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Article

Social sequencing to determine patterns in health and work-family trajectories for U.S. women, 1968–2013

Sarah McKetta[a,*], Seth J. Prins[b], Jonathan Platt[a], Lisa M. Bates[a], Katherine Keyes[a,c]

[a] Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, USA
[b] Department of Sociomedical Sciences, Mailman School of Public Health, Columbia University, New York, NY, USA
[c] Center for Research on Society and Health, Universidad Mayor, Santiago, Chile

A B S T R A C T

Background: Women's social roles (partnership, parenthood, and worker status) are associated with health, with more roles being associated with lower mortality rates. Few studies have examined social roles using a lifecourse perspective to understand how changing role dynamics affect health over time. Sequence analysis is one analytic technique for examining social trajectories.

Methods: Work-family trajectories were determined using social sequence analysis. We estimated mortality using age-standardized mortality rates and Poisson regression and examined the impact of personal income as a mediator.

Results: We identified 5 trajectory types according to probability distributions of work/marriage/child-rearing status and descriptions in previous research**:** Non-working, married, later-mothers; working divorced mothers; working and non-working, never-married mothers; working, never-married non-mothers; and non-working, married earlier-mothers. Our reference group**,** non-working, married, later-mothers had the lowest mortality rates (1.47 per 1000 person-years). Adjusting for confounders, timing of childbearing did not impact mortality rates for married, non-working women. Working, never-married non-mothers and working and non-working, never-married mothers had the highest adjusted rates of mortality (RR = 1.81 and 1.57, respectively) these effects were attenuated slightly by the addition of household income in the model. Mortality rates for other trajectory groups were not significantly elevated in adjusted models.

Conclusions: Mortality rates vary by work-family trajectories, but timing of childbearing does not meaningfully impact risk among women in this population, likely because few of the women who were married and had children also worked full-time. Household income has some mediating effect among those at highest risk of early mortality.

Background

Changes in female employment patterns in the twentieth century have resulted in changes in women's social roles in the United States (Waite & Nielson, 1963-1997). These changes were brought about by the intersection of social struggles, such as women's rights movements, and changing economic conditions, such as wage stagnation that required households to have two incomes (Waite & Nielson, 1963–1997; Blau, Kahn, & Waldfogel, 2000). Emancipation from traditional social roles – for example, being expected to marry young, engage in unpaid domestic labor, and remain outside of the labor force – was a major focus of women's rights advocacy and women's roles have changed dramatically in the past century, both domestically and abroad (Blau Weisskoff, 1972; Benston, 1989). In 1955, one-sixth (about 17%) of U.S. women with children under six years old were employed; in 2016, 65% of such women were employed (U.S. Department of Commerce, 1983; Bureau of Labor Statistics, 2017). However, increased involvement in the labor force has not resulted in gender equity for traditional roles: despite converging occupational demands, U.S. women still spend more time than male partners on domestic activities such as cleaning, food preparation, and childcare (Bureau of Labor Statistics, 2008). Because women's participation in the labor force has not completely supplanted their domestic roles, employment outside the home is viewed as an *additional* social role that women must integrate into their lives. Much social science inquiry has examined the impact of changing social roles on health and well-being (Hibbard & Pope, 1991; Greenhaus & Neutell, 1985; Parasuraman & Greenhaus, 2002; Bray, Kelly, & Hammer, 2013; Barnett & Hyde, 2001). Taking on additional social roles has been hypothesized to be detrimental to women's health as a result of "role strain," in which individuals with multiple social roles face conflicting obligations (Moen, Dempster-McClain, & Williams Robin, 1992; Simon, 1995; McBride, 1990); yet alternative hypotheses propose that multiple social roles could be beneficial to women's health through "role enhancement," in that individuals with multiple roles feel more fulfilled and have more emotional outlets and social resources (Reid & Hardy, 1999; Marks, 1977).

In fact, taking on additional social roles is associated with primarily positive health outcomes among women (Hibbard & Pope, 1991;

* Correspondence to: Mailman School of Public Health, 722 West 168th Street, New York, NY 10032, USA.
E-mail address: scm2170@cumc.columbia.edu (S. McKetta).

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Martikainen, 1995; Glynn, Maclean, Forte, & Cohen, 2009). Compared to married mothers who do not work, working married mothers have, for example, lower rates of all-cause mortality at most ages, better self-rated health, lower rates of chronic disease, less psychological distress, and a lower risk of mental health disorders, though these findings do not generally account for the mediating role of income (Hibbard & Pope, 1991; Martikainen, 1995; Barnett, Marshall, & Singer, 1992; Plaisier, Beekman, & de Bruijin, 2008). Role context and quality are additionally meaningful for health. For example, the effects of women's roles on their health is influenced by their life stage. Among women ages 39–60, the "triple role" (of laborer, parent, and partner) is more strongly associated with good health than among younger women ages 20–38 (Janzen & Muhajarine, 2003; Fan & Frisbie, 2009). While some of these protective effects may be due in part to the "healthy worker effect"—that women who work are healthy enough to do so (Li & Sung, 1999)—role quality is associated with health as well, with more subjectively fulfilling roles being better for health, suggesting that some of the benefits are due to the causal effects of the roles themselves (Glynn et al., 2009; Barnett et al., 1992; Plaisier et al., 2008; Baruch & Barnett, 1986; Baruch, Biener, & Barnett, 1987; Muhajarine & Janzen, 2006). Multiple roles may be beneficial for women not only through "role enhancement" and expansion of social networks, but also increased personal income, as often the role that is added to a woman's life is employment (Adelmann, 1987; Lee, Zvonkovic, & Crawford, 2013; Berkman, Glass, Brissette, & Seeman, 2000).

One challenge to understanding how multiple social roles influence health is the manner in which these roles are measured and contextualized. Women's social roles change over the lifecourse, and traditional methods—such as dichotomizing women's roles (e.g., to "ever-married" vs. "never-married") or grouping women who currently work full-time together with each other—do not capture the complex dynamics of women's roles. Multiple roles interact and change over time: for example, women may go in and out of the labor force according to their children's age (Bureau of Labor Statistics, 2017). As such, the timing, onset, and duration of these roles may be as meaningful as the number or types of roles themselves.

Analytic techniques have been adapted to capture these lifecourse dynamics (Umberson, Pudrovska, & Reczek, 2010). Social sequence analysis is one such technique that has been applied in studies of women's multiple roles (McMunn et al., 2015; Lacey, Sacker, & Kumari, 2015; Lacey, Kumari, Sacker, Stafford, & Kuh, 2016; Sabbath, Guevara, Glymour, & Berkman, 2015). A *sequence* is an ordered list of elements—or an array, rather than a single data point. In this case, each sequence contains a woman's roles through the lifecourse, and sequence analysis allows accounting for how the ordering, onset, and temporality of different roles vary among women (Abbott, 1995; Cornwell, 2015). Social sequence analysis uses an individual's own sequence, in comparison to the sequences of others in the sample, to identify common sociologic phenomena (Abbott, 1995; Aisenbrey & Fasang, 2010; Gauthier, Widmer, Bucher, & Notredame, 2010). Sequence analysis has been used to examine how women's lifecourses are structured and organized around marriage, parenting, and working, and to what extent timing and transitions matter: for example, using data from a British birth cohort, researchers showed that regardless of the number of roles occupied at any one time, women who had children earlier in life rather than later in life had increased both metabolic (McMunn et al., 2015; Lacey et al., 2016) and inflammatory markers (Lacey et al., 2015). The sequencing of life events has implications for both health and for women's engagement in the labor force (O'Rand, 1996). Sabbath et al., (2015) found that women who are married, have children, and then subsequently join the labor force had lower mortality rates than never-married mothers, regardless of their work status; additionally, among married women who have children and then join the labor force, returning to the labor force earlier rather than later was shown to be protective against early mortality (Sabbath et al., 2015).

In this study we sought to replicate and extend the foundational research of Sabbath et al. (2015), which used sequence analysis to build work-family trajectories in order to examine how ordering and relative timing of roles impact mortality; we used the same approach, in a nationally-representative prospective cohort, and we extended our work to consider the mediating role of household income. Our study aims were as follows: first, to determine the number and type of work-family trajectories of women in this sample; second, to examine the mortality risks associated with belonging to different work-family trajectories; finally, to estimate how these associations are impacted when we consider the role of household income—this covariate can be conceptualized as a potential mediator of the relationship between work-family trajectories and mortality, or as another control variable—and to then quantify the remaining direct association of work-family trajectories with mortality through pathways other than household income. We anticipated that women who delay childbearing and women who occupy the triple role of worker, partner, and parent would have lower rates of mortality than those who initiate childbearing earlier and occupy fewer roles. We also hypothesized that household income would be a major mechanism through which these relationships operate.

Methods

We used data from the 1968–2013 waves of the Panel Study on Income Dynamics (PSID), a nationally-representative, longitudinal survey of households in the United States (Dynamics, 2016). The PSID is the world's longest-running household panel survey, and contains rich economic and health information over the life course (Smith & Morgan, 1970; Haas, 2006; Fletcher, 2011). PSID surveys are administered at the level of the household with the head of the household being the primary respondent, but PSID also collects information on all members of the household, including children and spouses, as reported by the head of household.

We included women in our analytic sample if they were either heads of household or spouses in any year between 1968 and 2013. Because roles may change as women exit their reproductive years, as well as when they approach retirement, we restricted the sample to women ages 18 to 50. Of these, 18,082 provided at least one year of information on job status, child-rearing status, and marriage status. To have a sufficient number of women in our final analyses and in each lifecourse type, as well as to ensure that each woman represented in our data had provided information on a meaningful proportion of her life, we included sequences from women who had contributed a minimum of 10 years of data. This cut-off was determined to ensure positivity, so that women had sufficient time under observation to be able to be potentially represented by the various lifecourse types, some of which were ultimately delineated by timing of events e.g., "early" vs. "late" child-rearing. We examined distributions from multiple subsets of women to confirm that allowing women with missing data did not dramatically change our sample characteristics for the purposes of sequence analysis; we considered other cut-offs (e.g., 5 years of observation, 15 years of observation) and explore those subsamples in greater detail in Appendix A. A total of 6297 women provided information on at least 10 years of marriage, child-rearing, and employment status, and had information regarding year of death, if deceased.

Exposures

Exposure status was defined as membership in a work-family trajectory among sample women. Sequence analysis was performed on eligible respondents to identify distinct patterns based on employment, marital, and child status. Consistent with Sabbath et al.'s approach (Sabbath et al., 2015), to assemble each individual woman's sequence, women were assigned "statuses" based on their partnership status, child-rearing status, and employment status at each participating wave from ages 18 to 50. A woman was considered "married" if she self-reported being married or cohabitating with non-spouse partners (the original PSID survey administration treated cohabitating partners as spouses). A woman was considered to be currently raising children if there were 1 or more children under the age of 18 living in the household. A woman was considered to have a job if she reported full-time employment (1500 h or more a year) to be consistent with previous research in this area, which examines roles through the context of full-time employment rather than part-time. Many women in this sample did work fewer than 1500 h a year and we chose to group part-time workers with non-workers; Appendix B provides a more in-depth exploration of part-time labor for women in the PSID and in this analytic sample. This information was used to create 8 mutually exclusive "statuses" for every year of observation based on combinations of married/unmarried, child rearing/no child rearing, and full-time employed/not full-time employed.

Sequence analysis was then performed to generate a sequence for every woman based on her individual statuses for each year of age between ages 18–50. Optimal matching was used to compute pairwise distances between each woman's individual lifecourse sequence (Abbott, 2000; Gadabinho, Ritschard, Muller, & Studer, 2011). Optimal matching compares the individual sequences to each other to determine how close or far away one woman's sequence is from another's (Abott, 2000). Next, hierarchical clustering was used to distill each woman's sequence into one of a series of clusters, with the appropriate number of clusters chosen using average silhouette width, a way of visualizing how much of the variance is explained by the number of clusters selected (Rousseeuw, 1987). We evaluated from k = 2 to k = 10 clusters to determine which of clusters best explained the observed data.

Outcomes

The outcomes included all-cause mortality and cause of death. Mortality status was ascertained both in the PSID questionnaire as well as linked National Death Index (NDI) records, and coded using ICD-9 or ICD-10 codes. Causes of death were grouped into the following categories: infectious disease; neoplasms; endocrine, nutritional, or metabolic disorders; cardiovascular disease and blood disorders; nervous system disorders; respiratory disease; gastrointestinal or genitourinary disease; musculoskeletal, congenital, or miscellaneous causes; psychiatric disease, injuries, and poisoning. There were 589 total deaths among the women included in the sequence analysis. All deaths occurred between 1977 and 2013. Cause of death data were examined for the 589 women who died during the study period. Of these, 32 women (5.4% of all who died) had National Death Index data that conflicted with PSID data, and as a result their cause of death was treated as missing or unknown. Three additional women did not have data for cause of death, and they were treated as missing as well.

Next, three sets of analyses were performed to test whether all-cause mortality rates and causes differed significantly according to lifecourse sequence type. First, among women with at least 10 years of observation (n = 6297), age-standardized mortality rates (Arias, 2014), were computed to determine excess mortality by lifecourse type. Second, among women with complete death information (n = 554), we examined differences in cause of death by lifecourse type using chi-square. Third, we examined the adjusted mortality risk by lifecourse type using Poisson regression with robust standard error. Covariate data were missing for 258 women and these data were imputed using multiple imputation with chained equations (MICE) (Yuan, 2000; Azur, Stuart, Frangakis, & Leaf, 2011). Consistent with work by Sabbath et al. (2015) we adjusted for the following potential confounders: lifetime number of births, race (defined as first-reported race: Black, White, or other), and age. To account for early exposures that may impact both selection into lifecourse type and mortality, we additionally controlled for educational attainment (defined as less than high school, high school/GED, some college, college degree, and more than college degree). In our final adjusted models we included household income as a time-varying covariate: we conceptualized household income as a potential explanatory or mediating variable in the relationship between lifecourse type and mortality, though it could also be considered a confounder. Household income was measured nearly continuously in the PSID (household income values at $1,000,000 or more were coded as 999,999 in many survey waves) and in our adjusted models we controlled for income quintiles each year. In sensitivity analyses, we considered the mediating impact of time-varying health behaviors (smoking and alcohol use) as well as self-rated health; these analyses were performed on the subset of our sample who received questionnaires containing health information between 1999 and 2013, and are included in Appendix C.

Sequence analysis was performed using TraMineR for R (Gabadinho et al., 2011) all other analyses were performed using SAS 9.4.

Results

Among the 6297 women in our analytic sample, there were 6254 distinct lifecourse sequences, showing that nearly every woman had a unique trajectory. We arrived at a five-cluster solution for the different lifecourse trajectories of women, after considering between 2 and 10 clusters and using silhouette width index and interpretability to determine best fit. A two-cluster solution had the highest silhouette value (0.16) but rendered uninterpretable lifecourse types; a five-cluster solution had the next highest silhouette value (0.12) and resulted in lifecourse types that were interpretable and consistent with previous literature. In this sample, labor force engagement did not delineate the clustering: in fact, the clusters were almost totally predicated upon marriage or child-rearing status. The five work-family trajectories are described as follows and in Fig. 1, using terminology consistent with previous studies (Sabbath et al., 2015):

- Type 1, "Non-working, married, later-mothers" (N = 2340): These women were consistently married, had children later than other women (e.g., mid-to-late twenties compared to early twenties), and were unlikely to work during their reproductive years.
- Type 2, "Working, divorced mothers" (N = 2264): These women had a high probability of marriage early in life and to be unmarried later. They were more likely to work as they got older (e.g., after age 35). Nearly all had children.
- Type 3, "Working and non-working never-married mothers" (N = 581): These women were much less likely to be married at any point in time than other women with children. They were about equally likely to be working as not during these years. Nearly all had

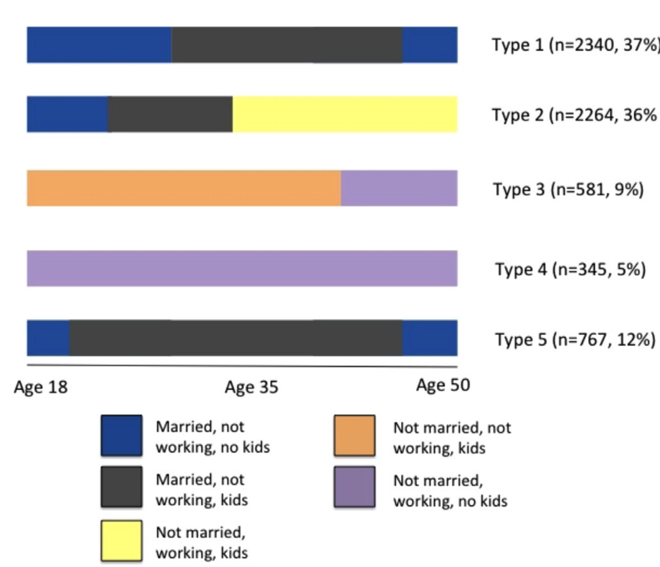

Fig. 1. Lifecourse types.

Table 1
Age-standardized mortality rate per 1000 person years by group status, and p-values for pairwise comparisons between group rates.

	Type 1 Non-working, married, later-mothers	Type 2 Working, divorced mothers	Type 3 Working and non-working never-married mothers	Type 4 Working, never-married non-mothers	Type 5 Non-working, married, earlier-mothers
Age standardized mortality rate per 1,000 person-years	1.47	2.70	3.89	2.44	4.89
95% CI	1.21–1.74	2.31–3.09	3.04–4.74	1.52–3.36	4.18–5.61
	Adjusted p-values for pairwise comparisons				
Non-working, married later mothers					
Working divorced mothers	p = 0.0003				
Never-married mothers	p = 0.0003	p = 0.0107			
Working non-mothers	p = 0.0263	p = 0.6201	p = 0.0449		
Non-working, married earlier mothers	p=0.0003	p=0.0003	p = 0.0971	p = 0.0014	

children.

- Type 4, "Working, never-married non-mothers" (N=345): These women worked consistently, and were less likely than other women to marry or have children.
- Type 5, "Non-working, married, earlier-mothers" (N=767): These women were less likely to work, were consistently married, and had children earlier than the "Non-working, married later mothers."

We calculated standardized mortality ratios (SMRs) for each lifecourse type. Results are shown in Table 1, with p-values adjusted using the false discovery rate correction to adjust for multiple comparisons (Noble, 2009). Type 1 (non-working, married, later-mothers) had the lowest adjusted standardized mortality rates (aSMRs) at 1.47 deaths per 1,000 person-years of observation. Type 2 (working, divorced mothers) and type 4 (working, never-married non-mothers) had the next lowest aSMRs (2.70 and 2.44, respectively); these did not differ significantly. Of the 554 women who had died and who had cause of death information, we found no significant association between cause of death and lifecourse type (Supplementary Table 1).

Table 2 shows our sample characteristics once covariates are included for the complete cases. All women in the final sample were born between the years 1927 and 1978. Type 5 (non-working, married, earlier-mothers) were on average older than the other women in the sample and had the highest number of children. Type 3 (working and non-working never-married mothers) were predominantly Black women, compared to all other lifecourse types which were majority White. Type 1 (non-working, married, later-mothers) had on average the highest household incomes whereas type 3 (working and non-working, never-married mothers) had on average the lowest.

Next, to examine the association between lifecourse type and mortality, we estimated the unadjusted and adjusted relative risk of mortality. In our sample, 258 women (4.1%) were missing information regarding at least one of the covariates of interest (243 women were missing data regarding number of children, 154 were missing data regarding race, and 1 was missing data regarding educational attainment). Supplementary Table 2 shows the percentage of women missing

Table 2
Distribution of covariates by lifecourse type.

	Complete case sample N = 6039	1. Non-working, married, later-mothers 2284 (37.8%)	2. Working, divorced mothers 2120 (35.1%)	3. Working and non-working never-married mothers 569 (9.4%)	4. Working, never-married non-mothers 339 (5.6%)	5. Non-working, married, earlier-mothers 727 (12.0%)	p-value
Died	535 (8.9%)	104 (4.6%)	162 (7.6%)	75 (13.2%)	26 (7.7%)	168 (23.1%)	p < 0.0001
Race							p < 0.0001
• White	3716 (61.5%)	1697 (74.3%)	1160 (54.7%)	115 (20.2%)	217 (64.0%)	527 (72.5%)	
• Black	2193 (36.3%)	545 (23.9%)	903 (42.6%)	447 (78.6%)	116 (34.2%)	182 (25.0%)	
• Other	130 (2.2%)	42 (1.8%)	57 (2.7%)	7 (1.2%)	6 (1.8%)	18 (2.5%)	
Mean birthyear (SD)	1954 (11.51)	1955 (7.23)	1958 (12.79)	1952 (8.60)	1956 (7.81)	1938 (7.21)	p < 0.0001
Birth decade							p < 0.0001
• 1920s	137 (2.3%))	0 (0%)	65 (3.1%)	0 (0%)	0 (0%)	72 (9.9%)	
• 1930s	712 (11.8%)	19 (0.8%)	221 (10.4%)	67 (11.8%)	6 (1.8%)	399 (54.9%)	
• 1940s	1004 (16.6%)	538 (23.6%)	101 (4.8%)	126 (22.1%)	54 (15.9%)	185 (25.5%)	
• 1950s	2111 (35.0%)	1083 (47.4%)	547 (25.8%)	249 (43.8%)	161 (47.5%)	71 (9.8%)	
• 1960s	1576 (26.1%)	592 (25.9%)	755 (35.6%)	126 (22.1%)	103 (30.4%)	0 (0%)	
• 1970s	499 (8.3%)	52 (2.3%)	431 (20.3%)	1 (0.2%)	15 (4.4%)	0 (0%)	
Mean N live births (SD)	2.5 (1.74)	2.5 (1.17)	2.3 (1.75)	3.1 (1.70)	0.6 (1.08)	3.7 (2.37)	p < 0.0001
Educational attainment							p < 0.0001
• Less than high school	854 (14.1%)	197 (8.6%)	289 (13.6%)	159 (27.9%)	17 (5.0%)	192 (26.4%)	
• High school/GED	2342 (38.8%)	922 (40.4%)	787 (37.1%)	218 (38.3%)	92 (27.1%)	323 (44.4%)	
• Some college	1551 (25.7%)	585 (25.6%)	625 (29.5%)	147 (25.8%)	88 (26.0%)	106 (14.6%)	
• College degree	712 (11.8%)	318 (13.9%)	235 (11.1%)	28 (4.9%)	71 (20.9%)	60 (8.3%)	
• More than college degree	580 (9.6%)	262 (11.5%)	184 (8.7%)	17 (3.0%)	71 (20.9%)	46 (6.3%)	
Mean annual household income (SD)	$39,896 ($61,778)	$49,081 ($78,962)	$36,320 ($46,213)	$17,318 ($20,463)	$34,912 ($48,053)	$38,881 ($50,204)	p < 0.0001
Income Quintiles							p < 0.0001
• 0–20%	20%	12.2%	22.8%	48.8%	22.5%	15.3%	
• 21–40%	20%	17.1%	20.7%	23.1%	23.3%	23.0%	
• 41–60%	20%	20.5%	19.8%	14.6%	21.6%	22.3%	
• 61–80%	20%	23.5%	18.9%	9.1%	16.8%	21.3%	
• 81–100%	20%	55.5%	23.3%	2.4%	4.5%	14.3%	

Table 3
Risk ratio for mortality according to group status, adjusted by potential confounders.

RR (95% CI)	Type 1 Non-working, married, later-mothers	Type 2 Working, divorced mothers	Type 3 Working and non-working never-married mothers	Type 4 Working, never-married non-mothers	Type 5 Non-working, married, earlier-mothers
Model 1: Crude (Unadjusted)	Ref	2.30 (1.82, 2.90)	2.82 (2.14, 3.72)	1.57 (1.03, 2.40)	4.62 (3.69, 5.81)
Model 2: Adjusted for race	Ref	2.10 (1.66, 2.65)	2.24 (1.66, 3.02)	1.50 (0.98, 2.29)	4.63 (3.69, 5.80)
Model 3: Adjusted for birth year	Ref	1.29 (1.01, 1.65)	2.06 (1.56, 2.72)	1.66 (1.09, 2.54)	1.17 (0.90, 1.51)
Model 4: Adjusted for number of births	Ref	2.30 (1.82, 2.89)	2.57 (1.95, 3.39)	2.05 (1.34, 3.12)	3.76 (2.96, 4.77)
Model 5: Adjusted for educational attainment	Ref	2.06 (1.64, 2.60)	2.16 (1.63, 2.86)	1.87 (1.23, 2.85)	3.51 (2.78, 4.43)
Model 6: Adjusted for all of the above	Ref	1.14 (0.88, 1.46)	1.57 (1.17, 2.11)	1.81 (1.17, 2.79)	1.11 (0.86, 1.43)
Model 7: Further adjusted with household income	Ref	1.08 (0.84, 1.38)	1.42 (1.06, 1.90)	1.62 (1.05, 2.50)	1.14 (0.89, 1.47)

covariate information by lifecourse type. Type 2 women (working, divorced mothers) were missing the most covariate data (6.4%) and type 4 women (working, never-married non-mothers) were missing the least (1.7%). We imputed 10 datasets to achieve > 99% efficiency in continuous variables (number of births). In regression models using imputed covariate data, each lifecourse type was compared to the reference group of type 1 (non-working, married, later-mothers). The missing data did not significantly alter our results or interpretation in complete case models (Supplementary Table 3).

All model estimates using the imputed data are presented in Table 3. In the unadjusted models, all other lifecourse types had significantly higher risks of mortality compared to the reference group. However, most differences became non-significant after adjusting for potential confounders. Only type 3 (working and non-working never-married mothers) and type 4 (working, never-married non-mothers) remained at a significantly elevated risk (RR for type 3 = 1.57, 95% CI 1.17 - 2.11; RR for type 4 = 1.81, 95% CI 1.17, 2.79) when race, birth year, number of births, and educational attainment were included in the regression model (model 6).

We next considered how this association was impacted by the addition of family income in the model. Household income was associated with lifecourse type when measured both continuously and in quintiles. Income quintile was highly associated with mortality, demonstrating a gradient such that as income quintile increased, risk of mortality decreased in a dose-response manner (Supplementary Table 4). When income was included in the adjusted model, the impact of lifecourse type on mortality was reduced slightly but the differential mortality pattern was unchanged (Table 3); the risk among type 3 (working and non-working never-married mothers) and type 4 (working, never-married non-mothers) were still significantly elevated compared to type 1 (non-working, married, later-mothers) (RR for type 3 = 1.42 95% CI: 1.06 – 190; RR for type 4 = 1.62 (1.05, 2.50)). Results with imputed covariate information were very similar to results using complete case analysis (Supplementary Table 3). A subset of the analytic sample was queried regarding health-related mediators, and those are discussed in Appendix C; overall, the inclusion of health behaviors reduced the direct effect of lifecourse type on mortality. However, the subsample queried about health behaviors was likely not representative of the rest of the sample because they did not exhibit the same patterns regarding lifecourse type and mortality as the full analytic sample.

Conclusions/discussion

We have partially replicated, and extended, previous research on women's social roles and lifecourse trajectories by examining mortality patterns in a nationally-representative, prospective cohort in the United States and considering the mediating role of household income in the relationship between work-family trajectories and mortality.

Among the 5 meaningfully different lifecourse types in our sample, non-working, married, later-mothers (Type 1) had the lowest mortality rates, followed by working, divorced mothers (Type 2) and working, never-married non-mothers (Type 4). Working and non-working never-married mothers (Type 3) and non-working, married, earlier-mothers (Type 5) had the highest rates. These differences were mostly explained by age, number of births, race, and educational attainment, which confounded the relationship between lifecourse type and all-cause mortality, particularly between type 5 (non-working, married, earlier-mothers) compared to the reference group (type 1: non-working, married, later-mothers). The attenuation of any difference between type 1 and type 5 women suggests that the timing of child rearing—the feature that distinguished these two groups—was not differentially impacting mortality in this population. When we adjusted for these confounders, only type 3 (working and non-working never-married mothers) and type 4 (working, never-married non-mothers) had increased mortality rates compared to the reference group (type 1: non-working, married, later-mothers). Cause of death did not vary across lifecourse type.

Our finding that mortality rates are differential across lifecourse types, but that causes of death are not, show that this trend is not attributable to an increase in any single health condition, per se. It is not clear which pathophysiologic mechanisms are operating to create these trends, though previous work that has shown that women who started families earlier, and single working mothers, have elevated metabolic and inflammatory markers (McMunn et al., 20152015; Lacey et al., 2015; Lacey et al., 2016) which could be implicated in many health outcomes. Our sensitivity analyses examining health behaviors show that type 3 women (working and non-working never-married mothers) report higher levels of smoking and poorer overall health, consistent with a health profile that may increase mortality via multiple disease pathways; however, type 4 women (working, never-married non-mothers) do not exhibit the same health behaviors, yet had similarly elevated risks.

Comparing the adjusted model with and without the effects of household income included, our interpretation of the results did not change, though the effects of lifecourse type became attenuated. Both type 3 (working and non-working never-married mothers) and type 4 (working, never-married non-mothers) had elevated mortality relative to type 1 (non-working, married, later-mothers). We interpret this finding as evidence that household income mediates the relationship between lifecourse type and mortality, though incompletely.

Women in type 4 (working, never-married non-mothers) occupied a single role, and had the highest mortality rates in adjusted models. This finding provides evidence, consistent with other literature, that multiple roles confer benefits to health. However, for women belonging to type 3 (working and non-working never-married mothers), many of them occupied two roles, yet these women had persistently elevated mortality rates which were attenuated by less than 10% when household income was considered in the fully adjusted models. Among these women, over 75% were Black, whereas those in types 1 and 5 (non-working, married, later-mothers; non-working, married, earlier-mothers) were around 75% White. Though we adjusted for race in these analyses, the strong association between race, trajectory type, and mortality reflects the fact that systemic racialized disadvantage impacts health in ways that are not through processes of income alone, and which may have contributed to these women reporting poorer overall health (Bailey et al.; Krieger, 2004; Krieger, 2005). Simply comparing women's role statuses, while appropriate for examining changes in the lifecourse, may not sufficiently address the intersectionality of disadvantages that lead minority women to be selected into or exposed to different life trajectories.

On the whole, these results indicate the relationship between lifecourse type and mortality are partially attributable to income gaps that occur as a result of particular social roles (e.g. motherhood penalty (Avellar & Smock, 2003), loss of income due to divorce), but that social roles have implications for health through other mechanisms. Both of the lifecourse types with persistently elevated mortality rates are comprised of unmarried women, demonstrating that in this population there are protective effects of marriage, independent of its effect on household income. This is a well-established finding in the social science literature: marriage is thought to provide not only economies of scale but also social support (Rendall, Weden, Favreault, & Waldron, 2011). While the PSID provides rich information regarding household income and social roles, it does not provide comprehensive information regarding the psychosocial mechanisms through which these roles operate.

While this research is consistent with previous studies using sequence analysis to examine the impact of women's roles on health, it also diverges in important ways (Sabbath et al., 2015; Berkman et al., 2015). Sabbath et al. and other researchers showed that timing of roles, like the relative age at which a person joins the labor force or starts child-rearing, is important for health outcomes (Lacey et al., 2015; Lacey et al., 2016; Sabbath et al., 2015), but we found that the mortality effects of earlier vs. later motherhood were mostly a result of confounding by age. In our sample, types 1 (non-working, married, later-mothers) and types 5 (non-working, married, earlier-mothers) had lifecourse trajectories that differed based on timing of childbearing: in crude models, earlier mothers (type 5) had elevated risks of premature mortality compared to later mothers (type 1), yet in adjusted models their risks were equivalent. Differences in these groups were explained by confounding, in particular that women who were earlier mothers were born earlier, with type 1 women being born an average 17 years later than type 5 women.

We believe this divergence from previous research is due to labor patterns in our sample: both the later- and earlier-mothers (types 1 and 5) were unlikely to be engaged in the labor force. Only 5.1% of type 1 women (non-working, married, later-mothers) and 1.6% of type 5 women (non-working, married, earlier-mothers) reported working full-time for the majority of their time under observation. The benefits to planning families later in life are thought to be mediated through the commensurate gains made in the workforce (Taniguchi, 1999; Iyigun, 2000; Caucutt, Guner, & Knowles, 2002; Lien & Wang, 2016; Fokkema, 2002), and our sample with few working, married mothers did not produce the lifecourse types that would be required to adequately demonstrate those benefits. In other words, women who do not work are unlikely to see the protective effects of delaying childbearing. In fact, while previous studies demonstrated the health benefits of the triple role of laborer, parent, and partner (Janzen & Muhajarine, 2003; Fan & Frisbie, 2009), we did not find any empirically-derived lifecourse type in which women consistently occupied all three roles at once. Therefore, for this sample of women, capturing the dynamic changes in social roles throughout the lifecourse that are introduced by timing and role transitions may have been less important for health than the number and kinds of roles themselves, which differed from other research in this area.

Features of this specific sample likely influenced the representation of lifecourse type. For example, in addition to the lack of women occupying triple roles concurrently, we also saw that the majority of women in our sample were consistently married. Because PSID data are collected at the level of the household, with the head of the household being the primary respondant, women who are married are more likely to be included in each wave, and women who are not the heads of the household or who divorce their spouses are often lost to follow up in subsequent surveys. As a result, married women are overrepresented in PSID, and both the number of lifecourse types we found as well as the distribution of women within them is consistent with what we would expect given this overrepresentation.

Social roles could cause health outcomes, or women with poor health could select into social roles (Fokkema, 2002). For example, childbearing may require relatively good health. While adjusting for educational attainment likely accounted for some amount of selection into certain lifecourse types, we were unable to account for preexisting health conditions or disabilities, which may be associated with an increased risk of mortality and chronic disease and which may also make women more likely to select into a certain lifecourse type. However, these factors are unlikely to affect women before the age of 18, which is the age of eligibility for our sample.

The use of social sequence analysis to answer questions about lifecourse epidemiology gives us the advantage of examining the intersection of multiple exposures in context and throughout time, with attention to role transitions throughout the lifecourse, which can detect nuances that regression models do not always afford. The method allowed us to identify lifecourse elements that are shared by women. However, within these groups, women's lived experiences varied considerably. Of the 6,297 women whose data informed the lifecourse types, there were 6,254 unique lifecourse trajectories. The heterogeneity within these individual data, coupled with our findings regarding the distribution of race across lifecourse type, tell us that the axes of partnership/parenting/employment are not be the only way to consider women's social roles or how we categorize and define lifecourse types.

To date these tools have been used primarily in a descriptive capacity, as well as to develop hypotheses about how social determinants of health may operate simultaneously along multiple pathways. Future research in this area will benefit from theory-based investigations of the social mechanisms that lead women to differential lifecourse experiences, and to what extent those are beneficial or harmful. The dramatic changes in employment patterns in the 20th century continue today. With labor patterns once again shifting, features like labor stability, wage stagnation, and non-standard forms of employment (for example, the rise of the "gig economy") will very likely both affect and be affected by family and marriage patterns for people of all genders (de Stefano, 2015; Center for American Progress, The Hamilton Project, 2010). Examining the *features* and *processes* of labor and family dynamics that are protective or detrimental will be fundamental to health sciences as these landscapes change.

Conflict of interest

The authors declare no conflicts of interest.

Data

Restricted data are available by requesting permission from the Panel Study on Income Dynamics. SAS code and R code for this research are available from the corresponding author by request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.ssmph.2018.10.003.

References

Abbott, A. (1995). Sequence analysis: New methods for old ideas. *Annual Review of Sociology, 21*, 93–113.

Abbott, A. (2000). Sequence analysis and optimal matching methods in sociology review and prospect. *Sociological Methods & Research, 29*(1), 3–33. https://doi.org/10.1177/0049124100029001001.

Adelmann, K. (1987). (P.) *Occupational Complexity, Control, and Personal Income: Their Relation to Psychological Well-Being in Men and Women, 72*. https://doi.org/10.1037/0021-9010.72.4.529.

Aisenbrey, S., & Fasang, A. E. (2010). New life for old ideas: The "Second Wave" of sequence analysis bringing the "Course" back into the life course. *Sociological Methods & Research, 38*(3), 420–462. https://doi.org/10.1177/0049124109357532.

Arias, E. (2014). *United States Life Tables, 2010, 63*. US Department of Health and Human Services.

Avellar, S., & Smock, P. J. (2003). Has the price of motherhood declined over time? A cross-cohort comparison of the motherhood wage penalty. *Journal of Marriage and Family, 65*(3), 597–607. https://doi.org/10.1111/j.1741-3737.2003.00597.x.

Azur, M. J., Stuart, E. A., Frangakis, C., & Leaf, P. J. (2011). Multiple Imputation by chained equations: What is it and how does it work? *International Journal of Methods in Psychiatric Research, 20*(1), 40–49. https://doi.org/10.1002/mpr.329.

Bailey Z., Krieger N., Agénor M., Graves J., Linos N., Bassett M. Structural racism and health inequities in the USA: evidence and interventions. Lancet. 389(10077):1453–1463. doi:10.1016/S0140-6736(17)30569-X.

Barnett, R. C., & Hyde, J. S. Women (2001). Men, work, and family: An expansionist theory. *American Psychologist, 56*(10), 781–796. https://doi.org/10.1037/0003-066X.56.10.781.

Barnett, R. C., Marshall, N. L., & Singer, J. D. (1992). Job experiences over time, multiple roles, and women's mental health: A longitudinal study. *Journal of Personality and Social Psychology, 62*(4), 634–644. https://doi.org/10.1037/0022-3514.62.4.634.

Baruch, G. K., & Barnett, R. C. (1986). Role quality, multiple role involvement, and psychological well-being in midlife women. *Journal of Personality and Social Psychology, 51*(3), 578–585.

Baruch, G. K., Biener, L., & Barnett, R. C. (1987). Women and gender in research on work and family stress. *American Psychologist, 42*(2), 130–136. https://doi.org/10.1037/0003-066X.42.2.130.

Benston, M. (1989). The political economy of women's liberation. *Monthly Review,* 31 (Business Insights: Essentials).

Berkman L., Glass T., Brissette I., Seeman T. (2000). From social integration to health: Durkheim in the new millennium☆☆This paper is adapted from Berkman, L.F., & Glass, T. Social integration, social networks, social support and health. In L. F. Berkman & I. Kawachi, Social Epidemiology. New York: Oxford University Press; and Brissette, I., Cohen S., Seeman, T. Measuring social integration and social networks. In S. Cohen, L. Underwood & B. Gottlieb, Social Support Measurements and Intervention. New York: Oxford University Press. *Soc Sci Med*;51(6):843-857. doi:https://doi.org/10.1016/S0277-9536(00)00065-4.

Berkman, L. F., Zheng, Y., Glymour, M. M., Avendano, M., Supan, A. B., & Sabbath, E. L. (2015). Mothering alone: Cross-national comparisons of later-life disability and health among women who were single mothers. *Journal of Epidemiology and Community Health, 69*(9), 865–872. https://doi.org/10.1136/jech-2014-205149.

Blau, F. D., Kahn, L. M., & Waldfogel, J. (2000). Understanding young women's marriage decisions: The role of labor and marriage market conditions. *ILR Rev, 53*(4), 624–647.

Blau Weisskoff, F. (1972). "Women's place" in the labor market. *American Economic Review, 62*(1/2), 161–166.

Bray, J. W., Kelly, E. L., Hammer, L. B., et al. (2013). An integrative, multilevel, and transdisciplinary research approach to challenges of work, family, and health. *Methods Reports RTI Press,* 1–38. https://doi.org/10.3768/rtipress.2013.mr.0024.1303.

Bureau of Labor Statistics (2008). *Married parents' use of time survey*. United States Department of Labor.

Bureau of Labor Statistics (2017). Women in the Labor Force: A Databook.

Bureau of Labor Statistics (2017). Employment Characteristics of Families Summary. *United States Department of Labor*.

Caucutt, E. M., Guner, N., & Knowles, J. (2002). Why do women wait? Matching, wage inequality, and the incentives for fertility delay. *Review of Economic Dynamics, 5*(4), 815–855. https://doi.org/10.1006/redy.2002.0190.

Center for American Progress, The Hamilton Project (2010). Creating 21st Century Jobs: Increasing Employment and Wages for American Workers in a Changing World. (Institutions TB, ed.).

Cornwell, B. (2015). *Social sequence analysis: Methods and applications.* Cambridge: Cambridge University Press.

Dynamics PS of I. Panel Study of Income Dynamics, Public use dataset, produced and distributed by the Survey Research Center. Survey Reseach Center University of Michigan, Ann Arbor, MI I for SR, ed. 2016.

Fan, G., & Frisbie, W. P. (2009). How do multiple roles affect young and middle-aged women's health? The impacts of employment and family roles. *International Journal of Population Studies, 38*, 33–65.

Fletcher, J. M. (2011). Cumulative effects of job characteristics on health. *Health Economics, 20*(5), 553–570. https://doi.org/10.1002/hec.1616.

Fokkema, T. (2002). Combining a job and children: Contrasting the health of married and divorced women in the Netherlands? *Social Science & Medicine, 54*(5), 741–752. https://doi.org/10.1016/S0277-9536(01)00106-X.

Gabadinho, A., Ritschard, G., Muller, N. S., & Studer, M. (2011). Analyzing and visualizing state sequences in R with TraMineR. *Journal of Statistical Software, 40*(4), 1–37.

Gauthier, J. A., Widmer, E. D., Bucher, P., & Notredame, C. (2010). Multichannel sequence analysis applied to social science data. *Sociological Methodology, 40*(1), 1–38.

Glynn, K., Maclean, H., Forte, T., & Cohen, M. (2009). The association between role overload and women's mental health. *Journal of Women's Health, 18*(2), 217–223.

Greenhaus, J. H., & Neutell, N. J. (1985). Sources of conflict between work and family roles. *Academy of Management Review, 10*(1), 76–88.

Haas, S. A. (2006). Health selection and the process of social stratification: The effect of childhood health on socioeconomic attainment. *Journal of Health and Social Behavior, 47*(4), 339–354. https://doi.org/10.1177/002214650604700403.

Hibbard, J. H., & Pope, C. R. (1991). Effect of domestic and occupational roles on morbidity and mortality. *Social Science & Medicine, 32*(7), 805–811.

Iyigun, M. F. (2000). Timing of childbearing and economic growth. *Journal of Development Economics, 61*(1), 255–269. https://doi.org/10.1016/S0304-3878(99)00066-8.

Janzen, B. L., & Muhajarine, N. (2003). Social role occupancy, gender, income adequacy, life stage, and health: A longitudinal study of employed Canadian men and women. *Social Science & Medicine, 57*, 1491–1503.

Krieger, N. (2004). Ecosocial theory. In N. B. Anderson (Ed.). *Encyclopedia of health and behavior*. Thousand Oaks: SAGE Publications, Inc.

Krieger, N. (2005). Embodiment: A conceptual glossary for epidemiology. *Journal of Epidemiology and Community Health, 59*(5), 350–355. https://doi.org/10.1136/jech.2004.024562.

Lacey, R. E., Kumari, M., Sacker, A., Stafford, M., Kuh, D., & McMunn, A. (2016). Work-family life courses and metabolic markers in the MRC National Survey of Health and Development. *PLoS One, 11*(8), e0161923. https://doi.org/10.1371/journal.pone.0161923.

Lacey, R. E., Sacker, A., Kumari, M., et al. (2015). Work-family life courses and markers of stress and inflammation in mid-life: Evidence from the National Child Development Study. *International Journal of Epidemiology*. https://doi.org/10.1093/ije/dyv205.

Lee, N., Zvonkovic, A. M., & Crawford, D. W. (2013). The Impact of Work–Family Conflict and Facilitation on Women's Perceptions of Role Balance. *Journal of Family Issues, 35*(9), 1252–1274. https://doi.org/10.1177/0192513X13481332.

Li, C. Y., & Sung, F. C. (1999). A review of the healthy worker effect in occupational epidemiology. *Occupational Medicine (Chic Ill), 49*(4), 225–229. https://doi.org/10.1093/occmed/49.4.225.

Lien, H.-M., & Wang, P. (2016). The timing of childbearing: The role of human capital and personal preferences. *Journal of Macroeconomics, 49*(Supplement C), 247–264. https://doi.org/10.1016/j.jmacro.2016.07.004.

Marks, S. R. (1977). Multiple roles and role strain: Some notes on human energy, time and commitment. *American Sociological Review, 42*(6), 921–936.

Martikainen, P. (1995). Women's employment, marriage, motherhood and mortality: A test of the multiple role and role accumulation hypotheses. *Social Science and Medicine, 40*(2), 199–212.

McBride, A. B. (1990). Mental health effects of women's multiple roles. *Addictions Nursing Network, 2*(3), 4–14. https://doi.org/10.3109/10884609009149669.

McMunn, A., Lacey, R. E., Kumari, M., Worts, D., McDonough, P., & Sacker, A. (2015). Work-family life courses and metabolic markers in mid-life: Evidence from the British National Child Development Study. *Journal of Epidemiology and Community Health, 0*, 1–7 (2015).

Moen, P., Dempster-McClain, D., & Williams Robin, M. (1992). Successful aging: A life-course perspective on women's multiple roles and health. *American Journal of Sociology, 97*(6), 1612–1638. https://doi.org/10.1086/229941.

Muhajarine, N., & Janzen, B. L. (2006). The health of employed women and men: Work, family, and community correlates. *Journal of Community & Applied Social Psychology, 16*, 233–241.

Noble, W. S. (2009). How does multiple testing correction work? *Nature Biotechnology, 27*(12), 1135–1137.

O'Rand, A. M. (1996). The precious and the precocious: Understanding cumulative disadvantage and cumulative advantage over the life course. *Gerontologist, 36*(2), 230–238. https://doi.org/10.1093/geront/36.2.230.

Parasuraman, S., & Greenhaus, J. H. (2002). Toward reducing some critical gaps in work–family research. *Human Resource Management Review, 12*(3), 299–312. https://doi.org/10.1016/S1053-4822(02)00062-1.

Plaisier, I., Beekman, A. T. F., de Bruijin, J. G. M., et al. (2008). The effect of social roles on mental health: A matter of quantity or quality? *Journal of Affective Disorders, 111*, 261–270.

Reid, J., & Hardy, M. (1999). Multiple roles and well-being among midlife women: testing role strain and role enhancement theories. *The Journals of Gerontology, Series B, 54B*(6), S329–S338.

Rendall, M. S., Weden, M. M., Favreault, M. M., & Waldron, H. (2011). The protective effect of marriage for survival: A review and update. *Demography, 48*(2), 481–506. https://doi.org/10.1007/s13524-011-0032-5.

Rousseeuw, P. J. (1987). Silhouettes: A graphical aid to the interpretation and validation of cluster analysis. *Journal of Computational and Applied Mathematics, 20*, 53–65.

Sabbath, E. L., Guevara, I. M., Glymour, M. M., & Berkman, L. F. (2015). Use of life course work-family profiles to predict mortality risk among US women. *American Journal of Public Health, 105*(4), e96–e102. https://doi.org/10.2105/ajph.2014.302471.

Simon, R. W. (1995). Gender, multiple roles, role meaning, and mental health. *Journal of Health and Social Behaviour, 36*(2), 182–194. https://doi.org/10.2307/2137224.

Smith, J., & Morgan, J. A. (1970). Dynamics of income distribution: Poverty and progress: Variability of economic well-being and its determinants. *American Economic Review, 60*(2), 286–295.

de Stefano, V. (2015). The rise of the “just-in-time workforce”: On-demand work, crowd work and labour protection in the “gig-economy”. *Comparative Labor Law & Policy Journal, 71 Cond Work Employ Ser No 71*.

Taniguchi, H. (1999). The timing of childbearing and women’s wages. *Journal of Marriage and Family, 61*(4), 1008–1019. https://doi.org/10.2307/354020.

U.S. Department of Commerce (1983). Trends in Child Care Arrangements of Working Mothers. (Census B of the, ed.).

Umberson, D., Pudrovska, T., & Reczek, C. (2010). Parenthood, Childlessness, and Well-Being: A Life Course Perspective. *Journal of Marriage and Family, 72*(3), 612–629. https://doi.org/10.1111/j.1741-3737.2010.00721.x.

Waite, L., & Nielson, M. (1963). The rise of the dual earner family. In R. Hertz, & N. L. Marshall (Eds.). *Working families: The transformation of the American home* (pp. 23–41). University of California Press.

Yuan, Y. C. (2000). *Multiple Imputation for Missing Data: Concepts and New Development*.