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The Effect of the Foreclosure Crisis on Health

By
Janelle Downing

A dissertation submitted in partial satisfaction of the
requirements for the degree of
Doctor of Philosophy
in
Health Services and Policy Analysis
in the
Graduate Division
of the
University of California, Berkeley

Committee in charge:

Professor Hector P. Rodriguez, Chair
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Abstract

The Effect of the Foreclosure Crisis on Health
by
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Professor Hector P. Rodriguez, Chair

Foreclosure rates reached unprecedented levels in the United States during the Great Recession. During 2010, one in 45 housing units nationwide received a foreclosure filing. Residents who lived near properties in foreclosure from 2007 to 2012 lost an estimated collective $2.2 trillion in property values, local governments tax base declined, and affected communities experienced an increase in crime and blight. In the aftermath of the foreclosure crisis, little is known about how the foreclosure crisis affected the health of homeowners who lost their homes to foreclosure and the health of residents living in communities hit hard by the crisis. This dissertation, made up of three papers, first explores the explicit and implicit theories evoked by the literature in this space, and then empirically tests the hypothesis that the foreclosure crisis had spillover effects on health. The first paper systematically reviews the existing, early-stage research on foreclosures and health by presenting an organizational schema based on level of analysis, type of housing distress measure, and health outcome. In addition, the review describes the specific mechanisms linking foreclosures and health, and how this field aligns and departs from the larger body of work on recessions and health. The second and third papers empirically test if the foreclosure crisis has an impact on glycemic control (hemoglobin A1c) and weight change of patients in a large clinical population of continuously insured patients with diabetes living in the Bay Area of California during 2007 to 2010. The three primary conclusions from this work are: 1) there was no evidence of a spillover effect of the foreclosure crisis on A1c or weight change among patients in a managed care system; 2) the pathways by which health is influenced by experiencing a foreclosure compared to living near a foreclosure are distinct and vary based on the manner in which the exposure and outcome are operationalized; 3) housing and labor market factors appear to have related yet discrete repercussions on health and healthcare.

For My Family

"*Work is Love Made Visible.*"
– Khalil Gibran

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Introduction

The rate of foreclosures in the United States reached an unparalleled high during the Great Recession. By 2010, 2.2% of homes received a foreclosure filing. The economic and political causes and effects of what came to be known as *the foreclosure crisis* have been studied and debated at length by researchers and policymakers. The financial impact of the crisis extended beyond the mortgage holders who lost their homes during this period; the spillover effect on residents living in communities hit hard by the crisis was estimated at $25,150 in lost household wealth on average and $40,297 for families in minority communities (Lending, 2013). In addition, the foreclosure crisis incurred additional negative externalities within neighborhoods including lower educational performance, crime, and blight (Bradbury, Burke, & Triest, 2014; Ellen, Lacoe, & Sharygin, 2013; Immergluck & Smith, 2006a). The extent to which the foreclosure crisis affected the health of homeowners who lost their homes to foreclosure and the health of residents living in communities hit hard by the crisis is still poorly understood. This dissertation, consisting of three papers, first seeks to describe the theories evoked by the literature in this space and summarize the existing evidence with a novel schema, and then provides an empirical examination of the question; did the foreclosure crisis have a spillover effect on health?

The first paper is a systematic review of the emerging research on foreclosures and health. A schema is proposed and applied to organize the literature by level of analysis, type of housing distress measure, and health outcome. There were 40 studies reviewed in this paper; 18 studies described the health individual homeowners who experienced a foreclosure or housing distress, and 12 studies discussed health of individuals living in neighborhoods where there were foreclosures. The review describes the pathways by which foreclosures and housing distress are anticipated to affect health. The paper presents a discussion of how the research on foreclosures and health contributes to and departs from the larger body of work on recessions and health.

The second and third papers empirically test if the foreclosure crisis has an impact on glycemic control (hemoglobin A1c) and weight change of patients in a large clinical population of continuously insured patients with diabetes living in the Bay Area of California during 2007 to 2010. The hypothesis of the second paper is that an increase in the neighborhood foreclosure rate could worsen glycemic control by activating stressors such as neighborhood crime, eroding neighborhood social cohesion, and reducing the housing wealth of homeowners. Clinical data from Kaiser Permanente Northern California was linked with address-level foreclosure data, and individual fixed-effects models with one-year lags were specified to estimate the effect of changes in the foreclosure rate per block group on A1c. A prior study showed that increases in health utilization due to foreclosures were driven by those with public health insurance (Currie & Tekin, 2011). To test the hypothesis that the health of those with publically insured was more likely to be affected by the foreclosure crisis, this paper estimated models for those with Medicaid. The second paper also employed an approach to mitigate bias from attrition to address the concern that those who were most affected by the foreclosure crisis were unable to return to the clinic for care.

The third paper looked at the spillover effect of the foreclosure crisis on weight change among the same study population included in the second paper. The mechanisms by which proximate foreclosures are expected to influence weight differ in part from those that affect A1c. This paper attempts to replicate the approach of the single existing study on the effect of foreclosures on weight gain (Arcaya et al., 2013). In addition, this study stratifies the main

results to look at the effects within subgroups that are expected to be particularly vulnerable to economic stressors, including older adults and racial minorities.

This dissertation: 1) outlines research questions through a systematic review on foreclosures and health in order to motivate future work that will provide context for policies in housing financing and healthcare; 2) answers a narrow set of questions on the spillover effects of the foreclosure crisis on two somatic health outcomes of a chronically ill population within a single healthcare system, and 3) couches the evidence-base on foreclosures and health in a broader discussion of economic recessions and health.

Paper 1

The health effects of the foreclosure crisis: a systematic review

1. Introduction

The housing bubble burst in early 2007 and by 2010, one in 45 homes in the United States was subject to at least one foreclosure filing. The politically charged nature and the magnitude of the foreclosure crisis precipitated extensive inquiry on not only as to how mortgage holders fared, but also how the crisis affected other, seemingly unrelated domains. Studies have documented externalities of the foreclosure crisis on property values, crime, and education (Bradbury et al., 2014; Ellen et al., 2013; Z. Lin, Rosenblatt, & Yao, 2009). An emerging body of research has begun to look at the effect of the foreclosure crisis on the health of homeowners who lost their homes and the spillover effects on health within neighborhoods.

The salience of the foreclosure crisis to public health is manifest in its history. The field public health, rooted in medicine, has evolved since the early days of Durkheim to take into account the social distribution and determinants of health. The social distribution of the foreclosure crisis was inarguably unequal across race and class; neighborhood patterns of subprime lending were heavily concentrated in minority neighborhoods which resulted in $1.1 trillion in home equity as a result of spillover from homes in foreclosure (Bocian, Li, Reid, & Quercia, 2011). In addition, although the link between housing and health policies has been recognized since the Industrial Revolution, the recent initiatives by the Obama administrative has built upon these efforts by adopting a cross-sector initiative to put "health in all policies" in housing and community development (Bostic, Thornton, Rudd, & Sternthal, 2012).

The foreclosure crisis, although a unique phenomenon, is not an isolated one. At a national level, the U.S. housing crisis preceded the Great Recession and contributed in part to the increase in unemployment (Estevão & Tsounta, 2011; Karahan & Rhee, 2013). However, the labor market turned downward prior to the housing market in a slight majority of metropolitan statistical areas (Winkler, 2013). The tension between the housing and labor markets has defined housing affordability; housing claims the largest portion of wages for most Americans and contributes to access to the labor market (M. Stone, 2010). Studies on recessions have been countercyclical and historically focused exclusively on the labor market, despite its inexorable linkage with the housing market.

This review synthesizes the literature testing the associations between foreclosures of housing affordability and health. First, I describe the conceptual space and discuss mechanisms linking housing and health that are explicitly tested or invoked in the literature. Next, I summarize the evidence in each line of inquiry, provide context for discrepancies in research findings, and consider areas for improving measurement and methods. I conclude with a discussion of how these findings add to the existing research on the economy and health.

The purpose of this review is to: 1) uncover gaps in the research agenda in this emerging body of literature, 2) inform future study design by organizing the conceptual space, and 3) offer an inclusive approach to understanding economic recessions and health by providing context for the labor and housing market crises.

2. Methods

The studies included in this review were collected through a search for peer-reviewed articles that address an association between foreclosures or housing affordability and health. Next, the references from each article were reviewed to identify additional peer-reviewed articles that met these criteria. The following databases were reviewed: PubMed, EconLit, and the National Bureau of Economic Research, in addition to all databases available through Google Scholar. The search was limited to articles written in English. There was no restriction for publication date or country of origin of the research. This search was conducted between December 2014 and March 2015.

The following terms were used in the search: "foreclosure," "mortgage," "mortgage debt or distress," "secured debt," "repossession," "arrear," "housing insecurity," "housing wealth," "housing equity," "recession," *and* "health," "psychological," "abuse," "violence," "violent crime," "depression," and "anxiety."

Studies were included for review if they were peer-reviewed, applied quantitative methods, and estimated a coefficient for foreclosure or housing affordability that was either an exposure or outcome (not mediator or moderator). Housing affordability could be measured either objectively, using a measure such as income to mortgage debt, or subjectively, through a self-report assessment of perceived financial affordability of housing. This process yielded a total of 72 studies.

Studies were then excluded from the final set for analysis if they focused exclusively on housing tenure (i.e. homeownership compared to renter status), evictions, and/or housing affordability of renters. Research on housing instability (frequently moving, residence in a crowded home, or homelessness) was also excluded. Studies that did not define how each foreclosure or housing affordability variable was measured were excluded. Additionally, studies that included foreclosures as an input for a composite measure such as neighborhood instability were excluded. Finally, studies on crime were excluded if violent crime was not estimated as a discrete outcome of interest. This process yielded 40 studies for final inclusion in this review.

3. Results

3.1 Review of the Conceptual Space

3.1.1 Level of analysis

The research in this review falls into one of two lines of inquiry. Some studies, referred to as "risk-factor" or individual-level studies, explore how differential exposure to a contracting housing market relates to the health of individuals. These studies focus on the somatic, psychological, and behavioral health of those who experience foreclosure, mortgage delinquency, or unaffordable housing.

The second type of inquiry, "net-effects" or population-level studies, aims to relate health to variation in measures of foreclosures, mortgage delinquency, or unaffordable housing aggregated by populations within a spatial or administrative unit of analysis. This line of inquiry examines, for example, the relationship between health and the number of foreclosures per housing units in a given census tract. This population-level variable should not be used as a proxy for individual-level phenomena, but rather interpreted as a composite of effects

experienced by the homeowner who has been foreclosed upon and the spillover effect of foreclosures on their community members. While statistical approaches are available to researchers who wish to decompose the individual and population-level variance, the net-effects parameter is the most salient to designing policies with the intention of improving population health.

3.1.2 Health outcomes

The literature includes three classifications of health-related outcomes: 1) psychological and behavioral morbidities; 2) somatic morbidities and mortalities; and 3) health services utilization. Psychological and behavioral morbidities include psychological outcomes (namely distress, mental health, depression, and anxiety), suicide, substance abuse, and violent behavior. The second group, somatic morbidities and mortalities, includes outcomes such as self-reported health, cardiovascular events, and other clinical measures of disease. The third group, health services, includes healthcare utilization and health insurance coverage.

3.1.3 Constructs

Three types of discrete constructs or experiences of homeowner financial distress are dominant in the literature reviewed here: 1) housing affordability, 2) pre-foreclosure, and 3) foreclosure. The predominant narrative rests on the supposition that a shared phenomenon of homeowner financial distress forms the basis for all three types of constructs. Although the homeownership experience has been described as continuum in the literature, each point along the continuum might operate to impact health outcomes through a discrete theoretical mechanism. In order to reflect this, the literature for analysis was separated by construct in order to best assess the evidence each study offers.

3.1.3.1 Housing Affordability

One measure of homeowner distress that appears in the literature is housing affordability, which captures the relationship between people and housing, rather than representing a characteristic of housing (M. E. Stone, 2006). Few studies on health have defined ex-ante the theoretical basis for how housing affordability impacts on health. Unaffordable housing is often assessed subjectively by a self-report of burden or perceived inability to pay a mortgage. The subjective approach is grounded in neo-classical economic theory and suggests that households seek to maximize their utility and pay what they are able for housing. However, households face different constraints and preferences for housing consumption; households at the top of the income distribution have more choice than lower income households in how to allocate their resources between housing and non-housing costs.

Empirically, the relationship between housing costs and income or wealth has been examined as either a ratio or a difference. The relative approach of assessing housing affordability, changes in housing prices or costs and household income over time, has been widely used by mortgage lenders and the real-estate industry and thereby adopted in academia despite its atheoretical origin and lack of technical sophistication. Thus, it might not be a good proxy for housing affordability. Other more comprehensive methods, such as the shelter-poverty approach, factor in differences in household composition and income (M. Stone, 2010).

Housing affordability still rests largely on an ideological perspective (i.e. whether one believes all citizens should have safe housing without serious detriment). To avoid this, some researchers have focused on factors that precipitate unaffordable housing, such as changes in payments on mortgage debt, home equity, or household disposable income, which are driven by loan, borrower, and property characteristics. I include housing wealth or equity as measures of housing affordability because a decline in housing equity can reduce the ability of a homeowner to withdraw equity from their home in order to buffer the household from income and wealth shocks. Housing wealth has the ability to change household constraints and reflects the interdependency between homeowner and housing rather than serving as an independent characteristic of housing.

3.1.3.2 Pre-foreclosures and Foreclosures

Two other homeowner distress experiences are addressed in the literature, pre-foreclosures and foreclosures, which reflect homeowner actions presumed to be downstream and *in response to* unaffordable housing. Borrowers might perceive their mortgage is affordable or unaffordable, and simultaneously decide to either make payment, prepay the mortgage through refinancing or sale of the property (if there is enough equity in the home), delay payment (become delinquent), or stop payment (default). The speed at which a homeowner advances from unaffordable housing to experiencing a foreclosure on their home is dependent on the amount of liquid assets, home equity, state process (judicial or non-judicial), and several psychological factors such as inter-temporal choice.

Pre-foreclosure activities are delinquent mortgage payments and default. Most mortgages are considered in default after 30 days without payment, although the lender often does not initiate the default process until after 60 or 90 days. A notice of default marks the start of the official foreclosure process, which can last anywhere from a few months to several years depending on the state. Often these "foreclosure starts" can be stopped, usually with a penalty, if the mortgage-holder makes a payment within an agreed timeframe.

The foreclosure construct includes measures of completed foreclosures, when the property deed is transferred from the mortgage holder to the new buyer at auction. Otherwise, the property is retained by the lender or bank, known as real-estate-owned (REO), and often remains vacant until it is sold to another homeowner. The population of individuals who experienced a foreclosure is a sub-set of those who experienced pre-foreclosure.

3.1.3.3 Timing

The literature was further separated into two groups, U.S. foreclosure crisis and non-U.S. foreclosure crisis, based on time period and location. There are two reasons that this is a particularly salient dimension. Studies that exclusively captured the U.S. housing foreclosure crisis, 2006 to 2011, should be interpreted differently than those that did not. First, given that no large population-level increases in ill health occurred around the same time as the foreclosure crisis, the research on foreclosures and health during this time period could be interpreted as the health effects of foreclosures. The direction and magnitude of effect are far less predictable and interpretable in studies that capture a longer period of time (e.g. from 1980 to present).

Next, there was an unprecedented increase in households that experienced unaffordable housing due to changes in mortgage payments or home equity during the foreclosure crisis.

While there continued to be a number of households that were foreclosed upon due to a shock in income or wealth from job loss or illness, this represented a much smaller proportion of foreclosures from 2007 to 2011. The size of the subprime market grew more than 6-fold in a decade; by 2006 the subprime market reached $640 billion or 27 percent of all loan originations (Bocian et al., 2011). The distribution of subprime loans was unequal across neighborhoods and racial/ethnic groups, and carried a greater foreclosure risk than prime loans (Immergluck & Smith, 2005). As a result, foreclosures were clustered in low-income, minority neighborhoods during the foreclosure crisis. Studies of the foreclosure crisis should be interpreted in context of the characteristics and concentration of the loan products and borrowers.

3.1.4 Mechanisms

There are several mechanisms by which foreclosures or housing affordability may be associated with health behaviors and outcomes (see Appendix, Figure A1). Few studies explicitly test specific mechanisms, yet most motivate their research question by implying at least one mechanism is at play. In a prior review, the conceptual space on recessions and health was reduced to three broad mechanisms that operate in a countercyclical or procyclical manner at both the individual and population-level: stress, effect-budgeting, and frustration-aggression (Catalano et al., 2011). I also offer one original mechanism that has not yet been identified in the literature, namely trust. Below, I discuss how these mechanisms might operate in the literature on health and foreclosures or housing affordability. The extent to which each mechanism contributes to the total effect of foreclosures or housing affordability on health is an empirical question, yet the nascence of this field precludes the ability of this review to properly answer it. Thus the discussion of the mechanisms serves to provide context for the results and motivate future research to design studies to test these explicitly.

3.1.4.1 Stress

Similar to the literature on economic recessions and health, the stress mechanism is the most commonly evoked in the literature subject to this review. This mechanism may work when the biological stress-response process causes an increase hormones circulating in the blood stream and an increase risk for disease. There are differences in biological susceptibility in response to stress that interact with societally constructed concepts of self-care (Sapolsky, 2004).

The countercyclical argument states that declining housing markets (i.e. increased foreclosures and unaffordable housing) increases the incidence and anticipation of stressful events such as loss of wealth and forced relocation. The foreclosure process brought on feelings of guilt, anxiety, and shame for many homeowners who defaulted (Ross & Squires, 2011). Prior studies have shown that individuals who fell behind on their debt experienced elevated levels of financial strain and stress (Turunen & Hiilamo, 2014). The chronicity and severity of the foreclosure process are stressors that likely vary based on the length of the process and the sense of agency the homeowner experienced.

The procyclical argument is largely absent from the literature. The financial burden of mortgage payments, property taxes, insurance, and maintenance can be stressful in itself, especially for households with little non-housing wealth or unstable employment. Borrowers who found their debt stressful might experience less debt-related stress following the release from that debt. Additionally, the experience of home maintenance can be stressful, particularly

for first-time buyers. Those who experience a foreclosure and transition to rent a home are freed of the stress related to maintenance and repair.

At the population-level the cumulative and intersectional exposure to stressors varies across space. The neighborhood distribution of foreclosures was not random; some evidence suggests that subprime lending and the foreclosure crisis was concentrated in areas with a high prevalence of low-income, racial minority households (Reid & Laderman, 2009a). Communities with high concentrations of racial and ethnic minorities experience more stressors than predominately non-Hispanic White communities; minority communities have less access to high quality schools, higher rates of poverty, and more exposure to environmental toxins (Schulz et al., 2008), which might exacerbate the impact of foreclosures on health.

The countercyclical argument states that proximate foreclosures act as a chronic stressor for homeowners who anticipate a negative spillover to the value of their home, higher rates of crime, or social disorganization in their neighborhood. The saliency of the community foreclosure rate is largely linked to its visibility. Real estate owned (REO) foreclosures are more likely to remain vacant and poorly maintained than those sold at an auction.

The procyclical argument posits that when the housing market declines and foreclosures increase, there are fewer stressful events. First, there is less capital available for construction and maintenance. Neighborhood construction can be stressful to neighbors if it causes noise and disruption. Additionally, booming housing markets can increase incidence and anticipation of stressful events such as displacement and cultural change that is not present in declining or stable housing markets.

3.1.4.2 Frustration-aggression hypothesis

The frustration-aggression mechanism is derived from the idea that aggression results when individuals are denied an expected reward or a goal is blocked (Dollard, Miller, Doob, Mowrer, & Sears, 1939). Since the Great Depression, homeownership has been pegged to the American Dream and even portrayed as a political right (Shlay, 2006). The U.S. federal government has promoted this ideology through the mortgage interest tax deduction and government-sponsored enterprises.

The countercyclical argument of the frustration-aggression mechanism predicts that some individuals become violent while others engage in self-destructive behavior like substance abuse when they experience a foreclosure or unaffordable housing. Many of the borrowers who defaulted or experienced delinquency during the foreclosure crisis described feeling a deep violation of the trust between themselves and their mortgage broker (Ross & Squires, 2011). The level of anger a person had about the economic situation was significantly associated with strategic default, which occurs when individuals can afford to pay their mortgage but do not (Guiso, Sapienza, & Zingales, 2013). It follows that those who defaulted are expected to have higher rates of substance abuse, suicide, or violent behavior toward others or their families.

The procyclical assertion of this mechanism draws from the "inhibition hypothesis," which states that some individuals will regulate their behavior to avoid punishment in response to frustration (Catalano, Novaco, & McConnell, 2002). In this case, individuals who fear foreclosure or unaffordable housing will do everything in their power to stay away from it. These homeowners avoid conflict, drugs, and alcohol to keep their jobs and avoid costly hospitalizations in order to continue to make payments on their mortgage. Most homeowners during the foreclosure crisis who took out a subprime loan had little ability to thwart a

foreclosure, however this might apply to homeowners who experienced unaffordable housing as a result of a decline in housing prices rather than their loan characteristics. Additionally, this theory extends to those who wish to enter the housing market in the future (i.e. renters). The inhibition hypothesis predicts that when foreclosures are high, future entrants into the housing market would also reduce violent behavior and substance abuse.

The frustration-aggression hypothesis also operates at the population-level, where an individual lives in a neighborhood with foreclosures but does not experience a foreclosure herself. As the strength of the provocation response is dependent on whether the punishment or thwarting of the goal is socially justified (Berkowitz, 1989), the foreclosure crisis presents a unique application of this theory because there is still no consensus on who is to blame (Foote, Gerardi, & Willen, 2012). The media has promoted the fallacious idea that the mortgage holder is entirely at fault (Treas, 2010).

The countercyclical position argues that when individuals see others denied the attainment of a goal, in this case homeownership, they will experience higher levels of violence and substance abuse. The procyclical argument states that individuals will exhibit fewer acts of aggression toward themselves and others so they can keep their home or their dream of homeownership intact. For those who believe that borrowers are not at fault for the foreclosure and blame the regulatory climate or bank, the effect of frustration-aggression should be much greater in magnitude than for those who think that their neighbor deserved to default. There is a strong social barrier to foreclosure when underwater (Guiso, Sapienza, & Zingales, 2009). Foreclosure-related social stigma declines with increases in neighborhood foreclosures (Guiso et al., 2013). Neighborhoods with a high prevalence of foreclosures are more likely to view the foreclosure as socially unjustified.

3.1.4.3 Effect-budgeting

The third mechanism, "effect-budgeting," refers to the fixed amounts of resources, time, and energy available to manage an environment that vary based on expected costs and benefits (Catalano et al., 2011). A foreclosure represents a loss of wealth, time, and energy to a household that loses their home. The countercyclical argument states that individuals who typically invest in health-promoting behaviors, such as exercising, socializing, and eating healthily, are hypothesized to experience a decline in health following a foreclosure or loss of housing affordability due to a reduction in resources and time to engage in health promoting behaviors.

Homeowners who default on their mortgage have increased time constraints because of the attendant tasks such as filing paperwork related to the foreclosure process or searching for a new place to live. Those who report unaffordable housing but have not yet defaulted are likely to also face a constraint in time if they are searching for a more affordable home or additional sources of income. Foreclosures are often triggered by a decline in housing wealth, where housing wealth is exogenous to foreclosures and health, except for during the foreclosure crisis where foreclosures contributed to the decline in housing wealth of neighboring properties. As a result, this mechanism should be interpreted in respect to timing (see section 3.1.3.3).

The "effect-budgeting" mechanism implies that a foreclosure or decline in housing affordability will reduce the wealth available to purchase healthy inputs such as healthier food, healthcare, and education. Housing is the largest source of wealth for many Americans, particularly for those close to retirement (Lusardi & Mitchell, 2007). Unlike income, a change in

housing wealth does not explicitly change individual utility, but has been shown to have a small, yet significant effect on consumption of goods and services (Buiter, 2008).

While the relationship between health and wealth has been well documented (Deaton, 2002), the causal evidence supporting the effect of wealth on health does not converge. Some studies have shown a positive relationship between income and somatic and mental health (Costello, Compton, Keeler, & Angold, 2003; Ettner, 1996), while other research has found higher mortality and obesity rates following increases in income or wealth (Schmeiser, 2009; Snyder & Evans, 2006). Like the RAND Health Insurance Experiment, an increase in income or wealth might change health behaviors but not translate to health outcomes (Newhouse & Group, 1993). Alternatively, healthcare prices, insurance, or other economic variables on the pathway between wealth (i.e. housing prices) and health might serve to confound or mediate the relationship.

Many of these studies focus on the health behavior impact of an increase rather than a loss of income, and might not be generalizable given that individuals tend to be loss averse (Tversky & Kahneman, 1991) because a loss of a home or a decline in housing wealth is likely to be experienced quite differently than a gain of a home or an increase in housing wealth. The literature on health effects of indebtedness is particularly useful to fill this gap. There is emerging evidence that unpaid financial obligations are related to suicidal ideation, depression, subjective negative health reports, and health behavior, although the structure of the loan and individual characteristics appear to confound results (Turunen & Hiilamo, 2014).

The procyclical variant of the effect-budgeting mechanism assumes that substance use and risky behaviors are disposable, and that households will cut these items out of their budgets when experiencing unaffordable housing or a mortgage default. Additionally, more time is available to the homeowner in cases where unaffordable housing or foreclosure is precipitated by job loss.

"Effect-budgeting" at the population-level refers to the amount of time, energy, and resources a community has to manage the environment. A sharp increase in the foreclosure rate of a community can lead to a decline in the tax base (Apgar, Duda, Gorey, & Council, 2005) thereby reducing available resources to the local governments (Kingsley, Smith, & Price, 2009). Local communities that have traditionally invested in health-promoting activities such as education, community-building events, and preservation of green spaces have fewer resources and might have to redirect their limited resources to the management of blight. Those who live in communities that historically have spent little time on health-promoting activities might not see a change following a spike in foreclosures.

The concept of "effect-budgeting" was initially proposed to capture several different variations of a similar theme (Catalano et al., 2011). The most simplistic variation described above assumes that individuals make time consistent choices to maximize their personal utility and are aware and capable of processing the information related to their choice. As homeowners are oft subject to cognitive biases such as failing to walk away from a mortgage even when it is economically advantageous to do so, behavioral economic theory can be applied to further our hypotheses about how this mechanism operates. Additionally, the "effect-budgeting" can be expanded to take into account the role of age, wage, and education in the reallocation of resources devoted to health production (Grossman, 1972). For example, while the sequelae related to a foreclosure might be devastating to an older adult who has a chronic health condition, a younger adult might not experience any noticeable changes in health even if he chooses to drink alcohol and eat poorly. Highly educated individuals who default on their

mortgage might spend less time navigating the foreclosure process or find ways to continue their health-promoting activities despite a decline in resources and time.

3.1.4.4 Trust

The fourth mechanism by which foreclosures or housing affordability may relate to health is trust, defined as a belief that someone or something is reliable, honest, and good. Trust can be conceptualized differently at the individual and community levels.

Often first-time homebuyers turn to a mortgage-broker, lender, or another financial advisor for help in navigating the market and securing a mortgage. Many of the homeowners who defaulted on their mortgages as a result of a subprime loan believed their trust had been compromised (Ross & Squires, 2011). Some felt betrayed by the mortgage broker whom they had once turned to for help, while others lost trust or faith in themselves or in the way they had once known the world to operate. This sense of trust and confidence in the way the world is ordered (e.g. materially, ideologically, socially) has been referred to as ontological security (Dupuis & Thorns, 1998). Home can be a component of ontological security in that it creates a constant space where routines are performed without the surveillance of others, which in turn sets up a secure base around which homeowners construct an identity.

The countercyclical argument is that a foreclosure erodes trust and ontological security by removing the safe space and destroying the identity of homeowner, which in turn is hypothesized to have negative consequences for mental health. This mechanism has also been assessed in the literature on housing tenure (Easterlow, Smith, & Mallinson, 2000; Hiscock, Macintyre, Kearns, & Ellaway, 2003). For those who face unaffordable housing, the threat of a disruption to their ontological security might prevent them from defaulting on their mortgage, even if they have negative equity in their home.

The procyclical argument posits that homeowners who experience a foreclosure or face housing affordability problems will not experience a loss in ontological security if it was not secure at baseline. Given that the subprime lending allowed more first-time homebuyers to enter the market, and there was a higher foreclosure rate among those with subprime loans, many of these new homeowners might have not yet assimilated homeownership into a broader conception of ontological security due to the short tenure of their homeownership experience. In addition, ontological security might not be fashioned through homeownership, but rather through the consistency of daily patterns that can be achieved through work or social spaces.

Trust can also be conceptualized as conferred at the population-level, as social capital or social cohesion. Social capital and cohesion have been defined in many ways, sometimes ambiguously, but generally these terms refer to the degree of trust or social organization of the community which is thought to confer resources to its residents (Kawachi, Subramanian, & Kim, 2008; Macinko & Starfield, 2001). Individuals who live in neighborhoods with low social capital are expected to have lower levels of mental and physical health (Islam, Merlo, Kawachi, Lindström, & Gerdtham, 2006). Social capital, the collective value of all social networks and norms of reciprocity, can influence health-related behaviors, access to health services, and affect psychosocial processes (Kawachi & Berkman, 2000). Perception of social climate of one's neighborhood has been shown to play a substantial role in shaping mental health (Wright & Kloos, 2007).

The countercyclical argument is that individuals who live in areas with a higher number of foreclosures might experience a loss of social stability, capital, and cohesion. Neighborhoods

with high foreclosure rates have fewer people who are watching out for deviant behavior such as crime, drug use, and risky drinking.

The argument against this is that homeowners with short tenure might have been less integrated into the community, and therefore the loss of these members had no effect on neighborhood social capital. In fact, there has been little empirical evidence to demonstrate that neighborhood foreclosures cause a decline in social cohesion. A qualitative study of foreclosures in Boston showed that residential instability due to high numbers of renters in an area was a greater source of concern than foreclosed properties (Graves & Shuey, 2013).

3.2 Review of the literature

All studies included in the review are organized by level, construct, and outcome in Table 2.

3.2.1 Individual-level studies

At the individual-level, it is difficult to determine the causal direction between foreclosures and health because a homeowner's decision to establish a mortgage, refinance, or default implicitly reflects knowledge about current and future expectations of health status and economic well-being. A majority of homeowners who experienced foreclosure during the foreclosure crisis had recently established a new mortgage or refinanced. As a result, the estimates of the effect of experiencing a foreclosure on health of homeowners are likely to be biased upward. A majority of borrowers with subprime loans were formerly excluded from the housing market due to a poor credit history or insufficient wealth. Thus, a subprime mortgage holder with poor credit history is likely to be a hyperbolic discounter (value the present more than the future), a trait which is associated with increased rates of unhealthy behaviors such as overeating, tobacco use, and alcohol abuse (Loewenstein, Brennan, & Volpp, 2007). As a result, the studies are presented here without supposition of causal direction.

There were 18 unique studies at the individual-level that met the criteria for inclusion (see Table 1). 72 percent of the studies included at least one measure of foreclosure or pre-foreclosure, and the remainder focused exclusively on housing affordability. A third of the studies included data from outside the United States. 39% of studies were both inclusive of the U.S. foreclosure crisis (2007-2009) and 1-3 years before or after the crisis. 44 percent of the studies took advantage of temporal variation to adjust for residual confounding.

Six studies included more than one construct; there were 26 constructs used across the 18 unique studies. The foreclosure construct was used in 42 percent, the housing affordability construct was used in 31 percent, and a pre-foreclosure construct was used in 27 percent of studies. The distinction of a real estate owned foreclosure was not observed at the individual-level in any studies. Table 2 presents the studies organized by level, construct, and outcome.

3.2.1.1 Psychological and behavioral morbidity

63 percent of studies showed a countercyclical relationship of any construct with psychological health, suicide, and substance abuse (no studies were found on violent behavior). 29 percent found no association, and 8 percent found a procyclical relationship. More granularly, a countercyclical relationship was observed in 86 percent of studies on psychological

outcomes and foreclosures, compared to only 80 percent on pre-foreclosures and 33 percent on housing affordability.

In a study by Yilmazer et al using an individual fixed effects approach with the Panel Survey of Income Dynamics, the authors find those who have trouble paying the mortgage have higher rates of psychological distress and depression, and the magnitude of the effect increases when the foreclosure process has started (Yilmazer, Babiarz, & Liu, 2015). All of the other studies that reported countercyclical relationship between foreclosure or pre-foreclosures and psychological health were cross-sectional, except for two studies from the United Kingdom. Pevalin et al used an individual fixed effects approach and found that housing repossession was associated with common mental illness (Pevalin, 2009). Taylor et al used the same data and a similar time period and approach; they found a statistically significant negative association between late mortgage payments and mental well-being (Taylor, Pevalin, & Todd, 2007).

Evidence on housing affordability and psychological outcomes does not converge. Yilmazer finds that psychological health gets worse as the proportion of wealth from housing declines, although the effect size is small (Yilmazer et al., 2015). Taylor et al also found an association between self-reported unaffordable housing and poor psychological health (Taylor et al., 2007). In a cross-sectional study, Cannuscio et al observed a relationship between moderate housing strain and psychological distress (Cannuscio et al., 2012). Riumallo-Herl et al reported a procyclical association of housing wealth on depression among adults 50-64 that was observed in the U.S. but a no effect was observed within the European countries (Riumallo-Herl, Basu, Stuckler, Courtin, & Avendano, 2014). Using individual fixed effects approaches, no association between unaffordable housing and psychological health was reported by Mason et al in Australia (Mason, Baker, Blakely, & Bentley, 2013), and Lau et al in the U.S. Health and Retirement Survey (Leung & Lau, 2014).

Only one study on individual-level foreclosures and suicide was found; this study was descriptive in nature but suggests a countercyclical association (Fowler, Gladden, Vagi, Barnes, & Frazier, 2015), that is, more foreclosure-related suicides were observed during the foreclosure crisis.

Two studies on substance abuse and individual-level foreclosures were included in the review. A cross-sectional study by Burgard et al found that those who were behind on a mortgage or started the foreclosure process had a lower likelihood of alcohol abuse, while those who had completed a foreclosure had an increase in alcohol abuse (Burgard, Seefeldt, & Zelner, 2012). The other cross-sectional study found there was no increased risk for alcohol or drug use among those who underwent foreclosure (C. Pollack, Kurd, Livshits, Weiner, & Lynch, 2011).
Summary: There is some evidence of the countercyclical association between psychological health and foreclosures, but the housing affordability evidence is mixed. The limited evidence on the relation of foreclosures and suicide and substance abuse does not converge.

3.2.1.2 Somatic morbidity and mortality

There were 23 studies on somatic morbidity and mortality; a third of these studies on showed a countercyclical association while there was no evidence of an association in the remainder.

A third of studies (8 studies) found a countercyclical association for self-reported health. Yilmazer et al found a countercyclical association between self-reported health and housing wealth, but no evidence for foreclosure or mortgage delinquency (Yilmazer et al., 2015).

Cannuscio found no evidence of an association between housing affordability and self-reported health, but a positive relationship between experiencing a foreclosure and poor self-reported health (Cannuscio et al., 2012). In a study of a lower income population in the Community Advantage Program, Lindblad et al found no association between self-reported health and mortgage delinquency or foreclosure (Lindblad & Riley, 2015). The evidence from the longitudinal studies on the U.S. foreclosure crisis (Leung & Lau, 2014; Lindblad & Riley, 2015; Yilmazer et al., 2015) suggests that self-reported health has a small countercyclical relationship with housing affordability but there is no evidence of a relationship with events upstream to foreclosures or foreclosures.

Two studies on body mass index (BMI) found no association with housing affordability (Leung & Lau, 2014; C. E. Pollack, Griffin, & Lynch, 2010). No studies have examined foreclosure and pre-foreclosure with individual-level BMI.

There were seven studies focused on the relation of pre-foreclosures or foreclosures on hypertension control. One cross-sectional study found a countercyclical association between hypertension and housing affordability (C. E. Pollack et al., 2010), while two longitudinal studies found no association (Leung & Lau, 2014; Yilmazer et al., 2015). Two cross-sectional studies (C. Pollack et al., 2011; C. E. Pollack & Lynch, 2009) examined the relation of foreclosures and hypertension and find significant relationships, however, the single longitudinal study did not (Yilmazer et al., 2015).

The evidence from three studies conducted by the same author on the relation of housing affordability and foreclosures and cardiovascular disease did not converge(C. Pollack et al., 2011; C. E. Pollack et al., 2010; C. E. Pollack & Lynch, 2009). There were no individual-level studies of foreclosures and mortality.

Summary: Although the findings of studies examining individual-level self-reported health, BMI, cardiovascular disease, and hypertension do not converge, the studies that control for residual confounding more consistently find no evidence of association.

3.2.1.3 Health services utilization

Four unique studies account for nine parameters on health services utilization. Pollock et al finds a countercyclical relationship between no health insurance and experiencing a foreclosure (C. E. Pollack & Lynch, 2009), and no association with unaffordable housing in another study (C. E. Pollack et al., 2010).

Housing affordability was associated with cost-related healthcare non-adherence and cost-related prescription non-adherence, but not emergency department visits in the prior year study (C. E. Pollack et al., 2010). Another study found an association between mortgage delinquency and cost-related medication adherence (Alley et al., 2011). Individuals who experienced a foreclosure were more likely to have had an emergency department and outpatient visit in the 2 years prior to foreclosure (C. Pollack et al., 2011), and were less likely to fill a prescription in the prior year because of cost (C. E. Pollack & Lynch, 2009).

Summary: There is partial evidence to support the countercyclical relationship between health services utilization and individual-level housing affordability, mortgage delinquency, and foreclosures.

3.2.2 Population-level studies

As previously described, establishing causality in individual-level studies of foreclosure effects is challenging. The foreclosure crisis, as a large shock to the well being of the population, provides an opportunity to substantiate the foreclosure to health causal direction if there is no evidence of simultaneous large spike in illness at the population-level. Population-level or net-effects research has examined how variation in foreclosure rates within a neighborhood or other spatial catchment area relate to healthcare utilization, psychological health, health behaviors, and somatic outcomes.

There were 22 unique studies at the population-level that met the criteria for inclusion (see Table 1). 91% of these included a measure of foreclosure or pre-foreclosure, all of which were U.S.-based. Those remaining used a measure of housing affordability and focused on several European countries; one included a measure of self-reported unaffordable housing, while the other created an objective instrument of mortgage debt to disposable income. Only 7 unique studies temporally identified the foreclosure crisis as an exogenous shock.

Six studies included more than one construct (affordability, pre-foreclosure, foreclosure, foreclosure – REO). This yielded a sample of 30 when treating each construct separately. 10 percent of studies included a pre-foreclosure construct; 2 studies used notice of default and 1 study used the 90-day delinquency rate. A foreclosure construct was used in 57% of studies and a measure of real estate owned foreclosures was used in 27% of studies, together accounting for 84 percent.

3.2.2.1 Psychological and behavioral morbidity

More than three quarters (n=X) of the studies on psychological and behavioral morbidity found a countercyclical association, while the remaining quarter yielded null results. Among studies with the foreclosure construct, 80 percent found countercyclical associations.

There is some convergence of findings for studies examining population-level foreclosures on psychological outcomes. Currie and Tekin find that an additional foreclosure per 100,000 persons in a zip-code increases the number of mental health visits by 0.07 over four quarters (Currie & Tekin, 2011). Using data from two waves (2005-2006 and 2010-2011) of the National Social Life, Health, and Aging Project, Cagney et al found that an increase in the notice of default and the REO foreclosure rate at the zip-code level was associated with higher odds of depressive symptoms in the second wave among older adults (Cagney, Browning, Iveniuk, & English, 2014a). Houle found that an increase in the community foreclosure rate from 2006 to 2011 accounted for a decline of a small magnitude in residents' days in good mental health(Houle, 2014), but no effects were observed for notice of default.

There are only two studies of suicide at the population-level. In a study of 20 European countries using county and year fixed effects from 2002 to 2011, Reeves et al find no association between unaffordable housing and suicide (Reeves et al., 2014). Houle and Light use a state random-effects approach and find an association between the age-adjusted suicide rate and both foreclosures and REOs for adults 46 to 64 in the U.S. (Houle & Light, 2014).

Among the 14 studies of foreclosure and violence, 80 percent reported a countercyclical association while the remaining studies found no association. A majority of these studies used crime data from single cities. The evidence on violence toward children is mixed; Brooks-Gunn et al found no evidence of foreclosures and maternal spanking while Wood et al found both the

foreclosure and mortgage delinquency date were associated with child abuse (Brooks-Gunn, Schneider, & Waldfogel, 2013; Wood et al., 2012).
Summary: Evidence mostly supports the countercyclical mechanism of psychological and behavioral morbidity and foreclosures at the population-level.

3.2.2.2 Somatic morbidity and mortality

Very few have examined the effect of population-level foreclosures on somatic health. In a cross-sectional study of breast cancer survivors, those who live in census tracts with a high number of foreclosures had poorer self-reported health (Schootman, Deshpande, Pruitt, & Jeffe, 2012). However, neighborhoods are not distributed randomly and areas with high foreclosure rates are often characterized by other social and economic stressors (Calem, Gillen, & Wachter, 2004).

Currie and Tekin find that for adults over 65, an additional foreclosure in a zipcode is associated with an additional 0.310 visits for heart problems (Currie & Tekin, 2011). Two longitudinal studies by Arcaya et al have looked at the effect of foreclosures on changes in systolic blood pressure (SBP) and body mass index (BMI) using data on older adults from the Framingham Offspring Cohort from 1987 to 2008 (Arcaya et al., 2013, 2014). Arcaya et al find that a change of 10 real-estate owned (REO) foreclosures within 100 meters of a participant's home was associated with a one standard deviation change in SBP, but there was no effect of foreclosures on the odds of hypertension (Arcaya et al., 2014). Given that the likelihood of a change of 10 REOs within 100 meters is near zero, the results are clinically insubstantial. The other study by Arcaya et al finds that each additional foreclosure within 100 m of a participants home increased BMI by 0.20 units, and the odds of being overweight was associated with living near a foreclosure (Arcaya et al., 2013). The measures of foreclosures were pooled over four year periods at each wave. The authors did not control for time-invariant confounding, despite the availability of the repeated measure data structure (Roux, 2014).

Only a single study examined mortality, which used a housing affordability construct and includes data from 17 European countries (Clayton, Liñares-Zegarra, & Wilson, 2015). The authors find mortgage debt as percentage of disposable income has a positive and statistically significant effect on premature mortality, with a larger effect size among females. However, they found there was no association between mortgage debt and life expectancy at birth or at 65.
Summary: The evidence on foreclosures and somatic morbidities and mortality is mixed.

3.2.2.3 Health services utilization

There was only one study on population-level foreclosures and health utilization. In a study of states that experienced high foreclosure rates (Arizona, California, Florida, and New Jersey) from 2005 to 2009, Currie and Tekin use a zip-code and year fixed effects approach to find that an additional foreclosure per 100,000 persons in a zip-code increases the number of non-elective health service visits by 1.5 (Currie & Tekin, 2011). Excluding those 65+, those with public health insurance primarily account for the increase in the number of visits, while there is little or no impact among those with private health insurance or no insurance.
Summary: Foreclosures at the population-level have been associated with health services utilization, although the evidence is limited.

4. Discussion

The findings from this review suggest that there is a countercyclical relationship between foreclosures and psychological and behavioral morbidity, namely psychological outcomes such as anxiety and depression. This is consistent with the findings that show that job loss and undesirable financial setbacks are associated with psychological and behavioral outcomes (Catalano et al., 2002).

However, the evidence on housing affordability, which is assumed to be upstream to foreclosures, and psychological outcomes at the individual-level is mixed. This highlights the challenges of measuring housing affordability, particularly when assessed subjectively, because the measurement is subject to bias from the outcome. For example, anxiety might cause one to report their housing is unaffordable. More research is needed to understand the interplay between housing affordability and psychological health to enable intervention and policy design.

At the population-level, there has been a recent surge of studies focused on foreclosures and violent crime. Although the majority of these studies are limited to single cities, the evidence is mostly supportive of the countercyclical relationship between foreclosures and violent behavior. The countercyclical explanation of the frustration-aggression mechanism is likely to contribute to this relationship. The net effects research on violence and employment shows mixed effects based on the size and duration of the shock; countercyclical associations are seen with small declines while a procylical relationship is observed in response to a deeper decline (Catalano et al., 2002). More research is needed to assess if the variation in size of the shock to the area from foreclosures differentially impacts violence.

The recessions and health literature has demonstrated convergence in the net effects countercyclical association between suicide and job loss (Catalano et al., 2002). Although Fowler et al show an increase in the incidence of foreclosure-related suicides over time, and Houle and Light show a countercyclical association between the state foreclosure rate and suicides (Houle & Light, 2014), more replication of the evidence is needed.

There is mostly supportive evidence of the association between individual job loss and substance use and abuse, while the net effects literature is mixed (Catalano et al., 2011). There are only two unique studies on alcohol use and foreclosures at the individual-level, and both are cross-sectional. More research is needed in this space.

Like the research on unemployment, the evidence base on somatic morbidities and foreclosures at the individual and population-level is mixed. This might be because the stress response is highly variable across individuals or there is no empirical or theoretical basis for identifying the length of the lag from foreclosure to somatic health.

Finally, the results from this review present partial support for the countercyclical relationship between foreclosures and health services utilization at both the individual and population-levels. This is consistent with findings from research demonstrating that declining economies influence healthcare utilization (Barling & Handal, 1980; Catalano, 2009). More research is needed to understand the causal direction between housing affordability or foreclosures and health services utilization.

5. Conclusion

The patterns uncovered in this review of studies examining the relationship of foreclosures or housing affordability and health support three principal recommendations. First, the evidence base should be considered part of the research on recessions and health, yet distinct from the research on unemployment and health. These economic shocks differ in three primary ways: 1) the social patterning of the foreclosure crisis was more concentrated in minority populations compared to the Great Recession, and 2) the mechanisms by which these affect health differ, and 3) the timing and magnitude of these differ across space. Second, the mechanisms presented in this study are often evoked in the literature, yet few studies have implicitly tested them. Research informed by these mechanisms or other theory can help advance the knowledge base on recessions and health. Finally, future work should be interpreted in respect to the level of analysis, construct choice, and timing. Only a few studies reviewed here were precise in interpreting their results with respect to the level of analysis, type of construct, or period of analysis.

There are several limitations to this study. First, although the search process was thorough, some studies might have been missed. Also, there might be bias due to not including studies in languages other than English. Next, there was no formal assessment of the studies based on quality. Several studies were cross-sectional and did not control for residual confounding.

The advancement of knowledge on how the foreclosure crisis impacted health of homeowners and within communities has important policy implications. A number of mortgage demonstration programs, such as the Community Advantage Program (CAP), to assist low-income families in purchasing a home have been piloted at small-scales. The cost and effectiveness on health of scaling-up these programs are still poorly understood. This research also has implications for health policy; as interest in new models of delivering care such as accountable care organizations has grown following the Affordable Care Act, the prioritization of how social, economic, and environmental stressors affect health will increase as a means to control costs. And finally, as the American ideology rests upon the tenets that both housing and health are fundamental rights, then this research can be considered an investigation of social justice.

6. Tables and Figures

Table 1: Summary of Individual-Level and Community-Level Studies of Foreclosures, Housing Affordability, and Health

Citation	Years	Exposure	Outcome	Covariates	Approach	Relevant Results	Data
Individual-Level Studies							
(Alley et al., 2011)	2006-2009	Mortgage delinquency: ''Have you fallen more than 2 months behind on mortgage payments in the past 2 years?'	(a) Depressed (1/0) based on 6+ on revised version of the Center for Epidemiological Studies Depression Scale, (b) Major decline in self-rated health (1/0): From excellent, very good, or good health in 2006 to fair or poor health in 2008 or from fair health in 2006 to poor health in 2008, (c) Access to health-relevant resources (1/0): food insecure or non-medical adherence in past two years	Age, gender, marital status, race/ethnicity, income, non-housing debt, chronic health conditions, smoking status, physical activity level	Logistic regression	Mortgage-delinquent group were also significantly more likely to develop incident depressive symptoms, food insecurity, and cost-related medication non-adherence during follow-up. No association between major decline in self-reported health for those who were mortgage delinquent.	Health and Retirement Study
(Brown, Taylor, & Price, 2005)	1995-2000	Outstanding mortgage loans; Housing equity	GHQ12 of 12 (1/0)	Monthly income, annual savings, investments, windfall payments received over the previous year, outstanding mortgage loans and a subjective estimate of house value, year dummy, demographic, recent purchases	Ordered probit	No association between psychological distress and mortgage debt of housing equity.	British Household Panel Survey

(Burgard et al., 2012)	2006-2009	Behind schedule on mortgage or in foreclosure (1/0); Removed from a home due to foreclosure from 2006-2009 (1/0)	(a) Self-rated health, (b) depression, (c) anxiety attack, and (d) problematic alcohol use.	Socio-demographic	Logistic regression, cross-sectional retrospective	Those who were behind on mortgage or in foreclosure now had increased odds of self-reported poor health or an anxiety attack, a decreased odds of alcohol abuse, and no association with increased odds of depression. Those who *completed* a foreclosure recently were more likely to report major or minor depression or an anxiety attack or alcohol abuse, and no difference in self-reported health.	Michigan Recession and Recovery Study
(Cannuscio et al., 2012)	2008	*Default/Foreclosure*: default or foreclosure group if they, 1) were more than 30 days behind on mortgage payments and/or had received a notice of default or foreclosure from a lender; or 2) had experienced loss of their home through foreclosure in the last 12 months. *Moderate housing strain*: 1) had a history of at least one late or incomplete payment in the last year; or 2) paid 30% or more of their monthly income in housing costs, but were not in foreclosure.	(a) Self-rated health (1/0), (b) psychological distress (1/0) from K6, (c) count of somatic symptoms	Age, sex, race/ethnicity, education, marital status, and log income	Cross-sectional logistic regression and negative binomial regression	Compared to homeowners with no housing strain, those with moderate housing strain had a higher odds of significant psychological distress, but no differences in self-rated health. Those in foreclosure had a higher odds of psychological distress and poor self-rated health.	Online survey
(Fowler et al., 2015)	2005-2010	Foreclosure in past 12 months	Suicide	None	Chi-squared	Foreclosure-related suicides tripled from 2005 to 2010.	National Violent Death Reporting System
(Houle & Keene, 2014)	2007-2010	Health limitations worsened; Chronic conditions worsened	(a) Experienced a mortgage default or reported that it was 'very likely' that would default in the next 6 months; (b) Went through a home foreclosure in the past 3 years	Baseline socio-demographics, race/ethnicity, education, marital status, age, sex, family size	Pooled logistic regression	Worsening of health limitations and chronic conditions increased the risk of default and foreclosure between 2007 and 2010.	National Longitudinal Study of Youth

(Leung & Lau, 2014)	1998-2008	Loan to value ratio (amount of loan / self-reported home value) of 40 percent or less (affordable) or more than 40% (unaffordable)	Self-reported health, high blood pressure, obesity, presence of depressive symptoms (Center for Epidemiologic Studies Depression scale), and cancer	sex, age, education, year, unemployment	Individual fixed effects and Instrumental Variable approach	For models that adjusted for residual confounding (IV and FE), there is no relationship between high loan to value ratio and high blood pressure, depressive symptoms, or cancer - but there is a marginally significant relationship with decline in self-reported health.	Health and Retirement Survey (HRS)
(Lindblad & Riley, 2015)	2008-2013	Foreclosure or Loan Modifications	Self-reported Health, mental health problem (1/0), physical health problem (1/0), Perceived Stress Scale (PSS)	Group membership and for household specific factors	Difference-in-differences	No association between loan modifications or foreclosure sales and health or perceived stress.	Community Advantage Program and Self-Help
(Mason et al., 2013)	2001-2010	Unaffordable (housing payments>30% of household income)	Mental Health: The Mental Component Summary (MCS) score of the Short Form, 36 measure (SF-36)	Age, survey year, and household income.	Fixed-effects	The mental health scores of home purchasers were, on average, the same regardless of whether or not their housing was affordable	Household, Income and Labour Dynamics in Australia
(McLaughlin et al., 2012)	2008-2010	Experiencing foreclosure	Major depression and generalized anxiety disorder	Socio-demographic, psychiatric history, financial stressors	Cross-sectional logistic regression	Experiencing foreclosure associated with increased symptoms of major depression and generalized anxiety disorder	Detroit Neighborhoods and Health Study (DNHS)
(Nettleton & Burrows, 1998)	1991-1996	Mortgage indebtedness	Self-reported health (GHQ12)	Income, employment, physical health outcomes	Pooled multiple regression	Mortgage arrears is associated with poor self-reported health	British Household Panel Survey
(Pevalin, 2009)	1991-2008	Housing repossession	Common mental illness	Social class, marital status, age and employment status	Individual fixed-effects	Housing repossession was associated with an increased risk of common mental illness.	British Household Panel Survey

(C. E. Pollack & Lynch, 2009)	2008	Experiencing foreclosure	Insurance status, cost-related health care and prescription non-adherence, health care use, and health-related behaviors	Health insurance, and health behaviors	Chi-squared and logistic regression	Foreclosure sample was more likely than the community sample to lack health insurance and to not have filled a prescription because of cost in the preceding year, and have a higher odds of hypertension, heart disease, and psychiatric conditions.	2008 Southeastern Pennsylvania Household Health Survey
(C. Pollack et al., 2011)	2008	Experiencing foreclosure	Hypertension, renal disease, Charlson comorbidity indices, emergency department visits and outpatient visits in years prior to foreclosure, no-show appointments, primary care physicians (PCP) visits immediately prior to foreclosure	Age, gender, race/ethnicity, insurance status, and Charlson comorbidity index	Case-control	Compared to controls without exposure to foreclosure, people undergoing foreclosure were more likely to have higher rates of hypertension, renal disease, and Charlson, comorbidity indices. People undergoing foreclosure were more likely to have had an emergency department and outpatient visit in the 2 years prior to foreclosure, and were less likely to have a PCP visit within 6 months of foreclosure.	University of Pennsylvania Hospital System and RealtyTrac
(C. E. Pollack et al., 2010)	2008	Overall, how difficult was it for you to afford your housing costs during the past year? (Very difficult and somewhat difficult (1) vs not very difficult and not difficult at all (0))	Self-rated health, Chronic Conditions, Healthcare utilization, Smoking, Obesity	Age, gender, race, education, poverty, unemployment, county, perceived neighborhood safety, access to quality groceries, and social environment	Cross-sectional doubly robust propensity score–weighted regression models	People living in unaffordable housing had increased odds of poor self-rated health; hypertension; arthritis; cost-related healthcare non-adherence; and cost related prescription non-adherence. No association for heart disease, diabetes, asthma, psychiatric conditions, insurance, ED visits, smoking status, and obesity.	2008 Southeastern Pennsylvania Household Health Survey

(Riumallo-Herl et al., 2014)	2006-2010	Housing wealth (household financial and housing wealth minus liabilities)	Depressive symptoms: Center for Epidemiologic Studies Depression Scale (CESD-D) and Euro-Depression scale (EURO-D)	Gender, age, unemployment, marital status	Individual fixed-effects	Job loss is associated with depressive symptoms in USA and Europe, and wealth mitigates the impact of job loss on depression in the USA more than in Europe.	Health and Retirement Survey and the Survey of Health, Ageing and Retirement in Europe
(Taylor et al., 2007)	1991-2003	Arrears; trouble paying mortgage over past 12 months	Self-reported mental health (GHQ12)	Household income, wealth, marital status, number of children, age	Individual fixed-effects	Housing payment problems and entering arrears have a significant negative effect on mental well-being.	British Household Panel Survey (BHPS)
(Yilmazer et al., 2015)	2007-2011	Housing wealth, difficulty with payment, and foreclosures	Pyschological distress, depression, health status, blood pressure, distress	Non-housing wealth, income and unemployment status	Individual fixed-effects	Psychological health deteriorates more as the housing wealth relative to total wealth decreases. Finally, homeowners who have difficulties with mortgage payments report substantial increases in psychological distress and have higher rates of depression.	Panel Study of Income Dynamics
Community-Level Studies							
(Arcaya et al., 2014)	1987-2008	Counts of foreclosures and REO within 100-meters	Odds of Hypertension, systolic blood pressure, alcohol use	Municipal-level poverty rate, Municipal-level residential density, Municipal-level foreclosure rate; and Baseline Education, Income, Age, Gender, Ethnicity; alcohol use and BMI	Longitudinal non-hierarchical multi-level random-effects	Each additional REO located within 100 meters of a participant's home was associated with an increase in SBP of 1.71 mm/hg	Framingham Heart Study; Foreclosure Data from Warren Group
(Arcaya et al., 2013)	1987-2008	Counts of REO foreclosures within 100, 200, 300, 400, 500 meters and 1km	BMI; odds of being overweight	Municipal-level poverty rate, Municipal-level residential density, and Baseline Education, Income, Age, Gender, Ethnicity	Longitudinal multi-level regression	For each additional foreclosure, BMI increased by 0.20 units the odds ratio for being overweight associated with proximity to a foreclosure was 1.77.	Framingham Heart Study; Foreclosure Data from Warren Group

(Arnio, Baumer, & Wolff, 2012)	2007-2008	Foreclosures per 1000 mortgages in each county in 2007	Aggregated agency-level number of robberies known to the police per 100,000 residents per county in 2008	Resource deprivation, population size/density, immigration concentration, population change, unemployment, percentage of housing units built	Instrumental Variable Approach (Cross-Sectional)	There are significant linear and non-linear effects of foreclosure rates on robbery rates.	Uniform Crime Reporting (UCR) program, foreclosure rates from RealtyTrac
(Baumer, Wolff, & Arnio, 2012)	2007-2009	Foreclosures per 1000 housing units in each census tract in 2007-2008	Robberies per census tract in 2009	Residential stability, immigrant concentration, socioeconomic disadvantage	Poisson multilevel regression (Cross-Sectional)	High neighborhood foreclosure rates yield elevated robbery rates primarily in cities with relatively low foreclosure rates and high levels of socioeconomic disadvantage.	Uniform Crime Reporting (UCR) program, foreclosure data from RealtyTrac
(Brooks-Gunn et al., 2013)	2007-2010	Quarterly state mortgage foreclosure rate	Maternal spanking	Unemployment, Consumer Sentiment, Maternal age, education, race/ethnicity, immigrant status, relationship status, history of depression, child sex, low birth weight, child age in months, and household income-to-needs ratio	Multinomial logistic regression	No association between foreclosure rate and maternal spanking.	Fragile Families and Child Wellbeing Study and Mortgage Bankers Association's National Delinquency Survey
(Cagney, Browning, Iveniuk, & English, 2014b)	2005-2011	3-level variable (0= no change, 1=decrease, 2=increase) for (a) notice of default,(b) auction, and (c) REOs	Depressed from the CES-D at (0 = 0-8, 1 = 9-22).	Percentage of foreclosure, percentage poor, neighborhood disorder, household assets, marital status, limitations in activities of daily living, and whether the respondent moved between the 2 waves	Cross-sectional logit-linked regression; probability of depression among those without depression symptoms at baseline	A large increase in the number of notices of default and REOs were associated with depressive symptoms. No association found for non-REOs and depressive symptoms.	National Social Life, Health, and Aging Project; RealtyTrac Foreclosure Data
(Clayton et al., 2015)	1995-2012	Mortgage debt to disposable income	Life expectancy at birth, premature mortality.	Education, Real GDP per capita, alcohol consumption, public financing of health	Generalised Methods of Moments estimator (GMM-IV)	Mortgage debt as percentage of GDI has a positive and statistically significant effect on premature mortality. Mortgage debt has a positive effect on premature mortality due to AMI and mental and behavioral disorders for females, but not males. There is no association between mortgage debt and life expectancy.	OECD Health Database and Statistical Package on Lending to Households

(Cui & Walsh, 2015)	2006-2009	Foreclosures, Vacancy (REO + gas shut-off)	Violent crimes within 250 ft radial buffer from foreclosures	Neighborhood-quarter fixed effects as well as housing characteristics	Difference-in-difference	Foreclosure alone is found to have no effect on violent crime. Violent crime rates increase by roughly 19% once the foreclosed home becomes vacant – an effect that increases with length of vacancy.	Police Department of City of Pittsburgh and foreclosure data from City of Pittsburgh court records
(Currie & Tekin, 2011)	2005 to 2009	Foreclosures/Population in each Zip-Code	Non-elective visits, preventable visits (hypertension, diabetes, asthma), visits for cancer, heart disease, mental health, respiratory infection	County Unemployment, Zip-Code Housing Prices	Zip-code and year fixed-effects	An additional foreclosure in zip code results in 0.783 additional non-elective hospital or ER visits over the following four quarters.	RealtyTrac Foreclosure Data; Healthcare Cost Utilization Project (HCUP)
(Ellen et al., 2013)	2004-2008	Foreclosures per blockface	Criminal activity per blockface in each quarter	Total number of residential units on a blockface, measures of new construction or demolitions, and the number of active liquor licenses for a bar or alcohol purveyor on the blockface.	Differences-in differences	Marginal foreclosures on a blockface lead to a small number of additional crimes, with strongest effects found on violent crimes. These effects appear to be largest when foreclosure activity is measured by the number of foreclosed properties that are on their way to an auction or have reverted to bank ownership.	Foreclosure Data from Public Data Corporation and NYC Police Data
(Frioux et al., 2014)	1990-2010	Foreclosure rate (undefined) per county	Confirmed allegations of child abuse	N/A	Fixed-effects Poisson regression	1 percentage-point increase in current foreclosure rate was associated with 4.5 % increase in substantiated investigations, and 1 percentage-point increase in the prior year foreclosure rate was associated with 7.3 % increase in substantiations.	Foreclosure data from Core Logic and data from Child Protective Services

(Goodstein & Lee, 2010)	2002-2007	Count of mortgage loans in real estate owned status, divided by the count of all active loans in each county	Violent crimes per 100,000 population in each county	unemployment rate, per capita income, the wage rate of low-skilled workers, past crime rates	Instrumental Variable Approach	Foreclosure rates increase aggregate rates of violent crime, driven by a relatively large and statistically significant effect on aggravated assault. For all other violent crime types, the estimates are small in magnitude and not statistically different from zero.	Uniform Crime Report (UCR) data, foreclosure data from Lender Processing Services and LoanPerformance
(Houle, 2014)	2006-2011	Foreclosures/Households in each County; REO Foreclosures/Households in each County	Mental health days	Age, age squared, sex, race/ethnicity marital status, employment status, and educational attainment	County and year fixed effects	Rise in a county's foreclosure rate and REO-foreclosure rate is associated with a decline in residents' mental health. No association between NOD and changes in mental health.	Behavioral Risk Factor Surveillance System (BRFSS); RealtyTrac Foreclosure Data
(Houle & Light, 2014)	2005-2010	Foreclosures/Mortgages in each State; REO Foreclosures/Mortgages in each State	Number of suicides in the state per 100 000 residents	Structural disadvantage (composite of poverty, unemployment, female-headed households, % minority), % divorced, age, % foreign-born, population density	State random-effects and reduced-form hybrid effects	An increase in the within-state total foreclosure rate was associated with a within-state increase in the crude suicide rates; The effect of within-state foreclosures and REOs are associated with an increase in the suicide rates for individuals 46 to 64 years, but not other age groups.	Centers for Disease Control and Prevention (CDC) WONDER; RealtyTrac Foreclosure Data
(Immergluck & Smith, 2006b)	2001	Foreclosures/Owner-occupied households per Census Tract	Violent Crime Rate	Number of businesses, median income, % moved, % race	Ordinary least squares regression	A standard deviation increase in the foreclosure rate corresponds to an increase in neighborhood violent crime of approximately 6.7 per cent.	Chicago Police Crime Data and Dunn & Bradstreet

(Katz, Wallace, & Hedberg, 2011)	2003-2008	REO foreclosures per housing units in each block group	Monthly violent crimes per 1000 population per census block group	Month, Indicator for housing crisis, block characteristics: Hispanic, income, age structure, education, industry and shopping composition	Random and mixed effects	Pre-crisis, current, and 3 months of lagged foreclosures have a positive effect on the rate of CFS for violent crime.	Foreclosure data from Information Market; crime data from computer-aided dispatch (CAD)/police records management system (RMS) data
(Kirk & Hyra, 2012)	2004-2009	Foreclosures per mortgages	Yearly violent crime rate per 1,000 residents	Concentrated disadvantage, residential stability, percentage of votes won by Mayor, percentage of mortgage loans in 2003 originated by an IMC	Community-random effects approach with year fixed effects	Crime and foreclosures are spuriously related; controlling for concentrated disadvantage and the political hierarchy of communities makes the foreclosure-crime association insignificant.	Crime data reported by the Chicago Police Department; foreclosure data compiled by Woodstock Institute from data provided by the Foreclosure Report of Chicago
(Lacoe & Ellen, 2015)	2007-2011	Foreclosure counts per blockface	Counts of violent crime per blockface	Total crime of blockface	Negative binomial year and blockface fixed effects	Foreclosures are related to increases in violent crimes that occur indoors, and the association is stronger for crimes that occur indoors.	Crime data reported by the Chicago Police Department; Foreclosure data from Chicago from Record Information Services
(Reeves et al., 2014)	2002-2011	Unaffordable housing: "heavy financial burden due to housing costs"	Suicide	Current volume of antidepressant prescriptions, government expenditure per unemployed person on income replacement, investment in ALMP and total social protection	Country year fixed effects	Unaffordable housing was not significantly associated with suicides.	World Health Organization Human Mortality Database, 2013 edition
(Schootman et al., 2012)	2007 to 2009	Census tract-level foreclosure-abandonment risk score	Self-rated health (1=Fair/Poor, 0= Excellent/Very Good/Good)	Socio-demographic factors, cancer-related behaviors, perceived neighborhood conditions, census-tract poverty rate, access to medical care, psychosocial factors, and clinical characteristics.	Cross-sectional multi-level logistic regression	Women in high-foreclosure-risk areas no more likely to report being in fair-poor health than women who lived in low-foreclosure-risk areas after adjusting for income physical activity, and perceived neighborhood conditions.	RealtyTrac Foreclosure Data

(Stucky, Ottensmann, & Payton, 2012)	2003-2008	Foreclosures per 1000sq ft grid	Yearly total violent crime, including homicide, rape, robbery, aggravated assault	disadvantage index, stability index	Grid-area fixed-effects negative binomial models	Foreclosures had a positive effect on violent UCR-reported offenses in a cell and rape, aggravated assault.. In addition, foreclosures had greater effects on reported UCR crimes in stable neighborhoods, especially those with more owner-occupied homes.	Indianapolis Police Department (IPD) and foreclosures data from the Metropolitan Indianapolis Board of Realtors (MIBOR)
(Wood et al., 2012)	2000-2009	Foreclosure rate and 90-day mortgage delinquency rate	(1) Child physical abuse (under 6) and (2) high-risk traumatic brain injury	Unemployment and time	Poisson regression analyses with hospital and month as unit	90-day delinquency rate and active mortgage foreclosures were associated with both diagnosed physical abuse admissions as well as high risk TBI admissions.	38 hospitals in the Pediatric Hospital Information System database and CoreLogic Foreclosure Data

Table 2: Schema of Studies by Level, Construct, and Outcome

	Psychological and Behavioral Morbidity					Somatic Morbidity and Mortality					Health Services & Insurance
		Psychological	Suicide	Violent Behavior	Substance Abuse	Self-Rated Health	BMI	Hypertension	Cardiovascular disease	General Mortality	Health services utilization
Individual-Level Studies											
Affordability	Counter-cyclical	Cannuscio 2011 Taylor 2008 Yilmazer 2015				Yilmazer 2015 Lau 2013 Pollock 2010		Pollock 2010			Pollock 2010
	Pro-cyclical	Riumallo-Herl 2014									
	Null	Mason 2013 Pollock 2010 Lau 2013 Brown 2004 Riumallo-Herl 2014				Cannuscio 2011	Pollock 2010 Lau 2013	Yilmazer 2015 Lau 2013	Pollock 2010		Pollock 2010
Pre-Foreclosure	Counter-cyclical	Burgard 2012 Alley 2011 Taylor 2008 Yilmazer 2015				Burgard 2012 Houle and Keane 2014 Nettleton 1998					Alley 2011
	Pro-cyclical				Burgard 2012						
	Null	Burgard 2012				Alley 2011 Yilmazer 2015 Lindblad 2015		Yilmazer 2015			

Foreclosure	Counter-cyclical	Burgard 2012 Cannuscio 2011 McLaughlin 2011 Pevalin 2009 Pollock 2009 Yilmazer 2015	Fowler 2015		Burgard 2012	Cannuscio 2011 Houle and Keane 2014		Pollock 2009 Pollock 2011	Pollock 2009		Pollock 2009 Pollock 2011
	Pro-cyclical										
	Null	Pollock 2011			Pollock 2011	Burgard 2012 Pollock 2009 Yilmazer 2015 Lindblad 2015		Yilmazer 2015	Pollock 2011		
Community-Level Studies											
Affordability	Counter-cyclical									Clayton 2015	
	Pro-cyclical										
	Null		Reeves 2014							Clayton 2015	
Pre-Foreclosure	Counter-cyclical	Cagney 2014									
	Pro-cyclical										
	Null	Houle 2014									

Foreclosure	Countercyclical	Cagney 2014 Houle 2014 Currie and Tekin 2011	Houle and Light 2014	Arnio 2012 Baumer 2012 Cui 2012 Ellen 2012 Frioux 2014 Goldstein 2010 Immergluck 2006 Katz 2013 Lacooe 2015 Stucker 2012 Wood 2012			Arcaya 2013	Arcaya 2014	Currie and Tekin 2011		Currie and Tekin 2011
	Procyclical										
	Null	Cagney 2014		Cui 2012 Brooks-Gunn 2013 Kirk 2012		Schootman 2012					

Paper 2

The foreclosure crisis and glycemic control: evidence from the Diabetes Study of Northern California

Abstract

Objectives: To understand the health effects of an economic shock, specifically the home foreclosure crisis, on glycemic control (hemoglobin A1c) within a clinical population of continuously insured patients with diabetes. Based on previous studies linking foreclosures with poor health outcomes, we hypothesized that an increase in the neighborhood foreclosure rate could worsen glycemic control by activating stressors such as neighborhood crime, depressing housing prices, and eroding neighborhood social cohesion.

Research design and methods: We linked public foreclosure deed records from 2006 to 2009 with clinical records of Kaiser Permanente patients with type 2 diabetes for those living in one of nine Bay Area counties in at least two years of that period. Individual fixed-effects models with one-year lags were specified to estimate the effect of changes in the foreclosure rate per block group on changes in A1c among diabetic patients. The models controlled for individual time invariant confounders and area-level time-varying confounders including housing prices and unemployment rate.

Results: We found no statistically significant relationship between changes in the neighborhood foreclosure rate per block group in the prior year and changes in A1c.

Conclusions: There is no evidence that foreclosure rates impacted glycemic control in this continuously insured population with diabetes. More research is needed to inform our knowledge of the role of insurance and healthcare delivery systems in protecting the health of diabetic patients from economic shocks.

1. Introduction

The housing foreclosure crisis that occurred during the Great Recession was unprecedented. At its peak, one in 45 homes in the United States received at least one foreclosure filing during 2010 (Trac, 2011). This was a large financial shock to households and communities that operated in tandem to the Great Recession. The effect of recessions on health and healthcare has been a source of great interest (Catalano et al., 2011). During the Great Recession, routine medical care fell (Lusardi, Schneider, & Tufano, 2010), private health insurance enrollment slowed (Martin, Lassman, Whittle, & Catlin, 2011), and Medicaid hospital spending accelerated. The independent effect of the foreclosure crisis showed a similar pattern; urgent unscheduled visits, including those for preventable conditions like diabetes and asthma, increased among those with public health insurance (Currie & Tekin, 2011). Yet most studies omit the ubiquitous role of the health system in management of patient populations. No studies we are aware of have observed the effect of the foreclosure crisis on self-management of a chronic condition within a patient population of a single health system.

The goal of this study is to understand the role of a neighborhood-level economic shock, specifically the housing foreclosure crisis from 2006 to 2010, on glycemic control within a continuously insured population of patients with diabetes receiving care in a large integrated delivery system. An estimated one in eight U.S. adults with diabetes exhibited poor glycemic control from 2007 to 2010 (Ali, Bullard, Imperatore, Barker, & Gregg, 2012). One objective of Healthy People 2020 is to reduce the proportion of persons with diabetes with glycated hemoglobin (A1c) values greater than 9 percent (Services). Adverse psychosocial factors, such as unemployment, work strain, and other stressful life events, have been linked with poor glycemic control (Chida & Hamer, 2008), diabetes chronicity, comorbidities, and mortality (Saydah, Imperatore, & Beckles, 2013; Von Korff et al., 2005).

The foreclosure crisis might affect self-management of glycemic control by activating the psychological stress response, eroding social support, and reducing self-care behaviors. First, an elevated exposure to foreclosures in one's residential neighborhood might increase the incidence and anticipation of stressful events such as a loss of wealth and forced relocation, and increase the probability of other stressors such as crime and marital problems (Ellen et al., 2013; Libman, Fields, & Saegert, 2012). Psychological stress can increase consumption of sugary or starchy foods (Oliver & Wardle, 1999) and activate proinflammatory transcription factors, which can both disrupt glycemic control and increase risk for diabetic complications (Hartmann et al., 2012). Next, a rising neighborhood foreclosure rate might erode social support if several households in a tight-knit community lose homes and are forced to move outside the area. Social capital, the collective value of all social networks and norms of reciprocity, can influence health-related behaviors, access to health services, and affect psychosocial processes (Kawachi & Berkman, 2000). Finally, an increase in the foreclosure rate in one's neighborhood could have a spillover effect on wealth and reduce resources available to manage care. Diabetics have high out-of-pocket costs because management of diabetes requires regular screenings, medications, and treatment of complications (Saydah et al., 2013).

We hypothesized that there was a positive relationship between the community-level foreclosure rates and the hemoglobin A1c and the likelihood of poor glycemic control ($A1c \geq 9$) among patients with diabetes. Given the prior evidence that suggested that the health of those with public health insurance was most vulnerable to economic shocks, we stratify our results by health insurance type to test our hypothesis that the magnitude of the effect is greater among

those with Medicaid. Next, as the effect of the foreclosure crisis on health utilization was shown to vary by age (Currie & Tekin, 2011), we stratify our results by age group. Finally, we show how variation in neighborhood social conditions (using owner-occupied as a proxy) relates to our estimates.

2. Methods

2.1 Study Design and Subjects

The clinical data came from the Diabetes Registry of Kaiser Permanente Northern California (KPNC), an integrated healthcare delivery system with over 3 million members. The clinical data was collected over a four-year period from 2007 to 2010 from ambulatory patient visits of adults 18 and older to KPNC clinics (n = 295,544). We excluded patients with type 1 or unknown type diabetes (n=11,760), cancer within the study period and 1-year prior (n=19,097), and histories of lower extremity amputation (n=3,138), and pregnancy (n=2,893) within the study period and 1-year prior.

Patients with at least one valid geocoded address record in 2007 to 2010 were retained for analysis. Six and a half percent of the subjects were excluded from the analysis because they had only a single A1c measure over all four years. Patients lived in one of nine Bay Area counties that contained or had KPNC facilities near county borders.

The Institutional Review Boards of Kaiser Permanente Northern California and University of California, Berkeley approved this study.

2.2 Health outcomes

The outcome for this study was the annual average of hemoglobin A1c tests results during 2007 to 2010. This test measures the average plasma glucose concentration of the patient over the past 1 to 3 months. The A1c test is a measure of the percentage of hemoglobin that is glycated (covered with sugar). The average number of A1c tests per patient was 8.1 (4 – 12) over the four-year period. The American Diabetes Standards of Care recommends testing patients at least two times per year for patients who are meeting treatment goals (Association, 2014). As an alternative specification, we created an indicator variable for poorly controlled diabetes in each year that the patient has had at least one A1c ≥ 9 (*poor control*).

2.3 Foreclosure Measures

The foreclosure process occurs in several stages. We define foreclosure as the event where the deed of the property is transferred to the new owner. We compiled address-level data on all residential foreclosure deeds filed in the nine Bay Area counties between 2006 and 2009 from DataQuick, a private real estate research company. Our data did not allow us to identify real estate-owned (REO) properties, those that were transferred back to the bank after homeowner default, from those that were sold at auction. We used ArcGIS (ArcGIS, version 10, Redlands, CA, Environmental Systems Research Institute) and the package Data Scientist Toolkit in R to assign geographic coordinates to the foreclosures. Less than 1% (n=19) of the foreclosure addresses was not geocodable and subsequently excluded. The primary exposure of

interest was the annual foreclosures divided by the number of housing units per block group using estimates from the 2000 U.S. Census.

2.4 Covariates

Time-varying neighborhood-level covariates were collected from 2006 to 2009. Homeowners, particularly those whose houses are financed with subprime mortgages, may be more likely to default due to a drop in housing prices and resulting negative equity. To capture changes in housing prices, we controlled for mean housing sales price data from DataQuick at the zip-code level. As the unemployment rate might affect A1c through the stress response and the foreclosure rate of a community, an average county-level unemployment rate was collected from the Local Area Unemployment Statistics (LAUS) database.

A time-invariant indicator for movers was created for those who reported at least two different, valid addresses between 2006 and 2009. A measure of proportion of housing units occupied by owners in the individuals block group from 2005-2009 was created for each individual using the American Community Survey (ACS) 5-year estimates. Descriptive data on block-group demographics such as proportion of poverty was also collected from the ACS. We also collected demographic data including patient Medicaid insurance status (1/0) in each year, sex (female or male) and race/ethnicity (Asian, Non-Hispanic White, Black) from electronic health records.

2.5 Statistical Methods

To examine the relationship between foreclosures and A1c, a series of models were fit in order to relate mean individual health outcome in year *t* to the proportion of housing units in foreclosure in the prior one to 23 months (referred to here as year *t-1*). The general form of the model was specified as:

$Y_{it} = \beta_o + \beta_1 F_{it-1} + \beta_2 Z_{it-1} + \beta_3 X_i + \beta_4 yearD_t + u_i + v_{it}$, where Y_{it} is a measure of the mean A1c level of individual *i* in year *t*; F_{it-1} is one of the measures of *foreclosures* for individual *i* in year *t-1*; Z_{it-1} is a vector of lagged area level controls for individual *i* in year *t-1* (*unemployment, housing prices*); X_i is a vector of individual time-invariant covariates; *yearD* are dummies for year *t*; u_i is an individual fixed-effect, and v_{it} is the time and individual specific error term.

We used fixed and random effects estimators in order to reduce omitted variable bias that might be present in traditional ordinary least squares (OLS) estimators. We did not assume that all the variables that are common to both the community foreclosure rate and individual health were observed in the above equation.

We first used an individual fixed effects estimator by including a fixed-effect for each individual, notated as u_i above, in the model. This controlled for time-invariant confounding by design; the variables contained in X_i are fully collinear with the u_i and cannot be estimated or influence the coefficients.

Next, we used a random-effect estimator, where now u_i is a random-effect for each individual assumed to be uncorrelated with the foreclosure rate. The random effects estimator is more efficient than the fixed effects estimator, and is preferred if it is consistent but will be inconsistent if F_{it-1} is correlated with unobserved components u_i. We used a Hausman test to compare model specifications for consistency (Hausman, 1978).

We also estimate several subgroup models: we ran age-stratified fixed effects models for three groups of adults (20-49, 50-64, ≥65 years in 2007) to mirror the study by Currie and Tekin (Currie & Tekin, 2011). Next, we estimated the effects of foreclosure on A1c among individuals under 65 who used Medicaid. Finally, we stratified by neighborhood social conditions by creating three groups based on proportion of block group owner-occupied housing: predominately owner-occupied (70%+), mixed (31-69%) owner-renter, and predominately renter-occupied (30% or less).

2.6 Sensitivity Analyses

A series of alternate specifications were fit to assess robustness of the effects to foreclosure measure, model specification, attrition, and lag length. First, we created a measure of the foreclosures rate within the patient's block to proxy the length of an average block (100m), the distance at which a foreclosure is expected to have spillover effects on the values of neighboring properties (Z. Lin et al., 2009). We also used the absolute number of foreclosures within a 1-km Euclidean radius from the patient's block centroid, a buffer representing roughly 10 minutes walking distance.

A series of alternative model specifications were fit to determine if attrition influenced our results. As this is an unbalanced panel and not all individuals have clinical measurements for all years, we are concerned that our models might be biased if an unobserved factor that caused the individual to not return for a visit was correlated with their exposure to foreclosures. First, we re-estimated our models with individuals with a balanced panel. Next, we used two tests to look at observed randomness of attrition bias in this sample (Becketti, Gould, Lillard, & Welch, 1988; Fitzgerald, Gottschalk, & Moffitt, 1998). We re-ran our models using inverse probability of attrition weighting to reduce observable attrition bias.

A second type of attrition occurs because our predictor is at the neighborhood-level and moving occurs during the study period. If an individual's decision for moving was related to their health status and exposure to foreclosures, our estimates might be biased. We re-estimated our models with those who stayed in the same address for all four years.

Finally, in the absence of any prior knowledge about the appropriate lag period, alternative lag periods were fit. The contemporaneous model included A1c measurements 11 months prior to 11 months following a foreclosure and a model with a two-year lagged foreclosure rate included A1c measurements from 13 to 35 months after a foreclosure. All statistical analyses were performed with Stata 13.

3. Results

3.1 Descriptive Statistics

There were 105,930 individuals in this study that met the inclusion criteria above and had at least two measures of A1c from 2007 to 2010. A majority (57.8%) of the sample was clinically observed in all four years, and (17.3%) of the individuals moved at least once during the study period.

The mean A1c was 7.23 and the within-person standard deviation was 0.68 (Table 1). The average probability of poor control (A1c ≥9) was 15.3% and the average within-person standard deviation in A1c was 22.3%.

The foreclosure rate began to rise in late 2006 and peaked in summer of 2008 (Figure 1). The mean number of foreclosures was 0.28 in average block (20 homes per block), 6.88 in the average block group (2200 homes per block group), and 26 in the 1-km buffer. The within-person standard deviation was 0.6 foreclosures per block, 9.0 per block group, and 35 per 1-km buffer over the period.

Housing prices began to steeply decline in summer of 2008 (Figure 1). The average value of housing prices in each zip code was $537,699 and had a within-person standard deviation of $100,938. The unemployment rate nearly doubled from May 2008 to May 2009 (Figure 1). The mean county unemployment rate was 6.2% and the within-person standard deviation was 2.3%.

Of the 103,096 individuals clinically observed at baseline in 2007, 30% (n=31,693) had no measures of A1c in 2009 or 2010. These individuals were younger, more likely to be white and male, and live in a poorer neighborhood with lower housing prices (Table 5). In addition, they had a higher baseline A1c level, probability of poor control, and block group foreclosure rate.

Those who were exposed to a foreclosure in their neighborhood had a slightly higher A1c, and were younger, less likely to be non-Hispanic White, and had lived in a neighborhood with a higher poverty rate, and lower housing prices (Table 2) compared to those who had not.

3.2 Block group foreclosure rate and A1c

Results from the main models for A1c are shown in Table 3. For the individual fixed effects models, there were no statistically significant effect of changes in block group foreclosure rate and change in mean A1c (Models 1-5). There was a statistically significant association in the unadjusted model (Model 1) of a decline of 0.03% A1c (i.e. better glycemic control) for every one percent increase in block group foreclosure rate. The addition of year fixed effects (Model 2) attenuated the effect and the year fixed effects became statistically significant. The addition of covariates, the county unemployment rate and zip code housing prices, attenuated the estimate even further (Model 3), β=-0.00005, 95% CI [-0.009, 0.008]. The complete case approach (Model 4) and the model with inverse probability of attrition weights (Model 5) yielded similar, insignificant results.

In the random effects model (Model 6), for every one percent change in the block group foreclosure rate, A1c increased by 0.01 percent. Yet the magnitude of the effect was too small to be clinically meaningful. The addition of individual time-invariant covariates X_i did not change our estimates. When comparing Model 6 to Model 3, we rejected the null hypothesis of the Hausman test, indicating that the fixed effects model was preferred to random effects.

Table 4 shows the models stratified by age categories. The age-stratified results were statistically insignificant (Models 7-10) for those 20-49 and 50-64. Among those in the prime working age group (20-49), there was a statistically significant 0.03-0.06% increase in A1c for every one percent increase in unemployment. For individuals 65+ (Models 11-12) there was 0.02% decrease in A1c for every one percent increase in the block group foreclosure rate. Given that the average change in A1c for each individual over the period was 0.7%, this represents a very small and clinically irrelevant change.

There was no statistically significant effect of the foreclosure rate on A1c for those under 65 who used Medicaid for at least one year, n = 1,470, 95% CI [-0.13, 0.05]. This suggests that our true estimate of the effect of foreclosures on A1c in areas hit hard by the crisis might have

been large; a 14 percent increase in the foreclosure rate would translate to a fall in A1c of 1.8 (or 2.5 times the within-person standard deviation) or an increase of 0.7 (~1 standard deviation).

Finally, there was no effect of the foreclosure rate on A1c for those who lived in neighborhoods with mainly renters (≤ 30% owner-occupied), n = 15,509, 95% CI [-0.03, 0.04] or for those who lived in neighborhoods with mainly owners (≥ 70% owner-occupied), n = 51,744, 95% CI [-0.01, 0.01]. Given the confidence interval of mainly renters contains that of the mainly owners, this suggests the effect within each group are indistinguishable from each other and zero.

3.3 Sensitivity Analyses

Several other specifications yielded similar results (not shown). The individual fixed effect logit model estimating probability of poor control generated similar, statistically insignificant results, $\beta = 0.01$, 95% CI [-0.02, 0.05]. The models fit with block foreclosure rate, $\beta = 0.0003$, 95% CI [-0.001, 0.001] and absolute foreclosures per 1 km, $\beta = -0.00001$, 95% CI [-0.0001, 0.0001] as alternative predictors were also statistically insignificant. Additionally, the models were robust to alternate lag structures. The model fit with a contemporaneous foreclosure rate, $\beta = 0.005$, 95% CI [-0.009, 0.020], and the model fit with a two year lagged foreclosure rate, $\beta = 0.004$, 95% CI [-0.004, 0.013], were statistically insignificant. Finally, the estimates for those who did not move during the time period were identical to the full sample that contained those who moved.

4. Discussion

We found no evidence that the foreclosure crisis had a negative effect on A1c or the likelihood of poor glycemic control among continuously insured patients with diabetes. Our estimates are robust across varying spatial constructs of foreclosures and as well as within strata of populations we hypothesized would vary in their sensitivities to this type of economic shock.

While 53% of the population in our study was exposed to at least one foreclosure in their block, only 2.3% of the population in the study by Arcaya et al was exposed to a foreclosure in a comparable geographic unit (100-meter radius). Our higher rate of exposure makes the conclusions that can be drawn from this study more robust to Kaiser Permanente patients. We also believe that the individual fixed effects approach attenuated estimates by reducing bias away from the null, if for example, an unobserved time-invariant factor such as individual debt simultaneously increased the community foreclosure rate and individual A1c (Turunen & Hiilamo, 2014). The amount of individual wealth or debt is related to poor health and has a direct effect on the probability of foreclosure of one's home. Prior studies by Arcaya et al adjusted for a number of time-invariant variables including race, income, and education but did not use an individual fixed effect for each person to control for unmeasured time-invariant confounding (Arcaya et al., 2014).

While we detected a statistically significant decrease in A1c for an increase in the foreclosure rate for those who were 65+, the magnitude of the effect was not clinically substantive. Houle found that only 2% of the average expected change in mentally healthy days could be explained by the county-level foreclosure rate (Houle, 2014). The study by Arcaya et al of older adults also showed findings of similar magnitude; a one-unit increase in the standard deviation of foreclosures within a 100-meter radius was associated with an increase of 0.17 or

0.01% increase in systolic blood pressure. The magnitude of our findings for older adults was consistent with the other studies, yet we differ on the interpretation of clinical relevance.

Like the prior study by Currie and Tekin, (Currie & Tekin, 2011), the foreclosure crisis had little or no effect on the privately insured. However, we did not observe an effect of a large magnitude among those with public health insurance like their study. This suggests that the nature of KPNC's integrated delivery system buffered these individuals from ill effects of the foreclosure crisis, our outcome measure (A1c) was less sensitive to economic shocks, or we did not have enough power to detect an effect.

There are important limitations to our study. First, we are not able to observe the people who stop seeking healthcare. It is possible that diabetic patients who were most impacted by the foreclosure crisis dropped out of our sample. To address this concern, we included inverse probability of attrition weights in our regression models to reduce non-random attrition caused by observable factors. If we believe that those who stopped seeking healthcare were worse off than those who remained in our sample, our main results should be interpreted as a conservative estimate of the effect of foreclosures on A1c, thus the true effect might be larger.

Next, the period of observation from 2006 to 2010 might not have been long enough to detect an effect or there was too much noise in the timing of the lag period. The lag period from foreclosure to health is one to 23 months; for some people there might have been insufficient time for their A1c to respond to the shock and for others, the foreclosure occurred too far in the past. Our long lag period likely biased our results toward the null. Our results would be strengthened if we had the data on foreclosure rates by quarter instead of year and linked them with an A1c measure in the following quarter or two-quarters. It is more likely that exposure to a foreclosure in one's neighborhood would result in a change to health 1 to 5 months later.

Next, there might still have been unmeasured residual confounding; if available, inclusion of individual-level measures of income and employment status would have strengthened our results. Next, our results may not generalize outside of our population. While the external validity of the study is improved due to the relatively large market share of Kaiser Permanente in Northern California, this region has a high penetration of managed healthcare delivery systems and this limits the generalizability of the results to other states with different financing and delivery models. Finally, the validity of our spatial construct is unknown. Even though we used several spatial specifications of foreclosures, we have little evidence that individuals across various communities interact with their environment in the same way. A relational perspective would take into account more than distance; more qualitative exploration is needed to understand how individuals in different communities interact with the built environment.

There are several ways to interpret the results of this study. First, we might have correctly identified the null effect of the relationship between foreclosures and clinical health outcomes. Alternatively, there might have been an effect but it was undetectable in an insured managed care population like KPMC because the care delivery model has effectively buffered this chronically ill population from environmental stressors. Finally, we might have not correctly identified the appropriate construct of foreclosures or the lag period. More research is needed to determine if these findings are robust across clinical populations with different models of healthcare delivery and financing. Studies that are able to link foreclosure data with clinical measures of populations over time and across space will be particularly important in helping guide recommendations for health and housing policy in the years to come.

Figures and Tables

Figure 1: Bay Area Trends from 2006 to 2009: foreclosure rate, unemployment rate, and housing prices

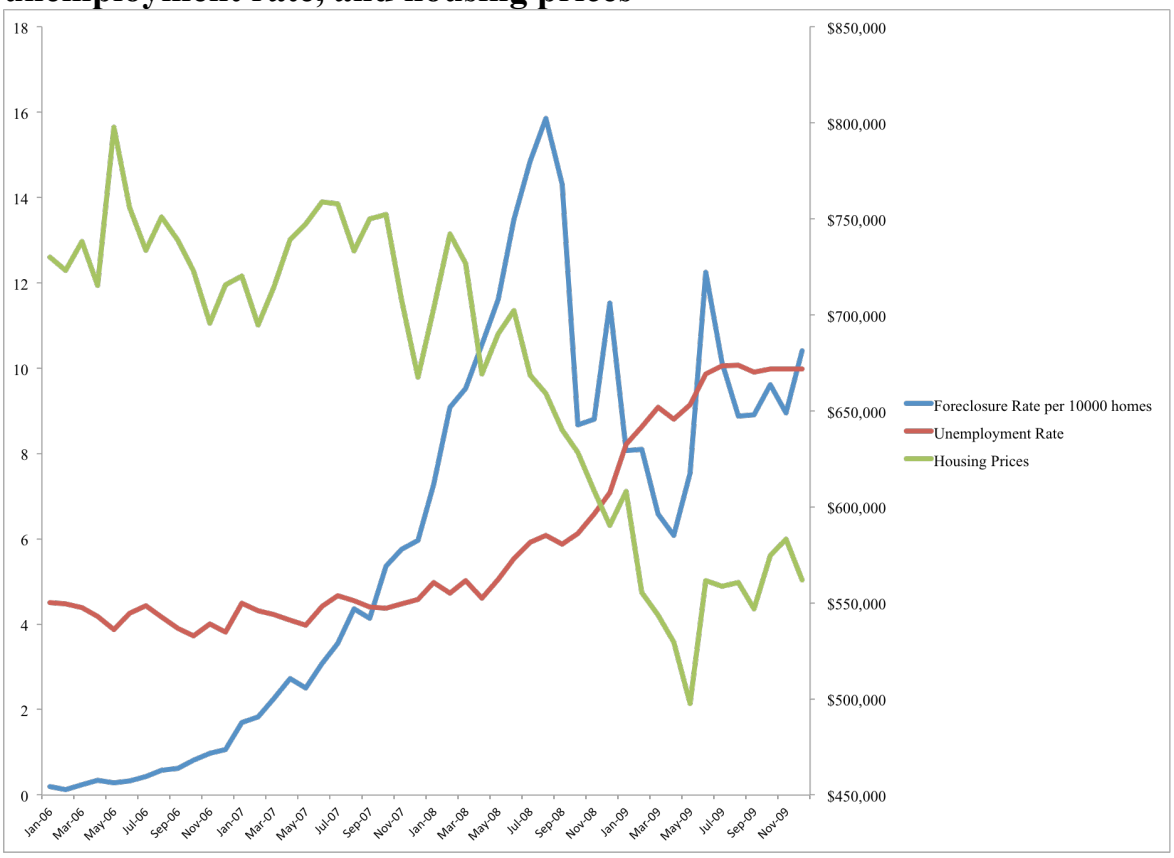


Table 1: Mean and standard deviation of within and between individual

Variable	Mean	Standard Deviation		
		Overall	Between	Within
A1c	7.23	1.43	1.34	0.68
Probability of Poor Control	15.3%	36.0%	30.2%	22.3%
Body Mass Index (BMI)	31.15	7.02	6.97	1.23
Block foreclosures per 20 homes	0.28	0.85	0.70	0.58
Block Group foreclosures per 2200 homes	6.88	13.28	10.05	9.02
Foreclosures per 1km	26.03	43.22	26.46	34.93
Mean Zip-Code Housing Prices (US$)	$537,699	$223,544	$200,504	$100,938
County Unemployment Rate (%)	6.2%	2.4%	0.9%	2.3%

Table 2: Baseline Characteristics of Participants and Their Neighborhoods, According to Exposure to Foreclosures (2007)				
	Full Cohort (n=120,857)	Never exposed to foreclosures within block (n= 57,039), Mean (SD)	Ever Exposed to Foreclosures Within Block (n= 63,818), Mean (SD)	Difference (p-value)
Characteristic				
A1c	7.3 (1.4)	7.2 (1.4)	7.4 (1.5)	< 0.01
BMI	31.1 (6.9)	30.8 (6.8)	31.5 (6.9)	< 0.01
Age	61.1 (12.8)	62.4 (12.8)	59.9 (12.6)	< 0.01
Female	46.7% (49.9%)	46.4% (49.9%)	47% (49.9%)	0.34
White	48.1% (49.9%)	52.5% (49.9%)	43.9% (49.6%)	< 0.01
Black	12.5% (33.1%)	9.4% (29.2%)	15.4% (36.1%)	< 0.01
Percent poverty	9.4% (9.3%)	8.6% (8.9%)	10.1% (9.5%)	< 0.01
Unemployment	4.6% (0.4%)	4.5% (0.4%)	4.6% (0.4%)	0.07
Housing Prices (US$)	610,536 (188,363)	698,764 (215,150)	554,972 (143,822)	< 0.01

Table 3: Linear Regression of Block Group Foreclosure Rate on Hemoglobin A1c						
	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Block group foreclosures per 100 homes $_{(t-1)}$	-0.03 (0.004)***	-0.0005 (0.004)	-0.00005 (0.0004)	-0.007 (0.004)	-0.006 (0.005)	0.01 (0.00)***
Unemployment rate $_{(t-1)}$			-0.006 (0.006)	0.002 (0.006)	-0.005 (0.006)	-0.01 (0.00)**
Mean Housing Price (thousands) $_{(t-1)}$			0.00008 (0.00003)	-0.00001 (0.00003)	-0.00001 (0.00003)	-0.00 (0.00) ***
Year dummies	no	yes	yes	yes	yes	yes
Individual fixed effects	yes	yes	yes	yes	yes	no
Complete Case	no	no	no	yes	no	no
P-weighted	no	no	no	no	yes	no
Intercept	7.2 (0.002)***	7.3 (0.003)***	7.3 (0.03)***	7.3 (0.04)***	7.3 (0.04)***	7.6 (0.03)***
Individuals	107,242	107,242	107,242	61,748	91,305	107,242
Observations	342,672	342,672	342,672	240,585	397,599	342,672
***p<0.01, **p<0.05, *p < 0.1						
Notes: P-weighted models were weighted regressions, where the weights were constructed as the individual inverse probability of attrition during the period. Weighted models only include individuals in the sample at baseline. The intercept is the average value of the fixed effects. The subscript *t-1* refers to an average 1-year lag, or observations 1 to 23 months prior to an A1c value. Model 6 includes individual random-effects rather than fixed effects. Robust Standard errors clustered at the block-group level are in parentheses.						

Table 4: Individual fixed-effects for change in A1c by Age						
	(7)	(8)	(9)	(10)	(11)	(12)
Variables	20-49		50-64		65+	
Intercept	7.83 (0.12)***	7.50 (0.14)***	7.46 (0.06) ***	7.37 (0.06) ***	7.00 (0.04)***	7.02 (0.04)***
Block group foreclosures per 100 homes $_{(t-1)}$	0.01 (0.01)	-0.00 (0.01)	0.01 (0.01)	-0.01 (0.01)	-0.02 (0.01)***	-0.02 (0.01)***
Unemployment rate $_{(t-1)}$	0.03 (0.02)*	0.06 (0.02)***	-0.01 (0.01)	0.01 (0.01)	-0.01 (0.01)**	-0.01 (0.01)**
Mean Housing Price (thousands) $_{(t-1)}$	-0.00 (00)	-0.00 (00)	0.00 (00)	0.00 (00)	0.00 (00)	0.00 (00)
Year Fixed Effects	yes	yes	yes	yes	yes	yes
Complete Case	no	yes	no	yes	no	yes
Individuals	17,625	7,790	40,574	24,099	40,255	26,854
Observations	51,591	29,645	132,011	93,588	137,085	105,634
***p<0.01, **p<0.05, *p < 0.1						
Note: Observations from (7), (9), (11) do not sum to 342,672 because they exclude those ages 18-19. Robust Standard errors clustered at the block group level are in parentheses.						

Table 5: Baseline (2007) Characteristics, by Attrition Status			
	All Participants (n=103,096)	Attritors (n= 31,693), Mean (SD)	Non-Attritors (n= 71,403), Mean (SD)
Characteristic			
Block group foreclosures rate	18.7% (29.0%)	19.1% (29.5%)	18.4% (28.8%)
A1c	7.3 (1.4)	7.5 (1.7)	7.2 (1.3)
Poor Control	16.7% (37.3%)	20.7% (40.5%)	14.9% (35.6%)
Age	62.1 (12.8)	61.0 (14.3)	62.5 (11.8)
Female	47.2% (49.9%)	45.8% (49.8%)	47.8% (49.9%)
Non-Hispanic White	48.1% (49.9%)	49.2% (49.9%)	47.8%
Percent poverty in block group	9.3% (9.3%)	10% (9.6%)	9% (8.9%)
Unemployment Rate	4.6% (0.4%)	4.6% (0.4%)	4.6% (0.4%)
Median Housing Prices (US$)	611,514 (189,015)	606,680 (188,678)	613,656 (189,126)
Note: Attrition includes any individual who had no A1c measurement in 2009 and 2010 or 2010			

Paper 3

No spillover effect of the foreclosure crisis on weight change

Abstract

Objectives: We examined the association between block foreclosure rates from 2006 to 2010 and individual measures of body mass index (BMI) in the subsequent year among a clinical population of insured patients with diabetes.

Methods: We linked ambulatory visit-level data from 105,919 Kaiser Permanente Northern California patients with diabetes to foreclosure records. We used an individual-fixed effects approach to regress the lagged annual foreclosure rate in each patient's block of residence on BMI.

Results: More than half (53%) of patients were exposed to at least one foreclosure within their residential block. We found no evidence of an association between block foreclosure rate and BMI. In contrast, non-foreclosure aspects of the Great Recession had a much larger association: a one standard deviation increase in the unemployment rate accounted for a half-pound gain ($p<0.1$), and among Blacks, a three-pound gain ($p<0.001$).

Conclusions: Our results suggest that unemployment, not foreclosures, accounted for a substantial proportion of variation in BMI, particularly among a subgroup especially affected economically by the recession (Blacks). Future work should further explore to what extent insurance is protective.

1. Introduction

The decline of U.S. economy from 2007 to 2009 was the largest in magnitude since the Great Depression. The housing collapse, later known as the foreclosure crisis, contributed in part to the rise in unemployment during the Great Recession (Estevão & Tsounta, 2011; Karahan & Rhee, 2013). Mortgage default has often been precipitated by job loss (Gerardi, Herkenhoff, Ohanian, & Willen, 2013). Despite the interdependence between the housing and labor markets, research on economic recessions and health has often omitted foreclosures from the discussion.

An emergent body of research on foreclosures and health has supplied several studies on the health of individual homeowners in response to experiencing a foreclosure (Burgard et al., 2012; Cannuscio et al., 2012; Houle & Keene, 2014; Lindblad & Riley, 2015; McLaughlin et al., 2012; Pevalin, 2009; C. Pollack et al., 2011; C. E. Pollack & Lynch, 2009; Taylor et al., 2007; Yilmazer et al., 2015). Like the research demonstrating the financial spillover effects of a foreclosure in a neighborhood (Campbell, Giglio, & Pathak, 2009; Z. Lin et al., 2009), the question of if there was a spillover effect on health is an empirical one. Yet only a small number of studies exist (Arcaya et al., 2013, 2014; Cagney et al., 2014b; Currie & Tekin, 2011; Houle, 2014; Houle & Light, 2014); these studies have yielded evidence mostly supporting the hypothesis that residing in a high foreclosure environment contributes to poor health.

Our study contributes to the literature on community-level foreclosures and somatic health by examining how the neighborhood foreclosure rate relates to individual body mass index (BMI) among an insured population with a chronic disease (diabetes) in California. Only a single study has previously examined the relationship between BMI and residing near a foreclosure (Arcaya et al., 2013). The study population was neither chronically ill nor derived from a single health system. The authors found that living within 100 meters of a foreclosure was associated with a 0.2 units increase in BMI. This finding is counter to the evidence from the unemployment literature; excess weight fell during economic downturns in the United States (Ruhm, 2005).

To further develop our hypotheses, we borrowed and built upon theories evoked in the recessions and health literature (Catalano et al., 2011) to inform the pathways by which the neighborhood foreclosure rate relates to individual BMI. First, a neighboring foreclosed home may act as a chronic stressor for homeowners who anticipate or experience a decline in the value of their home. A fall in housing equity could trigger default or reduce resources available to purchase inputs for health. In addition, homeowners or renters may experience or anticipate higher rates of crime or social disorganization in their neighborhood as homeowners vacate (Arnio et al., 2012; Baumer et al., 2012; Cui & Walsh, 2015; Ellen et al., 2013; Goodstein & Lee, 2010; Immergluck & Smith, 2006b; Katz et al., 2011; Lacoe & Ellen, 2015; Stucky et al., 2012; Wood et al., 2012).

Next, an increase in the foreclosure rate of a community can reduce the tax base (Apgar et al., 2005) and reduce local governments resources (Kingsley et al., 2009) devoted to health-promoting activities. Foreclosures might erode social capital within a community if there is a high attrition of socially connected residents and result in poorer health (Islam et al., 2006). Finally, high foreclosure areas could lead to job loss, particularly for those in industries like construction.

People with diabetes are particularly sensitive to stressors, which can decrease insulin sensitivity (Steptoe, Hamer, & Chida, 2007), and this increased stress, coupled with reductions in wealth, neighborhood health-promoting activities, and social cohesion could add to the challenges in diabetes self-management and healthy eating (Wang, Brownell, & Wadden, 2004) (Oliver & Wardle, 1999). Given the existing evidence and theory, we expected to observe a net positive relationship between foreclosure rate and BMI in our study population.

To inform our prediction about how health insurance might influence our results, we drew from a study which found that an additional foreclosure in a zip-code increased non-elective hospital visits among those with public but not private health insurance (Currie & Tekin, 2011). We expected that the effect would be larger among those with Medicaid insurance. To test our hypotheses, we linked public foreclosure deed records from 2006 to 2009 with clinical records of Kaiser Permanente patients with diabetes who lived in one of nine Bay Area counties and used an individual-fixed effects approach, adjusting for the unemployment rate, housing prices, and time trends, to estimate the effect of the block foreclosure rate on mean BMI.

2. Methods

2.1 Study Design and Subjects

The clinical data was obtained from ambulatory patient visits of patients with diabetes, receiving uniform access to care within a large, integrated, healthcare delivery system Kaiser Permanente Northern California (KPNC) from 2007 to 2011. Patients with type 1 or unknown type diabetes, histories of lower extremity amputation or pregnancy or cancer diagnosis within the study period and 1-year prior were excluded. Patients were retained for analysis if they had at a geocodable address record for at least two years over the period from 2006 to 2009 in one of nine Bay Area counties. Address data was collected according to the record on file in February of each year. 5.2% percent had only one BMI measure over all four years and were excluded from the analysis. This resulted in a sample size of 105,919.

Foreclosure data included address-level residential deed data and housing price data were compiled by DataQuick (Systems, 2006-2009) from the nine Bay Area counties between 2006 and 2009. Data on area-level demographics was also collected from the American Community Survey (ACS) (FactFinder, 2014). Data from the Local Area Unemployment Statistics database were used for county-level unemployment rates (Statistics, 2006-2009).

To answer our additional research questions, we appended the data described above to additional measures collected for a sub-set (n= 8,923) of patients within our population who had completed the Diabetes Study of Northern California (DISTANCE) survey at baseline, in 2006 (Moffet et al., 2009). The Institutional Review Boards of Kaiser Permanente Northern California and University of California, Berkeley approved this study.

2.2 Health outcome

The main outcome for this study, body mass index (BMI, kg/m^2), was measured during patient ambulatory visits from 2007 to 2010 and averaged across each calendar year. The mean number of BMI measurements per patient was 1.3 per year (0 – 3) and 8.1 (4 – 12) over the four-year period.

2.3 Foreclosure Measures

We define foreclosure as the event in which the residential deed is transferred to the new owner. This excludes notice of default or mortgage delinquencies. Our data did not differentiate between properties that were transferred back to the bank (real-estate owned) and those sold at auction. We used ArcGIS 10 and Data Scientist Toolkit in R to assign geographic coordinates to the

foreclosures. Less than 1% (19) of the foreclosure addresses was not geocodable and subsequently excluded.

The primary exposure of interest was the annual foreclosure rate within the patient's census block. The number of foreclosures was divided by the number of housing units in each block using data from the US Census 2000. In this region, the length of an average block is 100m, the distance at which a foreclosure is expected to have economic spillover effects on the values of neighboring properties (Z. Lin et al., 2009).

2.4 Covariates

Time-varying neighborhood-level covariates from 2006 to 2009 were used to control for area-level variation. We adjusted for mean housing prices at the zip-code level. A decline in housing prices can trigger foreclosures in those with negative equity in their homes and adversely impact health (H. Lin, Ketcham, Rosenquist, & Simon, 2013). We controlled for unemployment because it has been a predictor of mortgage default (Gerardi et al., 2013) and health (Strully, 2009).

Individual-level time-varying covariates were collected from 2007 to 2010. Age and changes in income or job loss might affect stress response to a proximate foreclosure and result in changes in diet or self-care habits. Medicaid status (1/0) was included as a proxy for low income or employment status. We created several time-varying heath-related variables that might influence both weight change and the neighborhood foreclosure rate to adjust for clustering of health-related behaviors and an elevated likelihood of experiencing a home foreclosure due to poor health (Himmelstein, Thorne, Warren, & Woolhandler, 2009; Houle & Keene, 2014; C. Pollack et al., 2011; C. E. Pollack & Lynch, 2009; Robertson, Egelhof, & Hoke, 2008). We included a Charlson comorbidity index score (Charlson, Pompei, Ales, & MacKenzie, 1987), which predicts the ten year mortality for a patient with a range of conditions, and annual indicators for use of medications clinically associated with weight change (*insulin*, *oral* diabetes medications, and psychiatric medications such as selective serotonin reuptake inhibitors (SSRIs) that can cause *weight gain* and *weight loss*.)

Homeownership status (1=owner, 0=renter) included individuals without missing data on housing status, and those who reported living "rent-free" (i.e. with a relative), or moved at least once from 2007 to 2009, were coded as missing. For the subsample with DISTANCE survey responses, we created measures of income (continuous), non-housing wealth (1=$10k+, 0=less than $10k), education (0=graduate degree+, 1=less than high school diploma, 2=high school diploma, 3=bachelors degree), employment status (1=employed full-time, 0=not employed), and partnership status (1=married or co-habiting, 0=non-married, divorced, separated, widowed).

2.5 Statistical Methods

To examine the relationship between foreclosures and BMI, we fit a series of models of individual BMI at time *t* on the block foreclosure rate in the prior year. All statistical analyses were performed with Stata 13. The general form of the model was specified as:

$Y_{it} = \beta_o + \beta_1 F_{it-1} + \beta_2 Z_{it-1} + \beta_3 C_{it} + \beta_4 X_i + \beta_5 yearD_t + u_i + v_{it}$, where Y_{it} is a measure of the mean BMI level of individual *i* in year *t*; F_{it-1} is the block *foreclosure rate* for individual *i* in year *t-1*; Z_{it-1} is a vector of lagged area-level controls for individual *i* in year *t-1* (*unemployment, housing prices*); C_{it} is a vector of individual time-variant covariates including indicators for Medicaid status and medication use; X_i is a vector of individual time-invariant

covariates such as sex and race; *yearD* are dummies for year *t*; u_i is an individual fixed-effect, and v_{it} is the time and individual specific error term.

Our primary parameter of interest, change in BMI for each one-unit change in the block foreclosure rate in the prior year, was estimated using an individual fixed effects approach by estimating a fixed-effect (u_i) for each individual. The inclusion of individual fixed effects allowed us to control for observed and unobserved factors that do not change over time that might be correlated with both individual body mass index and neighborhood foreclosure rate.

As foreclosures and health status are not randomly distributed, our estimates might differ based on health insurance or demographic characteristics. In response to the prior study where Currie and Tekin noted a differential effect by health insurance (Currie & Tekin, 2011), we restrict our sample first to those under 65 who used Medicaid at least once during the period (n = 4,463) and for the entire period (n=3,138). Next, to accompany the age-specific estimates on healthcare utilization by Currie and Tekin (Currie & Tekin, 2011), we stratified our results based on the individual's baseline age and created three groups of adults (20-49, 50-64, 65+). Then we stratified by groups differentially affected by the recession, using race/ethnicity (Asian, Black, Non-Hispanic White) as a marker of socioeconomic status (Flegal, Carroll, Kit, & Ogden, 2012).

In order to test one of the mechanisms by which the community foreclosure rate is hypothesized to influence BMI, we stratified by the main fixed effects models by homeownership status (owners or renters) among the DISTANCE respondents who lived in the same address for the period. If homeowners experience a nearby foreclosure as a stressful event because it signals a future potential loss of housing wealth and the stress response provokes an increase in BMI, we expect the relationship between foreclosure rate and BMI to be greater among owners than renters (Buiter, 2008).

2.6 Sensitivity analyses

We conducted a series of sensitivity analyses to examine the consistency of the study results to different analysis specifications. To examine the sensitivity of results to different geographic boundary definitions, we created two additional measures and repeated the study analyses using these alternative definitions: a census block group foreclosure rate and a count of foreclosures within a 1-km Euclidean radius around the patient's block centroid. The 1-km distance is equivalent to 10 minutes of walking. Second, in order to facilitate comparisons to the single existing study on foreclosures and body mass index, we replicated the analytic approach used by Arcaya et al (Arcaya et al., 2013). We used a linear mixed model fit with maximum likelihood containing both fixed and random effects with an independent covariance structure (Rabe-Hesketh & Skrondal, 2008) to regress the lagged number of foreclosures in the patient's census block on BMI, adjusting for education, income, age, race, sex, age, population density, foreclosures per 1km, and a quadratic time trend. Finally, we assessed the robustness of our main estimates to different lag structures, including two-year lag and contemporaneous specifications.

3. Results

3.1 Descriptive

There were 105,919 individuals in this study that meet the inclusion criteria above and had at least two measures of BMI between 2007 and 2010. Over half (58%) of the sample was clinically observed in all four years and 17.3% of the individuals moved at least once during the study period.

The means and standard deviations for the time-varying variables are reported in Table 1. The average BMI (kg/m^2) in this cohort was 31.15 (s.d= 1.2 units) over the period. For a person 5'6" and 193 pounds, this is equivalent to 7 pounds. There were 0.3 foreclosures in the average block (20 homes), 6.9 in the average block group (2200 homes), and 26 foreclosures within a 1km radius. The within-person standard deviation was 0.6, 9, and 35 foreclosures per block and block group, respectively. The mean value of housing prices in patient's zip code was $537,699 (s.d. = $100,938). The average unemployment rate in the patient's county was 6.2% (s.d. = 2.3%).

There were substantive differences at baseline (2006) between the individuals who lived in blocks that were most and least affected by the foreclosure crisis. Table 2 shows the baseline health, demographic, and neighborhood characteristics of individuals in 2006 that were in the bottom and top quintile of neighborhoods based on block foreclosure rate in 2008 (the peak). Those who lived in blocks hit hardest by foreclosures (i.e. top quintile) were more likely to be obese, Black, under 65, and living with a spouse or partner, while being far less likely to have a bachelors degree, employment, and non-housing wealth of over $10,000. These individuals also lived in neighborhoods in 2006 with an average block foreclosure rate that was double that of the bottom quintile. The neighborhoods in the top quintile also had lower housing prices, more poverty, a higher rate of owner-occupied units, a lower proportion of Whites, and a lower population density.

3.2 Main results

The individual fixed effects models for the full cohort show no statistically significant association between block foreclosure rate and BMI (Table 3). We observed a clinically irrelevant statistically significant relationship for the unadjusted model (Model 1), β = -0.007, 95% CI [-0.009, -0.005]. The addition of the year fixed effects attenuated the foreclosure rate coefficient and the effect became statistically insignificant (Model 2), β = 0.001, 95% CI [-0.001, 0.003]. The coefficients on year indicators are negative; BMI decreased from 2007 to 2010. The model adjusting for unemployment rate and mean housing prices left the coefficient and confidence interval on the block foreclosure rate unchanged (Model 3). The addition of the full set of individual time-varying covariates had no effect on the coefficient on block foreclosure rate (Model 4).

For every one standard deviation increase in the county unemployment rate, individual mean BMI increased by a half pound on average ($p<0.05$). Decreases in mean housing prices had a statistically significant relationship ($p<0.05$) with increased BMI, however the magnitude of the effect was less than a tenth of a pound gain for one standard deviation change in prices, too small to be clinically meaningful. Starting insulin or oral medication during the study period was associated with an increase of approximately two pounds ($p<0.001$).

3.3 Subgroup-Specific Results

Table 4 contains results among Medicaid patients. Among those under 65 who were enrolled in Medicaid for at least one year during the period (Model 5, $\beta = 0.004$, 95% CI [-0.02, 0.03]) and for all four years (Model 6, $\beta = 0.006$, 95% CI [-0.01, 0.02]), there was no statistically significant effect of block foreclosure rate on BMI. The confidence intervals around these estimates suggest that the Medicaid-specific results are virtually indistinguishable from the full cohort.

Table 5 contains sub-group specific results by age and race. Table 6 provides contextual descriptive statistics by race. For those above 50 and non-Hispanic Whites were similar to the full cohort, $\beta = 0.001$, 95% CI [-0.003, 0.004]. Among those ages 20 to 49 and Asians, the coefficient on the foreclosure rate was negative and statistically insignificant. For Blacks, for a three percent (~ 1 standard deviation) increase in unemployment rate, there was a statistically significant ($p<0.001$) half unit increase in BMI or roughly three-pound gain for an average 5'6" and 193 pound person ($\beta = 0.189$, 95% CI [0.079, 0.300]). For those ages 20 to 49 and 65+, there was a statistically significant ($p<0.001$) change in BMI for every one standard deviation change in housing prices, however this effect was of a negligible magnitude. Among the DISTANCE cohort (not shown), there was no difference between the relationship between foreclosure rate and BMI among homeowners and renters.

3.4 Sensitivity analysis

The main models were fit using alternate exposures, the block group foreclosure rate and the number of foreclosures within 1-km from the patient's block centroid, and yielded similar results to the block foreclosure rate, $\beta = 0.001$, 95% CI [-0.001, 0.003] (not shown).

For those who used Medicaid at least once during the period, there was a statistically significant ($p<0.05$) decrease of 0.26 kg/m^2 (~ 2 pounds) for every one percent increase in the block group foreclosure rate (Table 4, Model 7). No association between block group foreclosure rate and BMI among those who were enrolled in Medicaid for all four years (Model 8, $\beta = -0.098$, 95% CI [-0.287, 0.092]). There was no association between foreclosures per 1 km and BMI for those on Medicaid ever or for all four years (Models 9 and 10, 95% CI [-0.002, 0.003]).

The effect of unemployment on BMI among those who were observed to use Medicaid for all four years was robust across spatial measures of foreclosures; for every 3 percent (~ 1 standard deviation) increase in the unemployment rate, there was a statistically significant ($p<0.05$) increase of 1 kg/m^2 (~ 7 pounds).

We observed no association between body mass index and a 2-year lagged block foreclosure rate or contemporaneous block foreclosure rate. Finally, the mixed effects model that replicated the study by Arcaya et al (Arcaya et al., 2013) yielded no statistically significant association between block foreclosure rate and body mass index (n=57,791, $\beta = -0.0001$, 95% CI [-0.002, 0.002].

4. Discussion

Among our continuously insured managed care population with diabetes, we found no evidence of an association between proximity to foreclosures in the prior year and BMI for the full cohort. Our results differ from the single existing study known on proximity to foreclosures and BMI. This study by Arcaya et al (Arcaya et al., 2013) found an additional foreclosure within 100 meters is associated with an increase of 0.2 units in BMI. Only 2% of the population (n = 2,068) in the study by Arcaya et al was exposed to at least one foreclosure at 100m. Our study has greater internal validity because more than half of our population was exposed to at least one foreclosure in

their block. In addition, our population consisted of a much higher proportion of racial minorities (more than 50% compared to 0.5%). In our study, BMI was measured from visit level clinical data instead of pooling self-reported measured over a three-year period. Our foreclosure measure included all residential foreclosures instead of exclusively bank-owned foreclosures. Finally, our study selected to focus on the recent residential foreclosure crisis (2006 to 2010) in California, rather than the time period 1987 to 2008 in Massachusetts included in Arcaya et al's study.

Our results differ from the findings by Currie and Tekin (Currie & Tekin, 2011); while both studies found no effect of the foreclosure crisis on health among those with private health insurance, their study showed an effect of a large magnitude among those with public health insurance. One reason for the difference might be the geographical variation in the timing of the Great Recession and the foreclosure crisis (see Appendix Figure A2); while nationwide the foreclosure crisis preceded unemployment, the labor market declined before the housing market in more than half of metropolitan areas (Winkler, 2013). In the San Francisco-Oakland-Freemont Metropolitan area where a majority of our population resided in or near, the housing market declined 7 quarters prior to the labor market. Currie and Tekin's population included those in Arizona, California, New Jersey, and Florida (Currie & Tekin, 2011). These states contained metropolitan areas that have larger labor markets and, on average, experienced a shorter period between the decline of the housing and labor markets. It is possible that in some parts of these states, the labor market declined prior or simultaneous to the foreclosure rate increased. Thus, the inclusion of lagged unemployment might have induced confounding and biased the results away from the null if the temporal ordering was misspecified.

In our study, among those under 65 who used Medicaid at least once over the period, there was a marginally significant negative association between block group (but not the block) foreclosure rate and BMI. The relationship did not hold for those who used Medicaid for all four years, yet the unemployment rate for this population had a large positive effect. Our findings are consistent with the research that has shown that ambulatory care-sensitive conditions such as diabetes are influenced by the interruption in Medicaid coverage (Bindman, Chattopadhyay, & Auerback, 2008).

Our study has several limitations. We were unable to measure potentially important time-varying factors such as job status and income, thus unmeasured residual confounding might persist. Although we included several measures of foreclosures, our data did not allow us to distinguish real estate owned foreclosures (REOs), which are more likely to attract criminal activity. This limits the comparability of our results with estimates from other studies of REOs on community-level health and health behaviors (Arcaya et al., 2013, 2014; Cagney et al., 2014b; Cui & Walsh, 2015; Ellen et al., 2013; Goodstein & Lee, 2010; Houle, 2014; Houle & Light, 2014).

In addition, our study only includes four years of observations, which might not be long enough to detect an effect. Although we refer to the lag period as one year, it should be interpreted as an average; the actual lag period could have ranged from 1 to 23 months depending on the month of the foreclosure and clinical visit.

Our results might have limited external validity beyond diabetics with managed care in Kaiser Permanente. Finally, we are unable to observe those who stopped seeking healthcare and our sample might be biased if those who did not return for visits had a differential exposure to neighborhood foreclosures. To address this, we compared those who were in the sample for all four years compared to the full cohort of all patients with more than two years of visits, and the estimates were similar.

Our study adds to the literature on foreclosures and health, and has implications for disease management. Given the prevalence of diabetes in the United States over the past three decades has doubled to 8.3 per 100 (Geiss et al., 2014) and cost $245 billion dollars in direct medical costs and reduced productivity (Association, 2013), this study provides context for disease management. Our results suggest that the public's (physical) health did not "fall victim to the foreclosure epidemic" (Bennett, Scharoun-Lee, & Tucker-Seeley, 2009). More research is needed to understand the impact of various economic stressors on health outcomes across various populations. Healthcare delivery systems are positioned to play an important role in identifying and managing the environmental exposures to economic stressors.

Tables & Figures

Table 1: Mean and standard deviation of within and between individual

Variable	Mean	Standard Deviation		
		Overall	Between	Within
Body Mass Index (BMI)	31.15	7.02	6.97	1.23
Block foreclosures per 20 homes	0.28	0.85	0.70	0.58
Block Group foreclosures per 2200 homes	6.88	13.28	10.05	9.02
Foreclosures per 1km	26.03	43.22	26.46	34.93
Mean Housing Prices per Zip-Code (US$)	$537,699	$223,544	$200,504	$100,938
County Unemployment Rate (%)	6.2%	2.4%	0.9%	2.3%
Charlson Comorbidity Index	1.75	1.64	1.36	0.93
Insulin Use	13.8%	34.5%	30.5%	16.3%
Oral Medication Use	39.1%	48.8%	42.5%	24.3%
Medicaid	1.6%	12.5%	12.2%	3.9%

Table 2: Baseline Characteristics of Participants and Their Neighborhoods, According to Exposure to Foreclosures in 2008			
	All Participants (n= 66,543)	Residence in bottom 5th foreclosures (n = 40,374)	Residence in top 5th foreclosures (n= 13,089)
Health characteristics			
BMI (kg/m^2)	31.1	30.7	31.9
Obese (BMI>30) (%)	49.7	47.6	55.2
Demographic characteristics			
Over 65 (%)	42.6	45.8	35.7
Non-Hispanic White (%)	48.9	52.0	40.1
Black (%)	12.2	9.7	20.6
Asian (%)	25.4	25.5	23.9
Income under $35k	27.7	27.3	27.9
Non-housing wealth (10,000+) (%)	71.9	72.8	68.1
Homeowner (%)	79.8	77.2	85.7
Employed (%)	33.2	36.1	26.1
Bachelors degree + (%)	32.3	35.3	24.2
Partnered (%)	72.7	71.9	74.2
Neighborhood characteristic			
Block foreclosures per 1000 homes	1.4	1.2	2.4
Housing prices per zip-code	635,798.5	685,876	539,686.5
Percent owner-occupied in block group	66.1%	65.5%	67.5%
Percent poverty in block group	9.1%	8.3%	11.6%
Percent White in block group	54.2%	56.9%	47.9%
Population density per sq mile	9,780.30	10,252.90	8,556.90
Notes: All census blocks in the Bay Area with at least one participant in the study population were assigned to a quintile based on its foreclosure rate in 2008. There was a larger number n=40,374 of individuals living in the bottom quintile. Income, Homeowner, Employment, Education, and Partnership were only available for the DISTANCE sub-set (n = 8,923). There was a statistically significant difference ($p<0.01$) in the means of all variables except for Income under $35k			

Table 3: Linear regression of block foreclosure rate on body mass index (BMI) with individual fixed effects				
	(1)	(2)	(3)	(4)
Variables				
Block foreclosures per 100 homes $_{(t-1)}$	-0.00674***	0.000909	0.00124	0.00123
	(0.001)	(0.001)	(0.001)	(0.001)
Unemployment rate $_{(t-1)}$			0.0304***	0.0270**
			(0.012)	(0.012)
Mean Housing Price (logged) $_{(t-1)}$			0.0542**	0.0556**
			(0.024)	(0.024)
Medicaid				0.108
				(0.099)
Charlson Comorbidity Index				-0.0323***
				(0.004)
Insulin				0.382***
				(0.025)
Oral Medication				0.265***
				(0.016)
Weight Gain				-0.0547
				(0.037)
Weight Loss				-0.0775**
				(0.033)
2008		-0.0768***	-0.0822***	-0.0798***
		(0.007)	(0.008)	(0.008)
2009		-0.151***	-0.184***	-0.179***
		(0.009)	(0.021)	(0.021)
2010		-0.231***	-0.378***	-0.358***
		(0.010)	(0.068)	(0.068)
Intercept	31.19***	31.29***	30.44***	30.32***
	(0.001)	(0.005)	(0.339)	(0.342)
***p<0.01, **p<0.05, *p < 0.1				
Notes: Clustered robust standard errors are in parentheses. There are 105,919 individuals and 331,917 observations in each model.				

Table 4: Linear regression of foreclosures on body mass index (BMI) with individual fixed effects for Medicaid Patients						
	(5)	(6)	(7)	(8)	(9)	(10)
Variables	Block Foreclosure Rate		Block Group Foreclosure Rate		Foreclosures per 1 km	
Foreclosure Measure $_{(t-1)}$	0.00428	0.006	-0.264**	-0.098	0.0001	0.0005
	(0.012)	(0.008)	(0.105)	(0.097)	(0.001)	(0.001)
Unemployment rate $_{(t-1)}$	0.179	0.299*	0.234	0.343**	0.211	0.332**
	(0.191)	(0.168)	(0.191)	(0.165)	(0.192)	(0.170)
Mean Housing Price (logged) $_{(t-1)}$	0.203	-0.004	0.0544	-0.050	0.173	-0.001
	(0.247)	(0.0232)	(0.246)	(0.234)	(0.262)	0.267
2008	0.0454	-0.048	0.0741	-0.054	0.0405	-0.043
	(0.045)	(0.100)	(0.106)	(0.099)	(0.107)	(0.104)
2009	-0.177	-0.498*	-0.126	-0.522*	-0.232	-0.560
	(0.352)	(0.316)	(0.356)	(0.311)	(0.354)	(0.318)
2010	-1.012	-1.851*	-1.299	-2.100**	-1.212	-2.046**
	(1.117)	(0.987)	(1.118)	(0.971)	(1.127)	(1.010)
Intercept	31.64***	31.214***	33.34***	31.63***	31.83***	31.00***
	(3.453)	(3.175)	(3.431)	(3.202)	(3.600)	(3.563)
Individuals	1469	1064	1469	1064	1469	1064
Observations	4463	3749	4463	3749	4463	3749
***p<0.01, **p<0.05, *p < 0.1						
Note: Clustered robust errors are in parenthesis						

Table 5: Sub-group specific linear regression of block foreclosure rate on body mass index (BMI) with individual fixed effects

	(A1)	(A2)	(A3)	(A4)	(A5)	(A6)
Variables	Age 20-49	Age 50-64	Age 65+	Black	Non-Hispanic White	Asian
Block foreclosures per 100 homes $_{(t-1)}$	-0.003	0.002	0.001	0.004	0.001	-0.001
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Unemployment rate $_{(t-1)}$	0.082**	0.030	0.019	0.189***	0.030	0.014
	(0.042)	(0.022)	(0.018)	(0.056)	(0.021)	(0.019)
Mean Housing Price (logged) $_{(t-1)}$	0.251***	-0.021	0.124***	0.130	0.064	0.023
	(0.073)	(0.045)	(0.035)	(0.072)	(0.046)	(0.023)
Medicaid	-0.114	0.203	0.173	0.101	0.048	0.116
	(0.246)	(0.163)	(0.147)	(0.324)	(0.225)	(0.161)
Charlson Comorbidity Index	0.014	-0.022**	-0.037***	-0.032**	-0.052***	-0.018**
	(0.014)	(0.008)	(0.006)	(0.014)	(0.006)	(0.008)
Insulin	0.529***	0.383***	0.304***	0.361***	0.423***	0.299***
	(0.070)	(0.038)	(0.040)	(0.077)	(0.041)	(0.044)
Oral Medication	0.190***	0.217***	0.325***	0.115**	0.326***	0.209***
	(0.038)	(0.027)	(0.027)	(0.052)	(0.029)	(0.028)
Weight Gain	0.0213	0.009	-0.133**	-0.048	-0.075	-0.150
	(0.126)	(0.061)	(0.053)	(0.115)	(0.054)	(0.094)
Weight Loss	-0.040	0.0237	-0.175***	-0.169	-0.0677	-0.224**
	(0.086)	(0.061)	(0.046)	(0.110)	(0.044)	(0.077)
2008	-0.059**	-0.035***	-0.134***	-0.131***	-0.103***	-0.037***
	(0.026)	(0.013)	(0.011)	(0.030)	(0.013)	(0.013)
2009	-0.160**	-0.142***	-0.230***	-0.451***	-0.228***	-0.075**
	(0.077)	(0.037)	(0.029)	(0.093)	(0.037)	(0.033)
2010	-0.519**	-0.300**	-0.412***	-1.337***	-0.435***	-0.149
	(0.242)	(0.124)	(0.098)	(0.310)	(0.118)	(0.109)
Intercept	29.89***	32.16***	27.72***	30.69***	31.47***	26.77***
	(1.019)	(0.634)	(0.489)	(1.064)	(0.640)	(0.587)
Individuals	18534	41800	39712	10595	40891	22782
Observations	45888	118284	135662	32919	130455	70255

***p<0.01, **p<0.05, *p < 0.1

Note: Robust Standard errors are in parenthesis

Table 6: Mean and standard deviation of within and between individual, by Race

	Black				Asian				Non-Hispanic White			
Variable	Mean	Standard Deviation			Mean	Standard Deviation			Mean	Standard Deviation		
		Overall	Between	Within		Overall	Between	Within		Overall	Between	Within
Body Mass Index (BMI)	33.14	7.58	7.56	1.37	27.20	4.86	4.78	0.93	32.37	7.20	7.17	1.34
Block Foreclosure Rate per 100 homes	1.98	4.70	3.38	3.44	1.44	4.93	4.42	3.27	1.06	3.50	2.95	2.42
Zip-Code Mean Housing Prices (thousands US$)	$436.3	$192.6	$160.1	$110.4	$570.9	$222.5	$201.0	$97.3	$562.5	$236.8	$216.9	$97.0
County Unemployment Rate (%)	6.4%	2.4%	0.9%	2.3%	6.2%	2.4%	0.9%	2.3%	6.2%	2.4%	0.9%	2.3%
Charlson Co-Morbidity Index	1.89	1.73	1.44	0.98	1.55	1.46	1.19	0.86	1.92	1.75	1.45	1.00
Insulin Use	16.0%	36.6%	32.2%	17.6%	9.0%	28.6%	24.9%	14.2%	16.3%	37.0%	33.0%	16.9%
Oral Medication Use	39.9%	49.0%	42.5%	24.5%	41.5%	49.3%	43.2%	24.0%	37.6%	48.4%	42.6%	23.4%
Medicaid	3.0%	17.1%	17.0%	4.7%	1.8%	13.2%	12.8%	3.8%	0.9%	9.3%	9.2%	3.0%

Conclusion

This dissertation of two empirical papers and one systematic review on foreclosures and health culminate in three central conclusions. First, no spillover effect of the foreclosure crisis on A1c or weight change among patients in a managed care system was observed, even among those with public health insurance. These findings suggest that the healthcare system might play a role in buffering individuals from economic stressors or more plausibly, those who are part of Kaiser Permanente health system either through the commercial market or employer-sponsored health insurance have a certain level of financial resources that might be protective. These empirical results are only mostly inconsistent with prior studies. Our results are counter to the single study that found a spillover effect of foreclosures on weight gain (Arcaya et al., 2014). The relationship between foreclosures and health-utilization among those with Medicaid that was observed in a prior study (Currie & Tekin, 2011) was not observed. In addition, among sub-groups of older adults and racial minorities hypothesized to be more vulnerable to the foreclosure crisis, no effect was observed.

Next, the housing and labor market factors appear to have related yet discrete consequences for health and healthcare. An interesting secondary finding of the empirical studies yielded a useful contextual conclusion; a substantial effect of unemployment on weight gain was observed, which was particularly large in magnitude for Blacks. This suggests that unemployment likely plays a distinct role from foreclosures in influencing health. Theory also informs the conclusion that economic recessionary factors should not be conflated; drawing from the discussion in the review paper, the mechanisms by which health is influenced by foreclosures and housing distress differs from unemployment in several key ways. First, while those who lose their job will have more time available to manage their health resources, homeowners who experience a foreclosure will certainly not have more time. Next, a homeowner who experiences a foreclosure is likely to experience loss aversion due to a large shock to their wealth whereas an person who loses their job will experience future losses to their income. Finally at the community-level visibility of foreclosures is greater than that of unemployment, arguably except for in areas where there are mass layoffs and few employers.

A final conclusion of this set of papers is that the mechanisms through which health is influenced by experiencing a foreclosure opposed to living near a foreclosure are unique, and can vary by way a foreclosure or housing distress is conceptualized. The conclusions of studies at the individual-level where a homeowner undergoes a foreclosure should be interpreted separately from those at the population-level where an individual resides near a foreclosure because the pathways are theoretically discrete. In addition, the consistency in the way housing distress or foreclosure is measured (e.g. foreclosure, notice of default, etc.) and similarly the manner in which a health outcome is measured has direct implications for generating hypotheses. In other words, the question posed in a recent essay (Bennett et al., 2009) should not be, "will the public's health fall victim to the home foreclosure epidemic*?*", but *how* and *why*.

This dissertation has started the discussion to answer those questions, but more research is needed. First, future studies should expand on the idea that a large number of individuals at a low risk may cause more cases of disease than the small number of individuals who are at high risk (Rose, 2001). This is important for these studies because while there was a higher rate of subprime lending and mortgage default rate within low-income, minority communities, there were a higher number of white households affected in aggregate (Reid & Laderman, 2009b). Studies should take into account that the distribution of the risk factors and distribution of health

outcomes are not consistent across racial/ethnic and socioeconomic groups. Next, future work should address how specific policy levers such as the availability of subprime credit influenced the relationship between foreclosures and health. Finally, this research suggests that future studies should explore how these mechanisms operate in other populations and healthcare systems.

References

Ali, M. K., Bullard, K., Imperatore, G., Barker, L., & Gregg, E. W. (2012). Characteristics associated with poor glycemic control among adults with self-reported diagnosed diabetes—National Health and Nutrition Examination Survey, United States, 2007–2010. *MMWR Morb Mortal Wkly Rep, 61*(2), 32-37.

Alley, D. E., Lloyd, J., Pagán, J. A., Pollack, C. E., Shardell, M., & Cannuscio, C. (2011). Mortgage delinquency and changes in access to health resources and depressive symptoms in a nationally representative cohort of Americans older than 50 years. *American journal of public health, 101*(12), 2293-2298.

Apgar, W. C., Duda, M., Gorey, R. N., & Council, H. P. (2005). The municipal cost of foreclosures: A Chicago case study. *Minneapolis, MN: Homeownership Preservation Foundation*.

Arcaya, M., Glymour, M. M., Chakrabarti, P., Christakis, N. A., Kawachi, I., & Subramanian, S. (2013). Effects of proximate foreclosed properties on individuals' weight gain in Massachusetts, 1987–2008. *American journal of public health, 103*(9), e50-e56.

Arcaya, M., Glymour, M. M., Chakrabarti, P., Christakis, N. A., Kawachi, I., & Subramanian, S. (2014). Effects of Proximate Foreclosed Properties on Individuals' Systolic Blood Pressure in Massachusetts, 1987-2008. *Circulation*, CIRCULATIONAHA. 113.006205.

Arnio, A. N., Baumer, E. P., & Wolff, K. T. (2012). The contemporary foreclosure crisis and US crime rates. *Social science research, 41*(6), 1598-1614.

Association, A. D. (2013). Economic costs of diabetes in the US in 2012. *Diabetes Care, 36*(4), 1033-1046.

Association, A. D. (2014). Standards of medical care in diabetes--2014. *Diabetes care, 37*, S14.

Barling, P. W., & Handal, P. J. (1980). Incidence of utilization of public mental health facilities as a function of short-term economic decline. *American Journal of Community Psychology, 8*(1), 31-39.

Baumer, E. P., Wolff, K. T., & Arnio, A. N. (2012). A multicity neighborhood analysis of foreclosure and crime. *Social Science Quarterly, 93*(3), 577-601.

Becketti, S., Gould, W., Lillard, L., & Welch, F. (1988). The panel study of income dynamics after fourteen years: An evaluation. *Journal of Labor Economics*, 472-492.

Bennett, G. G., Scharoun-Lee, M., & Tucker-Seeley, R. (2009). Will the public's health fall victim to the home foreclosure epidemic? *PLoS medicine, 6*(6), e1000087.

Berkowitz, L. (1989). Frustration-aggression hypothesis: examination and reformulation. *Psychological bulletin, 106*(1), 59.

Bindman, A. B., Chattopadhyay, A., & Auerback, G. M. (2008). Interruptions in Medicaid coverage and risk for hospitalization for ambulatory care–sensitive conditions. *Annals of Internal Medicine, 149*(12), 854-860.

Bocian, D. G., Li, W., Reid, C., & Quercia, R. G. (2011). Lost ground, 2011: Disparities in mortgage lending and foreclosures. *Center for Responsible Lending*, 3.

Bostic, R. W., Thornton, R. L., Rudd, E. C., & Sternthal, M. J. (2012). Health in all policies: the role of the US Department of Housing and Urban Development and present and future challenges. *Health Affairs*, 10.1377/hlthaff. 2011.1014.

Bradbury, K. L., Burke, M. A., & Triest, R. K. (2014). Within-school spillover effects of foreclosures and student mobility on student academic performance.

Brooks-Gunn, J., Schneider, W., & Waldfogel, J. (2013). The Great Recession and the risk for child maltreatment. *Child abuse & neglect, 37*(10), 721-729.
Brown, S., Taylor, K., & Price, S. W. (2005). Debt and distress: Evaluating the psychological cost of credit. *Journal of Economic Psychology, 26*(5), 642-663.
Buiter, W. H. (2008). Housing wealth isn't wealth: National Bureau of Economic Research.
Burgard, S. A., Seefeldt, K. S., & Zelner, S. (2012). Housing instability and health: Findings from the Michigan Recession and Recovery Study. *Social science & medicine, 75*(12), 2215-2224.
Cagney, K. A., Browning, C. R., Iveniuk, J., & English, N. (2014a). The Onset of Depression During the Great Recession: Foreclosure and Older Adult Mental Health. *American journal of public health, 104*(3), 498-505.
Cagney, K. A., Browning, C. R., Iveniuk, J., & English, N. (2014b). The onset of depression during the Great Recession: foreclosure and older adult mental health. *Journal Information, 104*(3).
Calem, P. S., Gillen, K., & Wachter, S. (2004). The neighborhood distribution of subprime mortgage lending. *The Journal of Real Estate Finance and Economics, 29*(4), 393-410.
Campbell, J. Y., Giglio, S., & Pathak, P. (2009). Forced sales and house prices: National Bureau of Economic Research.
Cannuscio, C. C., Alley, D. E., Pagán, J. A., Soldo, B., Krasny, S., Shardell, M., . . . Lipman, T. H. (2012). Housing strain, mortgage foreclosure, and health. *Nursing outlook, 60*(3), 134-142. e131.
Catalano, R. (2009). Health, medical care, and economic crisis. *New England Journal of Medicine, 360*(8), 749-751.
Catalano, R., Goldman-Mellor, S., Saxton, K., Margerison-Zilko, C., Subbaraman, M., LeWinn, K., & Anderson, E. (2011). The health effects of economic decline. *Annual review of public health, 32*.
Catalano, R., Novaco, R. W., & McConnell, W. (2002). Layoffs and violence revisited. *Aggressive Behavior, 28*(3), 233-247.
Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *Journal of chronic diseases, 40*(5), 373-383.
Chida, Y., & Hamer, M. (2008). An association of adverse psychosocial factors with diabetes mellitus: a meta-analytic review of longitudinal cohort studies. *Diabetologia, 51*(12), 2168-2178.
Clayton, M., Liñares-Zegarra, J., & Wilson, J. O. (2015). Does debt affect health? Cross country evidence on the debt-health nexus. *Social science & medicine, 130*, 51-58.
Costello, E. J., Compton, S. N., Keeler, G., & Angold, A. (2003). Relationships between poverty and psychopathology: A natural experiment. *JAMA, 290*(15), 2023-2029.
Cui, L., & Walsh, R. (2015). Foreclosure, vacancy and crime. *Journal of Urban Economics*.
Currie, J., & Tekin, E. (2011). Is there a Link between Foreclosure and Health? : National Bureau of Economic Research.
Deaton, A. (2002). Policy implications of the gradient of health and wealth. *Health Affairs, 21*(2), 13-30.
Dollard, J., Miller, N. E., Doob, L. W., Mowrer, O. H., & Sears, R. R. (1939). Frustration and aggression.

Dupuis, A., & Thorns, D. C. (1998). Home, home ownership and the search for ontological security. *The Sociological Review, 46*(1), 24-47.
Easterlow, D., Smith, S. J., & Mallinson, S. (2000). Housing for health: the role of owner occupation. *Housing Studies, 15*(3), 367-386.
Ellen, I. G., Lacoe, J., & Sharygin, C. A. (2013). Do foreclosures cause crime? *Journal of Urban Economics, 74*, 59-70.
Estevão, M. M., & Tsounta, E. (2011). *Has the Great Recession raised US structural unemployment?* : International Monetary Fund Washington, DC.
Ettner, S. L. (1996). New evidence on the relationship between income and health. *Journal of health economics, 15*(1), 67-85.
FactFinder, U. S. C. B. A. (2014). American Community Survey. Retrieved 11/2014, from U.S. Census Bureau's American Community Survey Office http://factfinder2.census.gov
Fitzgerald, J., Gottschalk, P., & Moffitt, R. A. (1998). An analysis of sample attrition in panel data: The Michigan Panel Study of Income Dynamics: National Bureau of Economic Research Cambridge, Mass., USA.
Flegal, K. M., Carroll, M. D., Kit, B. K., & Ogden, C. L. (2012). Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. *Jama, 307*(5), 491-497.
Foote, C. L., Gerardi, K. S., & Willen, P. S. (2012). Why did so many people make so many ex post bad decisions? The causes of the foreclosure crisis: National Bureau of Economic Research.
Fowler, K. A., Gladden, R. M., Vagi, K. J., Barnes, J., & Frazier, L. (2015). Increase in Suicides Associated With Home Eviction and Foreclosure During the US Housing Crisis: Findings From 16 National Violent Death Reporting System States, 2005–2010. *American journal of public health, 105*(2), 311-316.
Frioux, S., Wood, J. N., Fakeye, O., Luan, X., Localio, R., & Rubin, D. M. (2014). Longitudinal Association of County-Level Economic Indicators and Child Maltreatment Incidents. *Maternal and child health journal, 18*(9), 2202-2208.
Geiss, L. S., Wang, J., Cheng, Y. J., Thompson, T. J., Barker, L., Li, Y., . . . Gregg, E. W. (2014). Prevalence and incidence trends for diagnosed diabetes among adults aged 20 to 79 years, United States, 1980-2012. *JAMA, 312*(12), 1218-1226.
Gerardi, K., Herkenhoff, K. F., Ohanian, L. E., & Willen, P. (2013). Unemployment, negative equity, and strategic default. *Available at SSRN 2293152*.
Goodstein, R., & Lee, Y. Y. (2010). Do Foreclosures Increase Crime? *Available at SSRN 1670842*.
Graves, E., & Shuey, E. (2013). The social impact of home rehabilitation in low-income neighborhoods: Federal Reserve Bank of Boston.
Grossman, M. (1972). On the concept of health capital and the demand for health. *The Journal of Political Economy*, 223-255.
Guiso, L., Sapienza, P., & Zingales, L. (2009). Moral and social constraints to strategic default on mortgages: National Bureau of Economic Research.
Guiso, L., Sapienza, P., & Zingales, L. (2013). The determinants of attitudes toward strategic default on mortgages. *The Journal of Finance, 68*(4), 1473-1515.
Hartmann, M., Kopf, S., Kircher, C., Faude-Lang, V., Djuric, Z., Augstein, F., . . . Humpert, P. M. (2012). Sustained effects of a mindfulness-based stress-reduction intervention in type

2 diabetic patients design and first results of a randomized controlled trial (the Heidelberger diabetes and stress-study). *Diabetes Care, 35*(5), 945-947.
Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica: Journal of the Econometric Society*, 1251-1271.
Himmelstein, D. U., Thorne, D., Warren, E., & Woolhandler, S. (2009). Medical bankruptcy in the United States, 2007: results of a national study. *The American journal of medicine, 122*(8), 741-746.
Hiscock, R., Macintyre, S., Kearns, A., & Ellaway, A. (2003). Residents and Residence: Factors Predicting the Health Disadvantage of Social Renters Compared to Owner‐Occupiers. *Journal of Social Issues, 59*(3), 527-546.
Houle, J. N. (2014). Mental health in the foreclosure crisis. *Social science & medicine, 118*, 1-8.
Houle, J. N., & Keene, D. E. (2014). Getting sick and falling behind: health and the risk of mortgage default and home foreclosure. *Journal of epidemiology and community health*, jech-2014-204637.
Houle, J. N., & Light, M. T. (2014). The home foreclosure crisis and rising suicide rates, 2005 to 2010. *American journal of public health, 104*(6), 1073-1079.
Immergluck, D., & Smith, G. (2005). Measuring the effect of subprime lending on neighborhood foreclosures evidence from Chicago. *Urban Affairs Review, 40*(3), 362-389.
Immergluck, D., & Smith, G. (2006a). The external costs of foreclosure: The impact of single‐family mortgage foreclosures on property values. *Housing Policy Debate, 17*(1), 57-79.
Immergluck, D., & Smith, G. (2006b). The impact of single-family mortgage foreclosures on neighborhood crime. *Housing Studies, 21*(6), 851-866.
Islam, M. K., Merlo, J., Kawachi, I., Lindström, M., & Gerdtham, U.-G. (2006). Social capital and health: Does egalitarianism matter? A literature review. *International journal for equity in health, 5*(1), 3.
Karahan, F., & Rhee, S. (2013). Geographical reallocation and unemployment during the great recession: The role of the housing bust. *FRB of New York Staff Report*(605).
Katz, C. M., Wallace, D., & Hedberg, E. (2011). A longitudinal assessment of the impact of foreclosure on neighborhood crime. *Journal of Research in Crime and Delinquency*, 0022427811431155.
Kawachi, I., & Berkman, L. (2000). Social cohesion, social capital, and health. *Social epidemiology*, 174-190.
Kawachi, I., Subramanian, S. V., & Kim, D. (2008). *Social capital and health*: Springer.
Kingsley, G. T., Smith, R., & Price, D. (2009). *The Impacts of Foreclosures on Families and Communuities*.
Kirk, D. S., & Hyra, D. S. (2012). Home Foreclosures and Community Crime: Causal or Spurious Association?*. *Social Science Quarterly, 93*(3), 648-670.
Lacoe, J., & Ellen, I. G. (2015). Mortgage Foreclosures and the Changing Mix of Crime in Micro-neighborhoods. *Journal of Research in Crime and Delinquency*, 0022427815572633.
Lending, C. f. R. (2013). 2013 Update: The Spillover Effects of Foreclosures
Leung, L. A., & Lau, C. (2014). Effect of mortgage indebtedness on health of US homeowners. *Review of Economics of the Household*, 1-26.
Libman, K., Fields, D., & Saegert, S. (2012). Housing and health: a social ecological perspective on the US foreclosure crisis. *Housing, Theory and Society, 29*(1), 1-24.

Lin, H., Ketcham, J. D., Rosenquist, J. N., & Simon, K. I. (2013). Financial distress and use of mental health care: Evidence from antidepressant prescription claims. *Economics Letters, 121*(3), 449-453.
Lin, Z., Rosenblatt, E., & Yao, V. W. (2009). Spillover effects of foreclosures on neighborhood property values. *The Journal of Real Estate Finance and Economics, 38*(4), 387-407.
Lindblad, M. R., & Riley, S. F. (2015). Loan Modifications and Foreclosure Sales during the Financial Crisis: Consequences for Health and Stress. *Housing Studies*(ahead-of-print), 1-24.
Loewenstein, G., Brennan, T., & Volpp, K. G. (2007). Asymmetric paternalism to improve health behaviors. *JAMA, 298*(20), 2415-2417.
Lusardi, A., & Mitchell, O. S. (2007). Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth. *Journal of monetary Economics, 54*(1), 205-224.
Lusardi, A., Schneider, D. J., & Tufano, P. (2010). The economic crisis and medical care usage: National Bureau of Economic Research.
Macinko, J., & Starfield, B. (2001). The utility of social capital in research on health determinants. *Milbank Quarterly, 79*(3), 387-427.
Martin, A., Lassman, D., Whittle, L., & Catlin, A. (2011). Recession contributes to slowest annual rate of increase in health spending in five decades. *Health Affairs, 30*(1), 11-22.
Mason, K. E., Baker, E., Blakely, T., & Bentley, R. J. (2013). Housing affordability and mental health: Does the relationship differ for renters and home purchasers? *Social science & medicine, 94*, 91-97.
McLaughlin, K. A., Nandi, A., Keyes, K. M., Uddin, M., Aiello, A. E., Galea, S., & Koenen, K. (2012). Home foreclosure and risk of psychiatric morbidity during the recent financial crisis. *Psychological medicine, 42*(07), 1441-1448.
Moffet, H. H., Adler, N., Schillinger, D., Ahmed, A. T., Laraia, B., Selby, J. V., . . . Warton, M. (2009). Cohort Profile: The Diabetes Study of Northern California (DISTANCE)—objectives and design of a survey follow-up study of social health disparities in a managed care population. *International journal of epidemiology, 38*(1), 38-47.
Nettleton, S., & Burrows, R. (1998). Mortgage debt, insecure home ownership and health: an exploratory analysis. *Sociology of health & Illness, 20*(5), 731-753.
Newhouse, J. P., & Group, R. C. I. E. (1993). *Free for all?: lessons from the RAND health insurance experiment*: Harvard University Press.
Oliver, G., & Wardle, J. (1999). Perceived effects of stress on food choice. *Physiology & behavior, 66*(3), 511-515.
Pevalin, D. J. (2009). Housing repossessions, evictions and common mental illness in the UK: results from a household panel study. *Journal of epidemiology and community health, 63*(11), 949-951.
Pollack, C., Kurd, S. K., Livshits, A., Weiner, M., & Lynch, J. (2011). A case–control study of home foreclosure, health conditions, and health care utilization. *Journal of Urban Health, 88*(3), 469-478.
Pollack, C. E., Griffin, B. A., & Lynch, J. (2010). Housing affordability and health among homeowners and renters. *American journal of preventive medicine, 39*(6), 515-521.
Pollack, C. E., & Lynch, J. (2009). Health status of people undergoing foreclosure in the Philadelphia region. *American journal of public health, 99*(10), 1833-1839.
Rabe-Hesketh, S., & Skrondal, A. (2008). *Multilevel and longitudinal modeling using Stata*: STATA press.

Reeves, A., McKee, M., Gunnell, D., Chang, S.-S., Basu, S., Barr, B., & Stuckler, D. (2014). Economic shocks, resilience, and male suicides in the Great Recession: cross-national analysis of 20 EU countries. *The European Journal of Public Health*, cku168.

Reid, C., & Laderman, E. (2009a). The untold costs of subprime lending: Examining the links among higher-priced lending, foreclosures and race in California: Federal Reserve Bank of San Francisco.

Reid, C., & Laderman, E. (2009b). The Untold Costs of Subprime Lending: Examining the Links among Higher-Priced Lending, Foreclosures, and Race in California. *San Francisco: Federal Reserve Bank of San Francisco*.

Riumallo-Herl, C., Basu, S., Stuckler, D., Courtin, E., & Avendano, M. (2014). Job loss, wealth and depression during the Great Recession in the USA and Europe. *International journal of epidemiology*, dyu048.

Robertson, C. T., Egelhof, R., & Hoke, M. (2008). Get Sick, Get Out: The Medical Causes for Home Mortgage Foreclosures. *Health Matrix, 18*, 65.

Rose, G. (2001). Sick individuals and sick populations. *International journal of epidemiology, 30*(3), 427-432.

Ross, L. M., & Squires, G. D. (2011). The personal costs of subprime lending and the foreclosure crisis: a matter of trust, insecurity, and institutional deception*. *Social Science Quarterly, 92*(1), 140-163.

Roux, A. V. D. (2014). The Foreclosure Crisis and Cardiovascular Disease. *Circulation*, CIRCULATIONAHA. 114.009932.

Ruhm, C. J. (2005). Healthy living in hard times. *Journal of health economics, 24*(2), 341-363.

Sapolsky, R. M. (2004). *Why zebras don't get ulcers: The acclaimed guide to stress, stress-related diseases, and coping-now revised and updated*: Macmillan.

Saydah, S. H., Imperatore, G., & Beckles, G. L. (2013). Socioeconomic Status and Mortality Contribution of health care access and psychological distress among US adults with diagnosed diabetes. *Diabetes Care, 36*(1), 49-55.

Schmeiser, M. D. (2009). Expanding wallets and waistlines: the impact of family income on the BMI of women and men eligible for the earned income tax credit. *Health economics, 18*(11), 1277-1294.

Schootman, M., Deshpande, A. D., Pruitt, S. L., & Jeffe, D. B. (2012). Neighborhood foreclosures and self-rated health among breast cancer survivors. *Quality of Life Research, 21*(1), 133-141.

Schulz, A. J., Zenk, S. N., Israel, B. A., Mentz, G., Stokes, C., & Galea, S. (2008). Do neighborhood economic characteristics, racial composition, and residential stability predict perceptions of stress associated with the physical and social environment? Findings from a multilevel analysis in Detroit. *Journal of Urban Health, 85*(5), 642-661.

Services, U. D. o. H. a. H. Healthy People 2020. Washington, D.C.

Shlay, A. B. (2006). Low-income homeownership: American dream or delusion? *Urban Studies, 43*(3), 511-531.

Snyder, S. E., & Evans, W. N. (2006). The effect of income on mortality: evidence from the social security notch. *The Review of Economics and Statistics, 88*(3), 482-495.

Statistics, U. (2006-2009). Bureau of Labor Statistics. *URL (Retrieved September 2014)*.

Steptoe, A., Hamer, M., & Chida, Y. (2007). The effects of acute psychological stress on circulating inflammatory factors in humans: a review and meta-analysis. *Brain, behavior, and immunity, 21*(7), 901-912.

Stone, M. (2010). *Shelter poverty: New ideas on housing affordability*: Temple University Press.
Stone, M. E. (2006). What is housing affordability? The case for the residual income approach. *Housing policy debate, 17*(1), 151-184.
Strully, K. W. (2009). Job loss and health in the US labor market. *Demography, 46*(2), 221-246.
Stucky, T. D., Ottensmann, J. R., & Payton, S. B. (2012). The Effect of Foreclosures on Crime in Indianapolis, 2003–2008*. *Social Science Quarterly, 93*(3), 602-624.
Systems, D. I. (2006-2009). *Address-level foreclosure records*. Retrieved from: http://www.dataquick.com
Taylor, M. P., Pevalin, D. J., & Todd, J. (2007). The psychological costs of unsustainable housing commitments. *Psychological medicine, 37*(07), 1027-1036.
Trac, R. (2011). Foreclosure Report. Retrieved 06/11/2015, from http://www.realtytrac.com
Treas, J. (2010). The great American recession: Sociological insights on blame and pain. *Sociological Perspectives, 53*(1), 3-17.
Turunen, E., & Hiilamo, H. (2014). Health effects of indebtedness: a systematic review. *BMC public health, 14*(1), 489.
Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics*, 1039-1061.
Von Korff, M., Katon, W., Lin, E. H., Simon, G., Ciechanowski, P., Ludman, E., . . . Young, B. (2005). Work disability among individuals with diabetes. *Diabetes Care, 28*(6), 1326-1332.
Wang, S. S., Brownell, K. D., & Wadden, T. (2004). The influence of the stigma of obesity on overweight individuals. *International journal of obesity, 28*(10), 1333-1337.
Winkler, A. E. (2013). Relationship between the Housing and Labor Market Crises and Doubling up: An MSA-Level Analysis, 2005-2011, The. *Monthly Lab. Rev., 136*, 1.
Wood, J. N., Medina, S. P., Feudtner, C., Luan, X., Localio, R., Fieldston, E. S., & Rubin, D. M. (2012). Local macroeconomic trends and hospital admissions for child abuse, 2000–2009. *Pediatrics, 130*(2), e358-e364.
Wright, P. A., & Kloos, B. (2007). Housing environment and mental health outcomes: A levels of analysis perspective. *Journal of Environmental Psychology, 27*(1), 79-89.
Yilmazer, T., Babiarz, P., & Liu, F. (2015). The impact of diminished housing wealth on health in the United States: Evidence from the Great Recession. *Social science & medicine, 130*, 234-241.

Appendix

Figure A1: Conceptual Model of Foreclosures and Health



Note: The exposure variable, foreclosures, is in yellow. The outcome variable, health, is in blue. The variables in red are backdoor paths from X to Y that must be conditioned upon to remove confounding. The variables in blue are variables on the path from foreclosures to health. This model was created in daggity.net.

Table A1: Variable Definitions

Variable Name	Variable Description
Mean Body Mass Index	Average kg/m^2 across all visits per year
Hemoglobin A1c	Average plasma glucose concentration of the patient over the past 1 to 3 months
Poor control	At least one A1c $\geq$ 9 per year
Block foreclosure rate	Number of foreclosures / # housing units per census block per year
Block group foreclosure rate	Number of foreclosures / # housing units per census block group per year
Foreclosures per 1km	Number of foreclosures within 1km Euclidian distance from the block centroid per year
Unemployment rate (county)	The percentage of the total labor force that is unemployed but actively seeking employment and willing to work in each county from the Local Area Unemployment Statistics (LAUS) database.
Mean housing price (zip-code)	The mean housing price in each zip-code from DataQuick estimates.
Medicaid	An indicator that is equal to 1 if a patient is using Medicaid in a given year, otherwise 0.
Charlson Comorbidity Index	And index that predicts the ten year mortality for a patient with a range of comorbid conditions.
Insulin	An indicator equal to 1 if a patient as at least 2 fills of insulin in a year.
Oral Medication	An indicator equal to 1 if a patient as at least 2 fills of oral medications for diabetes in a year.
Weight Loss	An indicator equal to 1 if a patient as at least 2 fills of a psychiatric medication associated with weight loss in a year.
Weight Gain	An indicator equal to 1 if a patient as at least 2 fills of a psychiatric medication associated with weight gain in a year.
Non-Hispanic White	The patient's race/ethnicity is Non-Hispanic and White as identified in the electronic medical record.
Black	The patient's race/ethnicity is Black as identified in the electronic medical record.
Asian	The patient's race/ethnicity is Asian as identified in the electronic medical record.
Income under $35k	Self-reported income from DISTANCE survey of an annual income of under $35,000
Non-housing wealth	Self-reported non-housing wealth from the DISTANCE survey
Homeowner	Self-reported indicator that is 1 if the patient reports homeownership, otherwise 0 if a renter from DISTANCE survey
Employed	Self-reported employed full-time indicator is 1, otherwise 0 if not employed full-time from DISTANCE survey

Bachelors degree	Self-reported completion of a bachelors degree is 1, otherwise 0 if reported less education from DISTANCE survey
Partnered	Self-reported has a co-habiting partner or is married indicator is 1, otherwise 0 if single, widowed, or divorced
Percent owner-occupied	Percent of housing units occupied by an owner in patient's block or block group from the American Community Survey
Percent poverty	Percent of people living in poverty in a patient's block or block group from the American Community Survey
Population density per sq mile	Number of people per square mile in a patient's block or block group from the American Community Survey
Mover	Indicator that is 1 if patient reports a different residential addresss at least once during the period, otherwise 0
Sex	Patient's sex from electronic medical record (Female or Male)
Age	Patient's age from electronic medical record in years