likely to hold part-time, hourly, or temporary employment (Webber and Williams, 2008), be paid less for equal work (Blau and Kahn, 2007), and perform more childcare among couples with children (Bittman et al., 2003). To examine one aspect of these unequal working conditions, we tested for multiplicative interaction between the employment ratio and parental status on the depression gap. The results of this sensitivity analysis ( $\beta = 0.026$ ; 95% CI = -0.01, 0.06; data not

shown) suggest that any indirect effect of employment ratios on the depression gap was irrespective of the presence of children. Together these differences may diminish any positive effects of expanded opportunities overall. Nevertheless, in the employment ratio mediation model, the depression gap increased by 44% compared with the main effects model (i.e., from -0.18 to -0.26) (see model 3 in Table 2 and model 2 in Table 4), suggesting that, in the absence of decreasing trends in the employment ratio, the depression gap would have been larger in magnitude. In addition, the effects of trends toward equity in housework at the population level did not mediate the observed decreases in the depression gap. Most studies of the effects of the division of housework on depression have focused on comparing housework levels between men and women within (heterosexual) marriages (Kiecolt-Glaser and Newton, 2001; Shelton and John, 1996). These studies have found that the perception of equity in housework inhibits depression for women in those households (Glass and Fujimoto, 1994).

Overall, there was inconsistent support of the hypothesis that women's changing social position relative to men would partially explain variation in the depression gap. There are several possible conceptual and methodological explanations for these inconsistencies. First, we operationalized changing gendered social position with only three indirect indicators. While these trends encompass meaningful changes, additional indicators would likely capture other important aspects of the gender landscape that are related to variation in the depression gap. One potentially important element is the gendered division of childcare. Time spent on childcare among fathers also increased during this period (Sayer et al., 2004). Further, this trend may yield unique mental health benefits of expanded gender role opportunities for men (Bird, 1999; Glass and Fujimoto, 1994), suggested by the slight decrease in men's CESD scores observed in this study. Second, education, employment, and housework ratios may have changed due to other economic or social causes not measured in this study. If these causes were also related to the depression gap, they would cause unmeasured confounding of the mediator-outcome relationship. For example, multi-generational family structures have increased since the 1970s (Cohn and Passel, 2018), which has allowed a greater number of women to obtain full-time employment, increasing the employment ratio, and also relieving women of some of their domestic labor burden, decreasing the housework ratio (Muennig et al., 2017). At the same time, older cohabitating adults (e.g., the parents of middle-aged working adults) may themselves become additional sources of the domestic labor burden, increasing depression symptoms among the women who care for them (Chisholm, 1999) and the depression gap in turn. We attempted to limit this bias by controlling for unemployment, weekly hours of paid work, and

marriage rates, however, confounding may still be a source of bias. Third, the mediator values were assigned to respondents based on Census-based population averages when respondents were age 20, in order to capture the age when the context of gendered social position was most salient for respondents. It may be that this assumption was satisfied for education, given college attendance and completion typically occurs around age 20; however, employment and housework ratios may be more important for women in their 30s and beyond. Unfortunately, we were not able to sufficiently vary the values to correspond with other ages, given the age ranges across cohorts (see below for more details), however, future work should interrogate this potential source of measurement error with additional data sources.

This research should be interpreted in light of several limitations. First, respondents' birth years were not evenly distributed within each cohort. Specifically, no respondent was born in 1955 and 1956, as well as from 1966 to 1971. Therefore, samples sizes for the 1965–74 cohort were much smaller than those of other cohorts, and estimates were interpolated over these missing years. When modeled as indicator variables, the depression gap clearly decreased among the 1985 and 1995 cohorts, which had coverage across all birth years. This supports the main conclusion that the depression gap is decreasing over time. Related, the age ranges of each cohort did not completely overlap, specifically the range that was included in all four birth cohorts was ages 28–29. We are confident that the empirical findings represent a valid test of our theoretical hypotheses, given that this age range represents the average beginning of independent adulthood, during which the formation and use of higher education, employment, and domestic labor (i.e., the indicators of gendered social position in this study), and there was substantial overlap for most other ages across three cohorts (e.g., trends for those 30–39 are based on cohorts 1955–64, 65–74, and 75–84). However, any interpretation related to age should note the cohorts for which data were on-support, without making further assumptions to extend the observed trends. Future work should seek to replicate this study using data with more complete coverage for these particular birth cohorts. Third, depression scores as measured in this study refer to short-term (2-week) prevalence, which may not reflect true depression status over the 2+ year period between interviews. Fourth, depression scores were measured with a symptom scale, which may measure sub-threshold depressive symptoms but not diagnostic criteria. Even though the CESD has been widely used as a measure of depression for over 40 years (Radloff, 1977), including in studies of the gender depression gap (Salk et al., 2017), it is likely a measure of more general psychological distress. Fifth, childcare was not included as housework so as not to limit the sample to respondents who have children. Because women spend more time on childcare on average, this omission may have introduced measurement error into the housework ratio variable, potentially attenuating any mediating effect of housework ratios on the depression gap. However, we believe that this was the best approach, considering the potential selection bias from restricting the sample to adults with children, though future work with data disaggregated by type of housework might be useful to estimate the sensitivity of these trends to the type of housework that men and women perform. Finally, the focus of this study is almost entirely on the effects of changing social context on depression. Men face an excess of externalizing and substance use problems (Kessler et al., 1994b), and researchers have argued that the gender depression gap simply reflects different manifestations of the same distress response, rather than greater psychiatric morbidity among women (Horwitz, 2002; Rogers and Pilgrim, 2014). Indeed, similar methods have been applied to understand historical variation in heavy and disordered alcohol use in men and women (Jager et al., 2015). While the goal of the present study was specifically on depression, future work to integrate these two bodies of research, potentially from a trans-diagnostic (Caspi et al., 2014) or dimensional (Eaton et al., 2012) perspective could provide a more comprehensive application of social stress theory to the understanding of social context and health.

The scope of this analysis was to explore the variation in the gender depression gap in the US population overall, but future work might acknowledge and examine heterogeneity in the gender depression gap changes across other intersecting social categories. Differences likely exist within and between other important categories that were not comprehensively measured in this study, such as race, ethnicity, nativity, gender identity, and sexual orientation. Each group is influenced by distinct norms and has experienced unique social changes during the study period, and the relationship between education, employment, housework, and depression scores varies across these groups. Future research with detailed attention to these and other groups would likely prove an important contribution to the social stress literature from an intersectional perspective.

This study is strengthened by the prospective measurement of depression symptoms, and the incorporation of population-representative measures of education, employment, and domestic labor status. Prospective study designs may be especially important in cohort analyses, as cohort effects are highly sensitive to differential recall bias (Lewinsohn et al., 1993). Also, studying the depression gap highlights the importance of gendered social position as a social determinant that is not directly observable at the individual-level, and examining population changes over time may allow effects of exposures that are ubiquitous in the population at any single point in time.

## 5. Conclusion

We provide evidence that the gender depression gap decreased in cohorts born from 1955 to 1994, and that these trends were partially explained by concurrent trends toward parity in college degree attainment between women and men. Overall, this signals that the opportunities and responsibilities dictated by gender norms are becoming less restrictive and that women's social position is improving relative to prior cohorts in ways that may bring mental health benefits.

## Author contribution

This manuscript describes original work and is not under consideration by any other journal. J.P. led the analysis and interpretation of the data and drafted initial versions of the article. All authors made substantial contributions to the study conception and design, interpretation of data, and manuscript revisions for intellectual content. All authors have approved the final submitted version. We complied with ethical standards in the treatment of individuals participating in the research. Thank you for considering our manuscript for review. We appreciate your time and look forward to your response.

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## Appendix A. Supplementary data

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