EXPOSURE TO BANK CRISES IN CHILDHOOD AND ADULT STROKE RISKS

Introduction

Exposure to poverty in childhood has been shown to affect not only childhood wellbeing but also long-term health and illness in later life (Falkstedt, Lundberg and Hemmingsson 2011; Galobardes, Smith and Lynch 2006; Gliksman et al. 1995; Kuh et al. 2002; Lawlor et al. 2005a). Economic crises both increase the share of the population living in poverty and aggravate the conditions of the existing poor. Several studies have found that health behaviors and health may actually improve during economic crises (Granados 2005; Neumayer 2004; Ruhm 2000), with fewer opportunities to suffer from traffic and occupational injuries and more time to engage in health-promoting activities. However, these studies have almost always found that suicide and in many cases cardiovascular mortality nonetheless increase during economic crises, highlighting that there is tremendous and life-threatening stress associated with these crises.

A particularly visible type of economic shock are crises of the banking sector, which are widely discussed in the media and create great concern about the safety of savings and the availability of credit. Bank crises are typically the result of insolvency of a large subset of borrowers in the community. They represent a personal and acute threat of destitution, above and beyond other ongoing threats like poverty or economic downturns. Some previous studies have examined the effects of banking crises on mortality and found that these were associated with increases in suicide and cardiovascular disease but did not affect other ongoing gains in survival.

In this study, we focus on the long-term consequences of banking crises. We posit that banking crises present a particularly acute stressor that can affect mental and cardiovascular health and may have behavioral sequelae; given existing evidence that the intrauterine environment is a determinant of long-term health and later-life chronic disease, we may expect the effects of a banking crisis to persist into the health of the next generation. This study will examine the cardiovascular disease, especially stroke, of older adults born during the Great Depression in U.S. counties that did and did not experience bank suspensions the year of their birth. Our hypothesis is that cardiovascular disease, including stroke, a health outcome particularly sensitive to external conditions, will be more likely to affect individuals who were exposed to an economic crisis *in utero* and during the first year of life, a particularly formative period for human health.

We use two unique datasets: the REasons for Geographic and Racial Differences in Stroke (REGARDS) study, a national population-based cohort of Black and White older adults, and a dataset of historical county-level characteristics collected through the U.S. Census and other public sources. This will be the first study to combine a national dataset of older adults with small-area independently-reported information on their exposure to a financial crises at the beginning of their lives. The sampling frame and size of REGARDS also makes it possible to examine Blacks and Whites separately, an important step given that stroke risks have been shown to be different for Blacks and Whites and that Blacks tended to be excluded from credit markets.

Community economic conditions and health

Children who live in poor households have poorer health in childhood, poorer long-term health, and higher risks of illness in later life, especially risks of cardiovascular disease (Claussen, Davey Smith and Thelle 2003; Falkstedt et al. 2011; Galobardes et al. 2006;

Gliksman et al. 1995; Kuh et al. 2002; Senese et al. 2009; Stone 2003; Wannamethee et al. 1996). For example, father's social class was associated with risk of stroke in a longitudinal study of men aged 35-64 years in Scotland (Hart, Hole and Smith 2000), an effect that was not mediated by adult socioeconomic circumstances (Smith et al. 1998). A study of all 30-69 year old inhabitants of Oslo, Norway, found that housing conditions in childhood and early life correlated with mortality from certain causes, with cumulative deprivation from childhood into adulthood strongly associated with stroke risk (Naess et al. 2004).

While much of the focus has been on the family environment, the early life environment is affected by neighborhood conditions, including environmental toxins, public services, schools, stores, and recreational spaces (Furumoto-Dawson et al. 2007). Studies examining the effects of the broader socio-economic environment in childhood on later-life health report mixed results. A study based on historical neighborhood characteristics in Boston in 1850-1970 found that population-level cardiovascular disease varied with infant mortality from sixty years earlier (Kelleher et al. 2004). A study of 12,681 Black and White 45-64 year-olds in 4 US communities (ARIC LC-SES) found that community socioeconomic status at age 10 was not significantly associated with chronic kidney disease (Shoham et al. 2007) or sub-clinical cardiovascular disease markers (Pollitt et al. 2007). In a study that combined census data from 1968 to 2005 with the Panel Study of Income Dynamics, childhood neighborhood characteristics had no effect on adult body mass index (Vartanian and Houser 2012).

Recessions and health

Economic recessions in the US, though officially determined and dated by a committee at National Bureau of Economic Research, is as a rule of thumb, two or more consecutive quarters of negative growth. Such economic downturns both aggravate the poverty of low socio-economic households and increase the number of households experiencing poverty. Several studies have suggested that health behaviors and health may actually improve during moderate financial hardship. For example, overall and most cause-specific mortality, with the exception of suicides, decreased during recessions, with the largest relationships seen in causes amenable to behavioral change (Granados 2005; Neumayer 2004; Ruhm 2000).

A longitudinal study of economic downturns, measured in terms of state-level unemployment rates, and self-rated health-related quality of life (HRQL) in the US found that HRQL was negatively affected by economic downturns in the previous year. Men and women experienced a 1% decrease in the Mental and Physical Health Scores with a 1% increase in state unemployment (Davalos and French 2011). A study of 1-year crises across OECD countries between the 1950s and the 2000s reports that such crises were associated with increases of about 2% in infant mortality. The increases were primarily in digestive deaths. The impact of economic crises was especially great in countries that already have high mortality, including the U.S. (Alexander, Harding and Lamarche 2011). Another longitudinal analysis of 14 high and middle-income countries across the twentieth century found that a negative relationship existed between recessions and maternal and infant morality in the 1930s to 1950s but not thereafter. For this period, a 10% reduction in income was associated with an infant mortality increase of 3/1,000 live births and an even greater percent increase in maternal mortality (Ensor et al. 2010). Across 26 E.U. countries between 1970 and 2007, economic crises, measured in terms of unemployment, were associated with increases in suicides, homicides, and alcohol-related deaths, but also decreases in road traffic deaths (Stuckler et al. 2009). In Japan, the economic stagnation of the 1980s to 2005 was

associated with increases in mortality, especially from suicide, for men in management and professional positions (Wada et al. 2012).

With respect to bank crises specifically, across 28 countries between 1960 and 2002, bank crises, defined as an episode when a significant proportion of banks fail or their assets are exhausted, were associated with increases in heart disease mortality, especially in lower-income countries. A study focused of bank suspensions in the U.S. during the Great Depression found that mortality from respiratory and cardio-metabolic conditions decreased during the years of the crisis and shortly thereafter (Stuckler et al. 2012).

Early-life exposure to economic crises and later-life health

Other studies have focused on cohort health and mortality, that is, the association of early life conditions with health and mortality risks many years later. Among Danish same-sex twins born between 1873 and 1906, those born in recessions, that is, in years when the business cycle was below the trend mean, experienced higher mortality rates. The effects were stronger for men: having survived to age 35, individuals born during a recession had an average lifespan 10 months shorter than individuals born during a boom. However, specific possible causal pathways – food prices, real wages, weather, infant mortality rate, and sex ratio among newborns – did not explain these associations (van den Berg, Doblhammer and Christensen 2009). The authors conclude that economic conditions during the first year of life and not *in utero* are important for later-life mortality. Individuals born during recessions had higher cardiovascular but not cancer mortality at older ages, and genetic variations in risk were stronger determinants of later-life health than were personal characteristics among individuals born during economically harsher conditions (van den Berg, Doblhammer-Reiter and Christensen 2011).

Cutler, Miller, and Norton examined the associations of economic crises during the Great Depression and later-life health in the nationally representative Health and Retirement Survey (HRS) (Cutler, Miller and Norton 2007). They assessed exposure to sudden unexpected economic changes while *in utero*, measured by regional (9 US census regions) and time (year) variations in agricultural yield, regional employment and infectious disease-related child mortality. The later-life health outcomes were death, arthritis, hypertension, diabetes, psychiatric conditions, chronic lung disease, stroke, and heart conditions, disability and BMI. There were no significant differences in later-life health associated with regional economic shocks, and there was indication that risk of stroke was positively associated with employment rates.

Bank suspensions

During the Great Depression, many banks in the U.S. failed, leaving individuals with lost assets and limited access to credit. In 1933, less than 60% of the 24,000 depository institutions available in 1929 were still operating. Banks failed for multiple reasons, including diversion of savings to cash, en masse withdrawals, and contraction of the economy leading to loan defaults and bank insolvency (Richardson 2007). The types of failures changed during this period: In the 1930s, small rural banks experienced great loan losses and failed. Starting in late 1930, networks of banks collapsed and panics developed, especially in the center of the country. The depression became more severe in 1931, as major banks in large costal cities closed, receiving widespread media coverage, and insolvency led to further failures (Richardson 2007). Most banks only closed temporarily, with more than a third resuming operations subsequently. Still, individuals did not know how long the closures

would last, which banks would reopen, and what personal losses they would suffer (Stuckler et al. 2012).

Cardiovascular disease and its early-life antecedents

Cardiovascular disease (CVD), including stroke, is a major cause of morbidity and mortality in the U.S., leading to 811,940 deaths in 2008 or 1 out of every 3 deaths in the US. (Roger et al. 2011). Important socio-economic and race disparities have been observed in CVD and its co-morbidities, with African Americans having a mortality ratio 3 to 4 times higher than whites between the ages of 45 and 65.(Howard and Howard 2001) Geographic disparities in stroke mortality have been observed with higher rates in the southeastern U.S. states, referred to as the "stroke belt." An area of the stroke belt consisting of the coastal plain region of Georgia, North Carolina, and South Carolina, has particularly high stroke mortality and is called the "stroke buckle". Overall, stroke mortality is about 20% higher in the stroke belt than the rest of the U.S., and about 40% higher in the stroke buckle than the rest of the U.S. (Howard et al. 1997).

A growing literature has documented the impact of social and economic conditions early in life as antecedents of later life stroke and other cardiovascular disease morbidity and mortality.(Eriksson et al. 2007; Eriksson et al. 2006; Forsen et al. 2000; Lackland, Egan and Ferguson 2003; Law et al. 2002; Lawlor et al. 2006; Lawlor et al. 2005b; Mzayek et al. 2009; Rich-Edwards et al. 1997)

Conceptual framework

We hypothesize that there are "leverage points" in the lifecourse that set in place health trajectories that persist for years afterwards. Lifecourse epidemiology has recognized the idea of sensitive or critical periods, when socioeconomic disadvantage may be especially influential due to critical developmental windows. The peri-natal and peri-pubertal periods have been found to be particularly sensitive times in human development. The fetal origins theory, or the "Barker hypothesis" (Barker 2000) posits that prenatal and early life conditions predispose to diseases later in life. There is an extensive body of evidence linking childhood socioeconomic conditions to immediate health outcomes such as low birth weight, postnatal growth, and development retardation and linking these to diseases and risk factors during adulthood, including hypertension, type 2 diabetes, heart disease and stroke. (Eriksson et al. 2007; Eriksson et al. 2006; Forsen et al. 2000; Lackland et al. 2003; Law et al. 2002; Lawlor et al. 2006; Lawlor et al. 2005b; Mzayek et al. 2009; Rich-Edwards et al. 1997)

While low social status and poverty may impact early development, for example, being associated with lower birth weight (Parker, Schoendorf and Kiely 1994; Rini et al. 1999; Rutter and Quine 1990), poverty-induced stress of the mother specifically has been found to correlate with poor pregnancy outcomes (Hoffman and Hatch 1996). Economic shocks likely to be of such magnitude were bank crises during the Great Depression. These crises received extensive media coverage at the time and many individuals experienced great concern about their savings and their access to credit. Banking crises have been shown to affect health, especially in working-age populations. We propose that bank suspensions led to great stress and sudden deprivation, resulting in health consequences for newborns that would affect their long-term cardiovascular health. Through this pathway, we expect that individuals who were born in a county that was experiencing bank failures during the Great Depression are now more likely to experience cardiovascular problems.

Data

While use of current community SES conditions is relatively common in the scientific literature, historic community measures of SES across the lifespan have been used only in a few studies. We have created a dataset of publicly available county-level historical data. Data were primarily collected from the National Historical Geographic Information System (NHGIS), which provides aggregate census data and GIS-compatible boundary files for the United States between 1790 and 2000. We verified data using additional sources, including the University of Virginia Library Historical Census Browser, the U.S. Census Bureau website, and the Interuniversity Consortium for Political and Social Research (ICPSR) website. We collected county-level socio-economic indicators from U.S. censuses of households and economic censuses when available, between 1910 and 1980. The result is a dataset of historical community socioeconomic indicators for the entire U.S. for most of the 20th century. The types of variables collected include, as available in various years: race, nativity, employment, education, land ownership, household assets, value of farms, and status of banks. Data on bank suspensions were collected through the U.S. Bureau of the Census between 1921 and 1937.

This dataset was linked with the REGARDS study. REGARDS is a national longitudinal study of 30,239 African American and white participants over age 45 (mean age at enrollment = 65.3 recruited January 2003-October 2007 from communities across all lower 48 states of the United States, including residents of 1,855 of the 3,033 US counties. The study was designed to measure and explain geographic and racial differences in stroke risk factors, incidence, and mortality. Potential participants were randomly selected from a well-characterized commercially available list used in many other national studies. To address regional and race differences in stroke captured in the concept of the stroke belt described above, 12 strata were used: 3 regions (stroke belt, stroke buckle and rest of nation) x 2 races (white and AA) x 2 sexes. By design, 35% of the REGARDS cohort was recruited from the buckle of the stroke belt (coastal plain region of NC, SC and GA), 21% from the other Stroke Belt states (remainder of NC, SC, and GA, plus AL, MS, TN, AR, and LA), and the remaining 44% from the other 40 contiguous states.

Each potential participant was mailed a letter and brochure introducing the study, then telephoned within two weeks to recruit, obtain verbal informed consent, and conduct a baseline health and demographic interview. Direct health assessments were conducted in the participant's home. City and state of birth and of residence from birth to the time of enrollment was obtained from a self-administered questionnaire. Participants are contacted every six months thereafter for surveillance of coronary and stroke events, stroke symptoms and changes in cognitive function. Hospital and death records are retrieved and centrally adjudicated. Further details of methods are available elsewhere. (Howard et al. 2005; Howard et al. 2011)

We selected all participants with residential history data at birth. The sample was restricted to match the availability of aggregate county-level data on banks, which were only collected during the years 1921-1937, so analysis was restricted to REGARDS respondents who were born during this period. The analytic sample was 7,874.

Variables

The main dependent variables, from REGARDS, are indicators of cardiovascular disease: number of stroke symptoms, self-reported stroke, Framingham CHD risk score, and Framingham stroke risk score at time of enrollment. We also will examine incident stroke during follow-ups through the adjudications completed through April 2011.

Incident stroke symptoms were ascertained during bi-annual telephone interviews using the Questionnaire for Verifying Stroke-Free Status (QVSFS), a validated questionnaire proposed as a quick screening instrument for the general population(Jones, Williams and Meschia 2001; Meschia et al. 2004). At the time of this analysis, participants had completed up to 14 follow-up interviews (median = 7). Participants were asked about the sudden onset of each of 6 stroke symptoms (Meschia et al. 2000): painless hemi-body weakness, painless hemi-body numbness, loss of vision in one or both eyes, loss of hemi-field vision, or inability to speak or understand. A positive response on $\geq$1 of these six stroke symptoms indicates a positive stroke symptom history. The Framingham Stroke Risk Score was used to estimate the 10-year probability of stroke given the participant's demographic and risk factor profile, specifically age, sex, systolic blood pressure (SBP), use of antihypertensive medications, current smoking status, history of heart disease, diabetes, left ventricular hypertrophy and atrial fibrillation. (D'Agostino et al. 1994; Wolf et al. 1991) The Framingham Coronary Heart Disease (CHD) Risk Score was similalry constructed using age, current smoking, total cholesterol, HDL cholesterol, blood pressure, treatment for hypertension.

The main exposure of interest of this study is the number of bank suspension in the county of birth in the year of birth. We also included other characteristics of banks in the county during that year, that is, whether there were any banks at all and total number of banks.

We used several control variables believed to be associated with cardiovascular disease: age, race (Black and White), sex, 4-category income (less than $20k, $20k-$34k, $35k-$74k, and $75k and above), 4-category education (less than high school, high school graduate, some college, college graduate and above), 3-category current exercise patterns (none, 1-3 times per week, and 4 or more times per week), relationship status (married, single, divorced, and widowed), smoking (current, never, past), alcohol use (current, never, past), region of current residence (stroke belt, stroke belt buckle, and non-belt), and current urban-rural location (rural, urban, and mixed).

Methods

FIPS codes were used to merge REGARDS respondents' data with data on the conditions in their county of birth and early life, merged from publicly available sources using their residential histories.

We used descriptive methods; linear and logistic regression; and will use discrete-time hazard models. In multivariate analyses, each outcome is expected to be determined by time-invariant individual characteristics, individual socio-economic variables in adulthood; and community-level variables in childhood.

Preliminary Results

Table 1 shows descriptive characteristics of the 7,874 REGARDS respondents born between 1921 and 1937 and characteristics of their county of residence at the time of their birth. Participants were on average almost age 74 years at the time of the baseline interview. Half were male and more than a third were Black. More than half were currently married, but 40% were divorced or widowed. More than a third were college graduates while 14% had not completed high school. Twenty percent had incomes of less than 20,000 per year, while the largest number had incomes of between 20,000 and 30,000. A third currently lived in the stroke belt and almost one in five lived in the stroke belt buckle. Almost 73% lived in a largely urban area. Respondents scored on average 12.9 and 15.4 respectively on the

Framingham CHD and stroke scores, out of a total possible of 100. They reported on average .3 stroke symptoms. The counties in which the respondents were born had on average 17 banks, and, while most did not experience a bank suspension, 10% did live in a country that experienced at least one bank suspension, and among these 40% had more than one suspension.

There is a consistent positive association between bank suspensions in the county of birth in the year of birth and later-life cardiovascular disease (Table 2). When we only control for bank conditions in the year of birth, that is, presence of banks, total number of banks, and number of bank suspensions, we find that bank suspensions are strongly significantly associated with number of stroke symptoms, Framingham stroke score, Framingham coronary heart disease score.

In multivariate models (Table 3), individuals who were born in a county experiencing a bank crisis had higher risks of stroke and coronary heart disease than other survey participants. This relationship is robust to the addition of current personal characteristics: age, gender, race, marital status, education, income, current smoking and alcohol use, and current region of residence and urbanicity.

Discussion

This study provides information about the importance of exposure to bank crises at birth for later-life cardiovascular disease. While socio-economic wellbeing has been shown to be important for long-term health, it is important both from an individual and from a policy perspective to understand whether finacial crises, a particular type of economic shock that was also a feature of 2008 recession, can affect long-term health. We found that individuals who were born in a county experiencing a bank crisis had more complications associated with stroke about 70 years later, and this relationship was not explained by current socio-economic characteristics.

Because poor socio-economic conditions may have already led to selective mortality before the beginning of REGARDS data collection, the poorest members of the cohort may have already died, leading to an under-estimate of the effect of SES. We will apply selection correction, that uses child mortality rates in the relevant communities, and will further stratify the sample into relatively younger initial respondents

Our approach offers several advantages. The most prominent US studies previously used in analysis of childhood environment and later-life health, the HRS and the PSID, are based on self-reports of health, while in REGARDS suspected events are identified and adjudicated by appropriate committees of neurologists and cardiologists. Indeed, 40% of self-reported stroke events are adjudicated as non-events in a formal adjudication process, and diagnoses is associated with SES. Also, REGARDS is slightly larger than the HRS and the PSID and over-samples African Americans and residents of the stroke belt. Specifically, REGARDS's sample is 1.7 times larger than the HRS and has 6.1 times more residents of the stroke belt (16,776 versus 2,768), 4.7 times more African Americans (12,531 versus 2,656), and 8.1 times more African American residents of the stroke belt (6,419 versus 795). Among the unique aspects of the REGARDS study is a residential history questionnaire where the participant listed the city/state (or country) of birth and every location he or she had lived for at least one year. Use of county-level data from respondents' early childhood presents several advantages. One is that it allows us to understand the importance of environmental variables beyond individual and family characteristics and the multiplicative effect of environmental and family characteristics. It also provides an external source of

information on the economic environment that is not subject to the respondent's recall or perception.

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Table 1: Descriptive statistics of REGRADS respondents born between 1921 and 1937 and their county of residence at birth (n=7,874)

VARIABLES	Mean or percent
Personal characteristics	
Age at interview	73.69
Male	48.98%
Black	34.24%
Marital status	
Married	55.85%
Divorced	10.40%
Other	1.40%
Single	2.92%
Widowed	29.43%
Education	
Less than high school grad	14.14%
College grad and above	33.86%
High school grad	26.06%
Some college	25.95%
Income	
<20k	19.66%
20-30k	29.73%
35-74K	28.28%
75k+	8.90%
Current smoker	8.84%
Current community characteristics	
Region	
Non stroke belt	33.15%
Stroke belt	47.19%
Stroke buckle	19.66%
Location	
Mixed: 25-75% urban	18.49%
Rural	8.70%
Urban	72.81%
Cardiovascular health	
Framingham CHD risk score (1-100)	12.91
Framingham stroke risk score (1-100)	15.40
Number of stroke symptoms (0-6)	0.30
Historical county characteristics	
Number of banks suspended	0.20
Total number of banks	16.94
County had no banks	151
Ratio rural to urban	1.64

Table 2: Association between bank conditions in the county and year of birth and multiple health measures at older ages (n=7874)

VARIABLES	(1) Number of stroke symptoms	(2) Framingham stroke risk score	(3) Framingham CHD risk score
Number of banks suspended	0.04**	0.96**	0.71**
	(0.012)	(0.200)	(0.203)

Models control for total number of banks in the county and whether the county had no banks.
Standard errors in parentheses
** p<0.01, * p<0.05, + p<0.1

Table 3: Association between bank conditions in the county and year of birth and number of stroke symptoms at older ages (n=7874)

VARIABLES	(1) Number of stroke symptoms	(2) Framingham stroke risk score	(3) Framingham CHD risk score
Historical finance characteristics			
Number of banks suspended	0.02*	-0.07	0.34*
	(0.012)	(0.185)	(0.171)
Total number of banks	-0.00	0.00	0.00
	(0.000)	(0.004)	(0.003)
County had no banks	0.05	0.69	0.94
	(0.060)	(0.926)	(0.862)
Personal characteristics			
Age at interview	0.01**	0.92**	0.37**
	(0.002)	(0.031)	(0.028)
Male	-0.03+	2.68**	9.73**
	(0.019)	(0.294)	(0.268)
Black	0.05*	2.74**	0.72**
	(0.019)	(0.295)	(0.264)
Marital status (ref=Married)			
Divorced	0.03	-0.45	-0.36
	(0.030)	(0.467)	(0.414)
Other	-0.11	-0.32	-2.21*
	(0.070)	(1.111)	(1.076)
Single	0.02	0.94	-0.32
	(0.050)	(0.773)	(0.693)
Widowed	-0.02	0.80*	-0.26
	(0.022)	(0.340)	(0.308)
Education (ref=Some high school)			
College grad and above	-0.19**		-2.41**
	(0.029)		(0.413)
High school grad	-0.17**		-1.87**
	(0.028)		(0.393)
Some college	-0.15**		-2.38**
	(0.028)		(0.405)
Income (ref=20-30k)			
<20k	0.11**	1.19**	0.40
	(0.025)	(0.392)	(0.358)
35-74K	-0.01	-0.26	-0.92**
	(0.022)	(0.345)	(0.320)
75k+	-0.02	-0.97+	-2.50**
	(0.033)	(0.511)	(0.476)
Current smoker	0.02	7.26**	12.43**
	(0.029)	(0.448)	(0.417)
Current community characteristics			
Region (ref=non belt)			

Stroke belt	0.01	0.61*	0.38
	(0.019)	(0.297)	(0.271)
Stroke buckle	0.01	0.55	-0.23
	(0.023)	(0.357)	(0.328)
Local (ref= mixed: 25-75% urban)			(0.413)
Rural	-0.06	-0.45	0.03
	(0.038)	(0.594)	(0.554)
Urban	-0.05+	-0.57	-0.23
	(0.029)	(0.458)	(0.425)

Model controls for missing values using dummy variable adjustments.
Standard errors in parentheses
** p<0.01, * p<0.05, + p<0.1