WHERE WE DIE: COUNTY-LEVEL DISPARITIES AND CONSTRAINED CHOICE AT THE END OF LIFE

by

AUBREY ELIZABETH LIMBURG

B.S., Portland State University, 2014

M.A., University of Colorado Boulder, 2019

A dissertation submitted to the

Faculty and Graduate School of the

University of Colorado in partial fulfillment

of the requirement for the degree of

Doctor of Philosophy

Department of Sociology

2022

Committee Members:

Jason Boardman

Stefanie Möllborn

Janet Jacobs

Mathieu Desan

Karen Lutfey-Spencer

Limburg, Aubrey Elizabeth (Ph.D., Sociology)

Where we die: County-level disparities and constrained choice at the end of life

Thesis directed by Dr. Jason Boardman and Dr. Stefanie Möllborn

Individual-level choice has become a fundamental and pervasive logic within research and policy focused on improving end-of-life care. This includes choosing the setting in which death is to occur (e.g., site of death including home, hospital, and nursing home). However, there is considerable geographic variability in site of death across the US, suggesting that where you live matters for where you die, beyond just individual choice and preference. This dissertation relied on an ecological framework to analyze geographic disparities in site of death and empirically investigate how death is shaped in different contexts in the US and how this has changed over time. This research utilized a unique combination of restricted population-level death certificate data (1991-2017) and county-level datasets focused on the social, economic, healthcare, political, and religious characteristics of counties. Analyses were restricted to older adults (65 years of age and older) who died of natural causes to isolate a pervasive and similar dying experience. Several innovative methods were employed, including multilevel modeling and latent class growth analysis. Despite a national trend depicting a decrease in hospital death and an increase in home death, findings from this dissertation suggest considerable variation in site of death across counties in the US. Additionally, the county where death occurred mattered substantially for the likelihood of dying in a particular setting. Finally, site of death was shaped by the characteristics of the context in which death occurred, including the county-level economic and healthcare environments. For example, counties with high and stable home death rates were more likely to have poorer economic circumstances and a lack of healthcare resources. Despite an emphasis on

choice at the end of life, I argue that heterogeneity in geographic context across counties makes choice related to site of death an illusion for many people. Continued reliance on the choice discourse will only detract from identifying and diminishing geographic disparities in site of death. Moving forward, it is imperative for research and policy focused on end-of-life care to consider how choice is embedded within local contexts.

DEDICATION

For Dr. Matthew Brown,

who taught me a considerable amount about both life and death

ACKNOWLEDGEMENTS

I share this accomplishment with many people, many of whom may never know their impact on me. First, I want to thank and acknowledge my committee members. Each of them brought something unique to the team, and I am so grateful for everyone's interest in and commitment to my success. I was fortunate to be primarily advised by two brilliant, thoughtful, and caring people. To Jason, who helped me not only to learn statistics but to absolutely love it (enough so that I chose to pursue a career in it!). Thank you for always entertaining my ideas and remaining excited about my dissertation, even when I was not. To Stef, who taught me the invaluable skills I needed to complete this dissertation, survive this program, and to (almost) *thrive* in graduate school. Thank you for continually pointing me towards the long-term goal even when I felt lost at sea.

My additional committee members were deeply committed to my success and took ample time to help advise me through this process. To Janet, who saw something in me as a young scholar that I wasn't entirely aware was there. To Matt, for being extremely generous with your time and providing some of the most excellent conversation I had in graduate school, whether it be about sociology, Japan, or French fries. To Karen, who not only entertained all my thoughts and ideas about death and dying but pushed me to think more deeply and thoughtfully about them. I feel immensely honored to have been advised and mentored by these fantastic sociologists. They took the time to help me develop and refine my ideas and get to know my own voice better. More importantly, all of them believed in me, even when I did not or could not believe in myself, and for that, I am immensely grateful.

I've been fortunate enough to have fantastic colleagues and peers who have helped to guide me through this process. To Glenda Walden, for bringing love and light into everything you do and walking with me through some of my most turbulent days in the program. To Josh Goode, for your humorous wisdom and expert finesse for statistical consulting. You have taught me so much about statistics and how to be an organized and thoughtful statistician. To Bethany Everett, for believing in me and giving me the opportunity to work on your team. Working alongside you allowed me to develop and hone the skills I needed to get through this program, this dissertation, and succeed in my post-graduate school life. To my many graduate student colleagues, with special and additional thanks to Ian, Jessica, Sara, Tara, and Trent. Thank you for always having the kindest and most encouraging words any frantic graduate student needs to hear. Thank you for providing ample love and distraction from the harsh, albeit monotonous, realities of graduate school. Thank you to Carrie, Patti, and Brigitte, the front office super team who assisted me with anything and everything, helping me navigate the complicated and absurd bureaucracy that is higher education.

Thank you to my closest confidants. First, Emma. Your friendship has been invaluable to me inside and outside of graduate school. Your beautifully curated disco playlists ushered me through a large portion of my dissertation and your care packages brought an abundance of joy, bliss, and frivolity to my daily life. And most importantly, Chase. You saw me through a high school degree, an Associate’s, a Bachelor’s, a Master’s, and now a PhD. Although I finally made it to the finish line, this accomplishment was only made possible by your unwavering love and devotion. Thank you for standing by me during the most difficult of days. I promise that I’m done with school now, and I can’t wait to see what a post-school life looks like for us.

Thank you to Thomas Barry, my very first sociology professor at community college all those years ago. You were the first to spark my sociological imagination. Thank you also to Maura Kelly, who believed in me as a sociologist and was the first to show me the path to graduate school. Thank you to my McNair scholar companions and dear friends for their continued support, Crystal Thornebrooke and Katie Whittaker. Finally, thank you to all of my wonderful colleagues at the Institute on Aging who helped inspire a deep passion for health and aging.

To my wonderful and abundant family, with special thanks to my parents, who didn't always understand exactly why I elected to be in school for 22 years (essentially three-quarters of my entire life), but who provided me with endless love and encouragement. I also want to acknowledge the individuals in my life who died during my time in the program: my grandfather, Charles Limburg; my grandmother-in-law, Dorothy Shaw; my stepfather, Marvin Combs; my colleague, first graduate school mentor, and dear friend, Matthew Brown. Graduate school is difficult enough without the immense heartbreak that accompanies loss.

Finally, I want to acknowledge all the individual deceased people who made up the analytic sample for my dissertation analyses. When looking at a dataset filled with millions upon millions of rows, it can be easy to disengage from the reality that all these people lived lives, died, and had families and friends that grieved (and continue to grieve) their absence. I cannot ever fully comprehend all of these individual death and dying experiences. Still, I hope that this dissertation will, in some small way, work to improve the death and dying experiences of future decedents.

CONTENTS

TABLES

FIGURES

CHAPTER 1. Introduction

Due to biomedical and technological advancement, it is possible to stave off death to limits not previously seen in human history. Additionally, due to increased social emphasis on patient autonomy within medicine, individuals are now not only given the right to make advance decisions about their death and dying experience but are strongly encouraged to do so to improve the quality of their dying experience. This idea of patient choice has been the preeminent discourse within research and policy focused on end-of-life care for several decades (Institute of Medicine 1997, 2015; World Health Organization 2004). Reflective of Western ideologies rooted in autonomy and self-determination, the patient choice discourse found its footing in a relatively contemporary shift towards valuing patient autonomy and patient-centered care (Kaufman 2005). The shift to valuing patient autonomy culminated in the passage of the Patient Self-Determination Act in 1991, allowing patients to accept and refuse medical treatment and utilize advance directives to articulate treatment preferences. Hence, the sheer number of choices related to how, what, when, and where someone dies have proliferated in recent decades. The emphasis on patient choice related to death and dying has been particularly salient concerning site of death (Gomes and Higginson 2004). Site of death, including home, hospital, and nursing homes, has been identified as an indicator of quality end-of-life care (De Schreye et al. 2017; Institute of Medicine 1997, 2015) and a large body of work focuses on individual preferences for site of death (Gomes et al. 2013; Higginson and Sen-Gupta 2000), as well as issues related to congruence in preferred and actual site of death (Ali et al. 2015; Bell, Somogyi-Zalud, and Masaki 2010; Fischer et al. 2013). In general, this research emphasizes that ascertaining an individual's preferred site of death and ensuring they can die in that place is an essential indicator of good and high-quality end-of-life care and has come to be regarded as "good dying" (Emanuel and Emanuel 1998).

Despite its altruistic focus on improving end-of-life care, a strong emphasis on patient choice[1] within end-of-life research is limited in three important ways. First, choice has long been thought to enhance end-of-life care; however, this has yet to be documented empirically. Rather patient choice does not always lead to the anticipated enhancements in end-of-life outcomes (Mol 2008). For example, research has suggested that patient choice could hinder both the quality and equity of healthcare services because choice may have different impacts on different groups, and patients may be unequally equipped to make choices in the first place (Fotaki 2010, 2013). Additionally, patient choice requires considerable amounts of energy (Schwartz 2014) and is often not consistent, varying based on the way information is provided, how the role of choice is framed, and the context in which decisions are made (Dixon et al. 2010). This is especially troublesome within the realm of end-of-life care, where individuals are likely in grave health and especially vulnerable.

Furthermore, research focused on choice at the end of life has primarily emphasized the relationship between advance care planning and end-of-life care quality. The purpose of advance care planning–including but not limited to advance directives, do-not-resuscitate (DNR) orders, living wills–is to create goal-concordant care in which preferred and actual care are congruent at the end of life for a variety of end-of-life outcomes. However, despite an enormous body of research investigating the potential effectiveness of advance care planning on improving end-of-life care for the dying, the results remain tenuous and inconclusive (Brinkman-Stoppelenburg,

[1] Choice, autonomy, and preference can be used interchangeably to refer to the same general idea that patients can and should be involved in their medical decision-making process, especially as it pertains to end-of-life care. Therefore, to avoid redundancy, I will also use these terms interchangeably but for the same general idea.

Rietjens, and van der Heide 2014) and have elicited critique in recent years (Fagerlin and Schneider 2004; Perkins 2007; Prendergast 2001; Teno 2004). Additionally, a paucity of research has explicitly examined congruency as an outcome and instead has focused primarily on limiting medical intervention (e.g., hospital and ICU admission, hospice use, life-sustaining treatment) regardless of stated patient preference. This makes it impossible to ascertain whether advance care planning results in differences in healthcare utilization or enhances the dying experience for patients based on their stated preferences (including preference for site of death). Therefore, despite the immense quantity of research, it is unclear whether or how enhanced patient choice related to death and dying results in improved care for the dying.

Secondly, the idea of choice is predicated on there being multiple conceivable options available for individuals to choose from. Choices about the dying experience are not simply a byproduct of individual preference. They can be constrained in significant ways, whether that be economic disadvantage, lack of social support, or health service inaccessibility, to name a few. For example, in the most extensive study of dying individuals ever undertaken, the availability of healthcare in a given region was predictive of whether someone died in a hospital rather than at home (Pritchard et al. 1998). Importantly, in this same study, no relationship was found between patient preferences and site of death. Therefore, if healthcare environment factors such as these influence site of death, then choice as a predictor for end-of-life outcomes is only pertinent when choices are available. In the case of site of death, individual preference is not simply a byproduct of choosing to die in one setting rather than another but is dictated and constrained by the geographic context (e.g., county, state, region) in which that person resides and the available resources. Since the rhetoric of patient choice often assumes that all individuals have similar or at least a few choices available to them, research in this area is currently limited by its narrow emphasis on choice to understand outcomes at the end of life.

Finally, when discussing "choice" as related to end-of-life care, home has become normalized and idealized as an outcome representative of the quality of the dying experience (Drought and Koenig 2002). Although site of death has been identified as an important indicator related to quality end-of-life care (De Schreye et al. 2017), home death is often assumed to be the positive and, therefore, preferable end-of-life care outcome. Home death is consistently portrayed as a positive outcome in part because overutilization of healthcare services at the end of life has been shown to lead to an intensification of adverse end-of-life events, including multiple healthcare transitions, hospitalizations, and ICU utilization (Hall 2019; Kaufman 2015). However, there is a spectrum of under- as well as over-utilization of health services at the end of life. On the one hand, home death could indicate a death that took place at home, assisted by hospice, with communication, foresight, and a lack of unnecessary medical intervention. On the other hand, a home death could indicate underutilization of healthcare services at the end of life due to inadequate economic, social, or healthcare resources. Therefore, home death may not so obviously suggest choice, availability, or high-quality care–all of which have become synonymous with home death in recent decades. Research is currently limited by its continual emphasis on home death as a positive indication of enhanced patient choice and good quality end-of-life care (MacArtney et al. 2016). More attention has been paid to the complicated experience of dying at home in recent years (Gray 2020; Kolata 2019; Leiter 2019); however, this remains an exceptional viewpoint.

Based on these three limitations of the choice discourse, it is critical for research focused on end-of-life care, generally, and site of death, specifically, to begin relying less heavily on these normalized, idealized, and subjective ideas of choice and preference within end-of-life care as their primary guiding framework. An emphasis on patient choice is not empirically supported and keeps research focused on individual behaviors, which are not easily altered (Cohen, Scribner, and Farley 2000; Drought and Koenig 2002). Additionally, the choice discourse draws attention away from the social and physical environments that likely shape dying in important ways–ones that are not altered by choice or preference. That is, the current emphasis on patient choice does not consider how choice could be complicated or constrained in important ways and instead assumes that choice is the primary mechanism by which to enhance end-of-life care. By not looking at these constraining factors, current research is missing an important opportunity to deemphasize the assumption of choice in end-of-life care and advance this critical field of inquiry.

A growing area of research has documented the critical role of ecological context in shaping health (Subramanian, Kawachi, and Kennedy 2001), mortality (Monnat et al. 2019), and health service access (Kirby 2008). Context is a term with a breadth of meaning, and in this case, is used to refer to the characteristics of a geographically bounded place (e.g., school, neighborhood, county, state), including but not limited to social features, political and religious ideology, economic well-being, and healthcare accessibility. Nascent research has extended this line of inquiry by investigating geographic variation in site of death and has begun to document place-based disparities in site of death. Utilizing this kind of ecological approach to investigate site of death enables two important outcomes. First, it allows research to circumvent the choice paradigm and instead consider how context shapes and constrains choice and autonomy at the end of life. Second, having enhanced clarity around how context shapes and constrains choice at the end of life could work to improve future end-of-life care research and policy.

Theoretical Framework

Arguably, one of the most important contributions of sociology to date is the notion that individual behavior is not simply produced from personal volition but rather is deeply influenced by the social context in which one resides. Utilizing suicide rates in various European countries during the nineteenth century, Durkheim demonstrated how "suicide is not a phenomenon just at the level of the individual, but rather has a social nature" (Durkheim 1951:46). Instead of assuming that suicide was an exclusively personal experience brought on by individual troubles, he identified immense permanence in suicide rates and extensive variability across countries with varying levels of social integration and regulation. The idea that the context in which we live has profound impacts on our lives beyond our own recognition has implications far beyond the study of suicide and has had a vast impact on how sociologists have approached the study of inequality.

Since Durkheim's seminal work, there has been a sustained tradition within social science research of investigating differences in human behavior, health, and mortality as a function of social context rather than just individual characteristics or choices (Gieryn 2000; Logan 2012). Context as a concept within social science research has become commonplace and has been used interchangeably with other concepts like place, environment, and structure. However, relying on an ecological model (Bronfenbrenner 1977; Center for Disease Control 2021), context can be conceptualized as the ways in which individuals are nested within both physical and social environments (e.g., home, school, neighborhood) that influence attitudes and behaviors. The principal theoretical underpinning of ecological perspectives suggests that the places where people live matter for individual health, well-being, and, ultimately, mortality. The primary hypothesis guiding ecological approaches to health posits that contextual characteristics are determinants of individual health and mortality in that geographic places provide differential opportunity structures for individuals living within that context (Lobao, Hooks, and Tickamyer 2007). Given that different contexts have different opportunity structures for residents, the same set of choices may likely not be available to all individuals and, therefore, will vary by context. As it relates to site of death, this suggests that the ability to make choices about site of death is constrained by the geographic context in which a death ultimately occurs. This could be as straightforward as a lack of contextual economic resources (e.g., county or state funding) to receive various forms of care or an absence of proximate healthcare options such as hospitals, long-term care (e.g., assisted living, nursing homes), hospice, or home health care. However, such choices could also be impacted by more complex and nebulous social structures, including social composition, religious ideology, or political ideology. Therefore, it is necessary to consider an ecological perspective in thinking about site of death as place-based and contextual characteristics are likely shaping the experience of dying in the US.

Building on the burgeoning area of research within studies of health, this research will be grounded in literature that has emphasized the importance of ecological factors on population health. An emphasis on structural and ecological approaches to studying mortality have been applied to outcomes such as life expectancy (Murray et al. 2006; Vierboom, Preston, and Hendi 2019), self-rated health (Subramanian et al. 2001), drug-related mortality (Monnat 2018a; Monnat et al. 2019), but have been applied less so within research on end-of-life care, including site of death. In terms of the importance of different contexts, this research will rely exclusively on the county as the geographic unit of analysis to understand how site of death varies within the US. Counties have long been considered an important unit of analysis within research on population health (Murray et al. 2006) and represent important social, economic, political, and healthcare environments in which people reside. Counties are particularly salient for research on end-of-life care and site of death because counties are important delegators of funding for public health, local health service infrastructure, and economic development, all of which are likely to impact both the provision and the perceived social value of end-of-life care. Other sub-national analyses, including census tracts, blocks, and neighborhood measures, have several drawbacks. First, and most importantly, they are not available for population-level mortality data. Second, these units of analysis are too small and plentiful to compare meaningful differences across the entire US. Finally, these small-area units are not administratively meaningful for studying mortality in the way that counties are. Although states are an available contextual indicator and have administrative relevance for healthcare provision, they do not provide sufficient information about variation related to death and dying as there is considerable variation related to site of death both across and within states. Therefore, counties represent an ideal scale by which to explore the role that ecological context plays in shaping site of death in the US.

By not taking place more seriously, previous research has missed an opportunity to acknowledge and consider how different geographic locales fundamentally shape individuals' social, cultural, and economic resources at the end of life. Therefore, this study relies on an ecological perspective to investigate notions of choice related to end-of-life care. For this dissertation, I aim to examine how site of death is related to county context by utilizing an ecological perspective to bring both new theoretical and analytic tools to our understanding of choice at the end of life.

Demographic Aging

Issues of death and dying cannot be fully understood without considering the aging of the population. First, global population aging is leading to an increase in the proportion of older adults in the population. Due to declines in fertility, mortality, and migration (Christensen et al. 2009; Goldstein 2009), the US is projected to see a significant increase in the proportion of adults over the age of 65 with the aging of the baby boomer population, who are expected to reach older adulthood by 2030 (US Census Bureau 2018). Additionally, the aging of the population is not randomly distributed within the US (US Census Bureau 2020), and rural areas have a higher proportion of aging adults due to the complex relationship between aging-in-place and out-migration of younger residents (Nelson 2013). This significant increase in the proportion of older adults in the population has important implications for the provision of care as it could put strain on the current end-of-life care system. Additionally, due to this demographic change, the nature of death has changed drastically over the last century, with the majority of the population dying in old age due to chronic illness (Crimmins 2015). This type of illness and death is fundamentally different from what has been observed in previous generations and requires special consideration.

Secondly, aging is a social process that is both ubiquitous and highly stratified (Abramson and Portacolone 2017). Despite the universal reality of aging across the population, the experience of aging within society is highly unequal. This has been shown repeatedly within theories of the life course and cumulative (dis)advantage (House et al. 1994; Pearlin et al. 2005; Willson, Shuey, and Elder 2007). Additionally, aging is a case by which to investigate the interplay between human lives and social structure as aging is both a social process at the level of the life course and a structural feature that shapes the experience of aging (Riley 1987). Therefore, it is imperative to consider aging in the context of end-of-life.

To account for the role age and aging plays in shaping experiences at the end of life, this dissertation will focus exclusively on older adults who have died of "natural causes[2]." The thought here is that the analytic sample will be restricted to similar *types* of death. Therefore, deaths due to accident, homicide, or suicide are inherently different in their implications for site of death. The same could be said for "natural deaths" occurring among individuals who are not yet considered to be "older adults." The type of death that I aim to analyze is one that is currently well documented in the literature: a death that is a byproduct of the demographic transition and the aging of the population resulting in a death in later life due to chronic illness and a dying experience that is (potentially) prolonged. By restricting the analytic sample in this way, I will be able to assess trends in geographic variation concerning one particular and prevalent kind of death.

Objectives

This dissertation will utilize an ecological perspective to analyze geographic disparities in site of death as a means of empirically investigating how death is shaped in different contexts within the US and how this has changed over time. I hypothesize that despite the contemporary emphasis on patient choice and autonomy, site of death is not simply a matter of choice within the general population and instead varies considerably based on where one lives in the US and is impacted by structural factors. Utilizing population-level death certificate data between 1991 and 2017, this dissertation aims to investigate both temporal and geographic variation in site of death using three distinct but complementary quantitative methods. In Chapter 2, I will examine the relationship between site of death and place of death between 1991 and 2017 in the US to ascertain how important counties are in shaping site of death and how this relationship has

[2] Natural deaths, for death certificate data, are those that are considered to *not* be the result of accident, suicide, homicide, or unknown source.

changed (if at all) in the past three decades. From here on, relative to site of death, "place of death" will refer to the geographic context (county, state, region) in which a death took place. In Chapter 3, I will utilize latent class growth analysis to, first, identify the most prevalent site of death trajectories among counties in the US between 1991 and 2017 and, second, to test whether county-level structural and cultural constraints are predictive of membership in site of death trajectories. In Chapter 4, I will explore the relationship between compositional and contextual effects for a contemporary period of deaths (2015-2017) to discern whether and how compositional and contextual factors shape individual site of death. In all, these three empirical chapters will work in tandem to provide a framework that aims to establish the importance of place in shaping site of death in the US and, in effect, provide important insights into future end-of-life policy interventions. Finally, in Chapter 5, I will provide a conclusion addressing what the empirical findings presented in the previous three chapters suggest about our current understanding of choice as related to site of death as well as suggestions for the future of both research and policy aimed at improving end-of-life care in the US.

CHAPTER 2. Temporal and Geographic Variation in Site of Death in the US

Introduction

End-of-life care is important given demographic changes in the aging population in the United States (US) due to declining fertility and mortality rates (Christensen et al. 2009; Goldstein 2009). The US is projected to see a significant increase in the proportion of adults over the age of 65 with the aging of the baby boomer population, who are expected to reach older adulthood by 2030 (US Census Bureau 2018). Site of death (e.g., the setting in which death occurs, including home, hospital, or nursing home) has been frequently used as a proxy measure for studying the quality of end-of-life care. Among the adult population, there has been an increase in the overall proportion of home and nursing home deaths and a decrease in hospital deaths (Cross and Warraich 2019; Olaisen 2020). Additionally, an emergent body of work has begun to document geographic variation related to site of death in the US, suggesting that the likelihood of dying in a particular site may vary based on the geographic context in which someone lives (Gruneir et al. 2007; Xu, Wu, and Fletcher 2020). However, to date, no research has analyzed geographic variation as a function of time. Since place is dynamic, adding a temporal dimension to the study of geographic disparities in site of death would allow for the identification of how the relationship between site of death and geographic context has changed over the course of several decades. Uncovering this empirical information would quantify geographic disparities and give a sense of whether potential place-based disparities in site of death are a new or persistent phenomenon.

In this chapter, I expand on these lines of inquiry to establish the importance of counties in shaping site of death in the US in the past 27 years. This study utilizes population-level death certificate data for older adults who died of natural causes between 1991 and 2017 to, first, quantify how important counties are (as a measure of place) in relation to site of death and, second to assess how spatial inequality in site of death has changed over time. This study will employ a multilevel approach to analyze two important end-of-life outcomes: hospital death and nursing home death (relative to home). Findings indicate that differences between counties account for a substantial portion of the variation in site of death and that this variation has remained consistent over the 27-year period suggesting that counties have remained (and will likely continue to remain) important factors in shaping site of death in the US. These findings contribute to a growing body of work focused on disparities in end-of-life care by adding additional empirical evidence regarding the role of geographic context in shaping site of death in the US. Finally, these findings suggest that future research or policy aimed at improving end-of-life care must consider the important role of geographic context in shaping site of death in the US.

Background

Over the last century, the US has undergone significant transformations in how death is understood, experienced, and medically treated. Improvements in population health have led to increased life expectancy and the prevalence of chronic disease (Kinsella 2000). Death is now likely to occur in later life due to a prolonged experience with chronic illness and the proliferation of biomedical technology that extends life even in the face of disease (Kaufman 2015; Lofland 2019). These social changes in the experience of dying have had profound impacts on the proportion of people dying at home and in institutionalized settings (e.g., hospital, nursing home). Until the first part of the twentieth century, death primarily occurred at home (Abel 2017). By 1949, 49.5 percent of all deaths occurred in an institutionalized setting, with nearly 80 percent of those deaths taking place in hospitals (Monroe 1970). This figure continued to rise until 1980, when institutionalized deaths peaked at 74 percent, with about 84 percent of those deaths taking place in hospitals (Brock and Foley 1998). However, recent estimates have shown a drastic reversal of this trend (Olaisen 2020). Some studies have even indicated that as of 2017, among those who died of natural causes, home death outpaced those in hospitals for the first time in several decades (Cross and Warraich 2019).

Contemporary trends in site of death are well documented and tell the same story: there is an increase in the overall proportion of home deaths and a decrease in hospital deaths. These studies are typically descriptive in nature, highlighting the overall population trend, emphasis on various sociodemographic groups (Chino et al. 2018; Cross, Kaufman, Taylor, et al. 2019; Cross, Kaufman, and Warraich 2019; Cross and Warraich 2019; Flory et al. 2004; Olaisen 2020; Temkin-Greener et al. 2013; Teno et al. 2013, 2018). These trend studies have focused on various sub-populations, making it challenging to fully ascertain what this trend looks like among older adults who died of natural causes. Additionally, contemporary analyses have not yet engaged all years of available data on the revised site of death measures (dating back to 1989, when home and nursing home deaths were included). Despite a handful of studies that have analyzed site of death trends across time, a large body of work focused on site of death has relied solely on data at one point in time or over a short period of time (Brock and Foley 1998; Gruneir et al. 2007; Weitzen et al. 2003). Although these studies provide insight into what site of death looks like at a snapshot in time, they are limited in their ability to engage with and speak to the continued transformation of site of death in the US.

Rather than just focusing on temporal variation, a small yet emergent body of work has begun exploring geographic variation in site of death. That is, how the context in which people live may shape their probability of dying in a particular setting. In terms of place of death, studies to date have looked at regional, state, and county differences in site of death (Chino et al. 2018; Flory et al. 2004; Gruneir et al. 2007; Xu et al. 2020). For example, in terms of regional variation, the South has been shown to have the largest proportion of inpatient hospital deaths (37%) and the West having the smallest (19%) (Flory et al. 2004). Regional variation has also been identified across hospital referral regions (Goodman et al. 2011). In terms of state variation, research has identified differences in site of death for individuals who died of cancer (Chino et al. 2018). Other research has utilized multilevel models to identify county- and state-level factors associated with site of death; however, this work did not assess geographic variation between counties or states (Gruneir et al. 2007). Finally, in terms of county urban/rural designation, some research has found significant differences based on rural/urban characteristics of a place (Chino et al. 2018) while others have not (Flory et al. 2004). In sum, despite significant growth in the overall proportion of people who die at home each year, this varies considerably based on where one lives in the US (Chino et al. 2018; Flory et al. 2004; Goodman et al. 2011; Xu et al. 2020). Although there is growing evidence of geographic variation in site of death, current empirical research remains sparse and, at times, inconsistent. Additionally, this work has been hindered by a reliance exclusively on short time periods or older datasets.

These two research areas (temporal and geographic variation) have demonstrated exciting findings for the study of site of death, specifically, and end-of-life care, generally. However, research in this area has yet to combine these streams of inquiry to establish further the role of place in shaping site of death and how/if this has changed over time. Continued emphasis exclusively on the site of death population trend in the US belies emergent evidence of geographic variation in site of death. Additionally, exclusive emphasis on geographic variation in site of death tells us very little about how this variability has changed over the last several decades. The investigation of contextual differences as a function of time is an important next step in this area of research. Contextual differences in site of death can be understood as the range of variation in the probability of dying in a particular setting across counties. A low level of contextual difference would be indicated by the probability of dying in a hospital or at home being consistent across counties. A high level of contextual difference would suggest the opposite–that the probability of dying in a hospital or home changes considerably based on what county you live in. Trends in spatial inequality are important to assess to understand if it has increased, decreased, or stayed the same in the past three decades. Based on previous research that has identified an increase in contextual inequality related to life expectancy and adult mortality (Cosby et al. 2018; Vierboom et al. 2019), I hypothesize that contextual inequality in regards to site of death will likely have increased in the past thirty years, indicating a trend toward increasing inequality in coming years.

To address this gap in the literature, this study aims to answer the following research questions: *How much variation in site of death do counties account for? And how has this changed in the last three decades?* To answer this question, this study will build upon previous research documenting important temporal trends and geographic variation in site of death within the US by utilizing population-level death certificate data. Restricted death certificate data provide a unique opportunity to analyze site of death over multiple decades for all decedents in the US, including the counties in which their deaths occurred. The overarching purpose of this study is to explore the important and unique role of context in shaping site of death in the US by considering all years of available data and all counties in the US simultaneously. Ultimately, this chapter aims to quantify precisely how important counties are to site of death in the US and how this has changed over time. Counties were chosen as the primary geographic unit for several reasons. First, restricted death certificate data provides counties as the smallest geographic unit for decedents. Second, counties are considered an important unit of analysis within research on population health (Murray et al. 2006) as they represent the social, economic, political, and healthcare environments in which people reside. Finally, counties are salient for research on end-of-life care because they are important delegators of funding for public health, local health service infrastructure, and economic development, all of which may impact the provision and the perceived social value of end-of-life care. Therefore, due to their availability and their potential importance for end-of-life care policy, counties are an important unit by which to explore the research questions proposed in this chapter.

Data

This study relies on Multiple Cause of Death (MCD) data which is composed of death certificate information for the entire US population and is managed by the National Vital Statistics System (NVSS) within the National Center for Health Statistics (NCHS). Information on a death certificate includes place of death (e.g., county and state of death), site of death (e.g., home, hospice, hospital, nursing home), sociodemographic characteristics of the decedent (e.g., age, race/ethnicity, gender, education, marital status), underlying cause of death, and co-occurring morbidities that contributed to death. Although these data are publicly available, NVSS stopped releasing geographic identifiers in publicly available data in 2015. Additionally, NVSS provides limited geographic identifiers in publicly available data for counties with fewer than fifty deaths. Therefore, to overcome these data challenges, all analyses were conducted on restricted data (made available through NCHS) using a secure remote server managed by the Institute of Behavioral Science (IBS) at the University of Colorado Boulder.

Although death certificate data are available from NVSS starting in 1959, site of death was only recorded on death certificates starting in 1989 (that is, for settings beyond the hospital). However, for the sake of reliability, both 1989 and 1990 are omitted from analysis for two reasons. First, significant changes were made to site of death coding starting in 1989 (with the inclusion of decedent home and long-term care facilities). Second, from ancillary analyses, both 1989 and 1990 appear to be significant outliers in their site of death composition without any apparent explanation besides potential coding errors due to inconsistencies in coding site of death across counties. Hence, to remain confident in the estimates of this analysis, years 1991 through 2017 were included.

Measures

Categories for site of death have changed minimally over the years but generally include hospital (inpatient, outpatient/ER, dead on arrival, unknown), hospice, nursing home or long-term care facility, decedents' home, other, and unknown. This analysis focuses on three sites of death: 1) home, 2) hospital, and 3) nursing home. These three sites accounted for over 95 percent of all deaths in the analytic sample. For analytic purposes, this study makes two analytic comparisons: 1) the odds of death occurring in a hospital relative to at home and 2) the odds of death occurring in a nursing home relative to home. For several reasons, home death is used as the reference category in each. First, this was done for ease of comparison across the two outcomes. Second, home death has often been considered the ideal site of death and provides a good referent for the other sites of death. Finally, hospitals and nursing homes are institutionalized settings making for relatable comparisons. Table 2.1 provides the coding scheme for both outcomes. Those who were indicated to be “dead on arrival” were not included in this analysis because their place of death was not able to be determined before they arrived at the hospital.[3]

Table 2.1. Place of Death Variable Coding

Site of death 1991 - 2002	Site of death 2003 - 2017	Outcome 1 (hospital vs home)	Outcome 2 (nursing home vs home)
Hospital, Clinical or Medical Center - Inpatient	Hospital, Clinical or Medical Center - Inpatient	1	.
Hospital, Clinical or Medical Center - Outpatient or admitted to Emergency Room	Hospital, Clinical or Medical Center - Outpatient or admitted to Emergency Room	1	.
Hospital, Clinic or Medical Center - Dead on Arrival	Hospital, Clinic or Medical Center - Dead on Arrival	1	.
Hospital, Clinic or Medical Center - Patient Status Unknown	-	1	.
Nursing home	Nursing home / long-term care	.	1
Residence	Decedent's home	0	0
-	Hospice facility	.	.
Other	Other	.	.
Unknown	Unknown	.	.

Restricted mortality data include Federal Information Processing System (FIPS) codes, a federal system for uniquely identifying states and counties in the US. These codes have changed very little, making them suitable for analysis across time. However, there are certain changes that make it challenging to track counties consistently over time. To accommodate this, I implemented an approach taken in other studies to create historically-stable units of analysis (Dwyer-Lindgren et al. 2018).

As of 2021, there were 3,143 counties in the US (including boroughs and census areas in Alaska and parishes in Louisiana, both of which are deemed county-equivalents, but not including Guam, Puerto Rico, and the Virgin Islands). However, this analysis will include fewer counties for a couple of different reasons. First, several informed decisions had to be made about

[3] For more detailed information on coding choices for “dead on arrival” and hospice, please see the limitations section in Chapter 5.

how to consolidate counties to create consistencies across the 27-year period. These changes are detailed in the Appendix (Table A.1). Some changes were as simple as a name and FIPS code change, while others were more complicated, needing to consolidate several counties into one across all years. Second, although the final analytic sample is composed of decedents living in 2,975 counties, this is not always reflected in the models. There is some variation due to discrepancies in recording site of death at the county level. For example, all the counties in Oklahoma were missing site of death information between 1990 and 1996. This reduces the number of eligible counties in the analytic sample to 2,899 between 1990 and 1996. Additionally, there were significant amounts of missing data related to site of death in Georgia in 2008 and 2009. For example, 93% of counties in Georgia in 2008 had incomplete site of death information, and all the counties in Georgia did not record site of death information for decedents in 2009. Therefore, Georgia was omitted from analysis in both 2008 and 2009, and the total number of counties included in the analytic sample for those years was 2,830.

For this analysis, the county of occurrence is being used. County of occurrence refers to the county in which death *occurred*. Death certificates also provide information about the county of residence (e.g., the county where the decedent resided at the time of death, even if they did not die in that county). There are several benefits to focusing on county of occurrence over residence. First, information about county of residence is missing at a higher rate relative to county of occurrence, making it more statistically unreliable. Second, for those who are not missing on county of residence, a relatively small percentage (16.02%) of the analytic sample had a difference in county of occurrence and residence (that is, most individuals died in their county of residence). Additionally, among those who did not have county concordance, nearly three-quarters (73.30%) died in a hospital relative to only two-fifths (40.06%) of those who did have county concordance. Third, focusing on county of occurrence sheds light on what the county context was like where the death took place[4].

Analytic sample

The analytic sample was composed of individuals who were 65 years of age or older at the time of death and who died of intrinsic or “natural” causes (e.g., not suicide, homicide, or accident). Between 1991 and 2017, 66,011,184 decedents were reported in the US. Analysis was restricted to older adults exclusively (65 years of age and over) (n=48,404,811). Analysis was further restricted to individuals who had died of intrinsic or “natural” causes (n=47,166,485). Additionally, individuals who died in counties that reported five or fewer deaths (for those in the analytic sample) at any point during the observation period were omitted (151 counties and 32,467 decedents omitted; see Table A.2 for additional details). Finally, individuals residing in counties that were missing site of death information (n=3,729,718) were omitted. This resulted in a final analytic sample size of 43,404,300 decedents across 2,975 counties between 1991 and 2017.

Methods

Analytic approach

First, for descriptive statistics, the percentage of deaths occurring in each setting (e.g., home, hospital, nursing home) between 1991 and 2017 and stratified by age category are provided. Additionally, national maps are included to depict the total change in the percentage of deaths

---

[4] However, focusing exclusively on county of occurrence could be missing important differences between people who died in their county of residence versus those that did not. For one, the death and dying experience of individuals that did not have site of death concordance could be empirically distinct from those who did (although this is difficult to discern with these data). Additionally, due to high levels of hospital death, these individuals may have resided in a county that did not have adequate healthcare infrastructure, providing conservative estimates of the impact of county-level healthcare availability. Finally, for these individuals, it is not possible to consider the role of county-level characteristics for which the decedent resided, missing potentially important information about economic, healthcare, or social features.

occurring in each setting for each county in the analytic sample to visualize potential county variation in site of death. Second, logistic regression models will be used to establish the predicted probability of dying in a hospital and nursing home (relative to home) net the effect of county. Finally, multilevel logistic regression models will be used to estimate the probability of dying in a hospital and nursing home (relative to home).

Since the outcomes of interest are binary, hierarchical generalized linear models (HGLM) with a logit link function will be employed for the multilevel models. In the subsequent presentation of models, an equation only for the hospital outcome will be presented, but the same analyses will be conducted for nursing homes. Model 1 (see Equation 1) will be a simple logistic regression predicting the odds of dying in a hospital relative to dying at home. This will serve as the baseline model and will estimate the predicted probability of dying in a hospital (relative to home) without considering county-level contextual effects.

$$Prob(hospital = 1) = \phi_{ij}, where\ Log\left[\frac{\phi}{(1-\phi)}\right] = \beta_0$$

[E1]

Model 2 (see Equation 2) is similar in structure to Model 1 but includes county-level random effects using the *meglm* command in Stata. Let $Prob(hospital_{ij} = 1|\beta_j) = \phi_{ij}$. In addition, let η_{ij} be the log-odds of dying in a hospital (relative to home), $Log\left[\frac{\phi_{ij}}{(1-\phi_{ij})}\right]$.

Level 1 (persons):

$$\eta_{ij} = \beta_{0j}$$

Level 2 (counties):

$$\beta_{0j} = \gamma_{00} + u_{0j}, \quad u_{0j} \sim N(0, \tau_{00})$$

[E2]

Due to the sheer quantity of data, the specified models were run separately for each of the 27 years. Convergence was not achievable with all data combined in a three-level model (with year at level three) or with all years pooled and year included as a control (even when using a 10% sample).

Several important pieces of statistical information will be derived from the multilevel analysis. First, the predicted probability of dying in a particular setting will be calculated for both logit and multilevel models. The main coefficient, γ_{00}, captures the average log odds of dying in a hospital relative to home when considering county-level random effects. The value of γ_{00}will be compared to the unconditional probability of dying in a hospital calculated in the simple logit models. Second, the plausible value range (PVR) will be estimated for each year. This value indicates the overall range in the probability of dying in a particular setting across all counties. This is calculated as a 95% confidence interval around the main model coefficient (γ_{00}) utilizing the level-2 variance (τ_{00}). Finally, the intraclass correlation coefficient (ICC) will be calculated for each multilevel model. In a two-level HGLM, the variance is partitioned at level two. This represents the total variability in the outcome (probability of dying in a hospital) that is attributable to the county. It is possible to use this value to calculate the ICC, which is the proportion of variance accounted for by the higher level of analysis (e.g., county). The following formula was utilized for the proportion of variance among counties,: $\tau_{00}/((\pi^2/3) + \tau_{00})$ (Guo and Zhao 2000). Utilizing this formula for the ICC, it is possible to ascertain what proportion of the variation in site of death counties account for. When analyzed over time, this ultimately provides information on whether counties have become more, less, or similarly important over time. Additionally, to assess whether these changes in site of death over a three-decade period were significant, additional analysis were conducted in which ICC was regressed on year to test for significant change.

Results

Descriptive results

Figure 2.1.A shows the percentage of deaths occurring in each site of death (e.g., home, hospital, nursing home) for all individuals in the analytic sample between 1991 and 2017. For all decedents over 65 years of age, there was an in increase in the total percentage of deaths occurring at home (from 18.59% to 34.54%) accounting for a 15.95 percentage point increase (85.79% increase). Additionally, there was a decline in the total percentage of deaths occurring in hospitals between 1991 and 2017 (from 58.29% to 36.61%) accounting for a 21.68 percentage point drop (37.19% decline). Finally, there is very little change exhibited in the percentage of deaths taking place in nursing homes during the observation period (only about a 6-percentage point increase over the 27-year period). This trend is relatively similar to that currently reported for all adults in the US (Olaisen 2016, 2020).

Figure 2.1.B - Figure 2.1.D depict the site of death trend stratified by age category. Similar patterns are present for all three age categories: an increase in home death, a decrease in hospital death, and a relatively stable rate of nursing home death. Figure 2.1.B shows the percentage of deaths occurring in each site of death (e.g., hospital, home, nursing home) for older adults between the ages of 65 and 74, who accounted for 24.85% of all deaths. This age group had the highest percentage of hospital deaths and accounted for the smallest percentage of nursing home deaths. Figure 1.C. presents the percentage of deaths occurring in each site of death for individuals between the ages of 75 and 84, who accounted for 36.75% of all deaths. This age group had a higher percentage of nursing home deaths relative to 65–74-year-olds but had an overall similar home death trajectory over the period. Finally, Figure 1.D. presents the percentage of deaths occurring in each site of death for decedents 85 years of age and older, who

accounted for 38.4% of all deaths. This age group had the highest percentage of deaths taking place in nursing homes. Overall, this demonstrates that the temporal changes in site of death for older adults is similar to that of the population, although, there are some important differences across age groups.

Figure 2.1. Percentage of Deaths Occurring at Each Site of Death in the US, 1991 to 2017

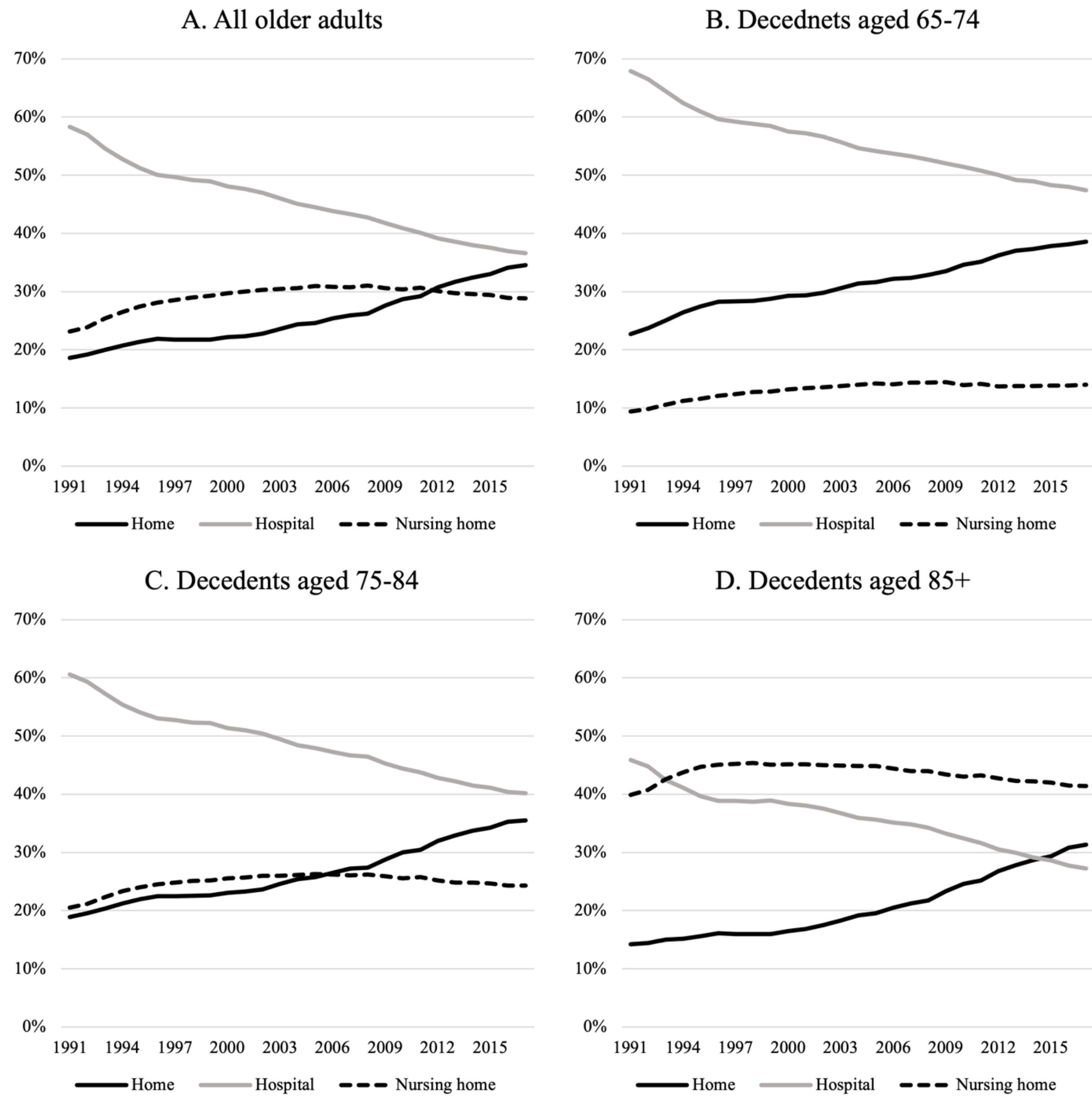
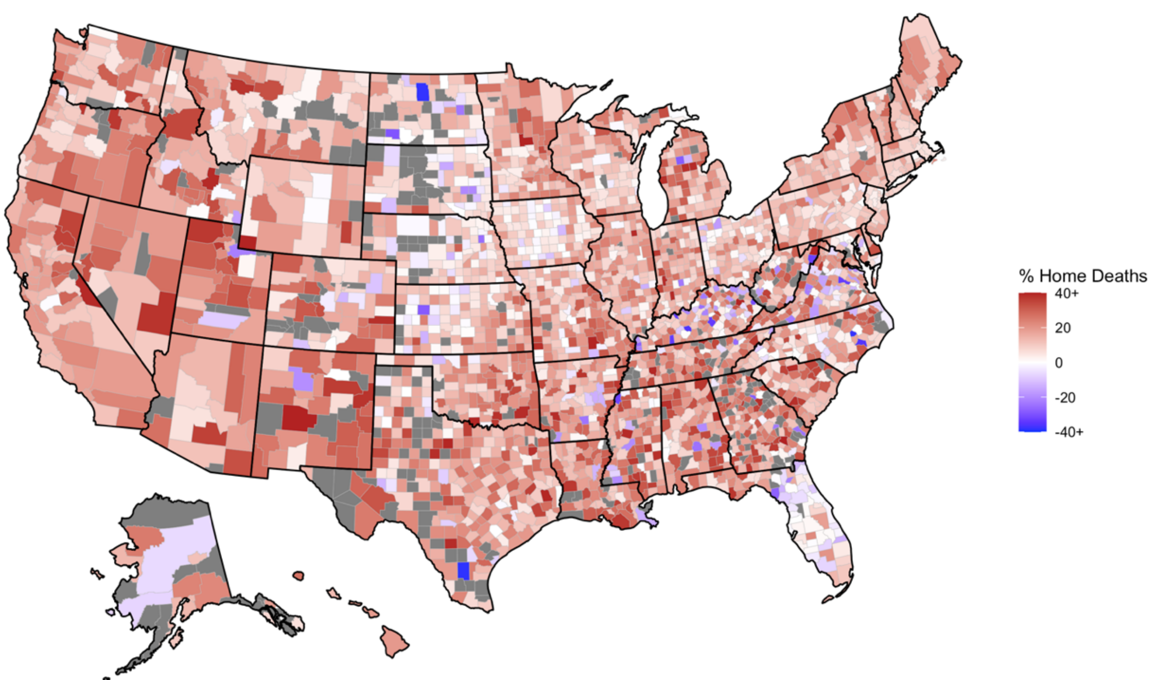


Figure 2.2 - Figure 2.4 depict the change in the percent of deaths occurring in each site of death (e.g., home, hospital, nursing home) between 1991 and 2017 for all counties included in

the analytic sample[5]. Figure 2.2 depicts the change in the percent of deaths occurring at home between 1991 and 2017 for 2,975 US counties. Most US counties did experience increases in home death (shown in red). However, there were a substantial number of counties that did not exhibit any change (shown in white) or experienced decreases in home death over the period (shown in blue). This suggests that beyond the national trends in site of death, there is also considerable variation in changes to the percent of deaths occurring at home across counties in the US. Additionally, supplementary analyses suggest that the percentage of home deaths reported in 1991 was moderately correlated with the percentage of home deaths reported in 2017 (0.62). The correlation was even stronger when comparing 2000 and 2017 (0.74).

Figure 2.2. Change in Percent of Deaths Occurring at Home between 1991 and 2017

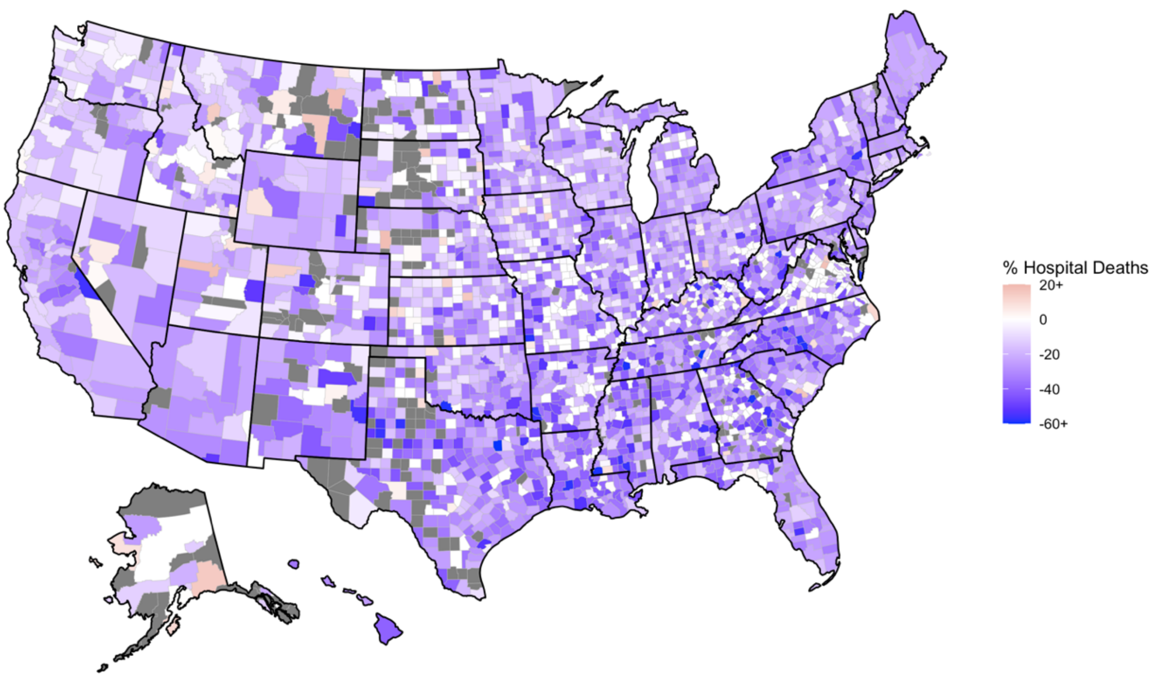


Similar trends were observed for hospital deaths (Figure 2.3). The vast majority of counties saw decreases in the percentage of deaths occurring in hospitals (shown in blue),

[5] Since Oklahoma is missing site of death information between 1991 and 1996, the percent change for all Oklahoma counties is based on 1997 than 1991.

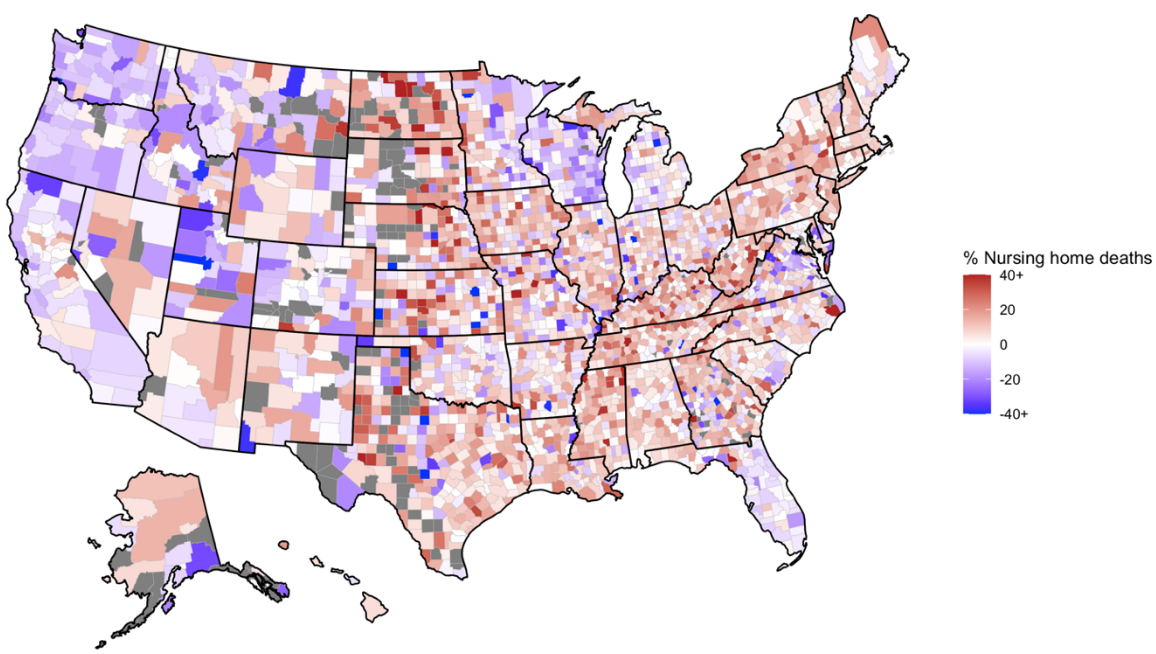
however, the degree of this change varied across counties with some counties exhibiting a 60-percentage point change while others only exhibiting a marginal change. Additionally, a not so insignificant number of counties saw no change to the percentage of deaths occurring in hospitals over the 27-year period. Finally, there were numerous counties that experienced *increases* (at least 10 percentage points) in hospital deaths including in Alaska, Colorado, Florida, Georgia, Iowa, Indiana, Kansas, Kentucky, Maryland, Minnesota, Montana, North Carolina, North Dakota, Nebraska, New Mexico, Ohio, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, and Virginia. Additionally, supplementary analyses suggest that the percentage of hospital deaths reported in 1991 was moderately correlated with the percentage of hospital deaths reported in 2017 (0.68). The correlation was even stronger when comparing 2000 and 2017 (0.75).

Figure 2.3. Change in percent of deaths occurring in hospitals between 1991 and 2017



Finally, for nursing home deaths, there was considerable variation across counties in the change in the percent of deaths occurring in this setting (Figure 2.4). Despite a generally stable national trend (Figure 2.1), Figure 2.4 suggests that there was considerable variation across counties in the US related to changes in nursing home death composition over the 27-year period. Additionally, supplementary analyses suggest that the percentage of nursing home deaths reported in 1991 was moderately correlated with the percentage of nursing home deaths reported in 2017 (0.58). The correlation was even stronger when comparing 2000 and 2017 (0.68). Finally, one important feature to take note of for Figure 2.2 - Figure 2.4 is that county-level variability in site of death is not homogenous within states. Even though states may exhibit homogeneity in their policy landscapes, these are not consistently reflected within counties.

Figure 2.4. Change in percent of deaths occurring in nursing homes between 1991 and 2017



Multilevel results

Figure 2.5 presents predicted probabilities (calculated from log odds) for the two outcomes (hospital versus home and nursing home versus home) for both sets of models (logistic regression and multilevel models – full model estimates can be found in Table A.3–Table A.6). The predicted probability of dying in a nursing home relative to home was virtually unchanged by accounting for the clustering of deaths within counties (logit and MLM models). However, there was a significant decrease in the overall probability of dying in a hospital relative to home when considering the nested structure of the data. That is, by considering how deaths are nested within counties, it was much less likely that an individual would die in a hospital relative to home. This suggests that by not considering the county of death, estimates for hospital versus home death will likely be biased and misleading.

Figure 2.5. Predicted probability of dying in a hospital or nursing home (relative to home) in the US, 1991-2017

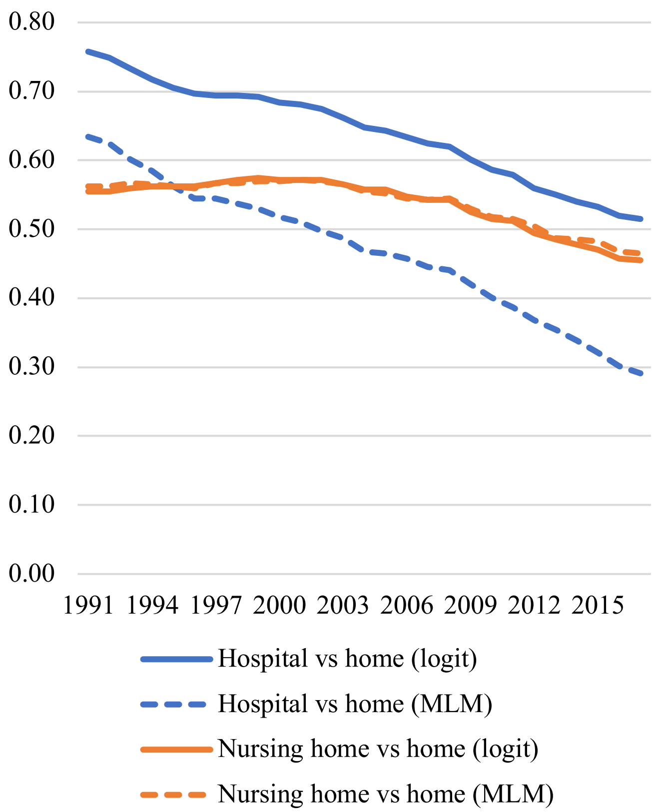
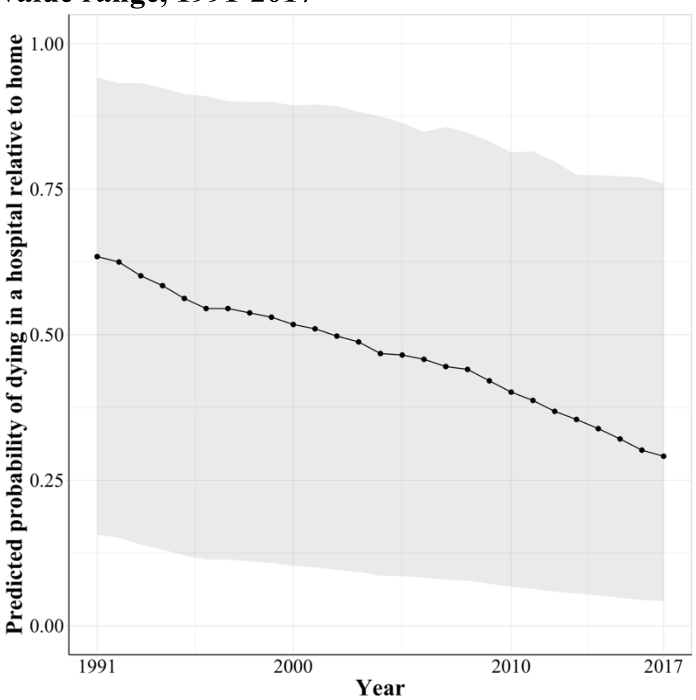


Figure 2.6 presents both the predicted probability as well as the PVRs for hospital versus home death. The PVR relies on the point estimate and variance component from the multilevel model to estimate a 95% confident estimate of all the total possible range of values that exist across a level-2 variable (in this case, counties). Although there is a general decline in the

predicted probability of dying in a hospital relative to home between 1991 and 2017 (as previously estimated in Figure 5), there is also considerable variation around the average predicted probability. That is, in 1991, while considering county context, individuals, on average, had a 0.63 probability of dying in a hospital relative to home. Despite this being the average, there was considerable variation, with some counties having a probability approaching 1 (about 0.94 in this case) and some having a probability of only 0.16. This variation is substantial and consistent across the period. This suggests that individual probability of dying in a hospital or home varies considerably across counties in the US.

Figure 2.6. Predicted probability of dying in a hospital relative to home including plausible value range, 1991-2017



In Figure 2.7, the same information is presented but for the nursing home versus home outcome. Again, there is very little change in the predicted probability of dying in a nursing home over the period but there is some variability across counties in the likelihood of dying in a nursing home relative to home. However, there is considerably less variability in the outcome than for the hospital versus home outcome. Although, there are still some counties where individuals are less likely to die in a nursing home and counties where individuals are more likely to die in a nursing home, both relative to home.

Figure 2.7. Predicted probability and plausible value range for nursing home versus home death, 1991-2017

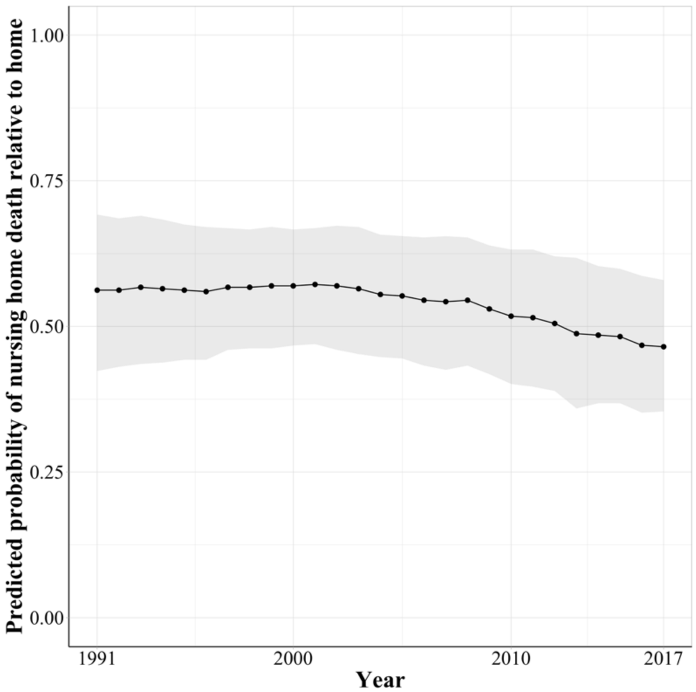
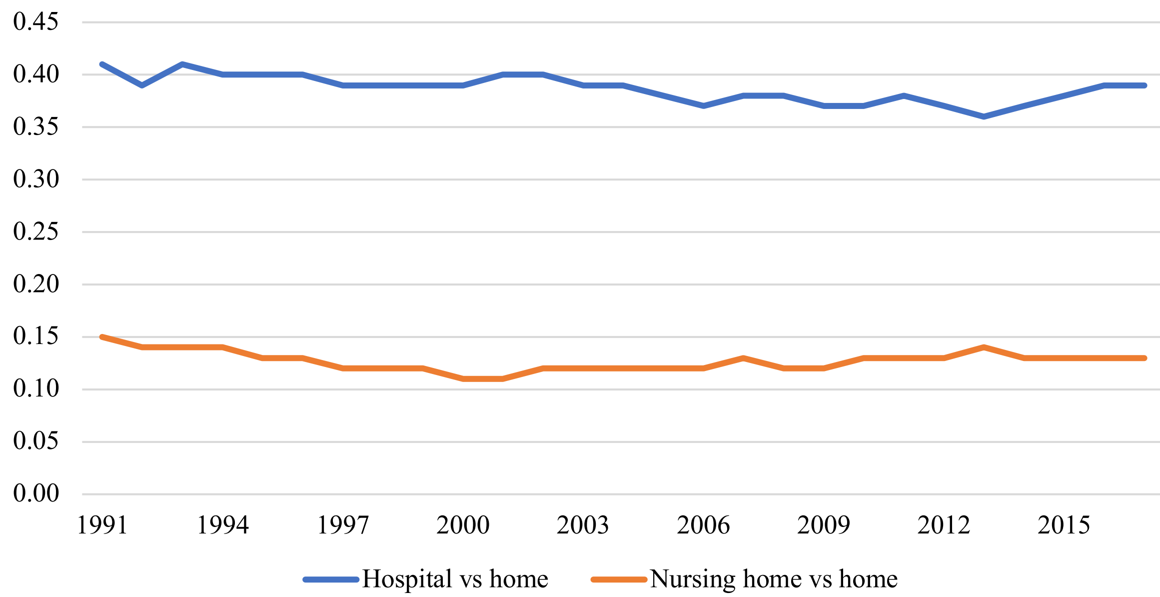


Figure 2.8 presents information related to the ICC for 1991 to 2017. Additional analyses (not shown here) in which ICC was regressed on year suggest that there was a significant decline in the ICC for the hospital (relative to home) outcome (B= –.001, p<.001) and no significant change for the nursing home (relative home) outcome (B = –.0002, p=.5). However, this means that there has been, on average, a 0.001 decline in the ICC each year which is substantively meaningless. Therefore, in just assessing the graph visually, in the case of hospital deaths (relative to home), the ICC has hovered around 0.40 suggesting that counties have accounted for, on average, about 40% of the variation in the probability of dying in a hospital compared to at home. This is in contrast to the second outcome, where the ICC hovers around 0.12, suggesting that counties account for around 12% of the variation in the probability of dying in a nursing

home compared to home. For both outcomes, the ICC has remained stable over the period of interest.

Figure 2.8. Intraclass Correlation Coefficients (ICC) for Multilevel Models, 1991-2017



Discussion

Two important literatures have emerged related to site of death in the US: the first focuses on temporal trends in site of death over the last several decades, while the other has assessed geographic variation in site of death in the US. Both have demonstrated how site of death has shifted remarkably in the last several decades and how there also appears to be considerable spatial inequality in regard to the setting in which death ultimately takes place. The current study aimed to build on these two literatures by further interrogating both temporal and geographic variation simultaneously to assess how much variation in site of death counties have accounted for as well as how and if this had changed over time.

Findings from this research demonstrate that counties are an essential geographic unit by which to understand site of death in the US. First, this study has complimented previous research by corroborating the existence of considerable geographic variation in site of death in the US

(Chino et al. 2018; Flory et al. 2004; Goodman et al. 2011; Xu et al. 2020). This study has also extended this area of inquiry by quantifying the unique role of counties for two important site of death outcomes. More specifically, for hospital deaths relative to home deaths, the ICC was, on average, 0.40 over the 27-year period indicating that about two-fifths of the total variation in this outcome was due to differences between counties in the US. Additionally, for nursing home deaths relative to home deaths, the ICC value was, on average, around 0.12 suggesting that 12 percent of the variation in site of death in the US was attributable to differences between counties. Overall, this provides empirical evidence that the likelihood of dying in a particular setting is impacted by the county where death occurs and that this is especially true for hospital deaths relative to home deaths. Although previous research has focused extensively on individual-level disparities in site of death (Cross and Warraich 2019; Harris-Kojetin et al. 2016; Johnson 2013; Long and Curtis 2016; NHPCO 2018), these findings suggest that it is imperative to look beyond just decedent characteristics and to be additionally attentive to the geographic context in which deaths are taking place.

Second, results from this research indicate that counties have remained remarkably stable in their overall contribution to variation in site of death. That is, despite a nearly three-decade timespan, both hospital and nursing home deaths hovered around their respective ICC values (0.40 and 0.12) for the entire duration of the study period. Although this finding does not align with the original hypothesis that contextual inequality would increase over the period, it still suggests that counties were important nearly 30 years ago, have remained important over the 27-year period, and will likely remain an important source of variation in site of death in the US in coming years. It was not within the purview of this research to investigate the source of this stability. However, such stability may be attributable to the consistency of structural differences within counties (e.g., economic wellbeing, healthcare accessibility), cultural differences (e.g., religious and political ideology), or some combination of the two. Therefore, these findings provide additional support for the need to be attentive to context, generally, and county, especially when investigating issues related to site of death in the US.

In addition to the main findings, it is important to note that, given the amount of variation that counties account for, hospitals and nursing homes were somewhat unique in their relationship to county, despite being both considered institutionalized settings. In other words, hospitals and nursing home were distinct in their overall relationship to the county, with counties accounting for considerably more variation in site of death for the hospital outcome relative to the nursing home outcome. However, this is not too surprising since these settings differ in their purpose and their structure. Nursing homes and long-term care settings are uniquely equipped to care for older adults with a wide range of care needs. Hospitals are often better suited to provide care in extreme cases of illness or disease. Dissimilarities among institutionalized settings is not a new finding (Gruneir et al. 2007), and these differences may indicate how institutionalized settings could be differentially impacted by locally tailored end-of-life care policy. That is, county-level policies aimed at improving end-of-life outcomes in hospitals may have more extensive and apparent impacts since counties accounted for a considerably larger portion of variation in site of death relative to the nursing home outcome. Although additional analysis is needed, these findings support the importance of distinguishing between different settings when studying site of death since they are different in their relationship to county context.

Similar to other research that has utilized an ecological perspective to explore geographic variation in health and mortality outcomes (Kirby 2008; Monnat 2018a; Subramanian et al. 2001; Vierboom et al. 2019), this research suggests that place matters substantially for where death ultimately takes place. That is, the likelihood of dying in a hospital or at your own home is not randomly distributed across the US. Depending on what county a decedent dies in, they may be more likely to die in a hospital relative to the national trend or to decedents in other counties. This was made especially apparent by the maps depicting the change in the proportion of deaths occurring in all three sites of death across nearly all counties in the US. Generally, there were not clear state or regional patterns (despite an on average higher rate of home death and lower rate of nursing home death in the West), suggesting an important level of randomness across counties. Therefore, this research speaks to a much larger body of work outside of end-of-life care that has begun to unearth important relationships between health, disease, and mortality outcomes and geographic context. In tandem, the findings from this study demonstrate that it is imperative to consider how context shapes the end of life. By not taking the geographic context more seriously, research and policy may fail to improve end-of-life care for places in the US that may be especially vulnerable to poor end-of-life care.

Now that the relationship between counties and site of death has been established at a baseline level, future research is well-positioned to take these findings and build on them in ways that would likely enhance the death and dying experience of people in the US. Despite investigating geographic variation in site of death, it remains unclear why geographic variation exists and its potential consequences for older adults who die of natural causes in the US. Therefore, future research should consider investigating how and why counties matter for site of death. Based on previous research, there is reason to believe that social, economic, or healthcare access factors could contribute to the county-level variation in site of death (Davies et al. 2019; Gruneir et al. 2007; Murphy et al. 2018; Pritchard et al. 1998). Beyond indicating that counties do matter, exploring the relationship between county-level features and site of death would allow for the potential refinement of mechanisms leading to this variation in site of death across counties in the US. Identification of potential mechanisms would provide additional specificity to policies at the local level. This research would be additionally complemented by qualitative research investigating the experience of dying in different geographic locales. While the current study established population trends, qualitative research would allow for the investigation of what is happening in different communities related to site of death and how this may differentially impact individuals and their families.

This study was limited in several ways that are important to note. First, this study was limited regarding the inclusion of additional end-of-life care indicators beyond site of death (e.g., healthcare utilization). For example, previous research has demonstrated that a high proportion of long-term care residents ultimately die in the hospital (Allers, Hoffmann, and Schnakenberg 2019). Death certificate data on its own does not allow for the tracking of individual decedent trajectories at the end of life, so while someone may have lived in a nursing home but died in a hospital, such nuances in end-of-life care are unable to be captured in this study. Second, due to the use of hierarchical generalized linear models, it is not possible to estimate a level-1 random effect to identify the proportion of the overall variation in site of death that is attributable to the individual level. Therefore, it is not possible to ascertain what proportion of the variation in site of death is between individual decedents. Third, due to the large quantity of data, it was not within the purview of this study to consider individual-level characteristics. However, future research would likely benefit from considering the interplay between individual-level factors and geographic features. Despite these limitations, to the best of my knowledge, this is the first study to use restricted US population death certificate data between 1991 and 2017 to analyze temporal and geographic variation in site of death for older adults who died of natural causes. By leveraging these data, findings from this study have demonstrated that future research and policy focused on site of death needs to continue to turn its eye to structural features of the dying experience.

In conclusion, reducing disparities in end-of-life care is growing increasingly important with the aging of the baby boomer population (US Census Bureau 2018) and the continued demonstration of disparities in end-of-life experience (Long and Curtis 2016; Orlovic, Smith, and Mossialos 2018; Perry et al. 2013). Additionally, site of death has been increasingly treated as an important indicator of quality of end-of-life care (Ali et al. 2015; Institute of Medicine 2015). Investigating disparities in site of death has the potential to impact end-of-life care in positive ways by providing specific and tailored support for individuals who may be especially vulnerable or marginalized. Findings from this research highlight the need to think about the role of place in shaping the experience of end-of-life care, generally, and site of death, specifically. Collectively, findings from this study support the idea that there is considerable spatial inequality in site of death in the US and that future research and policy must consider the role of geographic context to improve end-of-life care. Given the level of spatial inequality within the US, it is likely the case that tailored county-level interventions must be made to support people at the end of their lives.

CHAPTER 3. Analyzing County-Level Site of Death Composition Trajectories: A Latent Class Growth Analysis Approach

Introduction

There have been significant changes to the site of death trajectory in the US in the past several decades, with a significant increase in the percentage of deaths that occur at home as well as a significant decline in the percentage of deaths that occur in hospitals (Cross and Warraich 2019; Olaisen 2020). Additionally, there has been a growing body of work demonstrating geographic variation in site of death across various geographic units (Chino et al. 2018; Flory et al. 2004; Goodman et al. 2011; Xu et al. 2020) as well as important contextual-level features that are associated with the likelihood of dying in a particular setting (Davies et al. 2019; Gruneir et al. 2007; Murphy et al. 2018; Pritchard et al. 1998). Furthermore, although the average county in the US has seen an increase in home deaths based on findings related to geographic variability, this trend might not be the case for all counties in the US. To date, research has not investigated the unique site of death trajectories over time of US counties. This is an important area of inquiry because without fully understanding geographic variation, it is not possible to effectively implement end-of-life care policy or direct healthcare resources due to the potentially heterogeneous needs of counties.

To address this gap in the literature, this study utilizes aggregated county-level data derived from US population death certificates between 1991 and 2017 to achieve two aims. First, this research aims to identify county-level variation in site of death trajectories by establishing unique subgroups of counties that have exhibited similar site of death trajectories over the 27-year period. Second, this research aims to better understand these county subgroups by analyzing important county-level contextual features that may predict membership in these groups. Overall, findings from this research demonstrate that there is variability in site of death trajectories among US counties. Additionally, several county-level social, economic, and healthcare factors were significantly associated with membership in various trajectories. Overall, these findings suggest that temporal changes to site of death are not homogenous across counties signifying how counties that differ from the national trend are, in most cases, more likely to have experienced economic and healthcare accessibility challenges.

Background

Site of death, that is, whether an individual dies at home, in a hospital, or a nursing home, has become of increasing interest to researchers and policymakers focused on end-of-life care in recent years. This is due to vast changes since the 1980s in where people die in the US, with an overall decline in the proportion of deaths taking place in a hospital and an increase in the proportion of deaths taking place at home (Cross and Warraich 2019; Olaisen 2020). In addition, with changes to the provision of end-of-life care in the US (e.g., hospice and palliative care) as well as a social and cultural emphasis on the demedicalization of death, more people are dying at home since the turn of the twentieth century (Hall 2019; Livne 2019). This is a significant social change in a relatively short period, and researchers and policymakers continue to grapple with the cause, meaning, and consequences of this shift. Hence, site of death has been increasingly used as a proxy measure for end-of-life care quality and an indicator of patient choice at the end of life (Ali et al. 2015; Higginson and Sen-Gupta 2000; Institute of Medicine 2015).

Overall, this change in site of death is representative of a national trend in the US, but additional emerging evidence suggests considerable variation in site of death based on geographic context (Chino et al. 2018; Flory et al. 2004; Goodman et al. 2011; Xu et al. 2020). This area of research has emphasized how the contexts in which people live differentially shape the likelihood of dying in a particular setting within the US. For example, variation in site of death outcomes have been identified across US regions (e.g., Midwest Northeast, South, West) (Flory et al. 2004), states (Chino et al. 2018), and hospital referral regions (Goodman et al. 2011). Therefore, although the national trend suggests a general downward trend in hospital deaths, evidence of geographic variation at different levels of social life suggests that you may be more or less likely to die in a hospital depending on where you live. Such variation in the likelihood of dying in a particular setting also suggests that there may be differences in the quality of end-of-life care that are not attributable to individual sociodemographic features but rather are characteristics of a given place.

Despite the evidence of both temporal trends in site of death and geographic variation in site of death, research has yet to explore heterogeneity among counties in their unique site of death composition and trajectory. Given emergent evidence demonstrating geographic variation, it is unlikely that all counties in the US are experiencing the same downward trend in the proportion of hospital deaths that aligns with the national trend. Continued reliance on a single population trajectory for site of death may be masking important place-based disparities. It is possible that there are counties with similar contemporary rates of home death, while also exhibiting divergent site of death compositional trajectories. For example, a homogeneous county subgroup with high hospital death at one point and low hospital death at another could indicate (de)medicalization and social changes to the conceptualization of high-quality death. However, another county subgroup may also have relatively high rates of home death contemporarily but may have been persistent over the entire three-decade period. Hence, this second county subgroup would not have exhibited any change in site of death, although it looks relatively similar, from a contemporary perspective, to the first county subgroup. Therefore, considering several decades simultaneously is imperative since site of death trajectory across counties likely looks very different across multiple years even though some counties may look similarly for a single year. Overall, research needs to investigate the unique site of death trajectories of counties in the US to understand better disparities in end-of-life care that may be masked at the national level.

Constrained choice

To date, research focused on site of death as a proxy measure for end-of-life care has emphasized the role of patient choice and autonomy (Ali et al. 2015; Bell et al. 2010). However, the choice framework is limited in that it assumes that individuals live in a context that will facilitate the ability to choose where to die. To date, several studies have identified contextual factors that influence site of death (Davies et al. 2019; Gruneir et al. 2007; Murphy et al. 2018; Pritchard et al. 1998), which may function as constraints to "choice" at the end of life. The primary constraints on site of death at the county level can be conceptualized as occurring within two categories: 1) structural constraints and 2) cultural constraints. Structural constraints are the kinds of economic and healthcare environments that may shape the ability to get access to various forms of care in a given county. To date, research has identified several economic and healthcare factors that are associated with site of death, including tract-level income (Davies et al. 2019), percent of adults living in poverty (Gruneir et al. 2007), Medicare reimbursement rates (Pritchard et al. 1998; Xu et al. 2020), and healthcare availability (Gruneir et al. 2007; Xu et al. 2020). The association between these structural factors and site of death provides justification for further consideration of important county-level structural factors that may influence site of death. To date, information on county-level education, employment, or economic dependency has not been explored. Additionally, investigations into the impact of healthcare environments on site of death have been limited to state-level Medicaid reimbursement rates and county-level healthcare accessibility indicators, including hospital and nursing home beds in a given county. There are a handful of end-of-life healthcare outcomes that have yet to be explored that may be associated with site of death and can give insight into not only the availability of healthcare but also the typical practices around end-of-life care in a given county. This includes end-of-life care measures such as hospital admissions and inpatient days per decedent. Further exploration into how economic and healthcare environments within a county impact site of death would provide important information on how choice at the end of life is constrained structurally. This would also provide information on what county-level factors need to be addressed to make significant changes to the provision of end-of-life care.

Cultural constraints are the kinds of county factors, such as religion or political ideology, that may shape norms and attitudes around health and healthcare, as well as death and dying. Both cultural and political factors related to end-of-life care have become important in recent years as political and religious ideologies often reflect ideas about the appropriate kinds of end-of-life care. Some research has identified a relationship between religion and preference for site of death at the individual level (Sharp, Carr, and Macdonald 2012); however, no research has yet analyzed indicators of religion at the contextual level. Religion at the county level could have important implications for values around the end of life, whether or not an individual holds those attitudes themself. Therefore, it is important to explore religious composition and density within a given county. In terms of political ideology, some research has documented a relationship between Republican vote share in a given place and other health outcomes, including obesity (Shin and McCarthy 2013) and vaccination rates among teenagers (Bernstein et al. 2016). Politics and issues of healthcare, patient autonomy, and end-of-life care have a longstanding and contentious relationship in the US. However, the role of political ideology has not yet been applied to end-of-life care, generally, and site of death, specifically. The political ideology of a county could impact county-level policies that allow for the provision of certain kinds of healthcare. Additionally, political ideology could shape social norms and attitudes, in a similar but distinct fashion from religion, to influence how people think about end-of-life care which could ultimately impact site of death at a county level. Therefore, this research will incorporate both structural and cultural constraints into its analysis of site of death to explore the role of various county-level factors that may be associated with site of death in the US.

Current study

Findings discussed previously demonstrate two critical features related to site of death and geographic context. First, there is variation in site of death based on the particular geographic locale in which someone lives and dies. Secondly, there are also place-based characteristics that influence site of death, including demographic features, access to healthcare, and economic (dis)advantage. However, research has yet to more fully explore the role of place in shaping site of death, above and beyond establishing that variation exists as well as a handful of important contextual characteristics associated with site of death. Building upon research conducted to date, this study aims to answer the following research questions: *Are there distinct, homogenous county subgroups, each having a unique site of death trajectory over time? If such heterogeneity in the site of death trajectory does exist, what county-level factors account for which counties have which trajectories?* With counties as the units of analysis, this study will utilize latent class growth analysis to further interrogate place-based disparities in site of death. This technique can be used to identify unique and distinct subgroups within a larger homogenous population that has a similar pattern of change over time (e.g., growth) on a variable of interest (e.g., site of death).

Therefore, rather than taking the demographic trend at face value, this study will seek to, first, investigate whether there is a subgroup of counties that are currently driving the population trend and if there are other clusters that deviate from this trend. After identifying these clusters, this study will utilize multinomial logistic regression to investigate what county-level factors make these homogeneous county clusters unique from one another as a way to understand better how place shapes site of death in the US.

Data

Data

This study utilizes restricted Multiple Cause of Death (MCD) data that have been merged with several county-level covariates. MCD data are composed of death certificate information for the entire US population and are managed by the National Vital Statistics System (NVSS) within the National Center for Health Statistics (NCHS). Information on a death certificate includes place of death (e.g., county and state of death), site of death (e.g., home, hospice, hospital, nursing home), sociodemographic characteristics of the decedent (e.g., age, gender, education, marital status), underlying cause of death, and co-occurring morbidities that contributed to death. Although these data are publicly available (National Center for Health Statistics 2018a), NVSS stopped releasing geographic identifiers in publicly available data in 2005. Additionally, NVSS provides limited geographic identifiers in publicly available data for counties that had more than fifty deaths in a given year. Therefore, to overcome these data challenges, all analyses were conducted on restricted data (made available through NCHS) using a secure remote server managed by the Institute of Behavioral Science (IBS). Although NCHS provides these data as a decedent-level file, they have been transformed into a county-level file for this study.

For county-level indicators, several data sources were used. First, the Area Health Resources Files (AHRF) is a collection of geographic, demographic, and healthcare data maintained by the Health Resources and Services Administration (HRSA) (Area Health Resources Files 2021). The AHRF contains readily accessible county-level information from a variety of sources, including the American Hospital Association (AHA), the Census Bureau, the Center for Medicaid Services (CMS), and the Economic Research Service (ERS). Second, the Dartmouth Atlas end-of-life care indicators were integrated to provide measures of end-of-life care in the US (Dartmouth Atlas Project 2021). Third, the 2020 Religious Congregations and Membership Study (Religious Census) was integrated to provide information about county-level religious ideology (Grammich et al. 2010). Finally, voting data were retrieved from the MIT Election Data and Science Lab (MIT) (MIT Election Data and Science Lab 2018). All these data sources are publicly available and contain county-identifying information that can be linked directly with restricted MCD data.

Measures

Decedent-level death certificate data were used to create three primary outcomes of interest: percent of all deaths (among the analytic sample) occurring in a 1) home, 2) hospital, or 3) nursing home in each county. Table 3.1 demonstrates how site of death was coded at the decedent level. Each outcome was calculated by tallying the total number of decedents reported to have died in each setting divided by the total number of deaths in that county and year[6]. Site of death has been measured on death certificates since 1989 (for settings beyond just the hospital). However, for the sake of reliability, both 1989 and 1990 are omitted because significant changes were made to site of death coding starting in 1989 (with the inclusion of decedent home and

---

[6] Those coded as "missing" on site of death according to Table 3.1 were not included in the denominator since site of death could not be accurately identified.

long-term care facilities). Both 1989 and 1990 appear to be significant outliers without any obvious explanation besides potential coding errors due to inconsistencies in coding site of death across counties. Hence, to remain confident in the estimates of this analysis, only 1991 through 2017 were included.

Table 3.1. Site of death variable coding

Site of death 1991 - 2002	Site of death 2003 - 2017	Hospital deaths	Home deaths	Nursing home deaths
Hospital, Clinical or Medical Center - Inpatient	Hospital, Clinical or Medical Center - Inpatient	1	0	0
Hospital, Clinical or Medical Center - Outpatient or admitted to Emergency Room	Hospital, Clinical or Medical Center - Outpatient or admitted to Emergency Room	1	0	0
Hospital, Clinic or Medical Center - Dead on Arrival	Hospital, Clinic or Medical Center - Dead on Arrival	.	.	0
Hospital, Clinic or Medical Center - Patient Status Unknown	-	1	0	0
Nursing home	Nursing home / long-term care	0	0	1
Residence	Decedent's home	0	1	0
-	Hospice facility	0	0	0
Other	Other	0	0	0
Unknown	Unknown	.	.	.

In addition to measures of site of death, this study relies on county-level geographic identifiers provided in restricted death certificate data. Restricted death certificate data includes Federal Information Processing System (FIPS) codes, a federal system for uniquely identifying states and counties in the US. These codes have changed very little, making them suitable for analysis across time. For this analysis, the county of occurrence is used. County of occurrence refers to which county the death *occurred* in. Death certificates also provide information about the county of residence (e.g., the county where the decedent resided at the time of death, even if they did not die in that county). There are several benefits of focusing on county of occurrence over residence. First, information related to county of residence is missing at a much higher rate relative to county of occurrence. Additionally, for those not missing on county of residence, a relatively small percentage (~17%) of the analytic sample had a difference in county of occurrence and residence (that is, most individuals died in their county of residence).Table 3.2

provides information regarding the county-level variables included in this analysis, their data source, and which years were included in the analysis. Although there are typically multiple years of current county-level data available, there are limitations in terms of not having the full range of county-level data necessary to mirror all years of death certificate data. I attempt to overcome this by selecting some county-level constraints that are measured over an extended period (e.g., persistent poverty, average voting patterns) or selecting measures that have likely not changed significantly over time (e.g., religious adherents). However, due to the limited availability of county-level data before 2010, many of the structural measures are used to infer county-level economic and healthcare constraints over a period for which there is not adequate data. Despite this limitation, these measures are still important indicators of constraints that possible county subgroups are experiencing in a contemporary context and may have experienced previously.

Table 3.2. County-level variables

Variable	Data Source	Years Utilized
CULTURAL CONSTRAINTS		
Religious		
Evangelical Protestant adherents per 1,000	Religious Census	2010
Mainline Protestant adherents per 1,000	Religious Census	2010
Catholic adherents per 1,000	Religious Census	2010
Political		
Proportion voting Democratic (president), 5-year average	MIT	2000-2016
Proportion voting Republican (president), 5-year average	MIT	2000-2016
STRUCTURAL CONSTRAINTS		
Economic		
County Typology Code	AHRF (ERS)	2015
Low education	AHRF (ERS)	2008-2012
Low employment	AHRF (ERS)	2008-2012
Persistent poverty	AHRF (ERS)	1980, 1990, 2000, 2007-2011
Healthcare		
Hospital beds per 1,000	AHRF (AHA)	2010
Nursing home beds per 1,000	AHRF (AHA)	2010
Number of hospices per 1,000 residents 65+	AHRF (CMS)	2010
Hospital admissions per decedent, last six months of life	Dartmouth Atlas	2010
Inpatient days per decedent, last six months of life	Dartmouth Atlas	2010
CONTROLS		
Percent 65+	AHRF (Census)	2010
Percent Black	AHRF (Census)	2010
Rural/Urban Continuum Code	AHRF (ERS)	2013
Population loss	AHRF (ERS)	1990-2000; 2000-2010
New retirement destination	AHRF (ERS)	2000-2010

Five *cultural constraints* were included focused on both religious and political ideology. For religious ideology, the number of religious adherents per 1,000 residents from the 2010 religious census was included. There was a wide range of denominations included in the religious census; however, many of the non-Christian religions (e.g., Jewish, Muslim, Buddhist, Hindu) had incomplete information. Therefore, to test for meaningful differences within the limitations of the data, religious adherence was measured using three religious categories focused exclusively on Christian religions: Evangelical Protestant, Mainline Protestant, and Catholic. This approach considers about 60 percent of all religious adherents and over 85 percent of Christian adherents (Pew Research Center 2015). Focusing on these categories best aligns with the relationship established in the literature between religion and end-of-life care (Sharp et al. 2012). Additionally, two political indicators were included based on county-level voting data: the proportion of county votes for the 1) Republican and 2) Democratic presidential candidate. A 5-year election average was calculated based on pooled data from the 2000, 2004, 2008, 2012, and 2016 presidential elections.

Nine *structural constraints* were included in the analysis, including measures for both economic and healthcare constraints. For economic indicators, county typology code was measured as a six-category mutually exclusive variable indicating the type of economic industry a given county was reliant upon between 2010 and 2012: farming, mining, manufacturing, government, recreation, and nonspecialized (referent). Second, low education was a binary variable measuring whether a county had 20 percent or more of its working-age residents earning less than a high school degree or equivalent between 2008 and 2012 (5-year average). Third, low employment was a binary variable measuring whether a county had less than 65 percent of working-age residents (25-64) employed between 2008 and 2012 (5-year average). Finally, persistent poverty was a binary variable measuring whether 20 percent or more of a county's residents were poor based on 1980, 1990, and 2000 censuses, as well as a five-year average across 2007-2011 based on the American Community Survey. All economic indicators were pre-coded by the ERS. Six healthcare constraints were also included focused on healthcare availability and end-of-life care characteristics. For healthcare availability, a measure of the number of hospital beds and nursing home beds per 1,000 residents in 2010 was included. Additionally, the number of hospices per 1,000 residents 65 years of age and older in each county was also included. For end-of-life care, two indicators were included focused exclusively on decedent outcomes during the last six months of life in 2010: 1) the number of hospital admissions and 2) inpatient days.

Finally, this study adjusted for five additional indicators, including demographic composition, a rural/urban scale, and indicators of demographic change. For demographic composition, measures of county-level age (percent of residents 65 years of age or older) and race (percent of residents identifying as Black) as measured by the 2010 census were included. A three-category rural-urban continuum variable was also included to distinguish between both population and adjacency of a county to a metro area, including 1) metro, 2) non-metro and adjacent to a metro area, and 3) non-metro and not adjacent to a metro area. For demographic change, two indicators were included that measured changes in the population over time, including a measure of population loss and a county being a retirement destination. Population loss was measured as a binary variable defined as the population of a given county declining between the 1990 and 2000 census as well as the 2000 and 2010 census. New retirement destination was also a binary variable defined as the total proportion of residents over the age of 60 growing at least 15 percent between 2000 and 2010.

Analytic sample

As of 2021, there were 3,143 counties in the US (including boroughs and census areas in Alaska and parishes in Louisiana, both of which are deemed county-equivalents, but not including Guam, Puerto Rico, and the Virgin Islands). However, this analysis will include fewer counties for several reasons. First, the analysis was restricted to counties within the continental US[7]. Second, counties that reported fewer than ten deaths in the analytic sample in a given year were omitted due to challenges with estimating reliable variation in site of death. Third, counties missing on site of death information were omitted (this was primarily restricted to Oklahoma between 1990 and 1996 and Georgia in 2008 and 2009). Finally, several counties with incomplete trajectory information were omitted. However, the method used in this analysis could account for missingness in trajectories. Therefore, only counties with one or two total observations were omitted (n=8). The consolidation and omission of counties left 3,043 county trajectories in the final trajectory analysis (see Appendix A Table A.7 for a comprehensive list of counties that were omitted from the analytic sample). Of the final counties included in the analysis, 87.51% had complete trajectory information.

Method

Analytic approach

As a way to address heterogeneity in site of death trajectories in the US, this study utilized latent class growth analysis (LCGA) to interrogate place-based disparities in site of death across counties (for detailed information on LCGA as a statistical technique, see Jung and Wickrama 2008). LCGA is a statistical technique that can be used to identify unique and homogeneous

[7] There were a couple of challenges with including Alaska in the analysis due to several changes to FIPS codes over the 27-year period making it challenging to track changes over time for the same geographic space as well as the fact that voting information is not reported at the county-level for Alaska.

latent groups (e.g., subpopulations or subgroups) within a larger heterogeneous population that have a similar pattern of change over time (e.g., growth or trajectory) on a variable of interest (e.g., site of death). Therefore, rather than just considering the overall trend in which there has been a national decline in hospital deaths and a national increase in home deaths, LCGA identifies county subgroups that exhibit divergent trajectories from the entire US population. From this perspective, for example, there are myriad trajectories that a given county could experience over a nearly three-decade period related to site of death. Although some counties may exhibit decreases in hospital death and increases in home deaths (similar to the population trend), there may also be counties that exhibit the opposite (e.g., increases in hospital death and decreases in home death). Furthermore, some counties may exhibit very little or no change over the three-decade period, consistently exhibiting high rates of hospital or home death. LCGA is well suited for investigating variation in site of death over time because it explores the potential for multiple growth trajectories to exist in the same population over the course of nearly three decades. Therefore, this method allows for the detection of unanticipated or small, albeit meaningful, subgroups that may have otherwise gone unnoticed.

The analysis will proceed in two distinct steps. First, LCGA models will be estimated for each of the three outcomes of interest (e.g., percent of deaths occurring in a 1) home, 2) hospital, or 3) nursing home within a county). A stepwise model approach will be implemented to determine the optimal number of latent subgroups. Each model will be compared using Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), as well as an assessment of entropy levels across models. Linear models will be estimated for all three trajectory models. Second, after identifying the county trajectories using LCGA, the structural and cultural constraints will be used to further explore between county variation in site of death. This will expand on the first portion of this analysis by exploring what these county trajectories look like in their economic, social, healthcare, and political composition and will elucidate which kinds of structural and cultural factors shape and constrain county-level site of death trends. Depending on the number of classes identified in the LCGA, I will first compare the structural and cultural constraints across all county trajectories to identify potential sites of variation. Second, I will utilize multinomial logistic regression (assuming there are >2 county trajectories) to examine the relationship between the county-level constraints and site of death trajectories. In other words, I will use multinomial logistic regression to predict membership in the latent class county trajectory based on key place-based measures. About 13 percent of the counties in the sample (n=396) were missing on at least one county-level variable. Therefore, multiple imputation by chained equations (MICE) was utilized to account for the missingness present in the data. Fifteen datasets were imputed. All analyses were conducted in Stata 16.0, and the "traj" plugin was used to estimate LCGA models (Jones and Nagin 2013; StataCorp 2019).

Results

Latent class growth analysis

Table 3.3 provides fit statistics (e.g., AIC, BIC, and entropy) for linear trajectory models for each of the three outcomes (e.g., percent home deaths, percent hospital deaths, and percent nursing home deaths). Results only for linear functions are presented here since quadratic functions did not significantly change the shape of the trajectories. Additional information about model fit can be found in the methodological supplement in Appendix B. Based on the stepwise model approach, a three-class model was selected for all three outcomes. Both the AIC and BIC declined in each subsequent solution up to a seven-class solution for nursing home deaths (Table 3.3). Additionally, entropy remained relatively high for all the class solutions, suggesting that the class solutions were highly distinct from one another. Finally, in terms of meaningfulness and interpretability, a three-class solution provided the most meaningful class solutions. For a detailed accounting of the growth estimates (e.g., intercept and slope) for each class solution, see Appendix A Table A.8.

Table 3.3. LCGA fit statistics

Number of classes	AIC	BIC	Entropy
Percent home death			
1	-335152.86	-335161.89	-
2	-308415.77	-308433.83	0.979
3	-294223.11	-294250.2	0.996
4	Did not converge		
Percent hospital deaths			
1	-321196.17	-321205.2	-
2	-282089.5	-282107.57	0.987
3	-263777.15	-263804.24	0.982
4	-256486.9	-256523.03	0.983
5	-252531.7	-252576.85	0.963
6	Did not converge		
Percent nursing home deaths			
1	-335367.98	-335377.01	-
2	-310987.77	-311005.83	0.969
3	-299308.53	-299335.62	0.98
4	-293620.68	-293656.8	0.979
5	-289388.56	-289433.72	0.943
6	-286064.62	-286118.8	0.989
7	Did not converge		

Note: AIC = Akaike Information Criteria; BIC = Bayesian Information Criteria

Figure 3.1-Figure 3.3 present two important pieces of information: 1) line graphs demonstrating the trajectories based on the LCGA solution for each of the county subgroups, as well as 2) county-level national maps depicting county subgroups to provide an understanding of geographic dispersion and clustering of the counties in each trajectory. Figure 3.1 presents the three-class trajectory model for the percentage of deaths occurring at home in US counties between 1991 and 2017. Trajectory 1 (low increasing group) accounts for almost 56% of counties in the analytic sample and suggests a moderate increase in the overall percentage of deaths occurring at home. An essential feature of this class is that although there was an increase in the overall percentage of deaths occurring at home, these counties had a low percentage of deaths at home in the early 1990s (~15%). Finally, Trajectory 1 is most similar to the national

home death trend. Trajectory 2 (medium increasing group) accounts for almost 35% of counties in the analytic sample. This subpopulation is similar to the first one with a couple of notable differences: 1) the trajectory of this subgroup (e.g., slope) is slightly steeper than for Trajectory 1 suggesting a more drastic shift to home death over the period and 2) a higher percentage of deaths occurring at home during the early 1990s (~25%). Trajectory 3 (high stable group) accounts for about 9% of the counties in the analytic sample and is characterized by high and relatively stable levels (~7% increase over the period) of home death over the 27-year period.

Figure 3.1. Three-class LCGA solution for percentage of deaths that occurred at home, 1991-2017

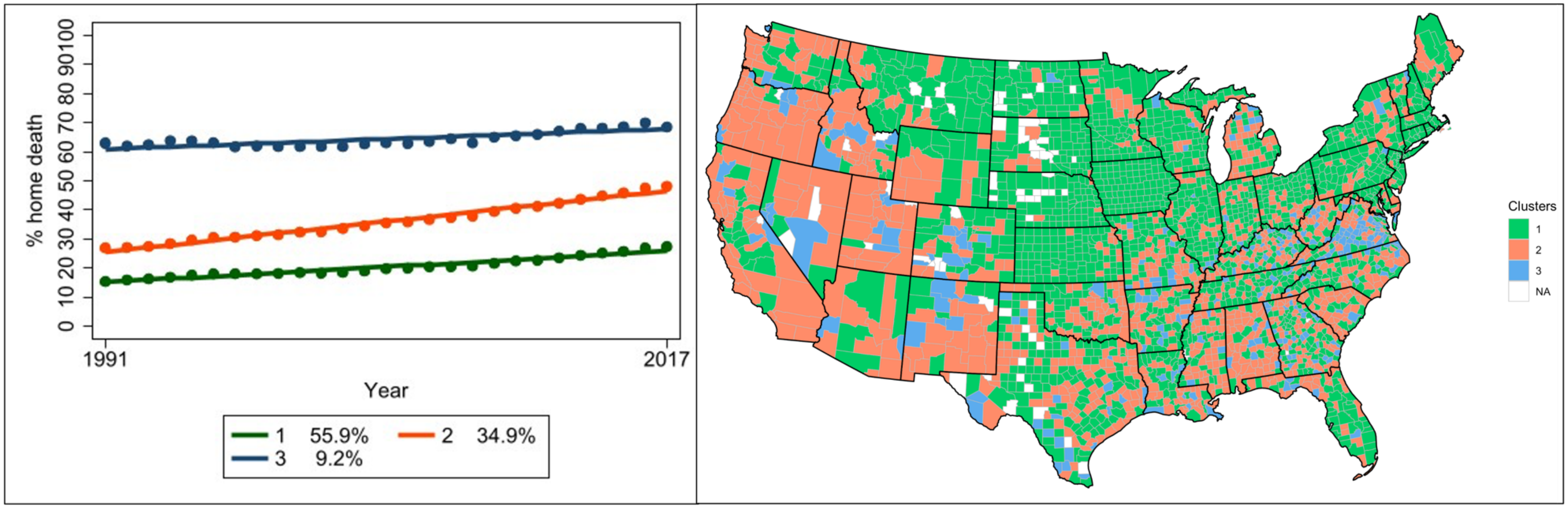


Figure 3.2 presents the three-class trajectory model for the percentage of hospital deaths occurring in US counties between 1991 and 2017. Trajectory 1 (low stable group) accounts for nearly 18% of all counties and is characterized by very low rates of hospital death over the entire 27-year period. Trajectory 2 (medium decreasing group) accounts for almost 46% of counties in the US and is characterized by a gradual decline in the percentage of hospital deaths occurring over the 27-year period. This trajectory looks most similar to the national hospital death trend. Finally, Trajectory 3 (high decreasing group) accounts for 36.4% of counties. Trajectories 2 and 3 look alike in their slope (exhibiting a gradual decline in the percent of hospital deaths), but overall Trajectory 3 exhibits a higher percentage of deaths occurring in hospitals over the entire period.

Figure 3.2. Three-class LCGA solution for percent of hospital deaths occurring at the county-level, 1991-2017

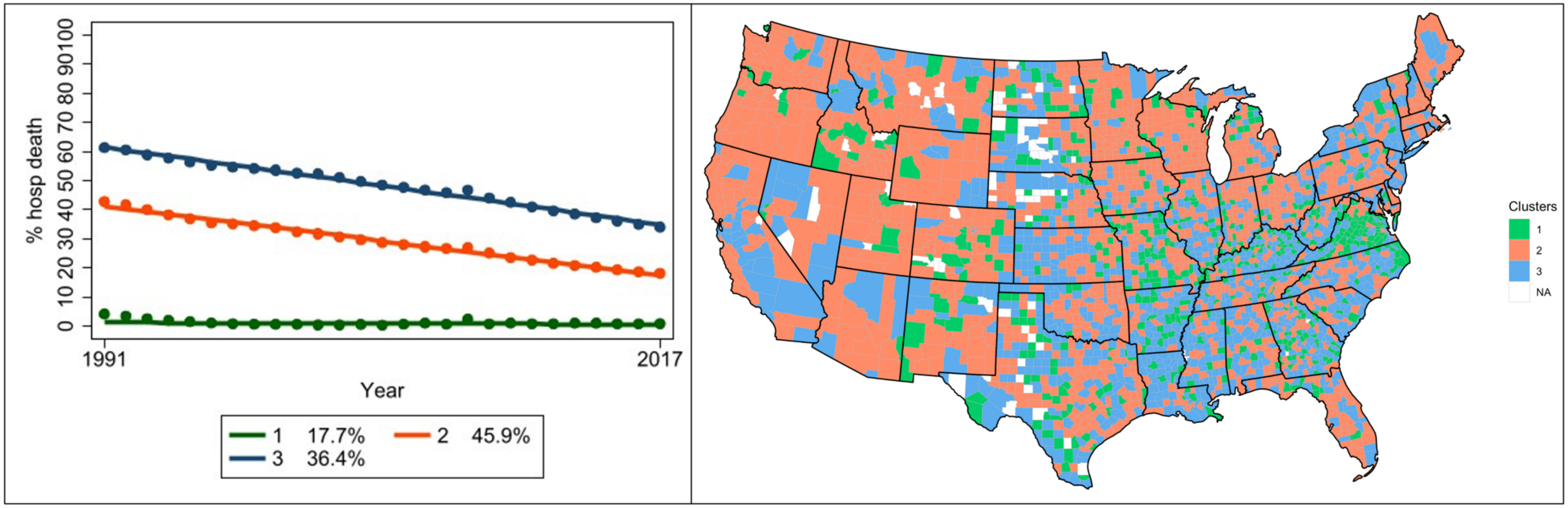
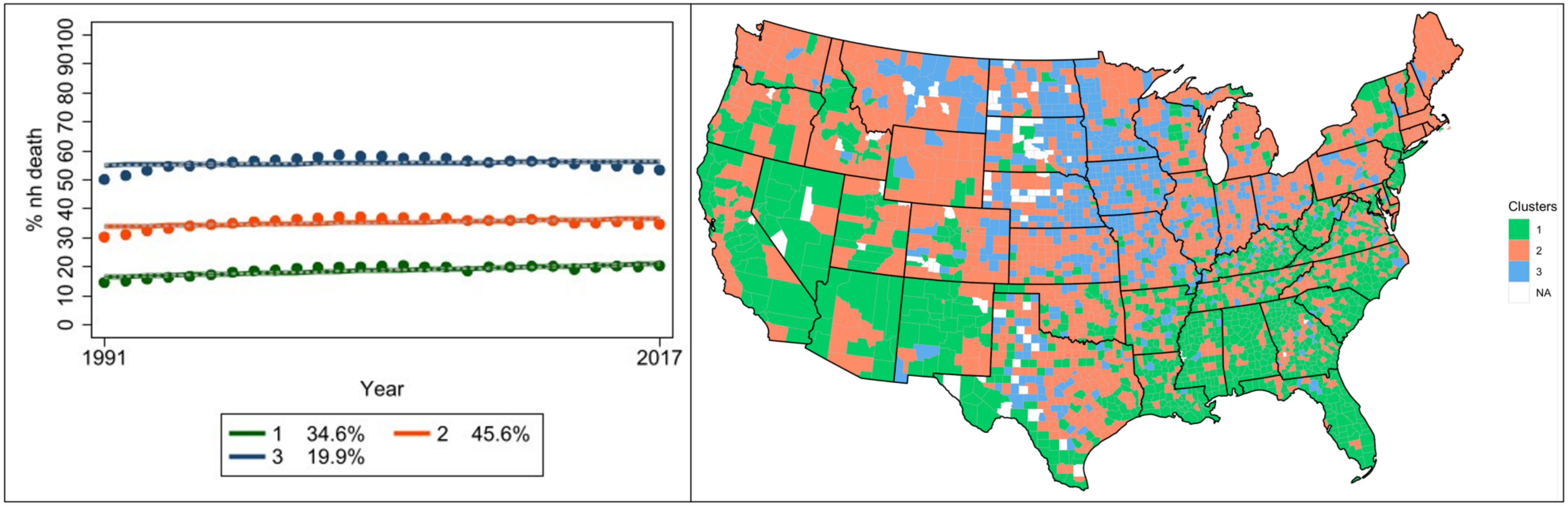


Figure 3.3 presents the three-class trajectory model for the percent of nursing home deaths occurring in US counties between 1991 and 2017. All three trajectories are very similar in their change over time in that they were all very stable across time. However, the main difference is in the overall percentage of nursing home deaths occurring in each trajectory with low, moderate, and high rates of nursing home death, respectively. Many of the counties (45.6%) fell into Trajectory 2 (medium stable group), with a moderate rate of nursing home death. Trajectories 1 (high stable group) and 3 (low stable group) appeared to be divergent trajectories with lower and higher than average rates of nursing home death, respectively.

Figure 3.3. Three-class LCGA solution for percent of nursing home deaths occurring at the county-level in the US, 1991-2017



Finally, looking at the maps for each outcome (Figure 3.1-Figure 3.3), there is considerable within-state variation, suggesting that these changes are meaningful at the county level and not merely a function of state policy. Additionally, it is important to note that these counties did not map neatly onto each other across outcomes. For example, for percentage of home deaths, of the counties that were identified as Trajectory 1, 4.47%, 43.08%, and 52.44% belonged in the first, second, and third trajectories for the second outcome (percent of hospital deaths), respectively. Hence, even among counties that had a similar home death trajectory, there is still variation in their hospital (and nursing home) death trajectories.

Descriptive statistics

Table 3.4 provides descriptive information for the three-class trajectory models for all three outcomes (e.g., percentage of home, hospital, and nursing home deaths). To test for significance, the point estimates of two trajectories were compared to the 95% confidence interval of the trajectory that most closely approximated the population trend. Due to the large sample size, most relationships are statistically significant. However, to remain concise, interpretation is only provided for substantively significant results. Additionally, I will refer only to the trajectory names rather than the trajectory numbers.

Table 3.4. Descriptive statistics for final trajectories stratified by site of death, 1991-2017

		Home Death Trajectories			Hospital Death Trajectories			Nursing Home Death Trajectories		
	Overall	1 Low increasing	2 Medium increasing	3 High stable	1 Low stable	2 Medium decreasing	3 High decreasing	1 Low stable	2 Medium stable	3 High stable
CULTURAL CONSTRAINTS	M/%		M/%			M/%			M/%	
Religious										
Evangelical protestant adherents per 1,000	223.92	224.68	249.86 *	229.32	237.83 *	206.49	266.44 *	265.95 *	216.70	217.66
Mainline protestant adherents per 1,000	115.79	144.75	81.88 *	68.83 *	115.69 *	123.42	106.26 *	74.69 *	109.17	202.09 *
Catholic adherents per 1,000	125.55	150.00	95.10 *	92.91 *	106.30 *	135.29	122.66 *	107.06 *	127.85	152.37 *
Political										
Percent voting Democratic, 5-year average	38.25	38.99	37.17 *	37.84 *	35.98 *	37.44	40.35 *	41.48 *	37.38	34.60 *
Percent voting Republican, 5-year average	59.13	58.32	60.29 *	59.72 *	61.56 *	59.68	57.28 *	56.24 *	59.83	62.56 *
STRUCTURAL CONSTRAINTS										
Economic										
County Typology Code										
Farming dependent	13.24	15.89	9.48 *	11.47 *	23.05 *	12.48	9.45 *	4.37 *	10.40	35.09 *
Mining dependent	6.93	6.36	7.98 *	6.45	5.39 *	7.17	7.38	6.94	7.51	5.60 *
Manufacturing dependent	16.43	15.30	18.97 *	13.62 *	15.24 *	19.80	12.78 *	14.45 *	17.05	18.45
Government dependent	12.78	12.54	12.49	15.41 *	13.01 *	9.40	16.22 *	16.73 *	12.07	7.58 *
Recreation dependent	10.29	6.83	14.08 *	16.85 *	11.71	13.13	6.03 *	11.03	12.43	4.12 *
Nonspecialized	40.32	43.08	37.00 *	36.20 *	31.60 *	38.02	47.43 *	46.48 *	40.53	29.16 *
Low education	15.02	10.42	19.34 *	26.52 *	18.77 *	10.98	18.27 *	24.81 *	10.48	8.40 *
Low employment	29.21	17.01	42.63 *	52.33 *	37.73 *	24.68	30.78 *	44.11 *	24.49	14.17 *
Persistent poverty	11.27	7.59	15.21 *	18.64 *	14.50 *	6.60	15.57 *	21.29 *	6.43	4.94 *
Healthcare										
Hospital beds per 1,000 residents	3.38	4.71	2.06 *	0.38 *	0.27 *	3.08	5.28 *	3.68 *	3.37	2.91 *
Nursing home beds per 1,000 residents	0.55	0.79	0.28 *	0.08 *	0.12 *	0.45	0.89 *	0.73 *	0.55	0.23 *
Number of hospices per 1,000 residents over 65 years of age	0.12	0.14	0.10 *	0.06 *	0.04 *	0.12	0.15 *	0.13	0.12	0.10 *
Hospital admissions per decedent during the last six months of life	1.37	1.37	1.36	1.33 *	1.32 *	1.30	1.46 *	1.44 *	1.34	1.28 *
Inpatient days per decedent during the last six months of life	8.22	8.24	8.21	8.19	8.02 *	7.56	9.16 *	9.17 *	7.95	7.20 *
CONTROLS										
Percent 65+	15.89	16.01	15.62 *	16.23 *	16.90 *	16.18	15.05 *	14.62 *	15.99	17.88 *
Percent Black	9.10	8.09	10.15 *	11.23 *	8.91 *	5.58	13.61 *	16.55 *	6.17	2.87 *
Percent Foreign Born	4.70	5.11	4.32 *	3.65 *	3.03 *	4.50	5.76 *	6.00 *	4.44	3.05 *
Rural/Urban Continuum Code										
Metro	37.99	38.79	35.96 *	40.86	38.48 *	35.44	40.95 *	45.53 *	37.79	25.37 *
Nonmetro, adjacent	33.32	29.49	39.53 *	32.97 *	30.11 *	39.17	27.54 *	31.18 *	34.32	34.76
Nonmetro, nonadjacent	28.69	31.72	24.51 *	26.16 *	31.41 *	25.39	31.50 *	23.29 *	27.89	39.87 *
Population loss	16.20	21.60	10.14 *	6.45 *	16.17 *	14.20	18.72 *	10.08 *	14.16	31.47 *
New retirement destination	14.43	10.48	19.53 *	19.00 *	17.47	17.22	9.45 *	16.63 *	14.60	10.21 *

Note: M=mean; %=percent; * denotes a significant difference between a trajectory and the reference group (ref)
n = 3,043

Home death trajectories

For home death trajectories, the low increasing group most closely resembled the national trend. This group had high rates of Mainline Protestant and Catholic adherents. Counties in the low increasing group were also likely to be nonspecialized in terms of economic type. Counties in this group were less likely to report low education, low employment, and persistent poverty. This group also had the highest levels of healthcare access of the three groups.

To test for significant differences between groups, the medium increasing and high stable groups were compared to the low increasing group. I will first focus on the medium increasing group. Compared with the low increasing group, the medium increasing group had higher average rates of Evangelical adherents and lower than average rates of Mainline Protestant and Catholic adherents. In terms of county typology, this group was also more likely to depend on manufacturing and recreation. In terms of economic outcomes, this group was more likely to be experiencing low education (19.34%), low employment (42.63%), and persistent poverty (15.21%). In terms of healthcare outcomes, this group had fewer hospital beds, nursing home beds, and hospices than the low increasing group. Finally, this group was more likely to be nonmetro and adjacent to a metro region and be a new retirement destination while also being less likely to be a nonmetro area that was nonadjacent to a metro area and to be both a site of population loss. The high stable group was similar to counties in Trajectory 2 with a few exceptions. First, a larger proportion of counties in the high stable group were experiencing economic disadvantage including low education (26.52%), low employment (52.33%), and persistent poverty (18.64%). Additionally, counties in this group had the lowest levels of healthcare availability of all three trajectories.

Hospital death trajectories

For hospital death trajectories, the medium decreasing group most closely resembled the national trend. This group had high rates of Mainline Protestant and Catholic adherents. Counties in the medium decreasing group were also likely to be dependent upon recreation or manufacturing, compared to the other groups. Counties in this group were less likely to report low education, low employment, and persistent poverty. This group also had the most moderate levels of healthcare access of the three groups.

To test for significant differences between groups, the low stable group and the high decreasing were compared to the medium decreasing group. I will first focus on the moderate decreasing group. Relative to the moderate decreasing group, the high stable group had higher average rates of Evangelical Protestant adherents and lower average rates of Mainline Protestant and Catholic adherents. In terms of county typology, this group was more likely to be economically dependent upon farming (23.05%). In terms of other economic outcomes, counties in Trajectory 1 were more likely to be experiencing low education (18.77%), low employment (37.73%), and persistent poverty (14.5%). In terms of healthcare factors, this group had fewer hospital beds, nursing home beds, and hospices relative to the moderate decreasing group. For controls, the high stable group had a higher, on average, percent of the population that identified as Black and a lower, on average, percent of the population that identified as foreign born. Finally, the high stable group was more likely to be metro or nonmetro nonadjacent

Relative to the medium decreasing group, the high decreasing group exhibited a significantly larger proportion of Evangelical Protestant adherents (266.44 versus 206.49). Counties in this trajectory were also more likely to be economically dependent on government (16.22%) or were economically nonspecialized (47.43%). In terms of economic outcomes, these counties were also economically disadvantaged with a larger percentage of counties exhibiting low education (18.22%), low employment (30.78%), and persistent poverty (15.57%). In terms of healthcare access, these counties had, on average, more healthcare availability with 5.38 hospital beds and .89 nursing home beds per 1,000 residents and 0.15 hospices per 1,000 residents over 65 years of age. These counties also exhibited higher rates of hospital admissions and longer inpatient hospital stays for decedents in the last six months of life. Finally, these counties were also characterized by an, on average, larger proportion of county residents identifying as Black and being foreign born; they were also more likely to be metro or nonmetro and nonadjacent counties; and were more likely to have experienced population loss.

Nursing home death trajectories

For nursing home death trajectories, the medium stable group most closely resembled the national trend. Counties in this group had average rates of religious adherents, relative to the other two trajectories. In terms of economic and healthcare outcomes, counties in this group looked fairly average and did not stand out as exceptionally low or high. However, counties in this group had, on average, a low percentage of the population that identified as Black.

To test for significant differences between groups, the low stable group and the high stable group were compared to the medium stable group. I will first focus on the low stable group. Relative to the medium stable group, counties in the low stable group had an on average higher proportion of Evangelical protestant adherents and on average lower proportion of both Mainline protestant and Catholic adherents. Counties in this group had an on average higher proportion of residents voting Democratic and were more likely to be economically dependent on government. In terms of economic outcomes, a larger proportion of counties in this group were experiencing economic disadvantage including low education (24.81%), low employment

(44.11%), and persistent poverty (21.29%). In terms of healthcare, these counties had more hospital beds and nursing home beds relative to the medium stable group. These counties also had higher rates of hospital admission and longer inpatient hospital stays for decedents in the last six months of life. Counties in this trajectory also had an on average higher percent of residents who were Black or foreign born. Finally, these counties were most often metro (45.53%) and a new retirement destination.

Relative to the medium stable group, counties in the high stable group had, on average, a higher proportion of Mainline protestant and Catholic adherents. This group also had a higher percentage of residents voting Republican (62.56% versus 59.83%) with over a third (35.09%) of all counties being economically dependent upon farming. Counties in this group were also the least likely to be economically dependent on recreation (4.12%). In terms of economic outcomes, counties in this group were faring better than the medium stable group with only a small percentage of counties experiencing low education (8.4%), low employment (14.17%), and persistent poverty (4.94%). Counties in this group were also on average older and had fewer Black and foreign-born residents. Finally, counties in this group were most likely (39.87%) to be nonmetro and nonadjacent to a metro area with more counties experience population loss relative to the medium stable group.

Multivariate Results

<u>Home death trajectories</u>

Relative risk ratios and 95% confidence intervals for each home death trajectory (compared to the low increasing group) are presented in Table 3.5. For the home death trajectories, cultural constraints were not substantively or significantly associated with greater odds of being in either the medium increasing or high stable groups (Model 3). I will first focus my attention on the unique features of the high increase group and then will move my attention to the high stable group. In terms of economic outcomes, being economically dependent on recreation relative to being nonspecialized (RRR=2.07, $p<.001$) was associated with significantly higher odds of being in the medium increasing group and being economically dependent on government relative to being nonspecialized was associated with significantly lower odds (RRR=0.72, $p<.05$) of being in this group. Low employment was also significantly associated with higher odds (RRR=2.10, $p<.001$) of a county belonging to this group. In terms of healthcare outcomes, four of the six outcomes were substantively and significantly associated with being in this group in the final model. Both the number of hospital beds (RRR=0.77, $p<.001$) and nursing home beds per 1,000 residents (RRR=0.20, $p<.001$) were significantly associated with lower odds of being in this group. Additionally, the number of hospital admissions per decedent during the last six months of life was significantly associated with lower odds (RRR=0.28, $p<.001$) of being in this group while the number of inpatient days per decedent during the last six months of life was significantly associated with higher odds (RRR=1.11, $p<.05$). Overall, this suggests that the medium increasing group was much more likely to be composed of counties that were economically disadvantaged and had less readily available healthcare.

Table 3.5. Multinomial logistic regression assessing the association between county-level variables and trajectory membership for home deaths, 1991-2017

	Model 1				Model 2				Model 3			
	Trajectory 2 – Medium increasing (n=1,065)		Trajectory 3 – High stable (n=279)		Trajectory 2 – Medium increasing		Trajectory 3 – High stable		Trajectory 2 – Medium increasing		Trajectory 3 – High stable	
	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)
Cultural constraints												
Religious												
Evangelical adherents per 1k residents	1.00***	(1.00-1.00)	1.00***	(1.00-1.00)					1.00*	(1.00-1.00)	1.00	(1.00-1.00)
Mainline Protestant adherents per 1k residents	0.99***	(0.99-0.99)	0.98***	(0.98-0.99)					0.99***	(0.99-0.99)	0.99***	(0.98-0.99)
Catholic adherents per 1k residents	1.00***	(1.00-1.00)	1.00***	(0.99-1.00)					1.00***	(1.00-1.00)	1.00***	(1.00-1.00)
Political												
Percent voting Democratic; 5-year average	1.03	(0.96-1.11)	1.23***	(1.09-1.39)					0.95	(0.85-1.05)	1.14	(0.93-1.39)
Percent voting Republican; 5-year average	1.05	(0.98-1.13)	1.25***	(1.11-1.41)					0.96	(0.86-1.06)	1.13	(0.93-1.37)
Structural constraints												
Economic												
County Typology Code (Ref: Nonspecialized)												
Farming dependent					0.63**	(0.46-0.86)	0.23***	(0.13-0.40)	1.44	(0.98-2.11)	0.65	(0.34-1.27)
Mining dependent					1.24	(0.86-1.77)	0.60	(0.29-1.25)	1.43	(0.96-2.12)	1.03	(0.46-2.28)
Manufacturing dependent					1.06	(0.82-1.36)	0.78	(0.46-1.32)	1.26	(0.96-1.65)	1.04	(0.59-1.81)
Government dependent					0.82	(0.61-1.10)	0.57*	(0.32-1.00)	0.72*	(0.53-0.98)	0.56	(0.31-1.01)
Recreation dependent					2.01***	(1.47-2.75)	1.50	(0.86-2.63)	2.07***	(1.44-2.97)	1.34	(0.71-2.54)
Low education					1.29	(0.97-1.71)	1.84*	(1.13-2.99)	0.94	(0.68-1.30)	1.37	(0.79-2.40)
Low employment					3.12***	(2.48-3.92)	4.20***	(2.77-6.37)	2.10***	(1.61-2.74)	2.41***	(1.49-3.89)
Persistent poverty					1.23	(0.88-1.71)	0.95	(0.54-1.65)	1.34	(0.91-1.95)	1.14	(0.60-2.17)
Healthcare												
Hospital beds per 1,000 residents					0.75***	(0.72-0.78)	0.33***	(0.27-0.40)	0.77***	(0.74-0.80)	0.35***	(0.29-0.42)
Nursing home beds per 1,000 residents					0.30***	(0.23-0.39)	0.00***	(0.00-0.00)	0.20***	(0.14-0.28)	0.00***	(0.00-0.00)
Number of hospices per 10,000 residents over 65 years of age					0.60*	(0.37-0.95)	0.70	(0.28-1.78)	0.69	(0.42-1.14)	1.24	(0.45-3.37)
Hospital admissions per decedent during the last six months of life					0.14***	(0.07-0.28)	0.02***	(0.00-0.08)	0.28***	(0.13-0.59)	0.06***	(0.01-0.27)
Inpatient days per decedent during the last six months of life					1.22***	(1.12-1.33)	1.55***	(1.31-1.84)	1.11*	(1.02-1.22)	1.32**	(1.09-1.59)
Controls												
Percent 65+									1.02	(0.99-1.06)	1.09**	(1.03-1.16)
Percent Black									1.01	(1.00-1.02)	1.00	(0.98-1.01)
Percent Foreign Born									1.02	(1.00-1.04)	1.00	(0.96-1.05)
Rural/Urban Continuum Code (Ref: Metro)												
Nonmetro, adjacent									0.73*	(0.56-0.95)	0.36***	(0.22-0.58)
Nonmetro, nonadjacent									0.48***	(0.35-0.65)	0.19***	(0.11-0.34)
Population loss									1.08	(0.78-1.51)	0.67	(0.33-1.35)
New retirement destination									0.88	(0.66-1.17)	0.85	(0.51-1.41)

Notes: Trajectory 1 is the referent (n=1,699); RRR = relative risk ratio; CI = confidence interval
* p<0.05; ** p<0.01; *** p<0.001

Now shifting focus back to the high stable group, counties in this group did not differ from the low increasing group in terms of county typology codes. In terms of economic outcomes, low employment was significantly associated with higher odds (RRR=2.41, $p<.001$) of a county being in the high stable group. In terms of healthcare outcomes, four of the six outcomes were substantive and significantly associated with being in this group. Both the number of hospital beds (RRR=0.35 $p<.001$) and nursing home beds per 1,000 residents (RRR=0.00, $p<.001$) was significantly associated with lower odds of being in this group. Additionally, the number of hospital admissions per decedent during the last six months of life was significantly associated with lower odds (RRR=0.06, $p<.001$) of being in this group. Finally, the number of inpatient days per decedent during the last six months of life was associated with higher odds (RRR=1.32, $p<0.01$) of belonging to this group. Finally, being a nonmetro county, both adjacent (RRR=0.73, $p<.05$; RRR=0.36, $p<.001$) and nonadjacent (RRR=0.48, $p<.001$; RRR=0.19, $p<.05$) relative to being a metro county, was significantly associated with lower odds of belonging to either the medium increasing or high stable group, respectively, relative to the low increasing group. Similar to the high increasing group, the high stable group also was much more likely to be composed of counties that were both economically disadvantaged and had fewer readily available healthcare resources, including both hospitals and nursing home beds.

<u>Hospital death trajectories</u>

Relative risk ratios and confidence intervals for each hospital death trajectory (compared to the medium decreasing group) are presented in Table 3.6. For the hospital death trajectories, cultural constraints were not substantively or significantly associated with greater odds of being in either the low stable or high decreasing group after the inclusion of structural constraints and controls (Model 3). I will first focus my attention on the unique features of the low stable group and then will move my attention to the high and decreasing group. County typology code and other economic outcomes were not associated with being in the low stable group relative to the medium decreasing group. In terms of healthcare outcomes, all six of the outcomes were substantively and significantly associated with odds of a county being in in this group in the final model. The number of hospital beds (RRR=0.20, p<.001), nursing home beds per 1,000 residents (RRR=0.00, p<.001), and number of hospices per 1,000 residents over 65 years of age (RRR=0.28, p<.001) were significantly associated with lower odds of being in this group. Additionally, the number of hospital admissions per decedent during the last six months of life was significantly associated with lower odds (RRR=0.11, p<.001) of being in this group while the number of inpatient days per decedent during the last six months of life was significantly associated with higher odds (RRR=1.37, p<.001). Overall, this suggests that the low stable group was much more likely to be composed of counties that had less readily available healthcare as well as residents who were older.

Table 3.6. Multinomial logistic regression assessing the association between county-level variables and trajectory membership for hospital deaths, 1991-2017

	Model 1				Model 2				Model 3			
	Trajectory 1 – Low stable (n=538)		Trajectory 3 – High increasing (n=1,111)		Trajectory 1 – Low stable		Trajectory 3 – High increasing		Trajectory 1 – Low stable		Trajectory 3 – High increasing	
	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)
Cultural constraints												
Religious												
Evangelical adherents per 1k residents	1.00	(1.00-1.00)	1.00***	(1.00-1.00)					1.00	(1.00-1.00)	1.00***	(1.00-1.00)
Mainline Protestant adherents per 1k residents	1.00	(1.00-1.00)	1.00	(1.00-1.00)					1.00	(1.00-1.00)	1.00	(1.00-1.00)
Catholic adherents per 1k residents	1.00**	(1.00-1.00)	1.00	(1.00-1.00)					1.00	(1.00-1.00)	1.00	(1.00-1.00)
Political												
Percent voting Democratic president; 5-year average	1.22***	(1.11-1.34)	1.19***	(1.10-1.28)					1.10	(0.93-1.30)	0.95	(0.86-1.06)
Percent voting Republican president; 5-year average	1.23***	(1.12-1.35)	1.16***	(1.07-1.24)					1.10	(0.93-1.30)	0.95	(0.86-1.05)
Structural constraints												
Economic												
County Typology Code (Ref: Nonspecialized)												
Farming dependent					2.07**	(1.24-3.47)	0.45***	(0.31-0.65)	1.57	(0.89-2.78)	0.45***	(0.29-0.68)
Mining dependent					0.80	(0.41-1.58)	0.76	(0.52-1.10)	0.78	(0.38-1.60)	0.66*	(0.45-0.99)
Manufacturing dependent					0.82	(0.54-1.26)	0.74*	(0.57-0.96)	0.79	(0.51-1.23)	0.67**	(0.51-0.89)
Government dependent					1.34	(0.81-2.22)	1.68***	(1.26-2.24)	1.61	(0.94-2.75)	1.65**	(1.20-2.25)
Recreation dependent					0.68	(0.41-1.11)	0.66*	(0.47-0.93)	0.67	(0.38-1.16)	1.03	(0.70-1.52)
Low education					0.85	(0.54-1.33)	1.24	(0.93-1.66)	1.09	(0.66-1.82)	0.86	(0.62-1.19)
Low employment					0.81	(0.56-1.17)	0.90	(0.71-1.14)	0.69	(0.45-1.05)	0.83	(0.63-1.09)
Persistent poverty					1.52	(0.91-2.56)	1.49*	(1.06-2.09)	1.46	(0.81-2.64)	0.78	(0.53-1.16)
Healthcare												
Hospital beds per 1,000 residents					0.19***	(0.15-0.23)	1.19***	(1.15-1.22)	0.20***	(0.17-0.24)	1.18***	(1.15-1.22)
Nursing home beds per 1,000 residents					0.00***	(0.00-0.01)	1.25***	(1.13-1.39)	0.00***	(0.00-0.00)	1.20**	(1.06-1.36)
Number of hospices per 10,000 residents over 65 years of age					0.27**	(0.11-0.69)	2.36***	(1.51-3.69)	0.28**	(0.11-0.72)	1.50	(0.95-2.38)
Hospital admissions per decedent during the last six months of life					0.13***	(0.04-0.42)	2.59**	(1.31-5.15)	0.11***	(0.03-0.39)	2.84**	(1.34-6.04)
Inpatient days per decedent during the last six months of life					1.40***	(1.20-1.63)	1.40***	(1.28-1.52)	1.37***	(1.16-1.61)	1.35***	(1.23-1.49)
Controls												
Percent 65+									1.07**	(1.02-1.13)	0.94***	(0.90-0.97)
Percent Black									1.01	(0.99-1.02)	1.03***	(1.02-1.04)
Percent Foreign Born									0.96	(0.92-1.00)	1.03**	(1.01-1.06)
Rural/Urban Continuum Code (Ref: Metro)												
Nonmetro, adjacent									0.45***	(0.30-0.67)	1.00	(0.76-1.31)
Nonmetro, nonadjacent									0.70	(0.43-1.15)	1.98***	(1.44-2.73)
Population loss									1.15	(0.65-2.03)	1.36	(0.98-1.88)
New retirement destination									0.95	(0.62-1.45)	0.68*	(0.50-0.93)

Notes: Trajectory 2 is the referent (n=1,394); RRR = relative risk ratio; CI = confidence intervals
* p<0.05; ** p<0.01; *** p<0.001

Now I will shift focus to the high decreasing group. In terms of economic outcomes, being economically dependent upon farming (RRR=0.45, p<.001), mining (RRR=0.66, p<.05), and manufacturing (RRR=0.67, p<.01) relative to being economically nonspecialized was associated with lower odds of belonging to the high decreasing group relative to the medium decreasing group. Additionally, being economically dependent upon government (RRR=1.65, p<.01) relative to being nonspecialized was associated with higher odds of belonging to this group. In terms of healthcare outcomes, five of the six outcomes were substantive and significantly associated with being in this group. Both the number of hospital beds (RRR=1.18, p<.001) and nursing home beds per 1,000 residents (RRR=1.20, p<.01) was significantly associated with higher odds of being in this group. Additionally, the number of hospital admissions (RRR=2.84, p<.001) and inpatient days (RRR=1.35, p<.001) per decedent during the last six months of life were significantly associated with higher odds of being in this group. Finally, in terms of controls, the percent of the county population composed of older adults (RRR=0.94, p<.001) was significantly associated with lower odds of belonging to the high decreasing group while the percent of the county population being composed of Black (RRR=1.03, p<.001) and foreign-born residents (RRR=1.03, p<.01) was associated with higher odds of belonging to the high decreasing group relative to the medium decreasing group. This suggests that counties in the high decreasing group were more likely to rely on government work, had higher levels of healthcare accessibility and healthcare utilization in the last six months of life, and had a younger population that was also more likely to be Black and foreign born.

Nursing home death trajectories

Relative risk ratios and confidence intervals for each nursing home death trajectory (compared to the medium stable group) are presented in Table 3.7. For the nursing home death trajectories, religious adherents were not substantively or significantly associated with greater odds of being in either the low stable or high stable groups (Model 3). I will first focus my attention on the unique features of the low stable group and then will move my attention to the high stable group. For political outcomes, both the percent of a county voting Democratic and Republican (RRR=0.87, $p<.01$) were associated with lower odds of belonging to the low stable group, after controlling for structural constraints and controls.

Table 3.7. Multinomial logistic regression assessing the association between county-level variables and trajectory membership for nursing home deaths, 1991-2017

	Model 1				Model 2				Model 3			
	Trajectory 1 – Low stable (n=1,052)		Trajectory 3 – High stable (n=607)		Trajectory 1 – Low stable		Trajectory 3 – Medium stable		Trajectory 1 – Low stable		Trajectory 3 – Medium stable	
	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)
Cultural constraints												
Religious												
Evangelical adherents per 1k residents	1.00***	(1.00-1.00)	1.00*	(1.00-1.00)					1.00***	(1.00-1.00)	1.00*	(1.00-1.00)
Mainline Protestant adherents per 1k residents	0.99***	(0.99-0.99)	1.01***	(1.01-1.01)					0.99***	(0.99-1.00)	1.01***	(1.01-1.01)
Catholic adherents per 1k residents	1.00*	(1.00-1.00)	1.00***	(1.00-1.00)					1.00	(1.00-1.00)	1.00***	(1.00-1.00)
Political												
Percent voting Democratic president; 5-year average	1.26***	(1.17-1.36)	0.97	(0.88-1.06)					0.87**	(0.79-0.95)	1.06	(0.93-1.20)
Percent voting Republican president; 5-year average	1.21***	(1.12-1.31)	0.98	(0.90-1.08)					0.87**	(0.79-0.95)	1.06	(0.94-1.21)
Structural constraints												
Economic												
County Typology Code (Ref: Nonspecialized)												
Farming dependent					0.38***	(0.26-0.58)	3.59***	(2.62-4.92)	0.53**	(0.34-0.84)	1.99***	(1.37-2.89)
Mining dependent					0.75	(0.52-1.09)	0.82	(0.53-1.28)	1.09	(0.74-1.62)	0.86	(0.53-1.41)
Manufacturing dependent					0.90	(0.69-1.16)	1.22	(0.91-1.63)	0.98	(0.74-1.30)	1.11	(0.81-1.52)
Government dependent					1.09	(0.84-1.43)	0.85	(0.58-1.24)	0.98	(0.74-1.31)	1.29	(0.85-1.95)
Recreation dependent					1.28	(0.96-1.70)	0.28***	(0.17-0.45)	1.98***	(1.41-2.77)	0.28***	(0.17-0.48)
Low education					1.69***	(1.30-2.21)	0.76	(0.51-1.11)	1.09	(0.80-1.47)	1.84**	(1.17-2.90)
Low employment					1.71***	(1.38-2.11)	0.51***	(0.38-0.69)	1.63***	(1.26-2.10)	0.72	(0.50-1.02)
Persistent poverty					2.14***	(1.57-2.92)	1.05	(0.64-1.72)	1.35	(0.94-1.93)	1.28	(0.73-2.24)
Healthcare												
Hospital beds per 1,000 residents					1.04***	(1.02-1.06)	0.94***	(0.91-0.96)	1.07***	(1.05-1.10)	0.89***	(0.86-0.92)
Nursing home beds per 1,000 residents					1.02	(0.96-1.09)	0.33***	(0.23-0.48)	0.93*	(0.87-0.99)	0.49***	(0.33-0.74)
Number of hospices per 10,000 residents over 65 years of age					1.58*	(1.03-2.41)	0.55*	(0.32-0.93)	1.49	(0.92-2.41)	0.42**	(0.23-0.75)
Hospital admissions per decedent during the last six months of life					0.30***	(0.16-0.57)	0.43	(0.18-1.02)	0.97	(0.46-2.05)	0.16***	(0.06-0.44)
Inpatient days per decedent during the last six months of life					1.47***	(1.36-1.59)	0.92	(0.82-1.03)	1.31***	(1.20-1.43)	1.00	(0.88-1.15)
Controls												
Percent 65+									0.97*	(0.94-1.00)	1.05*	(1.01-1.09)
Percent Black									1.04***	(1.03-1.05)	0.98**	(0.96-0.99)
Percent Foreign Born									1.05***	(1.03-1.08)	0.93***	(0.90-0.97)
Rural/Urban Continuum Code (Ref: Metro)												
Nonmetro, adjacent									0.81	(0.63-1.04)	0.83	(0.61-1.13)
Nonmetro, nonadjacent									0.84	(0.62-1.13)	0.89	(0.63-1.28)
Population loss									0.73	(0.51-1.04)	0.86	(0.60-1.23)
New retirement destination									1.15	(0.87-1.50)	1.25	(0.87-1.79)

Notes: Trajectory 2 is the referent (n=1,384); RRR = relative risk ratio; CI = confidence intervals
* p<0.05; ** p<0.01; *** p<0.001

In terms of economic outcomes, being economically dependent on farming (RRR=0.53, p<.01) relative to being nonspecialized was associated with lower odds of belonging to the low stable group, while economic dependency on recreation (RRR=1.98, p<.001) relative to being nonspecialized was associated with higher odds of belonging to the low stable group. Additionally, low employment (RRR=1.63, p<.001) was associated with higher odds of belonging to this group. In terms of healthcare outcomes, three of the six outcomes were substantively and significantly associated with odds of a county being in this group in the final model. The number of hospital beds (RRR=1.07, p<.001) was significantly associated with higher odds of being in this group while the number of nursing home beds per 1,000 residents (RRR=0.93, p<.05) was associated with lower odds of belonging to this group. Additionally, the number of inpatient days per decedent during the last six months of life was significantly associated with higher odds (RRR=1.31, p<.001). Finally, in terms of controls, the percent of the county population composed of older adults (RRR=0.97, p<.051) was significantly associated with lower odds of belonging to the low stable group, while the percent of the county population being composed of Black (RRR=1.05, p<.001) and foreign-born residents (RRR=1.05, p<.001) was associated with higher odds of belonging to the low stable group relative to the medium stable group. Overall, this suggests that the low stable group was composed of counties that had economic challenges related to employment, had lower rates of available nursing home beds and higher rates of hospital utilization at the end of life. The counties in this trajectory were also more likely to be younger and more racially diverse.

Now shifting focus to the high stable group, in terms of economic outcomes, being economically dependent upon farming (RRR=1.99, p<.001) relative to being nonspecialized was associated with lower odds of belonging to the high stable group relative to the medium stable group. Additionally, low education (RRR=1.84, p<.01) was associated with higher odds of a county belonging to this group. In terms of healthcare outcomes, five of the six outcomes were substantive and significantly associated with being in this group. The number of hospital beds (RRR=0.89, p<.001), nursing home beds per 1,000 residents (RRR=0.49, p<.01), and number of hospices (RRR=0.42, p<.01) was significantly associated with higher odds of being in this group. Additionally, the number of hospital admissions (RRR=0.16, p<.001) per decedent during the last six months of life was associated with lower odds of being in this group. Finally, in terms of controls, the percent of the county population composed of older adults (RRR=1.05, p<.001) was significantly associated with higher odds of belonging to this group while the percent of the county population being composed of Black (RRR=0.98, p<.001) and foreign-born residents (RRR=0.93, p<.01) was associated with higher odds of belonging to this group. This suggests that counties in the high stable nursing home group had high levels of reliance on farming, had lower levels of healthcare accessibility and healthcare utilization in the last six months of life, as well as an older and less diverse population.

Discussion

To date, research has demonstrated important temporal trends related to site of death in the US, including a decline in hospital deaths and an increase in home deaths (Cross and Warraich 2019; Olaisen 2020). However, previous research has suggested that there is also considerable variation in the likelihood of dying in a particular setting based on geographic context (Chino et al. 2018; Flory et al. 2004; Goodman et al. 2011; Xu et al. 2020). The goal of the present study was to combine these literatures to identify unique county site of death trajectories in the US and explore the relationship between key structural and cultural constraints and trajectory membership. Latent class growth analyses identified three meaningful and distinct county subgroups defined by homogenous site of death trajectories for all outcomes of interest (e.g., proportion of home deaths, hospital deaths, and nursing home deaths). This suggests that there are, in fact, unique and distinct county subgroups in the US that are not represented by the national trend. Additionally, this study identified several county-level factors associated with membership in county trajectories. Therefore, these county subgroups are not only different in their unique site of death trajectories but differ in important ways based on structural and cultural features. I expand on the relative significance of these findings for each outcome below.

First, for the home death outcome, three unique county trajectories were identified – a moderately increasing group, a high increasing group, and a high stable group. Unsurprisingly, the trajectory that most closely aligned with the population trend (low increasing group) was the most common trajectory among counties in the US (~56%). However, there were also two distinct trajectories that did not follow this trend. The first (medium increasing group) being similar to the national trend but having a larger y-intercept and a steeper positive slope suggesting a higher percentage of home deaths to begin with in 1991 and a larger proportion of home deaths than the national trend by 2017. Finally, a small but important trajectory had remarkably high rates of home death that remained stable over the entire period (high stable group). When coupled with the multinomial models, a more interesting picture begins to emerge, suggesting that economic and healthcare factors were associated with membership in different home death trajectories. For example, counties in both the newly established trajectories (the medium increasing and high stable groups) were significantly more likely than the counties in the low increasing group to be experiencing unemployment and low healthcare accessibility, even after controlling for geographic context factors and cultural constraints. These associations were even more pronounced for the high stable trajectory.

Second, the hospital death trajectories did, in some ways, mirror the trajectories of home deaths, exhibiting two trajectories that diverged from that of the population – a low stable group and a high decreasing group. Looking at the structural constraints, economic factors were not significantly associated with trajectory membership in the fully adjusted multinomial models. However, healthcare factors were significantly associated with trajectory membership in the final models, suggesting that high proportions of hospital deaths are more likely in places with more hospital beds. This is not surprising given previous research that has identified similar results related to healthcare accessibility and site of death (Gruneir et al. 2007; Pritchard et al. 1998). Additionally, counties in the high stable hospital death group were generally younger and contained a higher proportion of residents who were Black and foreign-born. Previous research has demonstrated a positive association between hospital death and percent of residents identifying as Black within a county (Gruneir et al. 2007). Previous research has not found age composition to be significant and has not tested for the relationship between foreign-born composition and site of death. However, some research has identified an increased risk of hospital death for foreign-born individuals (Lackan et al. 2009) and a decreased risk of hospital death with increasing age (Cross and Warraich 2019) at the individual level. Although this study did not consider individual-level characteristics, these findings suggest that county-level demographic features are associated with hospital death trajectories above and beyond individual age, race, and foreign-born composition.

Finally, for the nursing home outcome, the trajectory at the national level has remained relatively stable over the years. However, the LCGA still was able to identify three unique nursing home trajectories – a low, moderate, and high group. Counties with the lowest overall nursing home deaths (Trajectory 1) exhibited some economic disadvantage (higher rates of unemployment) but also had more hospitals beds, but fewer nursing home beds, and a higher number of inpatient days for decedents hospitalized in the last six months of life. Counties in this trajectory were also younger and had higher concentrations of Black and foreign-born residents. Counties in the high stable nursing home death group also exhibited some economic disadvantage (but in the form of county-level educational attainment). However, despite having the highest rates of nursing home death, these counties had, on average, fewer hospital and nursing home beds than the medium stable group. Additionally, this trajectory appeared to be on average older and had fewer Black and foreign-born residents. For nursing home deaths, healthcare accessibility appears to be playing a unique role, especially in relation to the previous two outcomes. That is, increased access to a hospital or nursing home beds does not appear to consistently increase rates of nursing home death as it does for hospital death, especially when considering the high stable group as a case. Instead, based on the significance of age composition in these models, the rate of nursing home death may reflect the differences in age distributions across counties. Overall, despite the stability in the nursing home trajectories, the results demonstrated significant differences between counties on economic, healthcare accessibility, and sociodemographic factors.

Although home death has often been treated as the ideal place to die or an indicator of a good quality death (Ali et al. 2015; Carr 2016), findings from this study suggest that changing rates of home, hospital, and nursing home deaths in the US are complicated by county context. For many of the counties that diverged from the population trend, there was both economic disadvantage as well as challenges related to healthcare accessibility. Since this analysis has been primarily inductive in nature, these findings do not denote a causal relationship but rather suggest that counties with high levels of home death are likely not bastions of high-quality end-of-life care or places where individuals and their families experience higher than average patient choice and autonomy. Instead, these unique trajectories indicate that in some counties where home death is high, economic issues may be creating challenges with affording access to care that may be needed. Furthermore, due to a lower rate of hospital and nursing home beds, individuals living in these counties may not have a "choice" to die anywhere other than their home and may not be receiving adequate healthcare support at the end of life.

While the hospice and palliative care movements within the US have aimed to demedicalize death, counties with extremely low levels of hospital deaths have significantly less healthcare infrastructure, including fewer hospital beds, nursing home beds, and hospices. These findings may be indicative of an access issue rather than just simply a shift towards the demedicalization of death. Although the hospital outcome was not associated with economic factors, counties with high and increasing rates of hospital death were likely to be more diverse in racial composition and nativity status. This was also the case for counties experiencing low and stable rates of nursing home death. It is not entirely clear why this is the case, but previous research has found associations between race, ethnicity, and nativity (although less research in this latter area) and site of death at the individual level (Gardner et al. 2018; Lackan et al. 2009; Orlovic et al. 2018). A longstanding explanation for higher rates of hospital deaths among these groups, especially among racial and ethnic minorities, has been different "preferences" for care at the end of life (Kwak and Haley 2005).

However, this approach has recently been critiqued, noting that it is important to consider the role of systemic racism in shaping end-of-life care (Cain 2021). These findings highlight that above individual race, ethnicity, or nativity, area-level characteristics, such as racism, are likely at play in shaping the experience of dying in these counties. Additionally, in opposition to home deaths, hospital deaths have frequently been used as a proxy for poor quality end-of-life care. However, this broad and subjective valuation likely has material consequences for the individuals who die in these counties – whether it attempts to exercise unnecessary social control over these deaths or systematically devalues these kinds of deaths altogether. Serious attention should be paid to the mechanisms that ultimately lead to these patterns in different places, as this appears to have important differential impacts on already vulnerable or marginalized populations. Overall, these findings bring new empirical evidence to research on site of death, and these trajectories begin to illuminate the complex social, cultural, and historical reality of counties in the US.

This study was limited in important ways. First, this analysis could not account for all counties in the US, as counties with very few deaths were excluded. These are likely the most rural counties, and their omission may be masking additional and unique challenges faced by rural counties in the US. Second, even though this study relies on death certificate data dating back to 1991, equivalent historical data for various county-level factors was not able to be integrated. Third, the ability to measure cultural constraints was limited and could be improved in the future. Regarding religious data, the data used for this research had several limitations, including non-response and missingness despite being the currently best available data source for county-level religiosity information. Additionally, voting data are not the only way to measure political ideology in an area and misses important nuances in political ideological expression, but county-level voting data are readily available, making it ideal for this study. Despite these limitations, this research has provided important and insightful information related to site of death. By applying a novel methodological tool (LCGA) to a rich source of population-level death certificate data commingled with county-level data, this study has provided additional evidence that there is considerable heterogeneity across counties in their site of death composition and trajectory that is obscured by continued emphasis on the national trend. Additionally, this study has provided a unique perspective on the site of death landscape historically, further demonstrating the important role of counties in shaping site of death and adding to additional determinants of site of death. Finally, these results suggest that the experience or quality of care provided at the end of life is not consistent across the US and that it is imperative to consider the variability in site of death across the US.

Although death certificate data are limited by what variables are available, future research in this area could undoubtedly utilize new and novel county-level data in studying geographic variation in site of death as it becomes available. By assessing additional social, cultural, and structural county features, a more complex and detailed understanding of geographic variation in site of death could be reached. Additionally, future research focused on site of death should carefully consider its treatment of different sites of death. That is, it is imperative to continue to investigate site of death while also considering preconceived notions about what these different settings of death represent. This is not to say that we should not study home death as an outcome when analyzing site of death or considering quality end-of-life care. Instead, it suggests that we more thoughtfully consider our subjective understanding of these categories and not simply consider "home death" as representative of a holistically positive outcome related to death and dying (Carr 2016). Continuing to treat this as a positive outcome in and of itself likely masks the complicated experiencing of dying at home for many people in the US (Gray 2020; Leiter 2019). In terms of policy, these findings suggest that interventions may not be universally applicable or effective due to the different challenges experienced by different county subgroups. There are likely different mechanisms that led to these homogeneous site of death trajectories, suggesting that policies put in place may not have the same impact on counties in different trajectories. Most end-of-life care policy takes place at the federal or state level. However, findings from this research suggest that county-level, tailored interventions are likely a necessary next step. There is likely not a one-size-fits-all approach that will address variation in site of death across counties since these counties are clearly so different from one another.

In conclusion, this study contributes to a growing body of research focused on the important role of context in shaping social life. Using a novel method of LCGA, this work builds on previous work that has explored how health-related outcomes have changed across place and time (Berger et al. 2019; Cho, Lee, and Harper 2020). This study also contributes to research focused on improving end-of-life care in the US. Since site of death has been considered an important indicator of end-of-life care, this study demonstrates distinct differences between counties in the US in their overall site of death trajectories. In addition to identifying geographic variation, this study also brings new empirical evidence to bear concerning our subjective understanding of site of death in the US, especially regarding home and hospital deaths. That is, this study provides novel empirical evidence that various sites of death may not be as universally positive or negative as they have previously been made out to be. There is considerable work that still needs to be accomplished to improve end-of-life care in the US. However, in order to do so, future research must be thoughtful about approaching these questions, to begin with, understanding that there is considerable geographic variation at the end of life in the US.

CHAPTER 4. Variation in Site of Death – Compositional or Contextual Effects?

Introduction

Death has colloquially been referred to as "the great equalizer" (Albom 1997; Moodie 1853), but there remains considerable variation in many end-of-life care outcomes, including the setting death ultimately takes place in (e.g., site of death) (Goodman et al. 2011). There has been a national decrease in the overall proportion of deaths occurring in a hospital in the last several decades (Olaisen 2020). However, research has demonstrated that one's likelihood of dying is impacted by the geographic context in which one dies – whether this is at the regional, state, or county level (Chino et al. 2018; Flory et al. 2004; Gruneir et al. 2007; Xu et al. 2020). Therefore, a growing body of scholarship has begun to demonstrate the importance of context in shaping site of death in the US. However, the source of this geographic variation remains unclear. That is, it is unknown whether the relationship between geographic context and site of death is attributable to the characteristics of a place (contextual effects) or the individual-level characteristics of people dying in that place (compositional effects). Furthermore, it may be possible that these contextual and compositional factors work in tandem or interact – resulting in different contextual effects for different decedents. One possible solution for more completely understanding the role of geographic variation in site of death is to investigate and identify the potential source(s) of this variation.

To date, causes of the total variation in site of death have yet to be wholly accounted for (Pritchard et al. 1998; Weitzen et al. 2003). Existing research has established numerous characteristics of both people and places associated with site of death. Studies have suggested that compositional factors could be important to geographic variation in site of death as several decedent-level characteristics–including gender, age, race, and education–have been associated with site of death (Bell et al. 2010; Cross and Warraich 2019; Gomes and Higginson 2006; Weitzen et al. 2003). Additionally, in terms of contextual factors, previous work has begun to identify some social, economic, and healthcare factors at various contextual levels of social life that are associated with site of death (Davies et al. 2019; Gruneir et al. 2007; Pritchard et al. 1998; Xu et al. 2020). However, these two sources of variation have not been explored in tandem. An exclusive focus on only one level of analysis makes it impossible to elucidate the potential additive or interactive relationship between macro and micro influences on site of death. An analysis of this type would provide empirical evidence demonstrating where resources should be allocated to improve outcomes most effectively for people at the end of life.

To address this gap in the literature, this study will employ multilevel level methods using restricted population death certificate data merged with county-level data focused on various contextual-level social, economic, healthcare, religious, and political factors. This study aims to investigate both compositional and contextual sources of variation in site of death between US counties for a contemporary period of deaths (2015-2017). Results suggest that although compositional factors (e.g., gender, age, race/ethnicity, education, marital status, cause of death) are significantly associated with site of death, they do not help to account for any of the geographic variation in site of death between counties. However, contextual factors were significantly associated with site of death and accounted for some of the total variation in site of death between counties. This was especially the case for healthcare accessibility and economic factors. Overall, findings from this study suggest that the previous focus on individual-level characteristics of decedents may have been overemphasized. Instead, research moving forward should focus on county characteristics as a critical source of variation that contributes to different site of death outcomes within the US. Additionally, research should consider the inclusion of a multilevel perspective to connect individual-level characteristics to their geographic context.

Background

Research on compositional and contextual effects is a growing area of research within ecological perspectives on health and mortality. The crux of the issue in this line of research is whether the characteristics of people who live (or die) in a particular place (e.g., composition[8]) or whether the actual characteristics of that place (e.g., context) impact people's health outcomes (Leyland and Groenewegen 2020). Within research on end-of-life care, the discourse of patient choice and autonomy has long prevailed, emphasizing individuals and individual-level characteristics associated with site of death (e.g., composition). To date, a handful of individual-level characteristics have been shown to be associated with site of death among numerous decedent populations. For example, older age is associated with a higher probability of home death relative to hospital death (Gruneir et al. 2007; Weitzen et al. 2003). Lower levels of education have been associated with a lower probability of home death (Weitzen et al. 2003) and a lower likelihood of congruence between preferred and actual site of death (Bell et al. 2010). Race has also been associated with site of death in that non-white decedents were more likely to have died in a hospital than at home (Gomes and Higginson 2006; Weitzen et al. 2003). The relationship between decedent gender and site of death has been somewhat inconclusive. Some research has found no association (Gomes and Higginson 2006; Weitzen et al. 2003), while other research has shown that men are significantly more likely to die in a hospital and less likely to die in a nursing

[8] There are two primary schools of thought for operationalizing composition. First, research refers to composition as the aggregate-level sociodemographic characteristics of places. Second, research uses composition to refer to individual-level characteristics of people who live in a particular place (see Leyland and Groenewegen 2020; Subramanian, Kawachi, and Kennedy 2001). For the purposes of this research, the latter definition is used, and composition will refer to the individual-level characteristics of people living in a particular area for the remainder of this dissertation.

home than at home relative to women (Cross, Kaufman, Taylor, et al. 2019; Cross and Warraich 2019). Some research has shown that marital status is significantly associated with site of death, with widows and other unmarried decedents being more likely to die at home than in a hospital (Gruneir et al. 2007; Weitzen et al. 2003).

Additionally, research has emphasized the role that cause of death has in shaping the likelihood of dying in a particular setting, including dementia (Cross, Kaufman, Taylor, et al. 2019; Mitchell et al. 2005; Xu et al. 2020), cancer (Gomes and Higginson 2006), and cerebrovascular disease (Cross, Kaufman, and Warraich 2019). However, current research utilizing individual-level characteristics has been limited in two important ways. First, the relationship between various sociodemographic characteristics and site of death has been tested among various subpopulations and, therefore, may be specific only to those subpopulations. Second, despite the importance of identifying these disparities in site of death, decedent characteristics have not fully accounted for the geographic variation in site of death, suggesting that there may be other factors beyond characteristics of decedents that are impacting the likelihood of dying in a given setting.

In an attempt to build on previous research focused on decedent characteristics, research has also begun to document various place-based factors associated with site of death. So far, this has included social, economic, and healthcare factors. In terms of social factors, a county’s racial and ethnic composition has been associated with an increased probability of hospital death (Gruneir et al. 2007). In terms of economic factors, area-level deprivation, as well as poverty and educational composition of a county, have been associated with site of death in that higher levels of poverty and lower proportions of adults with college degrees predicted an increased likelihood of hospital death (Davies et al. 2019; Gruneir et al. 2007). Finally, several health-care factors have also been associated with site of death, including state-level Medicare reimbursement rates (Pritchard et al. 1998; Xu et al. 2020) and healthcare availability in a given area (Gruneir et al. 2007; Pritchard et al. 1998; Xu et al. 2020). That is, higher rates of Medicare reimbursement were associated with a higher likelihood of dying in a hospital, while lower levels of healthcare availability (e.g., hospital, nursing home) was associated with a higher likelihood of home death. Despite the identification of these social, economic, and healthcare factors, to date, research has not yet investigated the relationship between county-level religious or political measures, although these could be influential in shaping norms around, attitudes about, and availability of end-of-life care.

Although research focused on site of death has analyzed both individual-level and aggregate-level associations, research has not explored the relationship between these compositional and contextual effects simultaneously. An exclusive focus on just one level of social life makes it impossible to fully elucidate the potential additive or interactive relationship between macro and micro influences on site of death. This is an important area of inquiry because contextual effects may have unique effects on different groups of people. For example, if contextual factors had an equivalent impact on all people, we would expect to see no variation in the probability of dying in an institutionalized setting across counties based on decedent characteristics, like education. However, if place had a differential impact on different groups of people, we may expect to see a stronger (or weaker) relationship between decedent characteristics and site of death in different counties. Furthermore, since site of death is socially patterned based on decedent-level gender, age, race/ethnicity, and education, these characteristics may activate various structural and cultural constraints simultaneously placing limits on the kinds of choices available to people at the end of life.

To address this gap in the literature, this study will employ a series of multilevel models for a contemporary period of deaths (2015-2017) to test the relationship between compositional and contextual effects and geographic variation in site of death across counties in the US. This research aims to answer the following research questions: *Do compositional factors and/or contextual factors help explain geographic variation in site of death? Are the effects of contextual factors the same for different decedents?* To answer this question, the analysis will proceed in two steps. First, I will utilize two-level multilevel models to assess the relationship between compositional factors and site of death, contextual factors and site of death, and both of these factors in tandem. Second, I will conduct a series of multilevel models that include cross-level interactions between compositional and contextual factors. This allows for the examination of essential and lingering questions about the mechanisms that contribute to and impact geographic variation in site of death.

Data

This study utilizes restricted Multiple Cause of Death (MCD) data that has been merged with several county-level covariates. MCD data comprises death certificate information for the entire US population and is managed by the National Vital Statistics System (NVSS) within the National Center for Health Statistics (NCHS). Information on a death certificate includes place of death (e.g., county and state of death), site of death (e.g., home, hospice, hospital, nursing home), sociodemographic characteristics of the decedent (e.g., age, gender, education, marital status), underlying cause of death, and co-occurring morbidities that contributed to death. Although these data are publicly available, NVSS stopped releasing geographic identifiers in publicly available data in 2005. Additionally, NVSS provides limited geographic identifiers in publicly available data for counties with more than fifty deaths in a given year. Therefore, to overcome these data challenges, all analyses were conducted on restricted data (made available through NCHS) using a secure remote server managed by the Institute of Behavioral Science (IBS).

To construct county-level indicators, several resources were used. First, the Area Health Resources Files (AHRF) is a collection of geographic, demographic, and healthcare data maintained by the Health Resources and Services Administration (HRSA) (Area Health Resources Files 2021). The AHRF contains readily accessible county-level information from a variety of sources including the American Hospital Association (AHA), the Census Bureau, the Center for Medicaid Services (CMS), and the Economic Research Service (ERS). Second, the 2020 Religious Congregations and Membership Study (Religious Census) was integrated to provide information about county-level religious ideology (Grammich et al. 2010). Finally, voting data were retrieved from the MIT Election Data and Science Lab (MIT) (MIT Election Data and Science Lab 2018). All these data sources are publicly available and contain county-identifying information (FIPS codes) that can be linked directly with restricted death certificate data.

Measures

For this analysis, there were two primary outcomes of interest: 1) odds of dying in a hospital relative to dying at home and 2) odds of dying in a nursing home relative to dying at home. Table 4.1 provides the coding scheme for both outcomes. Those who were indicated to be "dead on arrival" were not included in this analysis because their place of death could not be determined prior to their arrival at the hospital[9].

---

[9] For more detailed information on site of death including, including the omission of "dead on arrival" and hospice deaths, please see the section on limitations in Chapter 5.

Table 4.1. Site of death coding

Site of death categories	Outcome 1 (hospital vs home)	Outcome 2 (nursing home vs home)
Hospital, Clinical or Medical Center - Inpatient	1	.
Hospital, Clinical or Medical Center - Outpatient or admitted to Emergency Room	1	.
Hospital, Clinic or Medical Center - Dead on Arrival	.	.
Nursing home / long-term care	.	1
Decedent's home	0	0
Hospice facility	.	.
Other	.	.
Unknown	.	.

Table 4.2 provides detailed information about the compositional and contextual variables included in the analysis. For compositional variables, six decedent-level characteristics were utilized: gender, race/ethnicity, age, education, marital status, and cause of death. Gender was a binary outcome with male coded as the referent. Race was a four-category indicator which included non-Hispanic white (referent), non-Hispanic black, Hispanic, and other race. This variable was pre-coded by NVSS and includes all single-race options. Age was measured using reported age at death and was categorized as follows: 65-74 years old (referent); 75-84 years old; and 85 years of age and older. Educational attainment was coded into four categories (less than high school, high school degree (referent), some college, and college degree or more) from two different variables: 1) those who had a 1997 education coding, and 2) those who had a 2003 education coding. In 1997, education was coded based on years in school (not degree attainment). By 2003, this was altered so that education was based on degree attainment. For the 1997 education variable, years of schooling was roughly matched with degree attainment in 2003, where 0-11 years of education was coded as less than high school, 12 years as a high school degree (referent), 13-15 years as some college, and 16 or more years as a college degree or more. Marital status at time of death was four-category variable including: married (referent), divorced, single, and widowed. Finally, cause of death was coded using of the seven leading causes of death in 2017: 1) heart disease (referent), 2) cancer, 3) respiratory diseases, 4) stroke,

5) Alzheimer's disease, 6) diabetes, and 7) pneumonia (Kochanek et al. 2019). An eighth category was also added to capture all "other" natural causes of death that did not fall into one of the other seven categories. Cause of death coding was derived from the 39 causes of death ICD10 coding (National Center for Health Statistics 2018b). More detailed information about the coding scheme for "other" causes can be found in the Appendix A (Table A.9).

Table 4.2. Compositional and contextual variables

	Data Source	Years Utilized
Compositional factors		
Gender	MCD Data	2014-2017
Race/ethnicity	MCD Data	2014-2017
Age	MCD Data	2014-2017
Education	MCD Data	2014-2017
Marital status	MCD Data	2014-2017
Cause of death	MCD Data	2014-2017
Contextual factors		
Social		
Percent 65 years of age and older	Census	2010
Percent Black	Census	2010
Percent foreign born	Census ACS	2010
Rural/urban continuum code	ERS	2013
Economic		
Percent with a college degree	Census ACS	2014–2018
Percent in poverty	Census SAIPE	2010
Percent unemployed	BLS LAUS	2010
Percent uninsured	Census SAHIE	2010
Healthcare		
Hospital beds per 1k residents	AHA	2010
Nursing home beds per 1k residents	AHA	2010
Number of hospices per 1k residents over 65	CMS	2010
Health professional shortage area (primary care)	HRSA	2010
Religious		
Evangelical Protestant adherents per 1k	Religious Census	2010
Mainline Protestant adherents per 1k	Religious Census	2010
Catholic adherents per 1k	Religious Census	2010
Political		
Percentage voting for a Republican president	MIT	2012
Percentage voting for a Democratic president	MIT	2012

For contextual variables, measures of social, economic, healthcare, religious, and political context were included. Social factors included three measures of demographic composition of a county as measured by the 2010 Census (e.g., percent 65 years of age or older, percent Black, percent foreign born) as well as a measure of rurality in a given county as measured by the ERS in 2013. A three-category rural-urban continuum variable was used to distinguish between both population and adjacency of a county to a metro area including: 1) metro, 2) non-metro and adjacent to a metro area, and 3) non-metro and not adjacent to a metro area. Four economic indicators were analyzed including percent of county residents having earned a college degree, percent of county residents living below the poverty line, percent of unemployed county residents, and percent of uninsured county residents. Five indicators of healthcare environment within a county were included, including the number of hospital and nursing home beds per 1,000 residents as well as the number of hospice agencies per 1,000 residents over the age of 65. Additionally, an indicator of whether a county had been designated a health professional shortage area (HPSA) for primary care providers was also included which measures whether a county lacks enough healthcare providers to meet the needs of the population within a given county. Counties could fall into one of three categories: 1) county was not classified as a HPSA (referent), 2) all of the county was classified as an HPSA, or 3) one or more parts of a county were classified as an HPSA. For religious ideology, a measure of the number of religious adherents per 1,000 residents from the 2010 religious census was included[10]. There was a wide range of denominations included in the religious census, however, many of the non-Christian religions (e.g., Jewish, Muslim, Buddhist, Hindu) had incomplete information. Therefore, to test for meaningful differences within the limitations of the data, religious adherents was measured using three religious categories focused exclusively on Christian religions: Evangelical Protestant, Mainline Protestant, and Catholic. This approach considers about 60 percent of all religious adherents and over 85 percent of Christian adherents (Pew

[10] County-level religious adherents are counted by the county in which the adherents attend religious services and not the county in which they live. Therefore, it is possible for the number of adherents in a given county to exceed the number of residents.

Research Center 2015). Focusing on these categories best aligns with the relationship established in the literature between religion and end-of-life care (Sharp et al. 2012). Additionally, two political indicators were included based on county-level voting data for 2012: percentage of county votes for a Democratic and a Republican presidential candidate. All contextual variables were measured in years prior to the period being analyzed (2015–2017) to both avoid reverse causality, as well as to allow for a lagged effect of their impact on site of death. Therefore, when possible, 2010 county-level measures were utilized.

Analytic sample

There was a total of 8,288,096 decedents between 2015 and 2017. Analysis was restricted to decedents 65 years of age or older (n=6,038,220) and decedents who died of natural causes (e.g., not suicide, homicide, or accident; 195,802 decedents dropped). Additionally, decedents who did not die in a home, hospital, or nursing home were omitted (n=762,675; only 1,227 of these were truly "unknown"). There was some difficulty with model convergence when utilizing the full analytic sample (since there were 5,079,738 decedents in 3,099 counties at this stage). Therefore, all results are based on a 10% random sample (507,974 decedents in 3,009 counties). Finally, a total of 3.56% of the analytic sample was missing on at least one indicator. In terms of compositional variables, 2.92% of decedents were missing on gender, race/ethnicity, education, age, and marital status. In terms of contextual variables, only 0.65% of respondents were missing a county-level indicator. Since less than five percent of all decedents had missing data, listwise deletion was used to account for missingness within the data. This resulted in a final analytic sample of 489,890 decedents in 2,880 counties with 2,864 and 2,877 counties for the hospital and nursing home (relative to home) outcomes, respectively.

Method

Analytic approach

First, descriptive statistics for all compositional and contextual variables are provided. Second, a series of hierarchical generalized linear models (HGLM) were estimated for two binary outcomes: 1) the odds of dying in a hospital relative to home and 2) the odds of dying in a nursing home relative to home. The best way to empirically distinguish compositional from contextual effects is to employ multilevel modeling (Duncan, Jones, and Moon 1996, 1998). In the subsequent presentation of models, an equation only for the hospital outcome will be presented, but the same analyses will be conducted for nursing homes. I employed a stepwise modeling strategy that is demonstrated in Table 4.3. All analyses were conducted in Stata 16 and HGLM models were estimated using the "meglm" command (StataCorp 2019).

Table 4.3. Stepwise model strategy for HGLM estimates

Model number	Model specification
Model 1	Null model
Model 2	Compositional indicators
Model 3	Contextual indicators
Model 4	Compositional and contextual indicators
Model 5	Compositional and contextual indicators with interactions

Model 1 is a two-level model with only the outcome of interest (Equation 1). This is the null model and will provide baseline estimates for future comparison and provides a useful preliminary model demonstrating the amount of variation present in the outcomes between counties:

Level 1 (decedents):

$$\eta_{ij} = \beta_{0j}$$

Level 2 (counties):

$$\beta_{0j} = \gamma_{00} + u_{oj}, \qquad u_{0j} \sim N(0, \tau_{oo})$$

[E3]

Here, η_{ij} is the log-odds of dying in a hospital (relative to home) for decedent i in county j. Additionally, γ_{00} (the mean of β_{0j}) is the estimated odds of dying in a hospital (relative to home) in the average county in the US while τ_{00} (the variance of β_{0j}) demonstrates the amount of variation in the odds of dying in a hospital (relative to home) across US counties. From these estimates, the plausible value range (PVR) will be calculated for each year. This value indicates the overall range in the probability of dying in a particular setting across all counties. This is calculated as a 95% confidence interval around the main model coefficient (γ_{00}) utilizing the level-2 variance (τ_{00}). Additionally, the intraclass correlation coefficient (ICC) will be calculated for each multilevel model. In a two-level HGLM, the variance is partitioned at level two. This represents the total variability in the outcome (probability of dying in a hospital) that is attributable to the county. It is possible to use this value to calculate the ICC which is the proportion of variance accounted for by the higher level of analysis (e.g., county). The following formula was used: $\tau_{00}/((\pi^2/3) + \tau_{00})$ (Guo and Zhao 2000). By evaluating the ICC, it is possible to ascertain what proportion of the variation in site of death contextual factors account for.

Model 2 is a random intercepts model that builds on the null model by incorporating compositional indicators (e.g., gender, race/ethnicity, age, education, marital status, cause of death; see Equation 2). This model demonstrates the impact of each compositional indicator on the likelihood of dying in a hospital (relative to home). Additionally, relative to the null model, it will be possible to assess how much variation in the outcome between counties is accounted for by compositional characteristics.

Level 1 (decedents):
$$n_{ij} = \beta_{0j} + \beta_{xj}(compositional\ variables)$$

Level 2 (counties):
$$\beta_{0j} = \gamma_{00} + u_{oj}$$

[E4]

Model 3 is also a random intercepts model that builds on the null model by incorporating contextual indicators (e.g., social, economic, healthcare, religious, political) only (Equation 3). Again, from this model (relative to the null), it will be possible to see how much variation in the outcome between counties is accounted for exclusively by contextual characteristics.

Level 1 (decedents):
$$n_{ij} = \beta_{0j}$$

Level 2 (counties):
$$\beta_{0j} = \gamma_{oo} + \gamma_{0x}(contextual\ variables) + u_{0j}$$

[E5]

Model 4 is a random intercepts model that includes both the compositional and contextual indicators (Equation 4).

Level 1 (decedents):
$$n_{ij} = \beta_{0j} + \beta_{xj}(compositional\ variables)$$

Level 2 (counties):
$$\beta_{0j} = \gamma_{oo} + \gamma_{0x}(contextual\ variables) + u_{0j}$$

[E6]

Finally, Model 5 will build on Model 4 but will also include cross-level interactions in order to focus on the potential differential impacts of county on particular types of decedents.

Results

Descriptive statistics

Table 4.4 provides descriptive information for all compositional and contextual variables included in the analysis. The average decedent was female (53.24%), non-Hispanic white (81.76%), with a high school degree equivalent or less (65.18%), over 75 years of age (74.74%), widowed (43.77%) or married (37.47%), and having died of heart disease (29.46%) or cancer

(20.57%). Of the 2,880 counties, the average county had 15.90% of their residents being 65 years of age or older, 8.42% of residents identifying as Black, and 4.82% of residents being foreign born. However, there was considerable variation across counties in the demographic composition. Counties were also relatively evenly distributed in their rural status with 38.09% of counties being metro, 33.26% being nonmetro but adjacent to a metro region, and 28.65% of counties being nonmetro and not adjacent to a metro region. In terms of economic outcomes, the average county had 15.27% of residents having earned a college degree, 16.59% of residents living in poverty, 9.14% of residents being unemployed, and 18.25% of residents were uninsured. For healthcare factors, counties on average had 3.46 hospital beds and 0.57 nursing home beds per 1,000 residents and 0.12 hospices per 1,000 residents 65 years of age or older. Additionally, 40.73% of counties were designated as a health professional shortage area.

Table 4.4. Descriptive statistics for all compositional and contextual variables, 2015-2017

Variable name	Mean/%	SD	Minimum	Maximum
Compositional (Level 1; n=489,890)				
Female	53.24			
Race/ethnicity				
White	81.76			
Black	9.68			
Hispanic	5.79			
Other	2.80			
Education				
Less than high school	22.09			
High school degree or equivalent	43.09			
Some college	17.46			
College, plus	17.36			
Age				
65-74	25.26			
75-84	31.93			
85+	42.81			
Marital status				
Married	37.47			
Divorced	13.17			
Single	5.59			
Widowed	43.77			
Cause of death				
Heart disease	29.46			
Cancer	20.57			
Respiratory	6.78			
Stroke	5.98			
Alzheimer's	5.65			
Diabetes	3.07			
Pneumonia	2.54			
Other	25.95			
Contextual (Level 2; n=2,880)				
Percent 65 years of age and older	15.90	4.13	5.57	43.38
Percent Black	8.42	13.91	0.00	85.70
Percent foreign born	4.82	5.71	0.00	53.30
Rural/urban continuum code				
Metro	38.09			
Nonmetro, adjacent	33.26			
Nonmetro, nonadjacent	28.65			
Percent with a college degree	15.27	7.14	3.41	61.94
Percent in poverty	16.59	6.12	3.10	50.10
Percent unemployed	9.14	3.10	1.70	29.90
Percent uninsured	18.25	5.54	3.60	41.40
Hospital beds per 1k residents	3.46	4.64	0	70.70
Nursing home beds per 1k residents	0.57	1.48	0	38.86
Number of hospices per 1k residents over 65	0.12	0.21	0	2.30
Health professional shortage area (primary care)				
Not a HPSA	17.67			
Entire county is an HPSA	40.73			
Part of county is an HPSA	41.60			
Evangelical Protestant adherents per 1k	229.58	160.47	0.00	1308.69
Mainline Protestant adherents per 1k	117.99	100.11	0.51	771.27
Catholic adherents per 1k	130.35	133.27	0.00	999.57
Percentage voting for a Republican president	38.78	14.44	5.77	93.39
Percentage voting for a Democratic president	59.22	14.60	5.98	93.29

Notes: % = percent; SD = standard deviation; HPSA = health professional shortage area; 1k = 1,000

Multilevel models

In the presentation of multilevel results, all odds ratios are significant at the p<.001 level unless otherwise specified. Table 4.5 provides the estimated odds of dying in a hospital relative to home for older adults who died of natural causes between 2015 and 2017. Model 1 is the null model reporting the odds of dying in a hospital relative to home for a baseline estimate while also controlling for the random effect of counties (e.g., level-2 random effect). The overall odds ratio was 0.58, suggesting that there were 42% lower odds of dying in a hospital relative to home (Model 1). However, there is also considerable variation in the odds of dying in a hospital relative to home across counties. For example, calculating the 95% plausible value range (PVR), the odds of hospital death (relative to home) across counties ranged from 0.06 to 5.37. This suggests that some counties had 94% lower odds of dying in a hospital relative to home (much more likely to die at home), while some counties were more than five times as likely to die in a hospital relative to home. To account for some of this variation at the county level, subsequent models look to compositional and contextual factors to account for some of this variation.

Model 2 takes into consideration key compositional factors (e.g., gender, race/ethnicity, and education). In terms of the fixed effects components, there was a reduction in the odds of hospital death for women relative to men (OR=0.97). The odds of hospital death were elevated for Black (OR=1.15) and other race (OR=1.31) decedents relative to white decedents. Decedents with some college (OR=0.93) or at least a college degree (OR=0.83) had lower odds of hospital death relative to those with a high school degree. In terms of age, decedents 75-84 years of age (OR=0.89) and those 85 years of age and older (OR=0.61) had significantly lower odds of hospital death relative to those 65-74 years of age. In terms of marital status, widowed decedents (OR=0.94) had slightly lower odds of hospital death relative to married decedents. Finally, in terms of cause of death, individuals who died of cancer (OR=0.43), respiratory diseases (OR=0.82), Alzheimer's (OR=0.20), and diabetes (OR=0.78) had lower odds of dying in a hospital relative to those who died from heart disease. However, those who died of a stroke (OR=1.66), pneumonia (OR=13.04), or other intrinsic causes (OR=1.78) had higher odds of dying in a hospital relative to those who died of heart disease. Beyond the characteristics of individual decedents, it is important to note that even after controlling for compositional factors, the level-2 county-level variation did not decrease (and, in fact, slightly increased), suggesting that county-level variation in the rate of hospital deaths cannot be accounted for by the differential composition of those dying in US counties.

Table 4.5. Hierarchical generalized linear model results depicting odds ratios for the odds of dying in a hospital relative to home

	Model 1	Model 2	Model 3	Model 4
	Unconditional models	Compositional factors	Contextual factors	Full model
Fixed effects				
Compositional Effects				
Female		0.97***		0.97***
Race/ethnicity (Ref: Non-Hispanic White)				
Black - NH		1.15***		1.14***
Hispanic		0.99		0.98
Other		1.31***		1.31***
Education (Ref: High school)				
< High school		1.01		1.01
Some college		0.93***		0.93***
College - plus		0.83***		0.83***
Age (Ref: 65-74 years)				
75-84 years		0.89***		0.89***
85+ years		0.61***		0.60***
Marital status (Ref: Married)				
Divorced		0.98		0.98
Widowed		0.94***		0.94***
Cause of death (Ref: Heart disease)				
Cancer		0.43***		0.43***
Respiratory		0.82***		0.82***
Stroke		1.66***		1.66***
Alzheimer's		0.20***		0.20***
Diabetes		0.78***		0.78***
Pneumonia		13.04***		12.97***
Other		1.78***		1.78***
Contextual variables				
Social				
Percent 65+			0.98**	0.99*
Percent Black			1	1
Percent foreign born			1.02***	1.02***
Rural/Urban Continuum (Ref: Metro)				
Nonmetro - adjacent			0.95	0.96
Nonmetro - nonadjacent			1.13*	1.17**
Economic				
Percent with a college degree			1.03***	1.03***
Percent in poverty			1.04***	1.04***
Percent unemployed			0.99	0.99
Percent uninsured			0.97***	0.97***
Health care				
Hospital beds per 1k residents			1.11***	1.12***
Nursing home beds per 1k residents			1.08***	1.08***
Hospices per 1k residents over 65			1.56***	1.59***
Health provider shortage area - primary care (Ref: The county is not a shortage area)				
The whole county is a shortage area			0.81***	0.82***
One or more parts of the county is a shortage area			1.11*	1.12*
Religious				
Evangelical adherents per 1k residents			1.00***	1.00***
Mainline Protestant adherents per 1k residents			1.00***	1.00***
Catholic adherents per 1k residents			1.00***	1.00***
Political				
Percent voting Democratic president - 2012			0.98	0.98
Percent voting Republican president - 2012			0.98	0.98
Constant	0.58***	0.82***	1.86	2.15
	-0.01	-0.02	-2.36	-2.71
Variance components				
Level-2 random effect	3.02***	3.03***	1.81***	1.80***
Intraclass correlation coefficient	0.25	0.25	0.15	0.15
-2 log likelihood	-227,540.58	-210,523.29	-226,941.21	-209,921.99
Likelihood ratio test	26,670.15***	23,368.20***	11,108.87***	9,930.92***
Leve-1 N	348,008	348,008	348,008	348,008
Level-2 N	2,864	2,864	2,864	2,864

Notes: All estimates are odds ratios; all models control for year of death
* p<0.05; ** p<0.01; *** p<0.001

Model 3 analyzes the association between the outcome of interest and contextual variables (e.g., social, economic, healthcare, religious, and political factors). I will first focus on fixed effects components. For social factors, a one-unit increase in the percent of individuals over the age of 65 resulted in a 2% decrease in the odds of dying in a hospital ($p<.01$) while a one-unit increase in the percent of foreign-born individuals resulted in a 2% increase in the odds of dying in a hospital. Additionally, living in a non-metro county not adjacent to a metro county was associated with increased odds of dying in a hospital relative to home (OR=1.13, $p<.05$). In terms of economic factors, a one-unit increase in both the percent of county residents having a college degree and being in poverty was associated with a 3% increase in the odds of dying in a hospital. For healthcare factors, all variables were significantly associated with the odds of dying in a hospital. The number of hospital beds (OR=1.11), nursing home beds (OR=1.08), and hospices (OR=1.56) were positively associated with the odds of dying in a hospital (relative to home). Additionally, living in a county where one or more parts of the county are designated a shortage area was associated with increased odds of dying in a hospital (OR=1.11, $p<.05$) relative to counties that were not designated shortage areas. Additionally, a county being a shortage area (OR=0.81) was negatively associated with the odds of dying in a hospital relative to counties that were not designated shortage areas. Finally, in terms of both political and religious ideology, these factors do not appear to be significantly or substantively associated with odds of dying in a hospital relative to home.

When considering the random effects for Model 3, there is a considerable reduction in the level-2 variance. When comparing the ICCs between Model 1 and Model 3, there is a reduction from .25 to .15 (a 40% reduction in the ICC). This suggests that the contextual variables included in the model account for 10% of the variation in the outcome at the county level. Supplementary analyses suggest that this reduction in the ICC is primarily attributable to the healthcare variables in the model (accounting for ~70% of the 10% reduction in the ICC). Finally, Model 4 includes both compositional and contextual variables. Overall, there is very little change in the compositional parameters even after the inclusion of contextual variables. Additionally, relative to Model 3, the level-2 variance essentially goes unchanged with the inclusion of both compositional and contextual factors.

Table 4.6 provides the estimated odds of dying in a nursing home relative to home for older adults who died of natural causes between 2015 and 2017. Model 1 is the null model reporting the odds of dying in a nursing home relative to home for a baseline estimate while also controlling for the random effect of counties (e.g., level-2 random effect). The overall odds ratio was 0.95 ($p<.01$), suggesting that there were, on average, 5% lower odds of dying in a nursing home relative to home (Model 1). However, there is also some variation in the odds of dying in a nursing home relative to home across counties. Calculating the 95% plausible value range (PVR), the odds of nursing home death (relative to home) across counties ranged from 0.08 to 0.87. This suggests that almost all counties have lower odds of dying in a nursing home relative to home. However, there is still considerable variation across counties, with some counties having 92% lower odds of dying in a nursing home relative to home (much more likely to die at home), while some counties are similar in the odds of nursing home and home death (~3% lower odds of nursing home death). In order to account for some of this variation at the county level, subsequent models will look to compositional and contextual factors to account for some of this variation.

Table 4.6. Hierarchical generalized linear model results depicting odds ratios for the odds of dying in a nursing home relative to home

	Model 1	Model 2	Model 3	Model 4
	Unconditional models	Compositional factors	Contextual factors	Full model
Fixed effects				
Compositional Effects				
Female		1.16***		1.15***
Race/ethnicity (Ref: Non-Hispanic White)				
Black - NH		0.83***		0.85***
Hispanic		0.61***		0.62***
Other		0.84***		0.85***
Education (Ref: High school)				
< High school		0.97**		0.97**
Some college		0.89***		0.89***
College - plus		0.88***		0.88***
Age (Ref: 65-74 years)				
75-84 years		1.79***		1.79***
85+ years		2.75***		2.74***
Marital status (Ref: Married)				
Divorced		2.15***		2.15***
Single		3.07***		3.06***
Widowed		1.75***		1.75***
Cause of death (Ref: Heart disease)				
Cancer		0.60***		0.60***
Respiratory		0.98		0.98
Stroke		2.06***		2.06***
Alzheimer's		2.46***		2.47***
Diabetes		1.07**		1.06**
Pneumonia		3.56***		3.53***
Other		2.08***		2.08***
Contextual variables				
Social				
Percent 65+			1	1
Percent Black			0.99***	0.99***
Percent foreign born			1	1
Rural/Urban Continuum (Ref: Metro)				
Nonmetro - adjacent			1.08**	1.10**
Nonmetro - nonadjacent			1.14***	1.17***
Economic				
Percent with a college degree			0.99***	0.99***
Percent in poverty			1	1
Percent unemployed			0.96***	0.96***
Percent uninsured			0.97***	0.98***
Health care				
Hospital beds per 1k residents			1.02***	1.02***
Nursing home beds per 1k residents			1.03***	1.03***
Hospices per 1k residents over 65			1.03	1.03
The whole county is a shortage area			0.95	0.96
One or more parts of the county is a shortage area			1.07*	1.07*
Religious				
Evangelical adherents per 1k residents			1.00***	1.00***
Mainline Protestant adherents per 1k residents			1.00***	1.00***
Catholic adherents per 1k residents			1.00***	1.00***
Political				
Percent voting democrat president - 2012			1.01	1.02
Percent voting republican president - 2012			1.01	1.01
Constant	0.95**	0.27***	0.81	0.10**
	-0.01	-0.01	-0.61	-0.07
Variance components				
Level-2 random effect	1.46***	1.43***	1.19***	1.19***
Intraclass correlation coefficient	0.1	0.1	0.05	0.05
-2 log likelihood	-205,699.73	-183,860.45	-204,973.64	-183,191.92
Likelihood ratio test	14,304.86***	10,710.97***	6,109.45***	5,152.06***
Leve-1 N	308,565	308,565	308,565	308,565
Level-2 N	2,877	2,877	2,877	2,877

Notes: All esitamtes depict odds ratios; all models control for year of death
* p<0.05; ** p<0.01; *** p<0.001

Model 2 presents results for key compositional factors (e.g., gender, race/ethnicity, education, age, marital status, and cause of death). Regarding the fixed effects components, women had higher odds of nursing home death relative to men (OR=1.16). Relative to whites, all racial and ethnic minority groups had lower odds of nursing home death. Relative to those with a high school degree, those with less than a high school degree (OR=0.97, p<.01), some college (OR=0.89), and those with at least a college degree (OR=0.88) had lower odds of nursing home death. In terms of age, decedents 75-84 years of age (OR=1.79) and those 85 years of age and older (OR=2.75) had significantly higher odds of nursing home death relative to those 65-74 years of age. In terms of marital status, relative to married decedents, divorced (OR=2.15), single (OR=3.07), and widowed decedents (OR=1.75) all had higher odds of nursing home death. Finally, in terms of cause of death, individuals who died of cancer (OR=0.60) had lower odds of dying in a nursing home relative to those who died from heart disease. However, those who died of a stroke (OR=2.06), Alzheimer's disease (OR=2.46), diabetes (OR=1.07), pneumonia (OR=2.46), or other intrinsic causes (OR=2.08) had higher odds of dying in a nursing home relative to those who died of heart disease. Beyond the key characteristics of individual decedents, after controlling for compositional factors, the level-2 county-level variation decreased only slightly, suggesting that compositional features of decedents in counties account for only a small portion of the variation across counties in nursing home versus home death.

Model 3 analyzes the association between the outcome of interest and contextual variables (e.g., social, economic, healthcare, religious, and political factors). In terms of the fixed effects components, for social factors, a one-unit increase in the percent of individuals identifying as Black was associated with a 1% decrease in the odds of dying in a nursing home. Additionally, living in a non-metro area that was adjacent (OR=1.08, p<.01) or not adjacent to a metro county (OR=1.14) was associated with increased odds of dying in a nursing home relative to home. In terms of economic factors, a one-unit increase in the percent of county residents having a college degree, being unemployed, and being uninsured was associated with a 1%, 4%, and 3% decrease in the odds of dying in a nursing home. For healthcare factors, the number of hospital beds (OR=1.02) and nursing home beds (OR=1.03) were positively associated with the odds of dying in a nursing home (relative to home). Additionally, living in a county where one or more parts of the county are designated a shortage area was associated with increased odds of dying in a nursing home (OR=1.07) relative to counties that were not designated shortage areas. Finally, in terms of political and religious ideology, these contextual factors had a minimal positive association with the outcome of interest. Therefore, these factors did not appear to be substantively associated with odds of dying in a nursing home relative to home.

When considering the random effects for Model 3, there is a reduction in the level-2 variance. Comparing the ICCs between Model 1 and Model 3, there was a reduction from 0.10 to 0.05 (a 50% reduction in the ICC). Supplementary analyses suggest that this reduction in the ICC was primarily attributable to the contextual economic factors in the model. Finally, Model 4 includes both compositional and contextual variables. Similar to the hospital versus home outcome, there was very little change in the compositional parameters even after including contextual variables. Additionally, relative to Model 3, the level-2 variance goes unchanged with the inclusion of both compositional and contextual factors.

Interactions

To test if county-level factors differentially impacted individual decedents based on important characteristics (e.g., gender, race/ethnicity, education), additional sets of models were run with the inclusion of cross-level interactions. Since there were no a priori hypotheses about which county-level characteristics may differentially impact decedents, a set of stratified models for gender, race/ethnicity, and education were first estimated to assess differences. Models were evaluated to identify whether the key individual-level characteristics were substantively and statistically significant for various county-level indicators. Once significance was ascertained in the stratified models, due to the sheer volume, interaction models were estimated only in instances in which decedent characteristics were significantly associated with county-level indicators. There were no statistically or substantively significant interactions, suggesting that county-level factors for both outcomes had a similar impact on all county residents, regardless of gender, race/ethnicity, or education. Despite the lack of substantive or statistical significance for these cross-level interactions, this portion of the analysis is still interesting as a "non-finding". Findings from these interactions suggest that county-level factors may have a consistent and possibly equal impact on decedents, which further bolsters the need to address county-level factors when thinking about research and policy related to end-of-life care quality.

Discussion

To date, research has identified geographic variation in site of death in the US, suggesting potential disparities across place in terms of end-of-life care and outcomes (Chino et al. 2018; Flory et al. 2004; Gruneir et al. 2007; Xu et al. 2020). However, it is unclear what the source of this variation is. That is, do the characteristics of places (contextual factors) and/or the characteristics of people who die in those places (compositional factors) contribute to the overall geographic variation currently being observed? Utilizing multilevel level models and restricted death certificate data merged with a variety of county-level data, this research aimed to address this gap in the literature by evaluating the impact of compositional and contextual factors on geographic variation in site of death. Results from this analysis suggest that compositional and contextual factors are significantly related to site of death, but in different ways, which has important implications for both future research and policy interventions aimed at improving end-of-life care.

In terms of compositional factors, gender, race, age, education, marital status, and cause of death were all significantly associated with the hospital and nursing home (relative to home) outcomes and in directions that would be expected based on previous research. However, the inclusion of these six compositional indicators did not account for any of the variation in site of death across counties in the US. Therefore, this study aligns with previous work demonstrating that there are differences in the individual-level likelihoods of dying in different settings (Bell et al. 2010; Cross and Warraich 2019; Gomes and Higginson 2006; Weitzen et al. 2003). However, these results also suggest that individual-level compositional factors do not account for any of the geographic variation in either of the site of death outcomes. Given vast amounts of demonstrated variation in site of death across US counties, it is imperative to understand why this variation exists. However, these findings suggest that it is likely not a product of differences in the composition of individual decedents in counties. This is an important factor to rule out since previous research has focused extensively on differences in sociodemographic characteristics of decedents. Therefore, this research provides empirical evidence suggesting that individual-level characteristics of decedents are important but do not help explain widespread geographic variation in site of death.

In terms of contextual factors, many of the county-level features were significantly associated with site of death while also collectively accounting for a substantial portion of the variation in site of death across counties in the US. In line with previous work, this indicates that geographic variation does exist, and some of this variation can be explained by place-based factors (Davies et al. 2019; Gruneir et al. 2007; Pritchard et al. 1998; Xu et al. 2020). Regarding, hospital deaths (relative to home), healthcare availability factors accounted for the most considerable portion of variation in the outcome. This finding enhances previous research that has demonstrated an association between healthcare availability factors and site of death (Gruneir et al. 2007; Pritchard et al. 1998). For decedents living in a county with more available healthcare (hospital beds, nursing home beds, and hospices) there was an overall increase in the odds of hospital death. This may suggest that people were dying in hospitals due to area-level hospital availability, which may shape healthcare utilization norms. On the flip side, dying at home was more likely in areas with lower healthcare availability. This suggests that home death may be occurring not because individual decedents want to or have chosen to die there, as previous discourses have purported, but because they did not have a choice in the matter due to a lack of healthcare availability.

Economic factors also played a significant role for this outcome. County-level poverty was positively associated with hospital death, aligning with previous research (Davies et al. 2019). Area-level insurance status has not been previously assessed but, in this case, was negatively associated with the odds of hospital death. Finally, area-level college degree attainment was positively associated with the odds of hospital death, which runs contrary to previous research (Gruneir et al. 2007). Although, educational composition did not align as expected, findings suggest that hospital death is more likely than home death for decedents living in counties with higher poverty levels and lower rates of insured residents suggesting a potential economic accessibility issue.

For nursing home deaths (relative to home), economic factors accounted for the largest proportion of the variability in site of death between US counties. The percent of county residents with a college degree, who were unemployed, and uninsured were all negatively associated with the outcome. That is, decedents living in counties with higher levels of economic disadvantage were less likely to die in nursing homes. This could suggest an inability to access high-cost care at the end of life. This may be especially true in the US context, which does not provide comprehensive benefits for long-term care to older adults. Additionally, nursing homes are distinct in their relationship to site of death; unlike hospitals, healthcare factors didn't help explain a large portion of the variation in this outcome. Although, having increased access to hospital beds and nursing home beds was marginally associated with nursing home death relative to home. Overall, findings for both outcomes suggest that healthcare accessibility and the economic well-being of a county account for a significant portion of the variation in site of death and should be considered critical areas by which to enhance the provision of end-of-life care.

Finally, I consider the relationship between the compositional and contextual factors. First, the parameter estimates for the contextual factors were not impacted by the inclusion of compositional factors suggesting that the impact of these contextual factors holds even after adjusting for compositional effects. Support for a compositional effect would be demonstrated by contextual effects disappearing after adjusting for the composition of counties. However, this was not the case, suggesting that the characteristics of counties do matter above and beyond the sociodemographic characteristics of decedents. This provides additional evidence that individual-level factors are likely not as important for understanding disparities in site of death as previous research has made them out to be (Gruneir et al. 2007). Second, in terms of the interaction analysis, results suggest that, in general, county-level factors have similar impacts on decedents regardless of gender, race/ethnicity, and education. This finding provides additional evidence for the continued focus on geographic context, generally, and the role of county context, specifically, within research and policy arenas.

In terms of policy, findings provide additional evidence that counties are a level of social life that end-of-life care policy should be targeting. More specifically, to reduce geographic disparities in site of death across counties in the US, policy should consider targeting county-level healthcare accessibility and economic well-being. Additionally, since the interaction models suggested that contextual factors had similar impacts on all decedents, policy structured in this fashion would likely have positive outcomes for a wide range of people at the end of life.

This research demonstrated the role of both compositional and contextual factors in shaping county-level variation in site of death in the US. However, this research was limited in important ways. First, due to having large quantities of population-level data, there were challenges with convergence when running multilevel models in Stata. Therefore, all results presented in this research are based on a ten percent sample. Although this was an effective strategy to get preliminary estimates while maintaining sufficient power, this strategy may have prevented the inclusion of decedents in very rural or underpopulated counties in the US. Second, this outcome still has considerable variation that was not explained by the contextual and compositional features included in this research. However, future research should consider bringing additional county-level data to bear on this question. Since findings emphasized the importance of healthcare accessibility and economic well-being of counties, continued investigation into these areas would benefit our understanding of site of death. Beyond healthcare and economic factors, further identifying what contributes to the currently observed geographic variation in site of death would allow for additional tailoring of policy interventions at the county level. Finally, this study focused on a contemporary period of deaths (2015-2017).

Previous research has demonstrated that site of death in the US has been and continues to be a changing landscape (Olaisen 2020). While this research worked with the data that was readily available at the time, similar research in the future could update these findings to see whether and how they change. This is especially true when considering the role of the coronavirus pandemic in shaping death in the US.

Overall, this study aimed to assess the role of compositional and contextual effects in shaping geographic variation in site of death in the US. Results suggest that both compositional and contextual factors are significantly associated with site of death in the US. However, it would be a mistake to consider them as equivalent or interchangeable. Instead, these levels of social life must be considered from a multilevel perspective. Therefore, it is necessary to integrate context into our understanding of site of death, specifically, and end-of-life care outcomes, generally. Despite a longstanding emphasis on patient choice and autonomy within healthcare, generally, and end-of-life care, specifically, continued reliance on the choice discourse will likely only detract from identifying (and ultimately diminishing) geographic disparities in site of death. While there are important individual-level disparities in site of death, this research has provided additional evidence that the contexts in which people die shape and constrain their *choices* at the end of life in significant and important ways.

CHAPTER 5. Conclusion

Choice has been the preeminent discourse within research and policy focused on end-of-life care for several decades (Institute of Medicine 1997, 2015; World Health Organization 2004). Despite its altruistic focus on improving end-of-life care, a strong emphasis on patient choice and autonomy has limitations. Importantly, an emphasis on choice draws attention away from the social and physical environments that shape dying in important ways–ones that are not altered by choice or preference. In addition, there is considerable geographic variability in site of death across the US, suggesting that where you live matters for where you die, beyond just individual choice. It is imperative to investigate geographic variation in site of death further to understand better how choice may be constrained at the end of life.

To advance this line of inquiry, this dissertation relied upon an ecological framework to interrogate geographic variation in site of death for older adults who died of natural causes. To achieve this goal, this dissertation conducted three unique but complementary quantitative studies. Chapter 2 examined the relationship between site of death (e.g., home, hospital, and nursing home) and county of death between 1991 and 2017 in the US. Findings from this chapter suggest that, first, there is considerable variation in the likelihood of dying in a particular setting across counties in the US. Second, findings indicate that counties have been, currently are, and will likely remain an essential unit of analysis by which to understand differences in site of death, especially for hospital deaths relative to home deaths. Chapter 3 investigated site of death trajectories for all US counties between 1991 and 2017. First, findings from this chapter suggest that there are unique county trajectories in site of death composition that are not identifiable by focusing exclusively on the national trend. Second, findings indicated that county membership in these trajectories was significantly associated with social, economic, and healthcare characteristics of a given county. Chapter 4 explored the distinct and complementary impact of compositional and contextual factors on the likelihood of dying in a particular setting across US counties for a contemporary period of deaths (2015-2017). This study suggests that compositional and contextual factors were both related to the individual-level likelihood of dying in a particular setting but in distinct ways. More specifically, although compositional factors were associated with the likelihood of dying in a particular setting, contextual factors accounted for a significant portion of the variation in the site of death outcomes.

In sum, findings from this dissertation demonstrate that the county where death occurs matters substantially for the likelihood of dying in a particular setting, whether at home, in a hospital, or nursing home. Findings from this dissertation also indicate that site of death is further shaped by the characteristics of the context in which death occurs. This is especially the case when considering economic and healthcare factors which were associated with the likelihood of dying in a particular site of death. These findings support the idea of county-level constraints that influence where people ultimately die, above and beyond individual choice or preference. In the remainder of this chapter, I will discuss the implications of these findings, opportunities for future research and policy, as well as limitations.

Patient choice at the end of life

Individual-level choice has become a fundamental and pervasive logic in modern life. In a consumer society, we are confronted with myriad choices in our daily lives and as we approach our deaths. The contemporary experience of death and dying has fundamentally changed with the proliferation of choices due to advances in biomedical technology–whether this be curative treatments for chronic or terminal illness or options for life-sustaining measures (e.g., artificial nutrition, ventilator support, CPR). The end of life is a unique life course stage in which notions of choice are deployed in important and strategic ways. There has been a strong emphasis on patient choice, patient autonomy, and patient-centered care within end-of-life care. Advance care planning (ACP) has been the primary mechanism for the deployment of choice within end-of-life care, encouraging individuals to make decisions about the kinds of care they do and do not want to receive at the end of life (e.g., CPR, ventilator use, artificial nutrition, comfort care). More recently, this includes locating the setting in which death is to take place, with the ultimate goal of facilitating home death (Bell et al. 2010). However, the notion of choice regarding healthcare, broadly, and end-of-life care, specifically, has been the subject of critique in recent years (Bryant et al. 2007; Collyer et al. 2015; Drought and Koenig 2002; Fotaki 2013; Nordgren 2010). At the heart of this critique is the notion that, despite the pervasiveness of this discourse within healthcare, research has rarely questioned the normative use of this discourse in practice. Additionally, the choice framework is not able to take into consideration the subjective meaning or differential availability of choice. In the introduction, I identified three specific limitations of the choice paradigm related to site of death. Here I return to each of those and address them again, considering the findings from this dissertation.

The first limitation states that, despite a longstanding emphasis on choice as a way to improve end-of-life care, this has not been documented empirically. Although this dissertation did not directly investigate choice (e.g., meaning, ability, preference), it has brought new empirical evidence to bear on issues of geographic variation in site of death. Chapter 2 identified this variation and documented its persistence over the years, suggesting potential disparities regarding end-of-life experience and care. This indicates from the outset that the likelihood of dying in a particular setting is unequal and requires further investigation. As demonstrated in Chapters 3 and 4, counties varied in their social, economic, and healthcare environments. This heterogeneity shapes the likelihood of someone dying at home, in a hospital, or a nursing home. When thinking about choice explicitly, the findings suggest that choice is shaped, and possibly even constrained, at the end of life due to differences across counties. Despite research documenting preference for home death within a segment of the population[11] (Ali et al. 2015), it is clear that the kinds of choices being made as well as the availability of choices are contingent on structural constraints in the county in which one dies. Ultimately, this dissertation does not entirely negate the choice logic in and of itself. Instead, it demonstrates how choice operates within the larger county context of constraints. Choice does not need to be abandoned entirely as it is still useful for understanding how we assign social and cultural meaning to the end of life (especially since this is still the primary frame used in both research and policy). However, research focused on choice at the end of life would benefit from novel and rigorous approaches exploring not only whether choice matters but how, why, and when it matters. Therefore, despite the limitations of choice presented early in this dissertation, this dissertation provides new empirical evidence to help address some of these questions. Specifically, this dissertation provided evidence demonstrating how choice is embedded within local contexts that are heterogeneous in their social, economic, and healthcare resources. This dissertation also adds to a growing literature investigating the complexity of choice as it relates to the end of life (Borgstrom 2015; Lewis et al. 2021; MacArtney et al. 2016).

The second limitation notes that the logic of patient choice is predicated on there being multiple feasible options from which to choose. However, this dissertation suggests that there are places in the US where there are limited choices available. For example, in Chapter 3, findings indicated that counties in the high stable home death trajectory were more economically

[11] Although the estimates preferring home death are debated and not entirely known (see Hoare et al. 2015).

disadvantaged and had less access to various forms of healthcare. This was also the case for counties in the low stable hospital death trajectory, in which fewer hospital beds, nursing home beds, and hospices were associated with membership in this trajectory. These findings were corroborated by Chapter 4, which demonstrated that contextual factors accounted for a large proportion of the overall variation in site of death, suggesting that the characteristics of counties do shape site of death. These findings indicate that dying at home may be a function of access and resources rather than simply of choice in some counties. Stated another way, rather than dying at home because someone wanted to, people may be dying at home due to having few other available options. Therefore, findings from this research do not seem to point to a choice frame, and instead, the geographic variation in site of death appears to be impacted by two other frames: an access frame (healthcare) and a resource frame (economic). Hence, choice does not look the same across the US and should not be treated as a universalizing logic. Therefore, future research and policy must take seriously the context in which a death takes place. An overreliance on choice as a logic will only mask the structural features of people's lives that constrain their options at the end of life.

The third limitation focuses on home as the ideal setting to die. As a result of the hospice care movement, there has been a strong emphasis on the demedicalization of death and moving death back into the home. Due to these social changes in the meaning of site of death, home death is often used as an indicator of quality end-of-life care (Carr 2016). However, within a choice framework, this assumes that home death not only creates a higher-quality dying experience but is also the preferred site of death by the decedent (although this is often actually unknown). Findings from this dissertation demonstrate that home death does not always appear to be the ideal place for death. For example, the trajectory models presented in Chapter 3 suggest that counties with very high and stable home death rates are more likely to be experiencing challenges related to healthcare availability and accessibility and are more likely to be economically disadvantaged. If the choice rhetoric were to be taken at face value, a high rate of home death within a county would likely be taken as an overall positive outcome. However, it is clear from this research that although home death may be a positive experience for many decedents (e.g., a reprieve from unnecessary or excessive medicalization at the end of life), there are decedents in counties across the country who are experiencing home death in contexts that do not lend themselves to high-quality end-of-life care (e.g., a lack of access to hospitals and nursing homes; higher rates of economic disadvantage).

There has also been growing attention paid to the challenges of dying at home in recent years (Gray 2020; Kolata 2019; Leiter 2019). In the face of the medicalization of death and dying and concerns surrounding patient autonomy, the hospice and palliative care movements have provided a compelling alternative to the possible lonely, isolated, costly, and invasive experience of hospital death. However, home death comes with its own set of challenges, including pain and symptom management and caregiving demands. Continuing to treat home death as the ideal site of death only creates wider gaps between those who have wonderful home death experiences and those who experience immense challenges with home death – a gap that must be bridged if improvements are to be made to end-of-life care for all people. Furthermore, by subsuming all home deaths under the umbrella of "good" or "ideal," we unknowingly perpetuate inequality that likely leaves the most vulnerable and marginalized to die without the resources or services afforded to others. Therefore, findings from this dissertation suggest that less emphasis should be placed on differentially valuing various sites of death, and more emphasis should be placed on county context and the resources available to decedents at the end of life.

This dissertation was able to bring new empirical evidence related to the limitations of choice presented in Chapter 1. When considering these findings in tandem, it is clear that issues of choice, geographic variation, and site of death are related to broader issues around the reproduction of inequality. Although choice insinuates the ability to make decisions based on personal values and preferences, certain ways of approaching the end of life have become normative and held in higher regard than other ways. For instance, the notion of a "good death" has become pervasive within end-of-life research and policy, emphasizing acceptance of death, limited medical intervention, free from unnecessary suffering, and often at home (Emanuel and Emanuel 1998; Hart, Sainsbury, and Short 1998; Kehl 2006). However, such notions of a "good death" are representative of the ideologies and preferences held by historically socially advantaged groups (e.g., white, middle/upper class) (Livne 2019). Individuals from more advantaged social locations have more choices available to them and can more easily control the circumstances of their end-of-life experience. However, the most vulnerable and marginalized have less power and fewer resources to control when, how, or where they die. Social prioritization of one kind of death constrains the choices of dying people in its own right by emphasizing a normal and acceptable form of dying (Hart et al. 1998). Some have referred to the idea of making people long for choices and investing a lot in them as a "disciplining technique" (Mol 2008:4). Others have referred to the universality of the "good death" as a form of symbolic violence (Livne 2021). Therefore, the "good death" has become a new vehicle of social control, by which to manage "bad patients" and eliminate "bad deaths" (Hart et al. 1998).

Even if individuals are not able to wield as much power or control over their dying experience, at times individual values just do not align with notions of the "good death," regardless of the level of social persuasion. Therefore, if patients have preferences that do not align with current norms, their choices are not valued, and their deaths may be regarded as obstacles to overcome or failures (Hart et al. 1998; Livne 2021). This has been exemplified in research focused on the end-of-life values and preferences of working-class (Conway 2012) and Black individuals (Cain 2021). In the case of working-class people, sociologists have altogether neglected to document and examine their death-related experiences (Conway 2012). Moreover, in the case of Black people, their death and dying experiences are frequently framed only in terms of choice rather than being situated in larger systems of inequality, including systemic racism (Cain 2021). These findings are not new, as classical sociological work focused on death and dying identified that the autonomy of patients at the end of life is not equally valued and varies based on social location (Sudnow 1967). By focusing on choice or framing these issues as a choice, the reproduction of social inequality related to the experience of death and dying is rendered invisible. A continued emphasis on choice within end-of-life care with a reliance on home as the ideal site of death will likely have severe consequences for inequality in end-of-life care since choice is not a neutral logic but rather a moral and political one.

Despite the limitations of choice noted throughout this dissertation and the challenges that have been illuminated through the empirical findings, choice remains a pervasive and normalized frame by which to understand and investigate death and dying. Bourdieu (1990) provides us with a tool to help understand the permeation of such ideas within society, which he calls the scholastic point of view or skholè. The scholastic point of view argues that as scholars, professors, and researchers who study the social world, we project our worldview, theories, and ideologies onto the people we study. So what does this mean for choice? As those who study the social world, we value choice as a socially advantaged class of people and use these ideas in our research, projecting the notion of choice onto the people that we study, regardless of whether it is present or relevant. By treating the notion of choice as universally applicable, we implicitly legitimate a particular practice and the people who can engage in that practice.

However, prioritizing one frame and one practice has serious consequences, as Bourdieu notes: "…there is a manner, quite comfortable in short, of 'respecting the people' which consists in confining them to what they are, in *pushing them further down*, as we could say, by converting deprivation and hardship into an elective choice" (Bourdieu 1990:387). Thus, for those who which choice is not available or salient, we run the risk of oppressing and delegitimizing people at the end of life by holding steadfastly to notions of choice. Bourdieu argues that scientific thought cannot be separated from the social and economic conditions that made it possible, and therefore it is imperative that we investigate the presuppositions of the scholastic point of view and uncover the bias embedded in the tools of our intellectual work. We cannot just focus on the necessity or quantity of choice moving forward. Instead, we need to ask more fine-grained questions such as: Who is allowed to have choice? What kinds of choices are available? Whose choices are being valued more than others? If we do not do this, we will continue to ignore the practical and local features that structure people's lives.

A growing body of work has begun to document the complex reality of choice related to the end of life. Most of this work is qualitative and provides important and unique considerations that complement the findings of this dissertation. Borgstrom (2015) focused on two unique case studies from a larger project in order to explore what choice is and how it is enacted in the context of end-of-life care. She found that preferences and choices are often incredibly difficult for people to articulate, and an emphasis on choice does not acknowledge the complex social contexts where care is received. MacArtney et. al (2016) explored how patients in a specialist palliative care unit discuss their understanding and experience related to site of death. The authors argue that the ways in which people understand the setting in which they die is more complicated than simply just focusing on choice or preference. It was commonplace for other factors to constrain the decision-making process, including a wide range of physical, emotional, and social needs. Lewis et al. (2021) investigated how choice is negotiated and made meaningful at the end of life among women with metastatic breast cancer. Although the women often embraced a choice-as-control mentality, they were also frequently concerned with making the 'wrong choice,' and their decisions were also shaped by relational contexts, including relationship dynamics, considerations of time, and financial resources.

Overall, the findings in this dissertation complement and are complemented by these qualitative deep dives into the complex nature of choice for people at the end of life. First, in terms of complementing, this dissertation provides empirical quantitative evidence demonstrating how choice is locally embedded in the counties in which people die, complicating choice in ways that are not easily discernable when focused exclusively on choice. The factors that shape site of death likely interact with the individual challenges surrounding choice identified in these qualitative studies. In terms of complemented, these studies provide nuanced and detailed narrative accounts that help to amplify further the notion that choice is complex and should not be exclusively used as the measure of quality end-of-life care.

Beyond the limitations originally proposed, it has been argued that choice in and of itself is not bad, but it only becomes problematic when people are not able to make their own choices (Mol 2008). In sum, findings from this research have demonstrated considerable variation in site of death across counties in the US, suggesting inequalities in the experience of death and dying. Additionally, this research identified county-level structural factors working to shape and constrain choice within local contexts. The findings underscore the significance of interrogating end-of-life care from new and innovative theoretical frameworks. Beyond just the implications of this work for the interdisciplinary field of death and dying research, this dissertation has contributed to a rich and growing field of inquiry focused on issues of patient choice and autonomy within medical sociology. Issues of choice are not new and are not going away anytime soon, as we have seen in instances of abortion rights and vaccine hesitancy in recent years. Death, dying, and the end of life serve as interesting use cases to understand these complex notions of freedom and autonomy in a rapidly changing society. There is still much work to be done, but this dissertation provides an essential launching off point for future research to interrogate the end of life as a unique life course stage.

Ecological context

The primary theoretical framework for this dissertation was an ecological perspective. An ecological perspective, at its core, argues that the context that we live in (and die in) matters for a variety of factors, including our health, wellbeing, and mortality (Monnat 2018a; Murray et al. 2006; Subramanian et al. 2001). Places are not equal and provide differential opportunity structures, ultimately enabling or restricting various behaviors and choices. This dissertation utilized an ecological perspective to investigate geographic variation in site of death to understand how choice may be locally embedded within counties in the US. By merging population-level death certificate data with county-level datasets, it was possible to leverage a variety of county-level factors to help understand *why* such differences exist in site of death across counties, including social, economic, healthcare, religious, and political factors. This dissertation also employed a unique array of quantitative methods that complement an ecological perspective. Overall, economic and healthcare factors were the most significant county features shaping site of death. This is not too surprising given that economic and healthcare factors have long been considered social determinants of health (Marmot and Wilkinson 2005). I will explore the broader implications of each of these factors below.

The economic context was significantly associated with site of death in two chapters. The significant relationship between economic context and site of death varied across chapters but included county-level poverty, education, unemployment, and insurance status. In Chapter 3, counties with higher average rates of home death across the entire period (medium increasing and high stable home death trajectories) were more likely to be experiencing low employment at the county level. This was also the case for the low stable nursing home death trajectory. In Chapter 4, the percent living in poverty was positively associated with hospital death relative to home, while the uninsured percent was negatively associated with hospital death relative to home. For nursing home deaths relative to home, percent with a college degree, unemployed, or uninsured lowered the odds of nursing home death. These findings suggest that economic hardship at the county level may impact individuals' ability to access hospital or nursing home care at the end of life.

These findings corroborate previous research focused on site of death that has identified a similar relationship with economic context (Davies et al. 2019; Gruneir et al. 2007). The role of economic context in shaping health is not a new finding, and similar results have been found for a variety of health outcomes, including HIV (Harrison et al. 2008), cancer (Moss, Liu, and Feuer 2017; Saldana-Ruiz et al. 2013), and most recently COVID cases and mortality (Hawkins, Charles, and Mehaffey 2020). This suggests that even if someone is not economically disadvantaged at the individual level, living (and dying) in an area of economic deprivation will impact the options for care at the end of life. Therefore, this dissertation builds on previous work in this area while also expanding these insights to an important end-of-life care outcome.

Additionally, this suggests that focusing on the economic wellbeing of communities would likely have positive returns for people in terms of end-of-life care above and beyond their own socioeconomic wellbeing. Healthcare in the US is costly, and end-of-life care is increasingly expensive. Despite efforts to "economize" death within the hospice and palliative care movements (Livne 2019), it is essential to make care (regardless of the kinds of care) affordable to all types of individuals. Regardless of what people's choices ultimately end up being regarding end-of-life care, creating affordable options for care is necessary. Continuing to only focus on moving people out of hospitals and into homes to die will not fix the structural economic challenges exhibited within these communities. Additionally, expanding Medicaid dual eligibility options and enhancing Medicare coverage for care at the end of life would also help to reduce economic hardship. Furthermore, it is unclear at this time how the relationship between site of death and economic context has changed over time, although this would be an interesting and promising arena for future investigation.

The healthcare context was significantly associated with site of death in two chapters. This was measured by the availability of hospital beds, nursing home beds, hospices, hospital admissions, and inpatient days in the last six months of life, as well as counties being designated a health professional shortage area. In Chapter 3, counties with higher average rates of home death across the entire period (medium increasing and high stable home death trajectories) had fewer hospital beds, nursing home beds, lower hospital admissions, and higher inpatient days in the last six months of life. In Chapter 4, of all the county-level factors, healthcare factors accounted for the most considerable portion of the reduction in the overall variation in site of death for hospital versus home death outcome. Healthcare factors accounted for the second-largest reduction for the nursing home versus home death outcome. Additionally, the availability of both hospital beds and nursing home beds increased the likelihood of hospital death and nursing home death (relative to home). The impact of healthcare availability in a given area for predicting site of death is not a new finding (Gruneir et al. 2007; Pritchard et al. 1998; Xu et al. 2020). However, what is new is that these healthcare factors are associated with county site of death composition over multiple decades and not just simply the individual likelihood of hospital or home death. Additionally, healthcare factors accounted for a significant proportion of the total variation in site of death. These findings suggest that healthcare factors within a county are significant in shaping where people will ultimately die. Also, note that since this study utilized county of occurrence rather than county of residence, such estimates of healthcare accessibility are likely conservative. That is, people living in counties without healthcare resources readily available may need to travel to other counties for various forms of care and may ultimately die in that place.

Healthcare availability and accessibility are multidimensional, and previous research has documented several barriers to healthcare access in rural areas of the US. Such barriers include lack of services, lack of physicians, insufficient transportation, and poor internet access (Douthit et al. 2015). Therefore, addressing issues of healthcare accessibility will likely require a multi-pronged approach. Ensuring access to a wide variety of services for individuals living in areas with fewer healthcare resources is essential for improving end-of-life care. This is especially true when considering current and mounting challenges related to healthcare accessibility in rural counties in the US (Siegler 2019). This would also allow for more choices within a given area, providing a diversity of care options at the end of life. Geographic barriers to healthcare are important and are likely compounded by economic factors that make even potentially available healthcare services entirely inaccessible due to lack of economic resources or health insurance. Therefore, moving forward, it will also be important to consider how economic and healthcare access factors work in tandem to shape site of death in the US.

At its core, this dissertation focuses on issues that have been longstanding concerns within sociology around how social context shapes our reality. By explicitly engaging with an ecological framework to structure the framing and methods of this dissertation, the findings complement a contemporary genre of sociological work focused on the relationship between population health and geographic context (Monnat 2018b; Murray et al. 2006; Subramanian et al. 2001; Vierboom et al. 2019). These findings also complement a classical genre of work originating in Durkheim's seminal analysis of suicide (Durkheim 1951). In sum, the findings have identified structural features that constrain choice surrounding site of death and, therefore, underscore the significance of utilizing new theories to investigate issues at the end of life. It would be a mistake to continue to rely exclusively on the narrative of choice to analyze and improve end-of-life care, given the immense variation in the experience of death and dying across the US. There is still much work to be done to ensure improved care for the dying, but this dissertation serves as a comprehensive starting point by which to investigate these questions further.

Future directions

In recent years, increasing attention has been paid to site of death in both institutional arenas (Institute of Medicine 2015) and popular media (Gray 2020; Kolata 2019; Leiter 2019). This attention has been further enhanced by the coronavirus (COVID) pandemic. COVID has created even more severe complications related to site of death in the US. Unfortunately, complete population-level data were not available prior to the completion of this dissertation and therefore were not included. However, it is clear from preliminary data (National Center for Health Statistics 2021) and news coverage (Mazzei, Halleck, and Jr 2020) that the pandemic has had drastic effects on site of death. Nursing homes have had a unique spotlight as they experienced exceptionally high rates of virus transmission and death at the onset of the pandemic (Kim 2020). For the first time in decades, despite general and consistent declines in hospital deaths, there has been an overall increase in hospital deaths. Hospitals have faced additional challenges in allocating healthcare resources in areas where hospitals were full or approaching capacity (Lin II, Money, and Campa 2021; Paz 2021). Such difficulties were also exacerbated by COVID policies that did not allow friends or family to be with patients at their death beds (Hafner 2020). Unfortunately, roughly two years later, the pandemic still feels far from over, and we are only beginning to uncover the direct and indirect impacts of the pandemic and the inequities that have patterned COVID deaths (Khazanchi et al. 2020; Laster Pirtle 2020). If anything, and why I mention the pandemic in my discussion, COVID has demonstrated that it is imperative to remain attentive to issues of end-of-life care, generally, and site of death, specifically.

Despite the limitations of this dissertation to address these contemporary and continually emerging issues, there is a continued need for research focused on site of death in the context of the pandemic, especially as it relates to geographic inequality. New research has already begun to document geographic inequalities in county-level COVID cases, COVID mortality, and all-cause mortality (Khazanchi et al. 2020; Stokes, Lundberg, Elo, et al. 2021). Additionally, research has begun to focus on excess deaths due to COVID-19, including inaccurate COVID death assignment and deaths due indirectly to the impacts of COVID (e.g., delaying care, social/economic consequences of the pandemic) (Polyakova et al. 2021; Stokes, Lundberg, Bor, et al. 2021; Stokes, Lundberg, Elo, et al. 2021). One such study found that a larger proportion of excess deaths were not reported as COVID-19 in counties with lower rates of health insurance and primary care and higher rates of home death (Stokes, Lundberg, Bor, et al. 2021).

Further research is needed to understand better what these findings mean for people who died at home in these counties, but these findings suggest that it is essential to continue the line of inquiry laid out in this dissertation in a pandemic setting. For example, it is necessary to answer questions such as, what factors were associated with a home death (or hospital death) during COVID? Who was more likely to die at home during COVID? What county-level factors, beyond healthcare accessibility, were associated with home death in this context? The pandemic also provides an opportunity to study choice as it relates to an emergent and evolving public health crisis. This will likely not be the last time we experience this kind of epidemiological challenge and understanding how COVID has shaped and constrained choice at the end of life is an important area for exploration. For example, how has COVID impacted the ability of patients to make choices about their end-of-life care? How is the notion of "choice" understood by healthcare providers in a pandemic context? Additionally, how might choice be constrained in ways that are unique to the pandemic period? Overall, future research should consider the relationship between site of death, choice, geographic variation, and an evolving pandemic period.

Additionally, the restricted death certificate data utilized in this study were limited in what covariates could be integrated into the analysis. Future research could consider linking death certificate data with other external survey resources to expand this portion of the analysis. Due to increasing costs of deploying surveys as well as lower response rates, there has been increasing movement within survey research to find ways to creatively reuse data that is already available, whether that be administrative records or electronic health information (Conrad, Keusch, and Schober 2021; Groves 2011). For example, recent work produced within the US Census Bureau (Census) demonstrated the utility of using Census records to study mortality starting as early as 1990 (Finlay and Genadek 2021). Although these records do not contain information on the cause of death, they have the additional advantage of being linked with the Census' Data Linkage Infrastructure Program (US Census Bureau n.d.). This would allow the linkage of mortality records directly with the Decennial Census (dating back to 1940), the American Community Survey (ACS), various federal records (e.g., tax return information), extensive state and local government data (e.g., Medicare and Medicaid enrollment data), as well as MAF-ARF data which links individuals with residential addresses back to 2000, to name a few. Connecting these various data products would allow for the integration of variables at multiple levels of social life, including within individuals, families, households, neighborhoods, and so on. Such linkages could also fill in missingness related to county of residence, allowing for the inclusion of this as an important component of site of death. Overall, mortality data is a vital administrative record with endless potential when linking it with other administrative records and survey data. This would be a unique and exciting partnership that would allow for the further exploration of what shapes site of death in the US.

Policy implications

In terms of practical significance, this research also has implications for future policy. Coming up with concrete solutions to improve end-of-life care is no easy feat. However, the Institute of Medicine has recommended improving coverage for palliative care, the development of end-of-life care quality standards, education and training for professionals, and public education and engagement to improve the quality of end-of-life care (Institute of Medicine 2015). Unfortunately, these recommendations lean heavily on narratives of choice and do not consider the complex structural features of local communities that likely restrict choices at the end of life. Therefore, based on the findings in this dissertation, I would suggest it is necessary to move away from a singular and particular emphasis on choice for improving end-of-life care and instead redirect energy and resources to the structural features of local communities. To date, many end-of-life care interventions have emphasized individual-level and interactional factors, including sociodemographic characteristics, advance care planning, and patient-provider communication. Although these interventions are not unimportant, they may be unsuccessful in certain situations due to the considerable contextual factors that may affect site of death. Moreover, while state-level policy interventions have been implemented in recent decades (e.g., Medicaid expansion, legalization of medical aid in dying), how these policies play out in smaller and more heterogeneous communities within states likely differs. This is especially important when considering the differential access and availability of healthcare services for older adults in rural and urban settings (Glasgow and Berry 2013).

The county is an important level by which to assess geographic variation in site of death in the US. Counties also play a vital role in shaping overall health (e.g., public health programs and interventions, economic assistance programs, community-based services, healthcare availability) and hence provide a ripe site for social change. Although counties are highly diverse in their composition and needs, they are also more flexible in adapting to these challenges than the state. Improving the availability (both in terms of cost and access), diversity, and quality of care, especially for those in rural contexts, would be an excellent starting point. Additionally, creating or enhancing existing economic assistance programs would provide additional support to individuals and their families across the life course, and importantly, at the end of life. Focusing on improving county-level economic and healthcare factors would be an excellent starting point and positively impact a host of other health outcomes beyond just end-of-life care.

Despite the finding that home death appears to be, at times, occurring under conditions that are not conducive to high-quality end-of-life care, home death will likely remain the research and policy goal for the foreseeable future. However, it is necessary to ensure that adequate and appropriate resources are available for all people, regardless of needs and desires. This suggests that it is imperative to invest explicitly in care for the dying and make real investments in caregiving and caregivers. This could mean formal *and* informal caregiving support since informal caregivers comprise a significant component of unpaid care at the end of life (Gardiner et al. 2020). However, our attention cannot just be on improving home death without supporting individuals who are already more likely to die in hospitals (recall, this is still a common outcome for a large portion of the population). Therefore, it is essential to improve care for the dying in hospitals. This has long been a concern and challenge (Gawande 2015; Kaufman 2005). However, only focusing on improving home death leaves behind vulnerable and marginalized populations who are more likely to die in a hospital. Hence, improving care for the dying in these settings is imperative. Several approaches could be taken, ranging from enhanced education and training around end-of-life care issues in medical school to promoting integrated care teams within hospitals that include palliative care staff.

Despite a longstanding emphasis on moving death back into homes, I am not convinced that ensuring that more people can die at home is going to miraculously enhance end-of-life care. Instead, future policy interventions should be attentive to the multifaceted and unique needs of people living in counties where home death is less an option and more a necessity. This should be coupled with serious attempts to improve care for the dying in institutionalized settings, including both hospitals and nursing homes. Overall, attempts to prioritize more local solutions that deemphasize choice and focus more on resources will likely have important impacts on the end of life in ways that federal-, state-, and individual-level solutions have not.

Limitations

In addition to the limitations mentioned in each empirical chapter, the findings presented in this dissertation should be interpreted in light of a few additional limitations. First, this dissertation could not directly test the concept of "choice" in its own right. More specifically, this dissertation was unable to assess decedent values and preferences at the end of life, congruence between preferred and actual site of death, or the meaning of choice to decedents and their family members. Instead, this research relied on population-level death certificate data to assess heterogeneity in site of death across US counties. However, the goal of the research was not to directly assess choice in its own right but to utilize an ecological perspective on site of death to understand how choice is enabled or constrained by one's local context. Despite this limitation, this research shed light on choice at the end of life by identifying considerable heterogeneity in the experience of dying across counties in the US. Furthermore, counties vary in the availability of "choices" for those at the end of life. Second, aggregate measures of county-level conditions may mask differences within counties. Although there is substantial heterogeneity across counties, there is also considerable heterogeneity within counties. There could be significant differences in the social, economic, healthcare, political, and religious environment within a given county that may have important implications for site of death in the US. However, restricted death certificate data provides county as the smallest unit of analysis by which to analyze geographic differences. Therefore, due to the data used in this dissertation, it was not possible to assess within county heterogeneity.

Third, site of death coding has undergone numerous changes, and several decisions were made to enhance the efficacy of the results. This dissertation was limited by the omission of two site of death categories: 1) dead on arrival (at a hospital) and 2) hospice deaths. Deaths coded as "dead on arrival" appear to be a unique kind of death. Between 1991 and 2017, only 2 percent of deaths among the analytic sample (those 65 years of age and older who died of natural causes) were classified as "dead on arrival." Between 2015 and 2017, this dropped to only 0.22 percent. Among all deaths in this category, the vast majority were male and over half (50.42%) were not older adults (and hence would have been omitted from the analytic sample). Additionally, in terms of cause, these individuals were most likely to die from heart disease (48.27%) or external causes (22.12%, including accidents, suicide, and homicide). Of those who did die of heart disease, 36 percent were younger than 65 years of age. Overall, this does appear to be a group with an overall unique death experience primarily composed of younger, male decedents who died of heart disease or external causes. Despite excluding these deaths from the analytic sample, there is something unique about death and dying for this group of individuals. However, it was not within the purview of this dissertation to explore these differences, but these still appear to be important socially patterned deaths that could benefit from future investigation.

In terms of hospice deaths, death certificates do not adequately track deaths in hospice care and therefore analysis was restricted to hospitals, homes, and nursing homes. Starting in 2003, NVSS included hospice as an option for all non-hospital-related deaths. A hospice facility was defined as "a licensed institution providing hospice care (e.g., palliative or supportive care for the dying), not hospice care that might be provided in a number of different settings, including a patient's home" (Department of Health and Human Services 2003:34). Therefore, this definition only applies to inpatient hospice, which is the most restrictive and uncommon form of hospice. In 2015, the majority of hospice services were received in the home and not at an inpatient hospice facility (NHPCO 2018:3). Additionally, 46 percent of all Medicare decedents received some form of hospice care in 2015 (NHPCO 2018:3). However, according to the NVSS mortality data, only 7.81 percent of all deaths in 2015 occurred in hospice. Based on these various factors, this measure of hospice deaths was a dramatic underestimate from the actual number of hospice deaths in 2015 and thus was omitted from this analysis. Therefore, this analysis could not include hospice as a site of death. Despite this limitation, these data are the best suited for investigating variation in site of death for home, hospital, and nursing home deaths, which still account for the vast majority of deaths.

Conclusion

Research has demonstrated the numerous ways in which death and dying as social processes are highly unequal. Understanding this inequality is imperative for actively and creatively improving end-of-life care. Although we are seeing major shifts in where people die in the US (Olaisen 2016), findings from this dissertation suggest that the impacts of this are not felt equally. This study utilized an ecological perspective to analyze geographic disparities in site of death as a means of empirically investigating how death is shaped in different contexts within the US and how this has changed over time. Drawing on findings derived from various quantitative analyses, I have demonstrated that there is considerable geographic variation in site of death, and the characteristics of counties shape the likelihood of dying in a particular setting above and beyond sociodemographic characteristics. More importantly, this dissertation has argued that it is imperative to consider these findings outside of a framework focused on patient choice and autonomy. Overall, the choice discourse draws attention away from the social and physical environments that shape where we ultimately die. However, we cannot just cast this discourse aside as it is still the primary frame for end-of-life care. Instead, an ecological perspective has the potential to transform the choice discourse by further situating the experience of individuals in their larger context. Moving forward, it is imperative to consider how choice is embedded within local contexts in future research and policy. Shifting our focus in this way will likely result in new research insights and creative policy interventions that will improve the experience of death and dying for all people.

References

Abel, Emily K. 2017. *Inevitable Hour*. John Hopkins University Press.

Abramson, Corey M. and Elena Portacolone. 2017. "What Is New with Old? What Old Age Teaches Us about Inequality and Stratification." *Sociology Compass* 11(3):e12450. doi: 10.1111/soc4.12450.

Albom, Mitch. 1997. *Tuesdays with Morrie: An Old Man, a Young Man, and Life's Greatest Lesson, 20th Anniversary Edition*. New York: Doubleday.

Ali, Maimoona, Margred Capel, Gareth Jones, and Terri Gazi. 2015. "The Importance of Identifying Preferred Place of Death." *BMJ Supportive & Palliative Care*. doi: http://dx.doi.org.colorado.idm.oclc.org/10.1136/bmjspcare-2015-000878.

Allers, Katharina, Falk Hoffmann, and Rieke Schnakenberg. 2019. "Hospitalizations of Nursing Home Residents at the End of Life: A Systematic Review." *Palliative Medicine* 33(10):1282–98. doi: 10.1177/0269216319866648.

Area Health Resources Files. 2021. "Area Health Resources Files, 2020-2021 County Level Data." *Health Resources & Services Administration*. Retrieved from https://data.hrsa.gov/data/download.

Bell, Christina L., Emese Somogyi-Zalud, and Kamal H. Masaki. 2010. "Factors Associated with Congruence Between Preferred and Actual Place of Death." *Journal of Pain and Symptom Management* 39(3):591–604. doi: 10.1016/j.jpainsymman.2009.07.007.

Berger, Nicolas, Tanya K. Kaufman, Michael D. M. Bader, Andrew G. Rundle, Stephen J. Mooney, Kathryn M. Neckerman, and Gina S. Lovasi. 2019. "Disparities in Trajectories of Changes in the Unhealthy Food Environment in New York City: A Latent Class Growth Analysis, 1990–2010." *Social Science & Medicine* 234:112362. doi: 10.1016/j.socscimed.2019.112362.

Bernstein, Steven, Anna North, Jason Schwartz, and Linda M. Niccolai. 2016. "State-Level Voting Patterns and Adolescent Vaccination Coverage in the United States, 2014." *American Journal of Public Health* 106(10):1879–81. doi: 10.2105/AJPH.2016.303381.

Borgstrom, Erica. 2015. "Planning for an (Un)Certain Future: Choice within English End-of-Life Care." *Current Sociology* 63(5):700–713. doi: 10.1177/0011392115590084.

Bourdieu, Pierre. 1990. "The Scholastic Point of View." *Cultural Anthropology* 5(4):380–91.

Brinkman-Stoppelenburg, Arianne, Judith AC Rietjens, and Agnes van der Heide. 2014. "The Effects of Advance Care Planning on End-of-Life Care: A Systematic Review." *Palliative Medicine* 28(8):1000–1025. doi: 10.1177/0269216314526272.

Brock, Dwight B., and Daniel J. Foley. 1998. "Demography and Epidemiology of Dying in the U.S. with Emphasis on Deaths of Older Persons." *The Hospice Journal* 13(1–2):49–60. doi: 10.1080/0742-969X.1998.11882887.

Bronfenbrenner, Urie. 1977. "Toward an Experimental Ecology of Human Development." *American Psychologist* 32(7):513–31. doi: 10.1037/0003-066X.32.7.513.

Bryant, Louise D., Nicola Bown, Hilary L. Bekker, and Allan House. 2007. "The Lure of 'Patient Choice.'" *British Journal of General Practice* 5.

Cain, Cindy L. 2021. "Valuing Black Lives and the 'Good Death' in the United States." *Sociology of Health & Illness* 43(8):1840–44. doi: 10.1111/1467-9566.13310.

Carr, Deborah. 2016. "Is Death 'The Great Equalizer'? The Social Stratification of Death Quality in the United States." *The ANNALS of the American Academy of Political and Social Science* 663(1):331–54. doi: 10.1177/0002716215596982.

Center for Disease Control. 2021. "The Social-Ecological Model: A Framework for Prevention." Retrieved February 22, 2021 (https://www.cdc.gov/violenceprevention/about/social-ecologicalmodel.html).

Chino, Fumiko, Arif H. Kamal, Thomas W. Leblanc, S. Yousuf Zafar, Gita Suneja, and Junzo P. Chino. 2018. "Place of Death for Patients with Cancer in the United States, 1999 through 2015: Racial, Age, and Geographic Disparities." *Cancer* 124(22):4408–19. doi: https://doi.org/10.1002/cncr.31737.

Cho, Sujung, Yung Hyeock Lee, and Shannon B. Harper. 2020. "Testing the Systemic Model of Social Disorganization Theory in South Korean Neighborhoods: A Latent Class Growth Analysis Approach to Specifying Pathways to Homicide." *Homicide Studies* 1088767920941564. doi: 10.1177/1088767920941564.

Christensen, Kaare, Gabriele Doblhammer, Roland Rau, and James W. Vaupel. 2009. "Ageing Populations: The Challenges Ahead." *The Lancet* 374(9696):1196–1208. doi: 10.1016/S0140-6736(09)61460-4.

Cohen, Deborah A., Richard A. Scribner, and Thomas A. Farley. 2000. "A Structural Model of Health Behavior: A Pragmatic Approach to Explain and Influence Health Behaviors at the Population Level." *Preventive Medicine* 30(2):146–54. doi: 10.1006/pmed.1999.0609.

Collyer, Fran M., Karen F. Willis, Marika Franklin, Kirsten Harley, and Stephanie D. Short. 2015. "Healthcare Choice: Bourdieu's Capital, Habitus and Field." *Current Sociology* 63(5):685–99. doi: 10.1177/0011392115590082.

Conrad, Frederick G., Florian Keusch, and Michael F. Schober. 2021. "New Data in Social and Behavioral Research." *Public Opinion Quarterly* 85(S1):253–63. doi: 10.1093/poq/nfab027.

Conway, Steve. 2012. "Death, Working-Class Culture and Social Distinction." *Health Sociology Review* 21(4):441–49. doi: 10.5172/hesr.2012.21.4.441.

Cosby, Arthur G., M. Maya McDoom-Echebiri, Wesley James, Hasna Khandekar, Willie Brown, and Heather L. Hanna. 2018. "Growth and Persistence of Place-Based Mortality in the United States: The Rural Mortality Penalty." *American Journal of Public Health* 109(1):155–62. doi: 10.2105/AJPH.2018.304787.

Crimmins, Eileen M. 2015. "Lifespan and Healthspan: Past, Present, and Promise." *The Gerontologist* 55(6):901–11. doi: 10.1093/geront/gnv130.

Cross, Sarah H., Brystana G. Kaufman, Donald H. Taylor, Arif H. Kamal, and Haider J. Warraich. 2019. "Trends and Factors Associated with Place of Death for Individuals with

Dementia in the United States." *Journal of the American Geriatrics Society* 0(0). doi: 10.1111/jgs.16200.

Cross, Sarah H., Brystana G. Kaufman, and Haider J. Warraich. 2019. "Trends in Location of Death for Individuals with Cerebrovascular Disease in the United States." *JAMA Neurology* 76(11):1399. doi: 10.1001/jamaneurol.2019.2566.

Cross, Sarah H., and Haider J. Warraich. 2019. "Changes in the Place of Death in the United States." *New England Journal of Medicine* 381(24):2369–70. doi: 10.1056/NEJMc1911892.

Dartmouth Atlas Project. 2021. "End-of-Life Inpatient Care (All Decedents; Last Six Months of Life), 2010." *Dartmouth Atlas of Health Care*. Retrieved October 13, 2020 (https://data.dartmouthatlas.org/end-of-life-care/).

Davies, Joanna M., Katherine E. Sleeman, Javiera Leniz, Rebecca Wilson, Irene J. Higginson, Julia Verne, Matthew Maddocks, and Fliss E. M. Murtagh. 2019. "Socioeconomic Position and Use of Healthcare in the Last Year of Life: A Systematic Review and Meta-Analysis." *PLOS Medicine* 16(4):e1002782. doi: 10.1371/journal.pmed.1002782.

De Schreye, Robrecht, Dirk Houttekier, Luc Deliens, and Joachim Cohen. 2017. "Developing Indicators of Appropriate and Inappropriate End-of-Life Care in People with Alzheimer's Disease, Cancer or Chronic Obstructive Pulmonary Disease for Population-Level Administrative Databases: A RAND/UCLA Appropriateness Study." *Palliative Medicine* 31(10):932–45. doi: 10.1177/0269216317705099.

Department of Health and Human Services. 2003. *Physician's Handbook on Medical Certification of Death*. (PHS) 2003-1108. Hyattsville, MD: National Center for Health Statistics.

Dixon, Anna, Ruth Robertson, John Appleby, Peter Burge, Nancy Devlin, and Helen Magee. 2010. *Patient Choice: How Patients Choose and How Providers Respond*. London: The King's Fund.

Douthit, N., S. Kiv, T. Dwolatzky, and S. Biswas. 2015. "Exposing Some Important Barriers to Health Care Access in the Rural USA." *Public Health* 129(6):611–20. doi: 10.1016/j.puhe.2015.04.001.

Drought, Theresa S., and Barbara A. Koenig. 2002. "Choice in End-of-Life Decision Making: Researching Fact or Fiction?" *The Gerontologist* 42(suppl_3):114–28. doi: 10.1093/geront/42.suppl_3.114.

Durkheim, Emile. 1951. *Suicide*. New York: The Free Press.

Dwyer-Lindgren, Laura, Amelia Bertozzi-Villa, Rebecca W. Stubbs, Chloe Morozoff, Shreya Shirude, Jürgen Unützer, Mohsen Naghavi, Ali H. Mokdad, and Christopher JL Murray. 2018. "Trends and Patterns of Geographic Variation in Mortality from Substance Use Disorders and Intentional Injuries among US Counties, 1980-2014." *Jama* 319(10):1013–23.

Emanuel, Ezekiel J., and Linda L. Emanuel. 1998. "The Promise of a Good Death." *The Lancet* 351:SII21–29.

Fagerlin, Angela, and Carl E. Schneider. 2004. "Enough: The Failure of the Living Will." *Hastings Center Report* 34(2):30–42. doi: https://doi.org/10.2307/3527683.

Finlay, Keith, and Katie R. Genadek. 2021. "Measuring All-Cause Mortality with the Census Numident File." *American Journal of Public Health* 111(S2):S141–48. doi: 10.2105/AJPH.2021.306217.

Fischer, Stacy, Sung-Joon Min, Lilia Cervantes, and Jean Kutner. 2013. "Where Do You Want to Spend Your Last Days of Life? Low Concordance Between Preferred and Actual Site of Death Among Hospitalized Adults." *Journal of Hospital Medicine* 8(4):178–83. doi: 10.1002/jhm.2018.

Flory, James, Yinong Young-Xu, Ipek Gurol, Norman Levinsky, Arlene Ash, and Ezekiel Emanuel. 2004. "Place of Death: U.S. Trends Since 1980." *Health Affairs* 23(3):194–200. doi: 10.1377/hlthaff.23.3.194.

Fotaki, Marianna. 2010. "Patient Choice and Equity in the British National Health Service: Towards Developing an Alternative Framework." *Sociology of Health & Illness* 32(6):898–913. doi: 10.1111/j.1467-9566.2010.01254.x.

Fotaki, Marianna. 2013. "Is Patient Choice the Future of Health Care Systems?" *International Journal of Health Policy and Management* 1(2):121–23. doi: 10.15171/ijhpm.2013.22.

Gardiner, Clare, Jackie Robinson, Michael Connolly, Claire Hulme, Kristy Kang, Christine Rowland, Phil Larkin, David Meads, Tessa Morgan, and Merryn Gott. 2020. "Equity and the Financial Costs of Informal Caregiving in Palliative Care: A Critical Debate." *BMC Palliative Care* 19(1):71. doi: 10.1186/s12904-020-00577-2.

Gardner, Daniel S., Meredith Doherty, Gleneara Bates, Aliza Koplow, and Sarah Johnson. 2018. "Racial and Ethnic Disparities in Palliative Care: A Systematic Scoping Review." *Families in Society* 99(4):301–16. doi: 10.1177/1044389418809083.

Gawande, Atul. 2015. *Being Mortal Illness, Medicine and What Matters in the End*. New York: Metropolitan Books.

Gieryn, Thomas F. 2000. "A Space for Place in Sociology." *Annual Review of Sociology* 26(1):463–96. doi: 10.1146/annurev.soc.26.1.463.

Glasgow, Nina, and E. Helen Berry, eds. 2013. *Rural Aging in 21st Century America*. Springer Netherlands.

Goldstein, Joshua R. 2009. "How Populations Age." Pp. 7–18 in *International Handbook of Population Aging*, edited by P. Uhlenberg. Dordrecht: Springer Netherlands.

Gomes, Barbara, Natalia Calanzani, Marjolein Gysels, Sue Hall, and Irene J. Higginson. 2013. "Heterogeneity and Changes in Preferences for Dying at Home: A Systematic Review." *BMC Palliative Care* 12(1):7. doi: 10.1186/1472-684X-12-7.

Gomes, Barbara, and Irene J. Higginson. 2004. "Home or Hospital? Choices at the End of Life." *Journal of the Royal Society of Medicine* 97(9):413–14. doi: 10.1177/014107680409700901.

Gomes, Barbara, and Irene J. Higginson. 2006. "Factors Influencing Death at Home in Terminally Ill Patients with Cancer: Systematic Review." *BMJ* 332(7540):515–21. doi: 10.1136/bmj.38740.614954.55.

Goodman, David C., Amos R. Esty, Elliott S. Fisher, and Chiang-Hua Chang. 2011. *Trends and Variation in End-of-Life Care for Medicare Beneficiaries with Severe Chronic Illness*. The Dartmouth Atlas Project.

Grammich, Clifford, Kirk Hadaway, Richard Houseal, Dale E. Jones, Alexei Krindatch, Richie Stanely, and Richard H. Taylor. 2010. "2010 U.S. Religion Census: Religious Congregations & Membership Study." *Association of Statisticians of American Religious Bodies*. Retrieved October 14, 2021 (https://thearda.com/Archive/Files/Descriptions/RCMSCY10.asp).

Gray, Nathan. 2020. "Think You Want to Die at Home? You Might Want to Think Twice about That." *Los Angeles Times*, February 16.

Groves, Robert M. 2011. "Three Eras of Survey Research." *Public Opinion Quarterly* 75(5):861–71. doi: 10.1093/poq/nfr057.

Gruneir, Andrea, Vincent Mor, Sherry Weitzen, Rachael Truchil, Joan Teno, and Jason Roy. 2007. "Where People Die: A Multilevel Approach to Understanding Influences on Site of Death in America." *Medical Care Research and Review* 64(4):351–78. doi: 10.1177/1077558707301810.

Hafner, Katie. 2020. "'A Heart-Wrenching Thing': Hospital Bans on Visits Devastate Families." *The New York Times*, March 29.

Hall, Lauren K. 2019. *The Medicalization of Birth and Death*. Baltimore: John Hopkins University Press.

Harris-Kojetin, Lauren, Manisha Sengupta, Eunice Park-Lee, Roberto Valverde, Christine Caffrey, Vincent Rome, and Jessica Lendon. 2016. "Long-Term Care Providers and Services Users in the United States: Data from the National Study of Long-Term Care Providers, 2013-2014." National Center for Health Statistics. Vital Health Stat 3(38).

Harrison, Kathleen McDavid, Qiang Ling, Ruiguang Song, and H. Irene Hall. 2008. "County-Level Socioeconomic Status and Survival After HIV Diagnosis, United States." *Annals of Epidemiology* 18(12):919–27. doi: 10.1016/j.annepidem.2008.09.003.

Hart, Bethne, Peter Sainsbury, and Stephanie Short. 1998. "Whose Dying? A Sociological Critique of the 'Good Death.'" *Mortality* 3(1):65–77. doi: 10.1080/713685884.

Hawkins, R. B., E. J. Charles, and J. H. Mehaffey. 2020. "Socio-Economic Status and COVID-19–Related Cases and Fatalities." *Public Health* 189:129–34. doi: 10.1016/j.puhe.2020.09.016.

Higginson, Irene J., and G. j. a. Sen-Gupta. 2000. "Place of Care in Advanced Cancer: A Qualitative Systematic Literature Review of Patient Preferences." *Journal of Palliative Medicine* 3(3):287–300. doi: 10.1089/jpm.2000.3.287.

Hoare, Sarah, Zoë Slote Morris, Michael P. Kelly, Isla Kuhn, and Stephen Barclay. 2015. "Do Patients Want to Die at Home? A Systematic Review of the UK Literature, Focused on Missing Preferences for Place of Death." *PLOS ONE* 10(11):e0142723. doi: 10.1371/journal.pone.0142723.

House, James S., James M. Lepkowski, Ann M. Kinney, Richard P. Mero, Ronald C. Kessler, and A. Regula Herzog. 1994. "The Social Stratification of Aging and Health." *Journal of Health and Social Behavior* 35(3):213–34. doi: 10.2307/2137277.

Institute of Medicine. 1997. *Approaching Death: Improving Care at the End of Life*. National Academies Press (US).

Institute of Medicine. 2015. *Dying in America: Improving Quality and Honoring Individual Preferences near the End of Life*. Washington, DC: National Academies Press.

Johnson, Kimberly S. 2013. "Racial and Ethnic Disparities in Palliative Care." *Journal of Palliative Medicine* 16(11):1329–34. doi: 10.1089/jpm.2013.9468.

Jones, Bobby L., and Daniel S. Nagin. 2013. "A Note on a Stata Plugin for Estimating Group-Based Trajectory Models." *Sociological Methods & Research* 42(4):608–13. doi: 10.1177/0049124113503141.

Jung, Tony, and K. A. S. Wickrama. 2008. "An Introduction to Latent Class Growth Analysis and Growth Mixture Modeling: Latent Trajectory Classes." *Social and Personality Psychology Compass* 2(1):302–17. doi: 10.1111/j.1751-9004.2007.00054.x.

Kaufman, Sharon. 2005. *And a Time to Die: How American Hospitals Shape the End of Life*. Simon and Schuster.

Kaufman, Sharon R. 2015. *Ordinary Medicine: Extraordinary Treatments, Longer Lives, and Where to Draw the Line*. Duke University Press.

Kehl, Karen A. 2006. “Moving Toward Peace: An Analysis of the Concept of a Good Death.” *American Journal of Hospice and Palliative Medicine* 23(4):277–86. doi: 10.1177/1049909106290380.

Khazanchi, Rohan, Evan R. Beiter, Suhas Gondi, Adam L. Beckman, Alyssa Bilinski, and Ishani Ganguli. 2020. “County-Level Association of Social Vulnerability with COVID-19 Cases and Deaths in the USA.” *Journal of General Internal Medicine* 35(9):2784–87. doi: 10.1007/s11606-020-05882-3.

Kinsella, Kevin. 2000. “Demographic Dimensions of Global Aging.” *Journal of Family Issues* 21(5):541–58. doi: 10.1177/019251300021005002.

Kirby, James B. 2008. “Poor People, Poor Places and Access to Health Care in the United States.” *Social Forces* 87(1):325–55. doi: 10.1353/sof.0.0062.

Kochanek, Kenneth D., Sherry L. Murphy, Jiaquan Xu, and Elizabeth Arias. 2019. *Deaths: Final Data for 2017*. *National Vital Statistics Reports*. vol 68 no 9. Hyattsville, MD: National Center for Health Statistics.

Kolata, Gina. 2019. “More Americans Are Dying at Home Than in Hospitals.” *The New York Times*, December 11.

Kwak, J., and W. E. Haley. 2005. “Current Research Findings on End-of-Life Decision Making Among Racially or Ethnically Diverse Groups.” *The Gerontologist* 45(5):634–41. doi: 10.1093/geront/45.5.634.

Lackan, Nuha A., Karl Eschbach, Jim P. Stimpson, Jean L. Freeman, and James S. Goodwin. 2009. "Ethnic Differences in In-Hospital Place of Death among Older Adults in California: Effects of Individual and Contextual Characteristics and Medical Resource Supply." *Medical Care* 47(2):138–45.

Laster Pirtle, Whitney N. 2020. "Racial Capitalism: A Fundamental Cause of Novel Coronavirus (COVID-19) Pandemic Inequities in the United States." *Health Education & Behavior* 47(4):504–8. doi: 10.1177/1090198120922942.

Leiter, Richard. 2019. "Is Dying at Home Overrated?" *The New York Times*, September 3.

Lewis, Sophie, Katherine Kenny, Alex Broom, Emma Kirby, and Frances Boyle. 2021. "The Social Meanings of Choice in Living-with Advanced Breast Cancer." *Social Science & Medicine* 280:114047. doi: 10.1016/j.socscimed.2021.114047.

Leyland, Alastair H., and Peter P. Groenewegen. 2020. "Context, Composition and How Their Influences Vary." Pp. 107–22 in *Multilevel Modelling for Public Health and Health Services Research: Health in Context*, edited by A. H. Leyland and P. P. Groenewegen. Cham: Springer International Publishing.

Lin II, Rong-Gong, Luke Money, and Andrew J. Campa. 2021. "Overwhelmed by COVID-19, Hospitals 'Making Difficult Decisions' as Patient Care Deteriorates." *Los Angeles Times*, January 6.

Livne, Roi. 2019. *Values at the End of Life: The Logic of Palliative Care*. Harvard University Press.

Livne, Roi. 2021. "Toward a Sociology of Finitude: Life, Death, and the Question of Limits." *Theory and Society*. doi: 10.1007/s11186-021-09448-y.

Lobao, Linda M., Gregory Hooks, and Ann R. Tickamyer. 2007. *The Sociology of Spatial Inequality*. SUNY Press.

Lofland, Lyn H. 2019. *The Craft of Dying: The Modern Face of Death*. MIT Press.

Logan, John R. 2012. "Making a Place for Space: Spatial Thinking in Social Science." *Annual Review of Sociology* 38(1):507–24. doi: 10.1146/annurev-soc-071811-145531.

Long, Ann C., and J. Randall Curtis. 2016. "Health Disparities in End-of-Life Care." Pp. 325–39 in *Health Disparities in Respiratory Medicine*, *Respiratory Medicine*. Humana Press, Cham.

MacArtney, John I., Alex Broom, Emma Kirby, Phillip Good, Julia Wootton, and Jon Adams. 2016. "Locating Care at the End of Life: Burden, Vulnerability, and the Practical Accomplishment of Dying." *Sociology of Health & Illness* 38(3):479–92. doi: 10.1111/1467-9566.12375.

Marmot, Michael, and Richard Wilkinson. 2005. *Social Determinants of Health*. OUP Oxford.

Mazzei, Patricia, Rebecca Halleck, and Richard A. Oppel Jr. 2020. "'Found Unresponsive at Home': Grim Records Recount Lonely Deaths." *The New York Times*, May 8.

MIT Election Data and Science Lab. 2018. "County Presidential Election Returns 2000-2020, V9." *Harvard Dataverse*. Retrieved (https://doi.org/10.7910/DVN/VOQCHQ).

Mitchell, Susan L., Joan M. Teno, Susan C. Miller, and Vincent Mor. 2005. “A National Study of the Location of Death for Older Persons with Dementia.” *Journal of the American Geriatrics Society* 53(2):299–305. doi: https://doi.org/10.1111/j.1532-5415.2005.53118.x.

Mol, Annemarie. 2008. *The Logic of Care: Health and the Problem of Patient Choice*. London: Routledge.

Monnat, Shannon M. 2018a. “Factors Associated With County-Level Differences in U.S. Drug-Related Mortality Rates.” *American Journal of Preventive Medicine* 54(5):611–19. doi: 10.1016/j.amepre.2018.01.040.

Monnat, Shannon M. 2018b. “Factors Associated With County-Level Differences in U.S. Drug-Related Mortality Rates.” *American Journal of Preventive Medicine* 54(5):611–19. doi: 10.1016/j.amepre.2018.01.040.

Monnat, Shannon M., David J. Peters, Mark T. Berg, and Andrew Hochstetler. 2019. “Using Census Data to Understand County-Level Differences in Overall Drug Mortality and Opioid-Related Mortality by Opioid Type.” *American Journal of Public Health* 109(8):1084–91. doi: 10.2105/AJPH.2019.305136.

Monroe, Lerner. 1970. “When, Why, and Where People Die.” Pp. 5–29 in *The Dying Patient*, edited by N. A. Scotch. Russell Sage Foundation.

Moodie, Susanna. 1853. *Life in the Clearings Versus the Bush*. Ontario: New Candian Library.

Moss, Jennifer L., Benmei Liu, and Eric J. Feuer. 2017. "Urban/Rural Differences in Breast and Cervical Cancer Incidence: The Mediating Roles of Socioeconomic Status and Provider Density." *Women's Health Issues* 27(6):683–91. doi: 10.1016/j.whi.2017.09.008.

Murphy, Sherry L., Jiaquan Xu, Kenneth D. Kochanek, and Elizabeth Arias. 2018. *Mortality in the United States, 2017*. *NCHS Data Brief*. 328. Hyattsville, MD: National Center for Health Statistics.

Murray, Christopher J. L., Sandeep C. Kulkarni, Catherine Michaud, Niels Tomijima, Maria T. Bulzacchelli, Terrell J. Iandiorio, and Majid Ezzati. 2006. "Eight Americas: Investigating Mortality Disparities across Races, Counties, and Race-Counties in the United States." *PLOS Medicine* 3(9):e260. doi: 10.1371/journal.pmed.0030260.

National Center for Health Statistics. 2018a. "Multiple Cause-of-Death Data, 1957-2017." *National Bureau of Economic Research*. Retrieved October 19, 2021 (http://data.nber.org/data/vital-statistics-mortality-data-multiple-cause-of-death.html).

National Center for Health Statistics. 2018b. *Underlying and Multiple Cause of Death Codes*.

National Center for Health Statistics. 2021. "COVID-19 Provisional Counts - Weekly Updates by Select Demographic and Geographic Characteristics." *Centers for Disease Control and Prevention*. Retrieved February 26, 2021 (https://www.cdc.gov/nchs/nvss/vsrr/covid_weekly/index.htm).

Nelson, Peter B. 2013. "The Geography of Rural Aging in a Regional Context, 1990–2008." Pp. 37–54 in *Rural Aging in 21st Century America*. Springer.

NHPCO. 2018. *NHPCO Facts and Figures: Hospice Care in America*. Alexandria, VA: National Hospice and Palliative Care Organization.

Nordgren, Lars. 2010. "Mostly Empty Words – What the Discourse of 'Choice' in Health Care Does." *Journal of Health Organization and Management* 24(2):109–26. doi: 10.1108/14777261011047309.

Olaisen, R. Henry. 2016. *QuickStats: Percentage Distribution of Deaths, by Place of Death — United States, 2000–2014*. *Morbidity and Mortality Weekly Report*. Hyattsville, MD: National Center for Health Statistics.

Olaisen, R. Henry. 2020. *QuickStats: Percentage of Deaths, by Place of Death — National Vital Statistics System, United States, 2000–2018*. *Morbidity and Mortality Weekly Report*. Hyattsville, MD: National Center for Health Statistics.

Orlovic, Martina, Katharine Smith, and Elias Mossialos. 2018. "Racial and Ethnic Differences in End-of-Life Care in the United States: Evidence from the Health and Retirement Study (HRS)." *SSM - Population Health* 7:100331. doi: 10.1016/j.ssmph.2018.100331.

Paz, Isabella Grullón. 2021. "Colorado Hospitals Are Nearly Full as the State Battles a Growing Caseload." *The New York Times*, November 3.

Pearlin, Leonard I., Scott Schieman, Elena M. Fazio, and Stephen C. Meersman. 2005. "Stress, Health, and the Life Course: Some Conceptual Perspectives∗." *Journal of Health and Social Behavior* 46(2):205–19.

Perkins, Henry S. 2007. “Controlling Death: The False Promise of Advance Directives.” *Annals of Internal Medicine* 147(1):51–57. doi: 10.7326/0003-4819-147-1-200707030-00008.

Perry, William R. G., Alvin C. Kwok, Christina Kozycki, and Leo A. Celi. 2013. “Disparities in End-of-Life Care: A Perspective and Review of Quality.” *Population Health Management* 16(2):71–73. doi: 10.1089/pop.2012.0061.

Pew Research Center. 2015. *America’s Changing Religious Landscape*.

Polyakova, Maria, Victoria Udalova, Geoffrey Kocks, Katie Genadek, Keith Finlay, and Amy N. Finkelstein. 2021. “Racial Disparities In Excess All-Cause Mortality During The Early COVID-19 Pandemic Varied Substantially Across States.” *Health Affairs* 40(2):307–16. doi: 10.1377/hlthaff.2020.02142.

Prendergast, Thomas J. 2001. “Advance Care Planning: Pitfalls, Progress, Promise.” *Critical Care Medicine* 29(2):N34.

Pritchard, Robert S., Elliott S. Fisher, Joan M. Teno, Sandra M. Sharp, Douglas J. Reding, William A. Knaus, John E. Wennberg, and Joanne Lynn. 1998. “Influence of Patient Preferences and Local Health System Characteristics on the Place of Death.” *Journal of the American Geriatrics Society* 46(10):1242–50. doi: 10.1111/j.1532-5415.1998.tb04540.x.

Riley, Matilda White. 1987. “On the Significance of Age in Sociology.” *American Sociological Review* 52(1):1–14. doi: 10.2307/2095388.

Saldana-Ruiz, Nallely, Sean A. P. Clouston, Marcie S. Rubin, Cynthia G. Colen, and Bruce G. Link. 2013. “Fundamental Causes of Colorectal Cancer Mortality in the United States: Understanding the Importance of Socioeconomic Status in Creating Inequality in Mortality.” *American Journal of Public Health* 103(1):99–104. doi: 10.2105/AJPH.2012.300743.

Schwartz, Barry. 2014. *The Paradox of Choice: Why More Is Less*. Unabridged edition. Grand Rapids, Mich.: Brilliance Audio.

Sharp, Shane, Deborah Carr, and Cameron Macdonald. 2012. “Religion and End-of-Life Treatment Preferences: Assessing the Effects of Religious Denomination and Beliefs.” *Social Forces* 91(1):275–98. doi: 10.1093/sf/sos061.

Shin, Michael E., and William J. McCarthy. 2013. “The Association between County Political Inclination and Obesity: Results from the 2012 Presidential Election in the United States.” *Preventive Medicine* 57(5):721–24. doi: 10.1016/j.ypmed.2013.07.026.

Siegler, Kirk. 2019. “The Struggle To Hire And Keep Doctors In Rural Areas Means Patients Go Without Care.” *NPR*, May 21.

StataCorp. 2019. *Stata Statistical Software: Release 16*. College Station, TX: StataCrop LP.

Stokes, Andrew C., Dielle J. Lundberg, Jacob Bor, Irma T. Elo, Katherine Hempstead, and Samuel H. Preston. 2021. “Association of Health Care Factors With Excess Deaths Not Assigned to COVID-19 in the US.” *JAMA Network Open* 4(9):e2125287. doi: 10.1001/jamanetworkopen.2021.25287.

Stokes, Andrew C., Dielle J. Lundberg, Irma T. Elo, Katherine Hempstead, Jacob Bor, and Samuel H. Preston. 2021. "COVID-19 and Excess Mortality in the United States: A County-Level Analysis" edited by A. B. Suthar. *PLOS Medicine* 18(5):e1003571. doi: 10.1371/journal.pmed.1003571.

Subramanian, S. V., Ichiro Kawachi, and Bruce P. Kennedy. 2001. "Does the State You Live in Make a Difference? Multilevel Analysis of Self-Rated Health in the US." *Social Science & Medicine* 53(1):9–19. doi: 10.1016/S0277-9536(00)00309-9.

Sudnow, David. 1967. *Passing on: The Social Organization of Dying*. Prentice-Hall.

Temkin-Greener, Helena, Nan Tracy Zheng, Jingping Xing, and Dana B. Mukamel. 2013. "Site of Death Among Nursing Home Residents in the United States: Changing Patterns, 2003–2007." *Journal of the American Medical Directors Association* 14(10):741–48. doi: 10.1016/j.jamda.2013.03.009.

Teno, Joan M. 2004. "Advance Directives: Time To Move On." *Annals of Internal Medicine* 141(2):159–60. doi: 10.7326/0003-4819-141-2-200407200-00017.

Teno, Joan M., Pedro L. Gozalo, Julie P. W. Bynum, Natalie E. Leland, Susan C. Miller, Nancy E. Morden, Thomas Scupp, David C. Goodman, and Vincent Mor. 2013. "Change in End-of-Life Care for Medicare Beneficiaries: Site of Death, Place of Care, and Health Care Transitions in 2000, 2005, and 2009." *JAMA* 309(5):470–77. doi: 10.1001/jama.2012.207624.

Teno, Joan M., Pedro Gozalo, Amal N. Trivedi, Jennifer Bunker, Julie Lima, Jessica Ogarek, and Vincent Mor. 2018. "Site of Death, Place of Care, and Health Care Transitions Among

US Medicare Beneficiaries, 2000-2015." *JAMA* 320(3):264–71. doi: 10.1001/jama.2018.8981.

US Census Bureau. 2018. "Older People Projected to Outnumber Children for First Time in U.S. History." *The United States Census Bureau*. Retrieved December 1, 2018 (https://www.census.gov/newsroom/press-releases/2018/cb18-41-population-projections.html).

US Census Bureau. 2020. *Older and Growing: Percent Change among the 65 and Older Population, 2010 to 2019*.

US Census Bureau. n.d. "Data Linkage Infrastructure." *Census.Gov*. Retrieved February 3, 2022 (https://www.census.gov/datalinkage).

Vierboom, Yana C., Samuel H. Preston, and Arun S. Hendi. 2019. "Rising Geographic Inequality in Mortality in the United States." *SSM - Population Health* 9:100478. doi: 10.1016/j.ssmph.2019.100478.

Weitzen, Sherry, Joan M. Teno, Mary Fennell, and Vincent Mor. 2003. "Factors Associated with Site of Death: A National Study of Where People Die." *Medical Care* 41(2):323–35.

Willson, Andrea E., Kim M. Shuey, and Jr. Elder Glen H. 2007. "Cumulative Advantage Processes as Mechanisms of Inequality in Life Course Health." *American Journal of Sociology* 112(6):1886–1924. doi: 10.1086/512712.

World Health Organization. 2004. *Better Palliative Care for Older People*. World Health Organization.

Xu, Wei, Changshan Wu, and Jason Fletcher. 2020. “Assessment of Changes in Place of Death of Older Adults Who Died from Dementia in the United States, 2000–2014: A Time-Series Cross-Sectional Analysis.” *BMC Public Health* 20(1):765. doi: 10.1186/s12889-020-08894-0.

APPENDIX A. Supplementary Tables and Figures

Table A.1. Detailed accounting of county consolidation strategy, 1991-2017

State	County areas consolidated	Reason for consolidation	New FIPS code used
Alaska			
	Hoonah-Angoon Census Area (2105); Skagway Municipality (2230); Skagway-Yakutat-Angoon Census Area (2231)*; Skagway-Hoonah-Angoon Census Area (2232)*; Yakutat City/Borough (2282)	All counties originally derived from Skagway-Yakutat-Angoon Census Area (2231) which was split into Yakut City/Borough (2282) and Skagway Hoonah-Angoon Census Area (2231) in September 1992. Skagway Hoonah-Angoon Census Area was further divided into Hoonah-Angoon Census Area (2105) and Skagway Municipality (2230) in June 2007. The total 2010 Census population for these areas was 3,780 people	2105
	Ketchikan Gateway Borough (2130); Petersburg Borough (2195);Wrangell City (2275); Wrangell-Petersburg Census Area (2280)*; Prince of Wales-Hyder Census Area (2198); Prince of Wales-Outer Ketchikan Census Area (2201)*	First, Prince of Wales-Outer Ketchikan Census Area (2201) was split into three parts including Ketchikan Gateway Borough (2130), part of Wrangell City (2275), and Prince of Wales-Hyder Census Area (2198) in May 2008. Second, Wrangell-Petersburg Census Area was split into part of Wrangell City (2275) and Petersburg Borough (2195) in June 2008. Finally, part of Prince of Wales-Hyder Census Area (2198) was added to the Petersburg Borough (2195) in January 2013. The total 2010 Census population for these areas was 25,220 people	2130
	Kusilvak Census Area (2158); Wade Hampton Census Area (2270)*	Changed name and code from Wade Hampton Census Area (2270) to Kusilvak Census Area (02158) in July 2015	2158
	Denali Borough (2068); Yukon-Koyukuk Census Area (2290)	The Denali Borough (2068) was created in December 1990 from part of Yukon-Koyukuk Census Area (2290)	2290
	Kobuk Census Area (2140)*; Northwest Arctic Borough (2188)	Information was available for each of the counties separately: Kobuk Census Area between 1990 and 1993 and Northwest Arctic Borough between 1994 and 2017. Additionally, Northwest Arctic Borough was created from all of the former Kobuk Census Area in 1986.	2188
Arizona			
	La Paz County (4012); Yuma County (4027)	County data available for death certificates only dating back to 1994 for La Paz County. Additionally, La Paz County was created out of parts of Yuma County in 1989	4027
Colorado			
	Adams (8001); Boulder (8013); Broomfield (8014)	Broomfield County (8014) created from part of Adams (8001), Boulder (8013), Jefferson (8059), and Weld (8123) counties in November 2001; the majority of Broomfield's population came from Boulder County (21,512) and Adams County (15,870)	8013

Table A.1. Continued

State	County areas consolidated	Reason for consolidation	New FIPS code used
Florida			
	Dade County (12025)*; Miami-Dade County (12086)	Changed name and code from Dade County (12025) to Miami-Dade County (12086) in July 2007	12086
Hawaii			
	Kalawao County (15005); Maui County (15009)	The population of Kalawao county is 86 people and is a small geographic area that is surrounded by Maui County	15009
Maryland			
	Montgomery County (24031); Prince George (24033)	Takoma Park City (n=5,156) was moved from Prince George County to Montgomery County in July 1997	24031
Montana			
	Park County (30067); Yellowstone National Park (30113)*	Populated portion of Yellowstone National Park (n=52) was annexed to Park County in November 1997	30067
South Dakota			
	Oglala Lakota County (46102); Shannon County (46113)*	Changed name and code from Shannon County (46113) to Oglala Lakota County (46102) in May 2015	46102
Virginia			
	Alleghany County (51005); Clifton Forge City (51560)*	Clifton Forge City (n=4,289) was added to Alleghany county in July 2001	51005
	Augusta County (51015); Staunton City (51790); Waynesboro City (51820)	Waynesboro City was annexed from Augusta County in July 1994. Augusta County surrounds both Staunton City and Waynesboro City	51015
	Bedford County (51019); Bedford City (51515)*	The independent city of Bedford, Virginia was changed to "town status" and added to Bedford County in July 2013	51019
	Fairfax County (51059); Fairfax City (51600)	Parts of Fairfax County were annexed to Fairfax City in December 1991	51059
	Halifax County (51083); South Boston City (51780)*	South Boston City was added to Halifax County in June 1995	51083
	Southampton County (51175); Franklin City (51620)	Part of Southampton County (51175) annexed to Franklin City (51620) in December 1995 (n=400)	51175
	York County (51199); Newport News City (51700)	York County exchanged territory with Newport News City in July 2007 (n=293).	51199

Table A.2. Counties omitted due to reporting at least one year with less than five total deaths (n=151)

State	County FIPS
Alaska	2013; 2016; 2060; 2070; 2100; 2105; 2158; 2164; 2240
California	6003
Colorado	8027; 8033; 8047; 8053; 8057; 8079; 8091; 8109; 8111; 8113; 8117
Georgia	13007; 13011; 13049; 13053; 13101; 13177; 13181; 13183; 13209; 13239; 13249; 13265; 13301; 13307
Idaho	16025; 16033; 16061
Illinois	17155
Kansas	20097; 20187; 20199
Kentucky	21201
Michigan	26083
Mississippi	28055
Montana	30011; 30033; 30037; 30045; 30069; 30075; 30079; 30103
Nebraska	31005; 31007; 31009; 31049; 31063; 31075; 31085; 31091; 31103; 31113; 31115; 31117; 31165; 31171; 31183
Nevada	32009; 32011; 32029
New Mexico	35003; 35011; 35021
North Carolina	37177
North Dakota	38005; 38007; 38013; 38025; 38033; 38043; 38065; 38083; 38085; 38087; 38091
Oklahoma	40129
Oregon	41021; 41055; 41069
South Dakota	46017; 46021; 46031; 46041; 46057; 46061; 46063; 46071; 46075; 46085; 46095; 46117; 46119; 46137
Tennessee	47127; 47137; 47175
Texas	48033; 48045; 48079; 48101; 48109; 48111; 48125; 48137; 48155; 48173; 48197; 48229; 48235; 48243; 48247; 48261; 48263; 48269; 48271; 48283; 48301; 48311; 48327; 48345; 48359; 48377; 48393; 48421; 48431; 48435; 48443; 48489; 48507
Utah	49009; 49031; 49033; 49055
Vermont	50009; 50013
Virginia	51091; 51685
West Virginia	54105
Wisconsin	55078
Wyoming	56027

Table A.3. Logistic regression models depicting the log odds of dying in a hospital relative to home, 1991-2017

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Log odds	1.14***	1.09***	1.01***	0.93***	0.87***	0.83***	0.82***	0.82***	0.81***	0.77***	0.76***	0.73***	0.67***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
N	1,114,205	1,114,228	1,146,162	1,134,148	1,140,296	1,142,084	1,161,451	1,168,803	1,192,661	1,185,294	1,174,976	1,174,601	1,157,762	
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Log odds	0.61***	0.59***	0.55***	0.51***	0.49***	0.41***	0.35***	0.32***	0.24***	0.20***	0.16***	0.13***	0.08***	0.06***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	1,116,787	1,126,477	1,102,941	1,090,575	1,079,613	1,052,634	1,091,329	1,097,440	1,108,213	1,136,899	1,148,076	1,187,792	1,198,849	1,234,181

Standard errors in parentheses
* p<0.05; ** p<0.01; ***; p<0.001

Table A.4. Hierarchical generalized linear models depicting the log odds of dying in a hospital relative to home, 1991-2017

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Fixed effects														
Constant	0.55***	0.51***	0.41***	0.34***	0.25***	0.18***	0.18***	0.15***	0.12***	0.07*	0.04	-0.01	-0.05	
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	
Variance components														
Level-2 random effect (county)	2.28***	2.15***	2.26***	2.19***	2.15***	2.17***	2.07***	2.09***	2.12***	2.10***	2.15***	2.17***	2.11***	
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.08)	(0.07)	(0.08)	(0.08)	(0.07)	
Intraclass correlation coefficient	0.41	0.39	0.41	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.40	0.40	0.39	
Sample sizes														
Level-1 N	1,114,205	1,114,228	1,146,162	1,134,148	1,140,296	1,142,084	1,161,451	1,168,803	1,192,661	1,185,294	1,174,976	1,174,601	1,157,762	
Level-2 N	2,898	2,898	2,898	2,897	2,898	2,898	2,972	2,975	2,974	2,975	2,975	2,975	2,973	
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Fixed effects														
Constant	-0.13***	-0.14***	-0.17***	-0.22***	-0.24***	-0.32***	-0.40***	-0.46***	-0.54***	-0.60***	-0.67***	-0.75***	-0.84***	-0.89***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Predicted probabilities	0.47	0.47	0.46	0.45	0.44	0.42	0.40	0.39	0.37	0.35	0.34	0.32	0.30	0.29
Variance components														
Level-2 random effect (county)	2.12***	2.03***	1.93***	2.05***	1.99***	1.96***	1.91***	1.98***	1.95***	1.87***	1.94***	2.01***	2.09***	2.08***
	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Intraclass correlation coefficient	0.39	0.38	0.37	0.38	0.38	0.37	0.37	0.38	0.37	0.36	0.37	0.38	0.39	0.39
Sample sizes														
Level-1 N	1,116,787	1,126,477	1,102,941	1,090,575	1,079,613	1,052,634	1,091,329	1,097,440	1,108,213	1,136,899	1,148,076	1,187,792	1,198,849	1,234,181
Level-2 N	2,975	2,975	2,973	2,975	2,830	2,828	2,974	2,973	2,975	2,975	2,974	2,973	2,975	2,975

Standard errors in parentheses
* p<0.05; ** p<0.01; ***; p<0.001

Table A.5. Logistic regression model depicting the log odds of dying in a nursing home relative to home, 1991-2017

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Log odds	0.22***	0.22***	0.24***	0.25***	0.25***	0.25***	0.27***	0.29***	0.30***	0.29***	0.29***	0.29***	0.26***	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	
N	604,452	629,629	697,147	729,113	766,642	793,448	818,711	836,380	860,583	875,569	878,761	893,204	898,719	
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Log odds	0.23***	0.23***	0.19***	0.17***	0.17***	0.10***	0.06***	0.05***	-0.02***	-0.06***	-0.09***	-0.12***	-0.17***	-0.18***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	883,839	905,723	895,557	892,794	895,807	883,600	926,279	948,653	964,614	994,039	1,010,242	1,051,371	1,062,969	1,099,649

Standard errors in parentheses
* p<0.05; ** p<0.01; ***; p<0.001

Table A.6. Hierarchical generalized linear models depicting the log odds of dying in a nursing home relative to home, 1991-2017

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	
Fixed effects														
Constant	0.25***	0.25***	0.27***	0.26***	0.25***	0.24***	0.27***	0.27***	0.28***	0.28***	0.29***	0.28***	0.26***	
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	
Variance components														
Level-2 random effect (county)	0.57***	0.54***	0.54***	0.52***	0.49***	0.48***	0.44***	0.43***	0.44***	0.42***	0.42***	0.45***	0.46***	
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	
Intraclass correlation coefficient	0.15	0.14	0.14	0.14	0.13	0.13	0.12	0.12	0.12	0.11	0.11	0.12	0.12	
Sample size														
Level-1 N	604,452	629,629	697,147	729,113	766,642	793,448	818,711	836,380	860,583	875,569	878,761	893,204	898,719	
Level-2 N	2,899	2,899	2,898	2,899	2,899	2,898	2,975	2,975	2,975	2,975	2,975	2,975	2,975	
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Fixed effects														
Constant	0.22***	0.21***	0.18***	0.17***	0.18***	0.12***	0.07***	0.06***	0.02	-0.05***	-0.06***	-0.07***	-0.13***	-0.14***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Predicted probability	0.55	0.55	0.54	0.54	0.54	0.53	0.52	0.51	0.50	0.49	0.49	0.48	0.47	0.47
Variance components														
Level-2 random effect (county)	0.44***	0.44***	0.46***	0.48***	0.46***	0.46***	0.48***	0.49***	0.48***	0.54***	0.49***	0.48***	0.49***	0.47***
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Intraclass correlation coefficient	0.12	0.12	0.12	0.13	0.12	0.12	0.13	0.13	0.13	0.14	0.13	0.13	0.13	0.13
Sample size														
Level-1 N	883,839	905,723	895,557	892,794	895,807	883,600	926,279	948,653	964,614	994,039	1,010,242	1,051,371	1,062,969	1,099,649
Level-2 N	2,975	2,975	2,975	2,975	2,829	2,830	2,975	2,975	2,975	2,975	2,975	2,975	2,975	2,975

Standard errors in parentheses
* p<0.05; ** p<0.01; ***; p<0.001

Table A.7. Counties omitted from trajectory analysis

State	County FIPS code
Alaska	All counties in Alaska omitted
California	6003
Colorado	8053; 8057; 8079; 8111; 8113
Georgia	13265; 13307
Hawaii	All counties in Hawaii omitted
Idaho	16025; 16033
Michigan	26083
Mississippi	28055
Montana	30037; 30045; 30069; 30103
Nebraska	31005; 31007; 31009; 31075; 31085; 31103; 31113; 31115; 31117; 31165; 31171; 31183
Nevada	32009; 32011
New Mexico	35021
North Dakota	38007; 38013; 38033; 38065; 38083; 38087; 38091
Oregon	41055
South Dakota	46017; 46021; 46031; 46061; 46063; 46075; 46085; 46117; 46119; 46137
Texas	48033; 48045; 48137; 48173; 48229; 48235; 48261; 48269; 48301; 48311; 48345; 48359; 48393; 48443; 49009; 49031; 49033
Virginia	51560; 51780

Table A.8. Parameter estimates for latent class growth model (3-class solution) for percentage of deaths occurring at home, in a hospital, or nursing home, 1991-2017

Group	Parameter	Estimate	Standard error
Percentage of Deaths Occurring at Home			
Group	Parameter	Estimate	Standard error
Group 1	Intercept	-809.39	11.67
	Linear	0.41	0.01
Group 2	Intercept	-1589.59	15.02
	Linear	0.81	0.01
Group 3	Intercept	-475.91	29.43
	Linear	0.27	0.01
Group membership			
Group 1	%	55.95	0.93
Group 2	%	34.88	0.89
Group 3	%	9.17	0.52
Percentage of Deaths Occurring in a Hospital			
Group	Parameter	Estimate	Standard error
Group 1	Intercept	295.01	34.33
	Linear	-0.15	0.02
Group 2	Intercept	1875.18	14.35
	Linear	-0.92	0.01
Group 3	Intercept	2097.00	16.24
	Linear	-1.02	0.01
Group membership			
Group 1	%	17.67	0.69
Group 2	%	45.95	0.93
Group 3	%	36.39	0.90
Percentage of Deaths Occurring in a Nursing Home			
Group	Parameter	Estimate	Standard error
Group 1	Intercept	-333.10	16.95
	Linear	0.18	0.01
Group 2	Intercept	-182.50	14.82
	Linear	0.11	0.01
Group 3	Intercept	-48.37	22.26
	Linear	0.05	0.01
Group membership			
Group 1	%	34.59	0.93
Group 2	%	45.56	0.95
Group 3	%	19.86	0.74

Table A.9. ICD-10 codes used to construct cause of death categories

	ICD-10 39 Recode	ICD-10 Codes
Heart disease	019-023; 025-026	I100-I178
Cancer	004	C00-C97
Respiratory	028	J40-J47
Stroke	024	I60-I69
Alzheimer's disease	017	G30
Diabetes	016	E10-E14
Pneumonia	027	J10-J18
Other	All others excluding 038-042	Excluded V - Y

APPENDIX B. Methodological Appendix – Chapter 3

To overcome issues of convergence due to large quantities of data as well as a need to be able to test for multiple class sizes and trajectory shapes, supplementary analyses were conducted using a sample of data. Several subsets were tested, but every five years (looking at six observations rather than 27) proved to provide the least challenges related to convergence (Figure B.1). Therefore, the next set of estimates are based on this and include the years 1991, 1996, 2001, 2006, 2011, and 2016. Two counties were dropped from the trajectory analysis as they did not have sufficient information about site of death composition across the six years.

Table B.1. Data subsets

Year selection	Summary of results
Every year	Lots of false convergence for trajectories with non-linear estimates (e.g., models with a quadratic)
Every other year	Lots of false convergence (more than in the normal 27-year model)
Ever three years	Lots of false convergence
Every four years	Something called "singular convergence" but no false convergence
Every five years	One case of false convergence (four-class trajectory with all quadratics)

Home death trajectories

Figure B.2 provides the fit statistics for the first outcome (percent home death) using the subset of data. Convergence was achieved for nearly every model except for the final four-class model (highlighted in red). The three best fitting models (based on BIC and entropy) for each class group (for three-classes and higher) are highlighted in green and my original selection is highlighted in blue (also see Figure 1). First is the three-class trajectory with one quadratic function for second subgroup. This class saw a reduction in the BIC but an increase in entropy relative to my original class selection. The effect of the quadratic function was very small (0.018, $p<.001$) and did not substantively change the shape of the trajectories (see Figure 1 and 2 for comparison). Second, the four-class with linear functions also saw a reduction in the BIC and a small drop in the entropy. Additionally, the fourth subgroup was small, accounting for only

3.11% of all counties. This is important since class size is an essential component of LCGA trajectory selection (Jung and Wickrama 2008). Additionally, this fourth group had extremely high rates of home death that remain very consistent over the period. Unfortunately, this model did not converge when using all years of data. Finally, the five-class solution with a quadratic function for the first group saw an additional decline in the BIC and an increase in the entropy. However, the fifth group produced by this solution accounts for only 2.6% of all counties.

Table B.2. LCGA fit statistics based off data subset focused on every five years

Percent home death					
Number of classes	Trajectory shapes	BIC (n= 17,821)	BIC (n= 3,041)	AIC	Entropy
1	1	-74621.15	17821	-74609.46	-
2	0 0	-71025.91	-71022.38	-71010.34	0.958
2	1 1	-69681.71	-69676.4	-69658.34	0.961
2	1 2	-69686.15	-69679.96	-69658.89	0.961
2	2 2	-69689.46	-69682.39	-69658.31	0.961
3	0 0 0	-69423.58	-69418.27	-69400.21	0.906
3	1 1 1	-67360.01	-67352.05	-67324.96	0.921
3	2 1 1	-67363.64	-67354.8	-67324.7	0.919
3	1 2 1	-67327.85	-67319.01	-67288.91	0.918
3	1 1 2	-67364.77	-67355.93	-67325.83	0.919
3	2 2 1	-67366.91	-67357.18	-67324.07	0.921
3	2 1 2	-67368.41	-67358.69	-67325.58	0.919
3	2 2 2	-67371.69	-67367.08	-6732.96	0.92
4	0 0 0 0	-68626.25	-68615.17	-68595.09	0.879
4	1 1 1 1	-66220.71	-66210.1	-66173.98	0.909
4	2 1 1 1	-66223.38	-66211.89	-66172.76	0.908
4	1 2 1 1	-66225.02	-66213.53	-66174.4	0.908
4	1 1 2 1	-66225.02	-66213.53	-66174.4	0.908
4	1 1 1 2	-66225.61	-66214.12	-66174.99	0.907
4	2 2 2 2	Did not converge			
5	0 0 0 0 0	-68272.84	-68264	-68233.9	0.829
5	1 1 1 1 1	-66235.39	-66222.12	-66176.91	0.922
5	2 1 1 1 1	-65453.62	-654399.48	-65391.32	0.932
5	1 2 1 1 1	-65452.3	-65438.15	-65389.99	0.882
5	1 1 2 1 1	-65447.97	-65433.83	-65385.67	0.883
5	1 1 1 2 1	-66239.7	-66225.56	-66177.4	0.921
5	1 1 1 1 2	-66240.27	-66226.13	-66177.91	0.92
5	2 2 2 2 2	-65368.04	-65350.36	-65290.16	0.885

The selection of LCGA trajectories is interpretative and relies on several factors including change in BIC, entropy, parsimony, and interpretability (Jung and Wickarama 2008).

Figure B.1 - Figure B.4 provide plots of each of the best fitting classes. I argue that based on empirical indicators alone, a three- or five-class solution would be the best option. However, when considering parsimony and interpretability, the five-class trajectory does not add anything of substantive importance. Rather, the two additional trajectories in the five-class solution have the same slope as the other trajectories but with only slightly different y-intercepts suggesting only minor differences. Overall, based on these supplementary analyses, I feel confident in my original decision to move forward with a three-class solution for home death. Since the quadratic added very little, I will also continue with the linear trajectories for the three-class solution.

Figure B.1. Original three-class solution (linear function) for percent home death

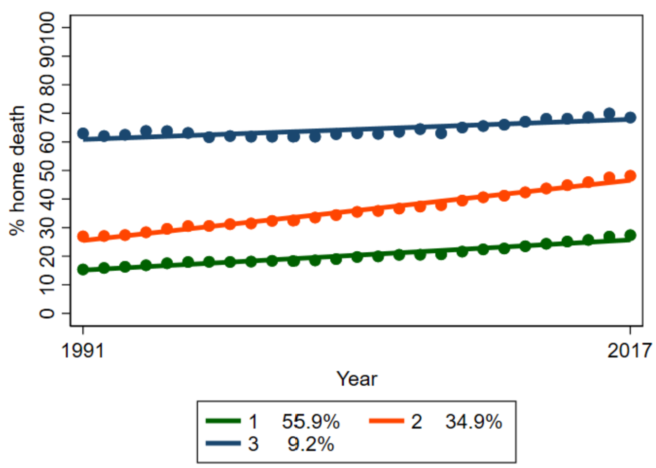


Figure B.2. Three-class solution (one quadratic function for group two) for percent home death

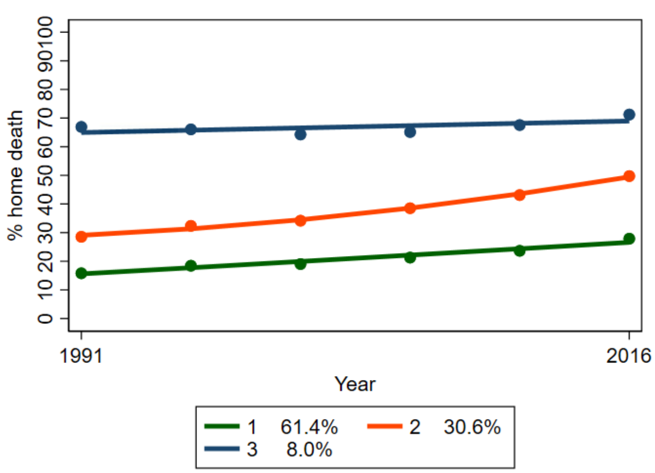


Figure B.3. Four-class solution (linear function) for percent home death

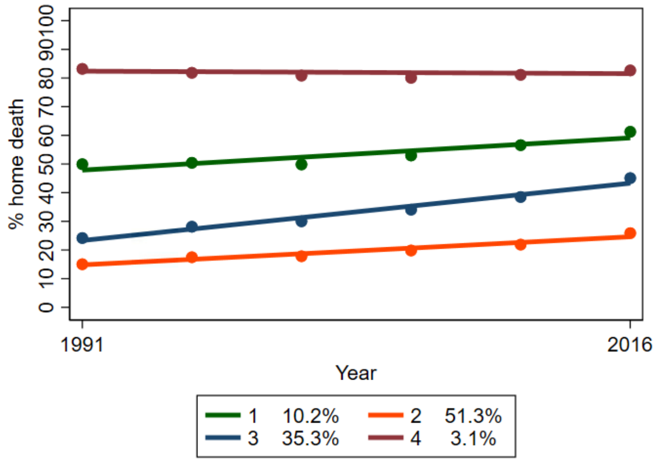
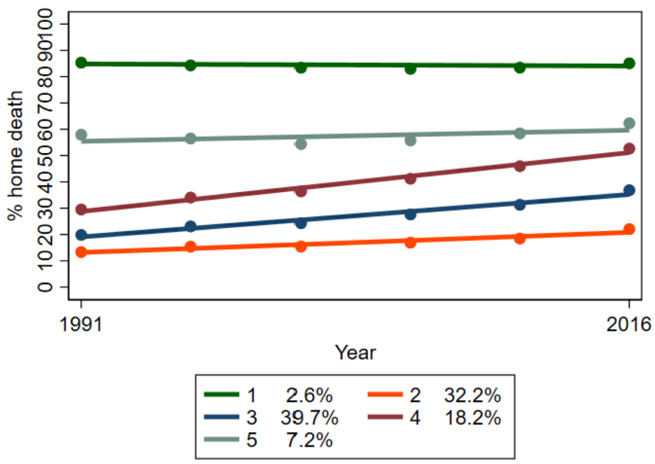


Figure B.4. Five-class solution (linear function) for percent home death



Hospital death trajectories

Figure B.3 provides the fit statistics for the second outcome (percent hospital death) using the subset of data. Convergence was achieved for every model; however, model estimates were not produced for six of the models (all with quadratic functions; highlighted in red). Quadratic functions did not improve model fit for any of the class-solutions with model estimates, resulting in best fit for the linear trajectory models only. The three best fitting solutions for each class group (for three-classes and higher) are highlighted in green. First is the three-class solution with linear functions for all three groups. This class was improved upon slightly with the inclusion of a fourth class, although the entropy does drop slightly for this model. Finally, the smallest BIC observed was for the five-class solution. There is also an uptick in the entropy for this solution.

Table B.3. LCGA fit statistics based off data subset focused on every five years

Percent hospital death					
Number of classes	Trajectory shapes	BIC (n= 17,821)	BIC (n= 3,041)	AIC	Entropy
1	1	-71366.33	-71363.67	-71354.64	-
2	0 0	-66033.92	-66030.38	-66018.34	0.99
2	1 1	-63777.16	-63771.86	-63753.8	0.991
2	1 2	-63782.29	-63776.1	-63755.04	0.991
2	2 2	-63787.27	-63780.2	-63756.12	0.991
3	0 0 0	-64506.49	-64501.18	-64483.12	0.863
3	1 1 1	-60924.05	-60916.09	-60889	0.899
3	2 1 1	No parameter estimates produced			
3	1 2 1	-60930.25	-60921.41	-60891.31	0.899
3	1 1 2	-60928.19	-60919.35	-60889.25	0.899
3	2 2 1	-60935.21	-60925.49	-60892.38	0.899
3	2 1 2	-60933.15	-60923.42	-60890.31	0.899
3	2 2 2	-60939.36	-60928.75	-60892.63	0.899
4	0 0 0 0	-64131.65	-64124.58	-64100.5	0.809
4	1 1 1 1	-59895.34	-59884.73	-59848.61	0.894
4	2 1 1 1	No parameter estimates produced			
4	1 2 1 1	-59901.63	-59890.13	-59851	0.894
4	1 1 2 1	-60707.88	-60696.39	-60657.26	0.918
4	1 1 1 2	-60707.88	-60696.39	-60657.26	0.918
4	2 2 2 2	-59915.74	-59901.59	-59853.43	0.894
5	0 0 0 0 0	-63963.09	-63954.25	-63924.15	0.839
5	1 1 1 1 1	-59357.16	-59343.9	-59298.75	0.92
5	2 1 1 1 1	No parameter estimates produced			
5	1 2 1 1 1	No parameter estimates produced			
5	1 1 2 1 1	-59361.52	-59347.37	-59299.21	0.92
5	1 1 1 2 1	No parameter estimates produced			
5	1 1 1 1 2	No parameter estimates produced			
5	2 2 2 2 2	-59382.78	-59365.1	-59304.9	0.92

Figures 4-6 provide plots of each of these best fitting classes. I would argue that based on empirical indicators alone, a three- or five-class solution would be the best option. However, when considering parsimony and interpretability, the five-class trajectory does not add anything of substantive importance. For example, the two additional trajectories in the five-class solution have the same slope as the other trajectories but with only slightly different y-intercepts suggesting only minor differences. Based on these supplementary analyses, I feel confident in my original decision to utilize a three-class solution for hospital death. The three-class solution provides excellent fit, high entropy, and provides sufficient information without going overboard into a realm of more difficult and complicated interpretation that would likely blunt the effectiveness of future multinomial models.

Figure B.5. Three-class solution (linear function) for percent hospital death

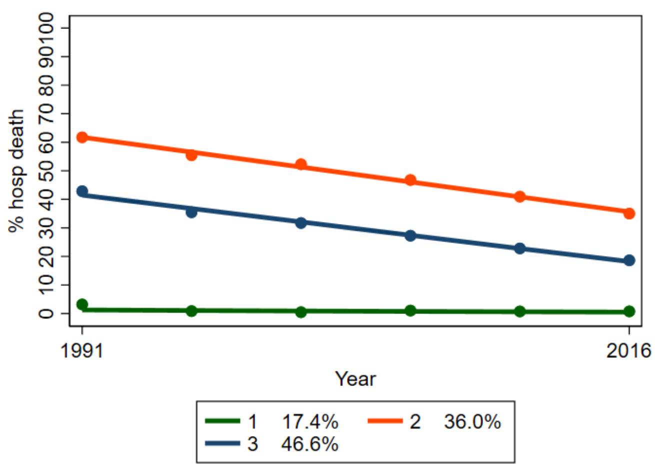


Figure B.6. Four-class solution (linear function) for percent hospital death

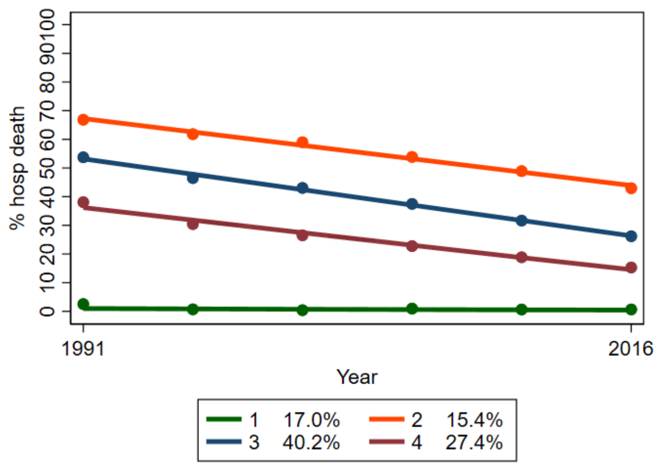
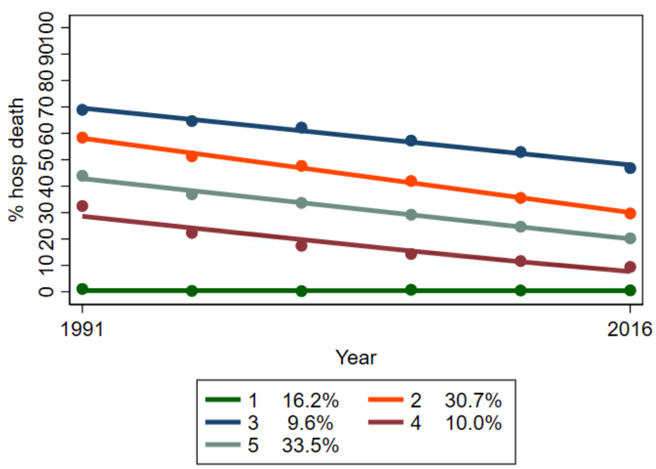


Figure B.7. Five-class solution (linear function) for percent hospital death



Nursing home death trajectories

Table B.4 provides the fit statistics for the third outcome (percent nursing home death) using the subset of data. Convergence was achieved for every model. The three best fitting models for each class group (for three-classes and higher) are highlighted in green and my original selection is highlighted in blue (also see Figure B.8). First is the three-class trajectory with all quadratic functions. This trajectory is very similar to the original selection even with the inclusion of the quadratic function for each group (Figure B.9). The general impact of the quadratic function for each group is quite small, with a parameter estimate of -0.02, -0.03, and -0.01, respectively. This three-class solution was improved upon with the inclusion of a fourth class; there is both a small decrease in the BIC and a slight increase in the entropy. Although, there are improvements to this solution, the fourth class is small, accounting for only 3.2% of counties (Figure B.10). However, what is interesting about this group is that they had virtually no nursing home death reported over the six-time observations between 1991 and 2016. Upon further investigation, this observation is not reflected when all years are included in the analysis (Figure B.11). More specifically, this group appears to have very low levels of nursing home death but not as low as portrayed when using only six observation times. Finally, the smallest BIC observed was for the five-class solution. However, there was an uptick in the entropy for this solution. Additionally, the five-class solution results in two relatively small trajectories, one with 3.1% of counties and one with 4.7% of counties (Figure B.12).

Table B.4. LCGA fit statistics based off data subset focused on every five years

Percent nursing home death					
Number of classes	Trajectory shapes	BIC (n= 17,821)	BIC (n= 3,041)	AIC	Entropy
1	1	-74440.25	-74437.59	-774428.56	-
2	0 0	-70556.99	-70553.46	-70541.42	0.873
2	1 1	-70448.05	-70442.74	-70424.68	0.875
2	1 2	-70453.29	-70447.1	-704226.03	0.875
2	2 2	-70458.81	-70451.73	-70427.65	0.875
3	0 0 0	-68810.35	-68805.01	-68786.95	0.872
3	1 1 1	-68661.37	-68653.41	-68626.32	0.874
3	2 1 1	-6866.7	-68657.86	-68627.76	0.874
3	1 2 1	-6866.91	-68658.07	-68627.97	0.874
3	1 1 2	-6866.43	-68657.59	-68627.49	0.874
3	2 2 1	-68672.25	-68662.53	-68629.42	0.874
3	2 1 2	-68671.76	-68662.04	-68628.93	0.874
3	2 2 2	-68453.41	-68442.8	-68406.69	0.878
4	0 0 0 0	-67976.75	-67969.71	-67945.63	0.905
4	1 1 1 1	-67788.26	-67777.65	-67741.53	0.91
4	2 1 1 1	-67793.13	-67781.64	-67742.51	0.91
4	1 2 1 1	-67793.82	-67782.33	-67743.2	0.91
4	1 1 2 1	-677793.65	-677882.16	-67743.03	0.91
4	1 1 1 2	-67793.29	-67781.8	-67742.67	0.91
4	2 2 2 2	-67547.86	-67533.71	-67482.56	0.913
5	0 0 0 0 0	-67285.85	-67277.01	-67246.91	0.883
5	1 1 1 1 1	-67063.64	-67050.38	-67005.23	0.889
5	2 1 1 1 1	-67068.52	-67054.37	-67006.21	0.889
5	1 2 1 1 1	-67069.17	-67055.02	-67006.86	0.889
5	1 1 2 1 1	-67068.52	-67054.37	-67006.21	0.895
5	1 1 1 2 1	-67068.95	-67054.8	-67006.64	0.889
5	1 1 1 1 2	-67068.48	-67054.33	-67006.17	0.889
5	2 2 2 2 2	-66797.54	-66779.86	-66719.66	0.898

Figure B.8. Original three-class solution (linear function) for percent nursing home death

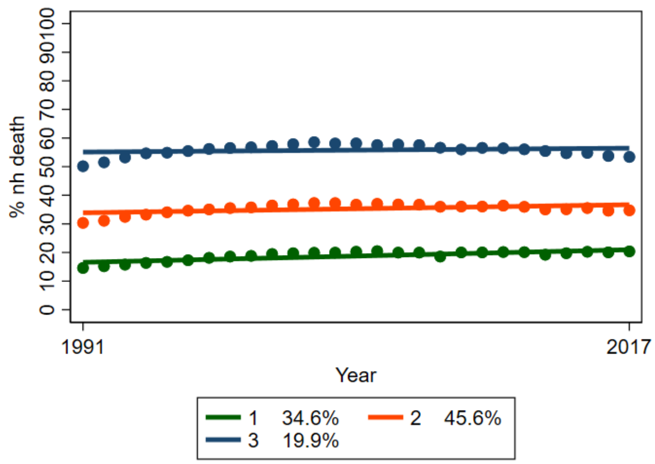


Figure B.9. Three-class solution (quadratic function) for percent nursing home death

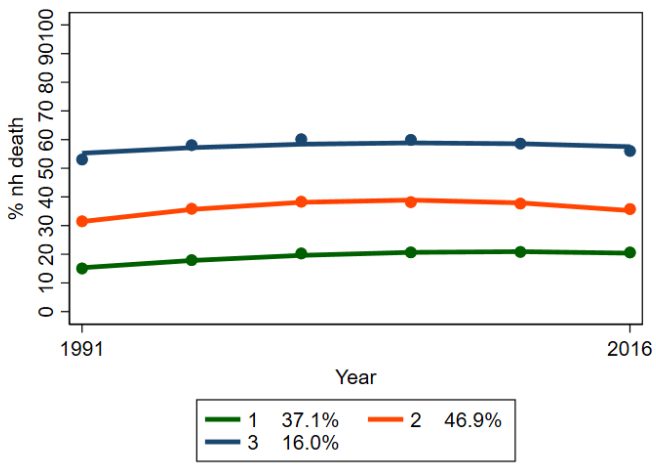


Figure B.10. Four-class solution (quadratic function) for percent nursing home death

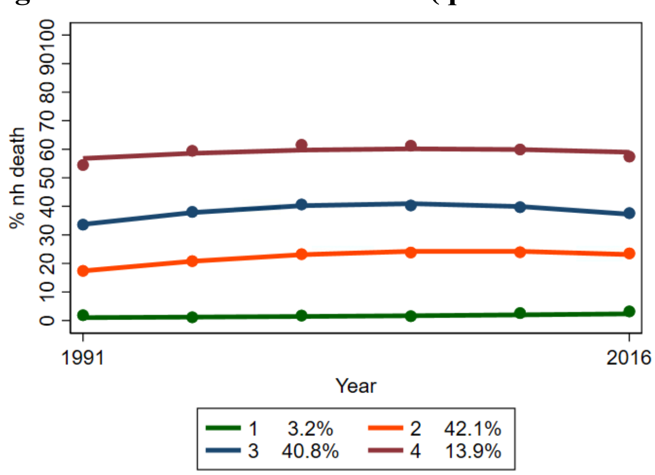


Figure B.11. Four-class solution (quadratic function) for percent nursing home death with the inclusion of all 27 years (rather than six)

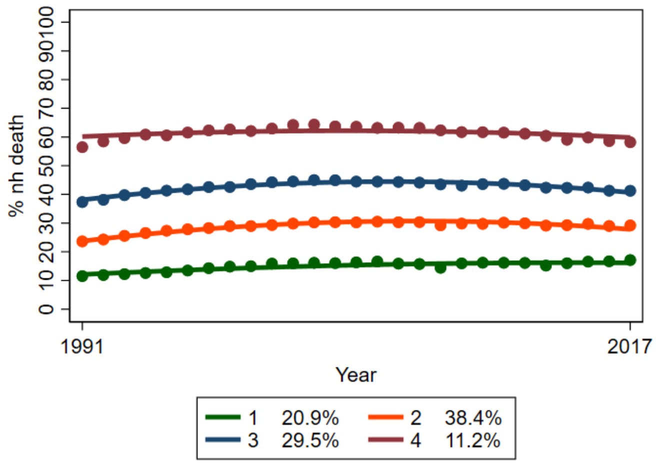


Figure B.12. Five-class solution (quadratic function) for percent nursing home death

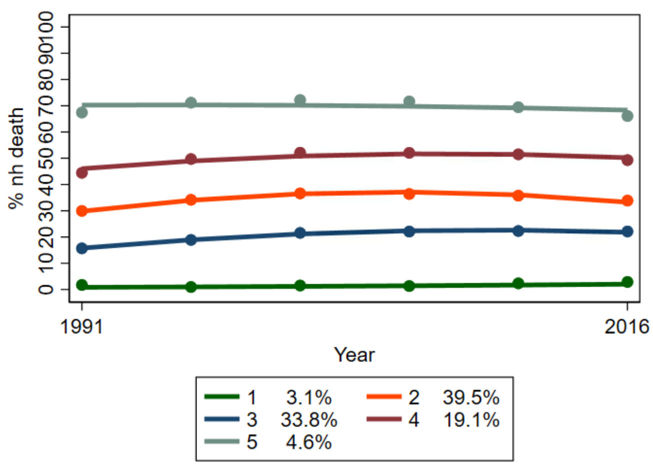


Figure B.9, Figure B.10, and Figure B.12 provide plots of each of these best fitting trajectory classes. I argue that, based on empirical indicators of BIC and entropy, a three- or four-class solution would be the best overall fit. However, when considering parsimony and interpretability, the four-class solution does not appear to add anything of substantial importance to the understanding of nursing home death trajectories. Across all the solutions, there were very few differences in the overall slope for these county subgroups (e.g., virtually flat) with only small changes in the y-intercept. Additionally, the three-class solution is more easily interpretable as low, medium, and high nursing home death subgroups. Therefore, the selection of a three-class solution for this outcome is the best fit. Overall, the three-class solution provides a low BIC, high entropy, and provides interpretable information about the county subgroups. Since the quadratic function in each trajectory was significant but very small, I feel confident in moving forward with my original selection of the three-class model with all linear trajectories.