THE ECOLOGICAL EFFECTS OF RELIGION ON HEALTH AND MORTALITY IN CHINA

by

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ABSTRACT

Public health research is only beginning to recognize that the demographic presence and socio-cultural influence of religion in local geographic areas affect population health and mortality. This dissertation project expands this work to mainland China where I investigate the ecological effect of religion on the physical health and mortality of China's rapidly aging population. I emphasize religion as a socio-cultural characteristic of communities and incorporate theoretical explanations for the religion-health connection into social epidemiological frameworks. Using geographic data of religious sites in China merged with population census reports and a longitudinal survey of older adults, I apply statistical methods for analyzing spatial and multilevel data to identify patterns in health and mortality associated with the religious composition of local Chinese areas. Overall, these patterns indicate that religion is an important ecological factor affecting the health and mortality of Chinese people. Results show that the presence of Buddhism and Islam in Chinese counties and prefectures are associated with lower mortality rates but that this association is due to common links with ethnic minority populations. The presence of Buddhism and Islam in Chinese prefectures is associated with worse self-rated health, whereas the presence of Christianity and Daoism in prefectures is associated with better self-rated health. Daoism is also associated with fewer chronic illnesses. Mediation analyses, however, do not provide evidence that social participation, social support, and health behaviors link these associations. Using China as a comparative case, this study draws attention to the religious environment as an important socio-cultural health factor, even in one of the least religious and most highly regulated societies in the world. Understanding factors associated with *who* gets sick and *where* can help reduce health inequalities, identify opportunities for disease prevention, and determine where more resources are needed.

CHAPTER 1: INTRODUCTION

In recent decades, public health research has discovered that the places where people live, work, and play matter more for their health than their genes and biology (e.g., Commission on Social Determinants of Health 2008). Identifying characteristics of the social environment that impact health (e.g., socioeconomic resources, education quality, access to health care, and neighborhood conditions) and understanding *how* they impact health are essential for addressing health disparities in our societies. Studies examining the effects of place on health, however, neglect a key aspect of local geographic areas: the religious environment.

Religion is often overlooked as a social determinant of health and has even been called "the invisible social determinant" (Idler 2014: 1). In fact, we know little about the potential health consequences associated with religious ecology—the demographic presence and socio-cultural influence of religion(s) in a local area (Blanchard et al. 2008: 1595)—as most health research conceptualizes religion as an individual-level attribute. But in addition to being something individuals believe and practice, religion is also a "group property" (Stark 1996: 164) with "an essentially social character" (Idler 2014: 3). As such, it has the potential to impact the health of individuals in ways that are distinct from but not necessarily independent of individual-level religiosity.

Much of the recent research investigating the ecological influence of religion has focused on crime & delinquency (e.g., Beyerlein and Hipp 2005; Lee and Bartkowski 2004; Regnerus 2003; Stark 1996; Xu et al. 2017), but scholars have begun to demonstrate the important ways that the religious environment also affects population health and mortality (e.g., Blanchard et al. 2008; Garcia, Bartkowski, and Xu 2017; Nie 2021; Stroope and Baker 2018). Thus far, the major finding from this line of research is that there are denominational differences: areas with greater concentrations of fundamentalist and Pentecostal Protestants have worse health and mortality outcomes than areas with greater concentrations of Mainline Protestants and Catholics (Bartkowski, Xu, and Garcia 2011; Blanchard et al. 2008; Garcia, Bartkowski, and Xu 2017; Nie 2021). Because these studies are exclusively based on data from the United States—a highly religious country that is predominately Christian—we do not yet know whether the ecological effects of religion on health are similar in *other* social, political, and cultural contexts (Idler 2011).

To address this underexplored approach to religion and health, this dissertation extends the study of how the religious environment impacts health and mortality to mainland China. China is an interesting and important case for several reasons. First, China's population is aging rapidly. Over the next half century, the number of people aged 60 or older is projected to double to about 35 percent of the total population (United Nations 2017: 28). In addition to the economic strains that will accompany this population shift, China will also experience an increase in chronic health problems that disproportionately burden older adults (Chatterji et al. 2008; Fang et al. 2015). Second, geographic health disparities, particularly between urban and rural areas and across regions, are a serious problem in China (Fang et al. 2010; Liu and Zhang 2019). Differences in economic development, health insurance systems, and health care resources are among the major causes of these health inequalities (Fang et al. 2010; Liu and Zhang 2019), but there is much more to be learned. Understanding factors associated with *who* gets sick and *where* can help reduce the disparities in health, identify opportunities for disease prevention, and determine where more healthcare resources need to be distributed.

Finally, several distinctive aspects of religion in Chinese society stand in contrast to the United States and other Western nations. Since about 1980, religion has grown dramatically in China despite strict regulations that suppress religious activity (Yang 2011). Today, China is simultaneously among the least religious, most religiously diverse, and least religiously free countries in the world (Pew Research Center 2014). Given these characteristics, studies of how the religious environment of China affects the health and mortality of Chinese can reveal important new insights into the well-established associations between religion and health, into the growing research on religious ecology, and into the social factors that contribute to geographic differences in health.

In this dissertation, I address the following research questions: 1) How does the religious ecology of local geographic areas in China impact population mortality rates? 2) What effect does the religious ecology of Chinese prefectures have on the physical health of older adults living there? 3) Does this effect depend on individual-level religious identity? and 4) By what mechanisms does the religious ecology of Chinese prefectures affect the physical health of older adults? In Chapter 3, I examine question 1 and establish associations between the religious environment and population mortality using census data aggregated at different geographic levels. In Chapter 4, I examine questions 2 and 3 to determine whether religion has contextual effects on individual

health outcomes using a nationally representative sample of older Chinese adults. In Chapter 5, I examine question 4 and test whether social support, social participation, and health behaviors are mechanisms that explain the associations between religious ecology and health.

To address these research questions, I integrate theoretical, conceptual, and empirical insights from several different literatures, including socio-ecological approaches to health, ecological studies of religion, and studies of associations between religion and health. In Chapter 2, I develop this theoretical background by: 1) situating this dissertation research within eco-social and social network epidemiological frameworks that emphasize features of the social environment as determinants of geographic variations in health (Krieger 2001; Macintyre, Ellaway, and Cummins 2002); 2) conceptualizing religion as an ecological characteristic that affects individual and community-level outcomes (Olson 2019; Stark 1996); and 3) drawing on mechanisms linking religion and health to explain the potential health consequences of religious ecology in the Chinese context (Chatters 2000; Ellison and Levin 1998; Idler et al. 2017). Additionally, I highlight relevant aspects of the religious and socio-political environment of mainland China.

Out of this background, I develop hypotheses for each of the above research questions to test with empirical analyses of geographic, survey, and census data. To measure religious ecology, I use data from the Online Spiritual Atlas of China (OSAC) (Yang et al. 2019), which includes information for nearly 73,000 religious sites in China from 2004, and I calculate the number of religious sites for each of the five official religions in Chinese counties and prefectures. These measures are merged with county- and prefecture-level mortality data from China's 2000 Population Census for the analyses in Chapter 3 and merged with of individual- and community-level survey data from the Chinese Health and Retirement Longitudinal Study (CHARLS 2011—2018) (Zhao et al. 2020) for the analyses in Chapters 4 and 5. Using spatial regression and multilevel models, I examine whether the religious composition of local geographic areas affects population mortality and measures of physical health. In addition, I test whether social participation, social support, and health behaviors play a role in these relationships.

This dissertation advances our understanding of the health and mortality consequences associated with the religious environment of local geographic areas. As one of the first studies to examine this topic in a context outside of the United States, this dissertation makes several contributions to research on the social determinants of health, the religion and health connection, and religious ecology. First, it confirms that the religious environment is an important social

determinant of population health and mortality in mainland China by showing that the presence of Buddhism, Christianity, Daoism, and Islam in local geographic areas all impact health or mortality, not only for their adherents but also for adherents of other religions and for the nonreligious. In addition, spatial regression models account for spatial dependencies, and multilevel modeling techniques disentangle contextual and compositional effects of religion, both of which provide stronger evidence for the contextual effects of religion. Finally, by extending research this topic to mainland China, this study shows that there are ecological effects of religion even in a society with low levels of religious involvement and strict regulations that suppress religion. This dissertation also has important implications for public health efforts in China to reduce inequalities in health and identify opportunities for disease prevention.

CHAPTER 2: BACKGROUND & LITERATURE REVIEW

Introduction

In this chapter I introduce and integrate theoretical, conceptual, and empirical insights from several different bodies of literature, relating them to the research questions posed by this dissertation about the ecological effects of religion on health in China. First, I draw on socio-ecological approaches to health to argue that characteristics of a local social environment are important factors that shape the health of the people living there. Next, I establish the religious *environment* as a concept and connect it to research on associations between *individual* religion and health to argue that mechanisms linking religion and health might also explain the potential health consequences of the religious environment. Then, I introduce mainland China as the context for this study, highlighting important characteristics that may play a role in how religious ecology impacts health and mortality.

Socio-ecological Approaches to Health

The social determinants of health paradigm highlights the importance of the social environment in determining population health (Berkman and Kawachi 2000; Link and Phelan 1995). From this perspective, social structures, processes, relationships, conditions, and characteristics are themselves "fundamental causes" of disease (Krieger 1994; Link and Phelan 1995). Individual-based explanations of health, disease, disability, and well-being are insufficient on their own (Roux 2007) and need to be contextualized within a broader social environment (Krieger 1994; Link and Phelan 1995). Understanding the social causes of health necessarily involves "focusing on places as well as people" and examining how features of local physical and social environments impact health (Macintyre, Maciver, and Sooman 1993: 213). Scholars now recognize that "where one lives makes a difference to one's health" (Berkman and Kawachi 2000: 1), particularly for older adults (Diez-Roux 2002; Krause 1996; Robert and Li 2001; Wen, Cagney, and Christakis 2005; Yao and Robert 2008).

Below, I introduce an ecosocial framework (Krieger 2001), types of "place effects" (Macintyre et al. 2002), and a conceptual model that links the social environment to individual and community health via social networks and social pathways (Berkman et al. 2000). Together, these

underline the role of local social environments (i.e., neighborhoods, networks, communities, cities, regions) and contextual factors in promoting or inhibiting health as well as provide an overarching theoretical structure in which religion fits alongside other characteristics of the social environment as influences on health.

Ecosocial Framework

The ecosocial framework seeks to "integrate social and biological reasoning and a dynamic, historical and ecological perspective to develop new insights into determinants of population distributions of disease and social inequalities in health" (Krieger 2001: 674). Positing that population patterns of health and disease are "biological expressions of social relations" (Krieger 2001), the ecosocial framework points towards the social, political, and economic processes that cause variation in population health (Krieger 1994, 2001). To answer its guiding question, "who or what are the causes?," ecosocial approaches consider multiple levels and domains of the socio-ecological environment, pathways that structure constraints and possibilities, the embodiment of the material and social world, and "upstream" factors that influence exposure, susceptibility, and resistance (Krieger 2001).

Types of Place Effects

Scholars have offered several different conceptualizations of the types of "place effects" or socio-environmental influences that impact health. Although first developed for understanding how neighborhoods impact health, they are largely compatible with larger geographic contexts. Sally Macintyre et al. (2000: 342-343; 1993: 220-221) have categorized explanations for area differences in health into five broad types: 1) physical features; 2) availability of healthy/unhealthy environments at home, at work, and at play; 3) public and/or private services that support daily life; 4) socio-cultural characteristics; and 5) area reputation. This framework specifically identifies the religious features of local areas as socio-cultural characteristics, which they describe as "the political, economic, ethnic, and religious history and current characteristics of the community; norms and values, the degree of community integration, levels of crime and of other perceived threats to personal safety, and networks of community support" (Macintyre et al. 1993: 220-221). In a slightly different conceptualization, Ellen et al. (2001: 393) have suggested the following

categories: (1) neighborhood institutions and resources; (2) stresses in the physical environment; (3) stresses in the social environment; and (4) neighborhood-based networks and norms. The category in which religion best fits is less obvious; but, in many local social environments, religion could conceivably be a neighborhood institution and resource, a source of tension in the social environment, and/or a major contributor to neighborhood-based networks and norms.

The effects of people (i.e., *compositional* effects) and the effects of places (i.e., *contextual* effects) are often distinguished as explanations of associations between place and health (Cummins 2007; Duncan, Jones, and Moon 1998; Macintyre et al. 2002). Compositional effects are due to characteristics of the individuals in a social environment; therefore, area differences in health are attributed to differences in the *people* that live in those places, rather than to the places themselves (Macintyre et al. 2000; Subramanian et al. 2003). In short, compositional effects are merely the aggregation of individual-level effects in a population. In contrast, contextual effects (or ecological effects) are due to characteristics of the social environment itself and are not simply the sum of individual properties (Macintyre et al. 2000; Subramanian et al. 2003). Contextual explanations attribute area differences in health outcomes to differences between *places*. In other words, features of the local area itself matter for health. Broadly speaking, the critical question is whether there are contextual differences in health outcomes between geographic areas, after considering individual differences in those areas (Subramanian et al. 2003). I argue that the religious environment is a feature of a place that is distinct from but not necessarily independent of individual-level religiosity.

Relational approaches—which view places as dynamic social networks of individuals as opposed to neutral spaces with static boundaries—emphasize the processes and interactions between people and places (Cummins 2007). Macintyre et al. (2002) propose that these complex interrelationships between characteristics of individuals and contexts produce a third kind of explanation: the *collective*. Consistent with Durkheim's understanding of the social environment as more than just the sum of its parts, the collective explanation emphasizes socio-cultural features of local areas that represent collective social functioning such as "shared norms, traditions, values, and interests" and which are factors in the relationship between places and health that cannot be distinguished from either people or places (Macintyre et al. 2002).

Geographic variation in health and mortality in China has been associated with a variety of area-level factors that correspond to the types of socio-environmental influences outlined above. They

include levels of economic development and employment (Fan et al. 2019; Pi et al. 2018), socioeconomic inequality (Banister and Zhang 2005; Fang 1993; Fan et al. 2019; Gu et al. 2019; Lei et al. 2014; Pi et al. 2018; Wang et al. 2019; Yu and Zhang 2020; Zhao 2006; Zimmer, Kaneda, and Spess 2007), health infrastructure (Smith, Tian, and Zhao 2013), availability and utilization of healthcare resources (Fan et al. 2019; Gu, Zhang, and Zeng 2009; Li et al. 2018; Pan and Shallcross 2016; Zhang and Zhang 2017; Zhao 2006), education levels (Banister and Zhang 2005; Fan et al. 2019; Pi et al. 2018; Zhou et al. 2019), and community resources (Zimmer et al. 2007). Research on areal-level socio-cultural influences on health in China has been limited except for studies showing that community-level social capital (Hou, Lin, and Zhang 2017; Liu, Kia-Keating, and Nylund-Gibson 2018; Liu et al. 2016; Shen and Yeatts 2013; Yip et al. 2007; Zhang and Jiang 2019) and trust (Meng and Chen 2014) associations with better self-rated health.

Social Networks, Mechanisms, and Pathways

How do social conditions and socio-cultural characteristics of local areas influence health? A conceptual model by Berkman et al. (2000) highlights the role of social networks in the process. Figure 1 reproduced from Berkman et al. (2000: 847) illustrates the "cascading causal process" that links upstream forces like social, cultural, economic, and political conditions with downstream mediating mechanisms and pathways that influence health. In brief, this theoretical chain of causation begins with 1) macro-level social-structural conditions that determine 2) the structure and characteristics of social networks. Network structures and characteristics then provide opportunities for 3) social support, social influence, social participation/engagement, and access to resources, which influence health through 4) pathways such as physiological responses to stress, psychological states, health behaviors, and exposure to infectious disease (Berkman et al. 2000: 846). The mechanisms and pathways in this model overlap considerably with those that link individual-level religion with health outcomes, particularly social support, social engagement, psychological states, and health behaviors (Chatters 2000; Ellison and Levin 1998). Despite these remarkable similarities, the ecological effect of religion on population health is an understudied area of social epidemiology.

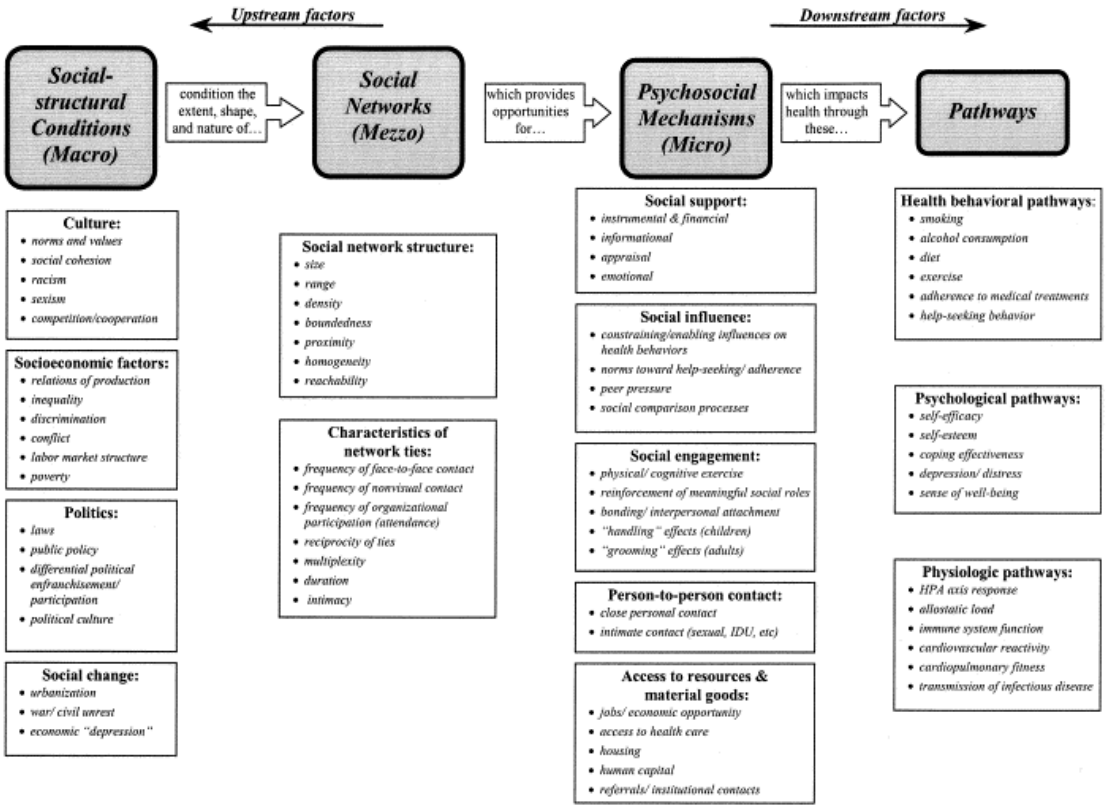

Figure 1. A conceptual model of the how macro-level social structural conditions impact health via social networks and psycho-social mechanisms from Berkman et al. (2000: 846).

A separate stream of social scientific research—mainly in sociology—has been investigating the effects of religious contexts or religious ecology on the lives of individuals and communities. This area of research, however, has paid relatively little attention to health outcomes. In the next section, I outline theoretical insights from studies of religious ecology useful for examining the health effects of the religious social environment.

Religious Ecology & Local Religious Subcultures

Although recent research from social epidemiology has shown that characteristics of the social environment significantly impact health-related behaviors and outcomes, we know relatively little about the potential health consequences associated with the *religious* characteristics of social contexts. Furthermore, studies of religion and health routinely conceptualize and measure religion as an individual-level attribute with little attention paid to religious influences on health that are *external* to individuals. Religion, however, is not only something that individuals believe,

practice, or identify with but it is also a "group property" (Stark 1996) with an "an essentially social character" (Idler 2014:3). It is a profoundly social phenomenon that is socially produced (Berger 1967), socially reinforced (Cornwall 1989), and socially transmitted in social environments such as congregations (Stroope 2011), families (Bengtson 2013; Smith and Faris 2005), and social networks (Cheadle and Schwadel 2012; Lofland and Stark 1965; Stark and Bainbridge 1980). As such, religion is a social force that has the potential to powerfully shape both individual and community health. The argument that religious features of the social environment influence health, however, is not new. Early sociologists Max Weber ([1905] 2013) and Émile Durkheim ([1897] 2005) emphasized the influence of the religious characteristics of the social environment on both community-level and individual-level attitudes, norms, behaviors, and outcomes. Studies of religious ecology have been sparse, but recently more attention has been directed to studying the contextual effects of religion.

Classical Theory

Examining how the religious characteristics of a social environment affects individuals and other aspects of the social world was a central concern in classical sociological theory. For both Émile Durkheim and Max Weber, the social character of religion played a major role in social change and in the health of a society.

In *The Protestant Ethic and the Spirit of Capitalism*, Max Weber ([1905] 2013) argued that the theological beliefs and religious values of Protestants contributed to the development of capitalism in Northern Europe. He explained that the theological doctrine of predestination, particularly among Calvinist Protestants, fostered the need for assurance of their salvation. Although they believed salvation could not be "earned," lay Calvinists understood their work to be a calling from God, seeking to live virtuous lives and accumulate wealth which they interpreted as a "sign of election." The norms, values, and behaviors associated with the ethic of hard work and rational pursuit of wealth that developed specifically among Calvinists eventually spilled over into the broader secular culture as a "spirit of capitalism" void of its original theological significance.

Émile Durkheim ([1897] 2005) believed that religion was a key factor in the social cohesion and therefore health of a society and its individuals. Using suicide as an example, he demonstrated that a pathology commonly attributed to individual-level factors was heavily

influenced by social integration—how "connected" or bonded individuals were. Durkheim argued that European societies with higher levels of social integration had lower rates of suicide. He attributed this variation to the integrative power of different religious groups, demonstrating that predominately Protestant areas had higher suicide rates than predominately Catholic areas.

Contemporary Perspectives

Moral Community Hypothesis

Building on these classical theories, several contemporary conceptualizations of religion's ecological influence have emerged. The moral community hypothesis, which draws directly on Durkheim's insights about the normative and integrative functions of religion in a society, posits that religion and religious institutions foster a moral environment that integrates individuals and regulates behavior within a community (Stark 1996; Stark, Kent, and Doyle 1982). According to the moral community hypothesis, the key factor between religion and individual behavior is the religious composition of the community. In investigations of religion's effects on crime, Stark, Kent, and Doyle (1982:6) argued that "religious effects on delinquency vary according to ecological conditions, namely, the religious climate of the community studied." For religion to influence the behavior of religious individuals, religion must "permeate the culture and the social interactions of the individuals in question" (Stark, Kent, and Doyle 1982:7). In other words, where religion is more widespread, its influence on norms and behavior will be stronger.

The moral community hypothesis proposes that the contextual effects of religion can be twofold. First, the religious composition of a community directly influences the attitudes, behaviors, and outcomes of both religious and non-religious individuals in the community (Regnerus 2003; Welch, Tittle, and Petee 1991). Second, the religious context moderates the effect of individual-level religious characteristics on attitudes, behaviors, and outcomes for individuals in the group. Under this proposition, the effect of individual-level religiosity depends on the religiosity of the social environment: "what counts is not only whether a particular person is religious, but whether this religiousness is, or is not, ratified by the social environment" (Stark 1996:164). This has been termed the "light switch hypothesis," because the effect of individual-level religion is "switched on" in communities where more people are actively religious (Regnerus

2003; Stroope and Baker 2018). The implication is that the effect of religion is greatest for highly religious individuals in highly religious social environments.

Much of the work examining and testing the moral community hypothesis has focused on the effects of religion and religious communities on crime and deviance (Lee 2006; Lee and Bartkowski 2004); however, evidence supporting it has been mixed (Regnerus 2003; Tittle and Welch 1983). The moral community hypothesis also has broader conceptual application beyond studies of delinquency and has been extended to explain the contextual effects of religion on other outcomes such as suicide (Ransome et al. 2019; van Tubergen, te Grotenhuis, and Ultee 2005), adolescent substance use (Nie and Yang 2019; Wallace et al. 2007), moral and social attitudes (Finke and Adamczyk 2008), and subjective well-being (Diener, Tay, and Myers 2011). Studies on volunteering (Lim and MacGregor 2012; Ruiter and De Graaf 2006) and gender attitudes (Moore and Vanneman 2003), however, have not supported the moral community hypothesis. Only a few studies have explicitly used the moral community hypothesis to explain variation in health and mortality (e.g., Hayward and Elliott 2014; Huijts and Kraaykamp 2011; Stroope and Baker 2018).

Local Religious Subcultures

Another conceptual framework that is useful for explaining the potential health effects of religious ecology emphasizes the cultural influences of religious groups on the broader population. In this model, local religious subcultures—the attitudes, values, beliefs, and practices shared by members of a common religious group (identity, denomination, congregation, organization)—not only influence members of the religious group but can also have indirect influences on non-members in the same local area (Olson 2019). Figure 2, reproduced from Olson (2019: 149), illustrates how the religious composition of local areas and local religious subcultures affects individual and community-level outcomes through influence on local public subcultures.

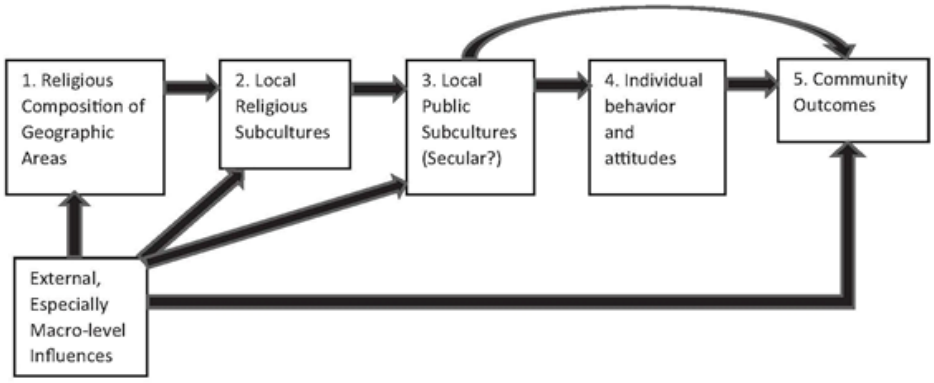

Figure 2. A conceptual model of the path from religious composition of local areas to individual and community outcomes from Olson (2019: 149).

In this model, the degree of influence that a local religious subculture has on others in the area—via its influence on the local public subculture—is largely determined by the size of the religious group. A main way that the religious subcultures shape the attitudes and behaviors of others is through interpersonal social interactions between individuals who are members of predominant religious groups and individuals who are not (Olson 2019). Because the size of a particular religious group in a local area is strongly associated with the number of close friends that individuals have from that religious group (Olson and Perl 2011), the religious composition of a local geographic area affects the structure of social networks; and, therefore, larger and more prominent local religious subcultures can potentially exert greater influence through social ties and social interactions between members and non-members (Olson 2019).

Prior Findings

Much of the work that has examined the ecological effects of religion has focused on non-health related individual-level outcomes such as adolescent delinquency (Regnerus 2003), volunteering (Lim and MacGregor 2012; Ruiter and De Graaf 2006), abortion decisions (Adamczyk 2008; Tong 2020), gender attitudes (Moore and Vanneman 2003), adolescent sexual activity (Adamczyk and Felson 2006), and social trust (Marshall and Olson 2018; Olson and Li 2015), as well as non-health community-level outcomes such as teen fertility rates (Ovadia and Moore 2010), sex ratios (Tong 2020; Tong, Sennotte, and Yang 2021), divorce rates (Glass and Levchak 2014), crime rates (Beyerlein and Hipp 2005; Lee and Bartkowski 2004), and public

policy (O'Connor and Berkman 1995). These studies have demonstrated the important independent effects that the religious environment can have on individuals and communities.

Only a few published studies have considered how the religious environment affects population health. Blanchard et al. (2008) showed that in U.S. counties a greater presence of Fundamentalist and Pentecostal Protestant congregations was associated with higher all-cause mortality rates, whereas a greater presence of Evangelical, Mainline Protestant, and Catholic congregations was associated with lower mortality rates. Similarly, studies of infant mortality found that counties with greater numbers of Catholic and non-Pentecostal conservative Protestant churches have lower infant mortality rates (Bartkowski et al. 2011), and counties with greater concentrations of mainline Protestant and Catholic adherents have lower post-neonatal infant mortality rates (Garcia et al. 2017). All these studies attribute the varying contextual effects on all-cause and infant mortality rates to differences in theological orientations between these religious groups. For example, the pro-nationalist, pro-life stances of many conservative Protestants, the civic-mindedness of Catholics, the other-worldly orientation of fundamentalist Protestants, and the faith-healing beliefs of Pentecostals may help explain these differences (Bartkowski et al. 2011; Blanchard et al. 2008; Garcia et al. 2017).

Evidence also suggests that the ecological effects of religion are not necessarily the same for everyone. In Europe, Protestants report better health than Catholics in national contexts where there is a greater proportion of Protestants and worse health where there is a greater proportion of Catholics (Huijts and Kraaykamp 2011). Similarly, Stroope and Baker (2018) use the light switch hypothesis to explain how in highly religious U.S. counties, religious individuals are more likely to have better health than non-religious individuals, but in less religious counties, the health of religious and non-religious individuals is no different. And at the national-level, religiosity has been found to be positively associated with health and well-being in more highly religious societies and negatively associated with health and well-being in less religious societies and in societies with higher levels of government restrictions (Diener et al. 2011; Elliott and Hayward 2009; Hayward and Elliott 2014). Evidence also suggests that health consequences of religious involvement differ between religious majority and religious minority groups (May and Smilde 2016).

Operationalizing Religious Ecology

The terms *religious ecology* and *religious environment* have been used to describe the demographic presence and socio-cultural influence of religion(s) in a social environment, most commonly a geographic area (Blanchard et al. 2008:1595). Olson (2019:149) distinguishes between the demographic presence of religions as *religious composition* and the socio-cultural features (i.e., beliefs, practices, values, and attitudes) of religions as *religious subcultures*; however, studies have generally used the religious composition of geographic areas as a stand in for the concept of religious ecology. Direct measures of religious subcultures are less accessible and are often theoretically derived for developing hypotheses about the effects of the religious environment (Olson 2019).

The most common measure of religious ecology has been the concentration of religious groups in an area or the community-level population share, operationalized by the number of adherents/members or religious congregations for each religious group in each geographic area (e.g., U.S. counties) adjusted for area population (Beyerlein and Hipp 2005; Blanchard et al. 2008; Harris and Ulmer 2017; Lim and MacGregor 2012; Marshall and Olson 2018; Olson 2019; Regnerus 2003). Other studies have used the proportion of a geographic context that is religious (Olson and Li 2015; Stark et al. 1982); measures of religious homogeneity/diversity (Lim and MacGregor 2012; Olson and Li 2015; Ulmer and Harris 2013); and aggregate measures of religious service attendance, beliefs, practices, and religious salience or a composite index of religiosity (Ransome et al. 2019; Stroope and Baker 2018). The geographic scale used has ranged from smaller, more localized areas such as census tracts, neighborhoods, cities, and counties (Blanchard et al. 2008; Garcia et al. 2017; Jaffe et al. 2005; Lee and Bartkowski 2004; Regnerus 2003; Stroope and Baker 2018) to larger geographic areas such as states (Moore and Vanneman 2003; Ransome et al. 2019), regions, and countries (Lim and MacGregor 2012; Olson and Li 2015; Ruiter and De Graaf 2006). Additionally, prior studies have found variations in the ecological effects of religion not only between broad categories of Christianity (e.g., evangelical Protestants, mainline Protestants, Black Protestants, and Catholics in Ransome et al. 2019) but also between more narrowly defined subgroups or denominational families (e.g., evangelicals, Pentecostals, and fundamentalists in Blanchard et al. 2008). These studies demonstrate the importance of examining different geographic levels and different religious groups (and subgroups) for understanding how religious ecology influences health outcomes.

In the next section, I draw on explanations of the associations between individual religious involvement and health outcomes to propose mechanisms and pathways that link religious ecology and health. Additionally, I provide a brief overview of associations between religion and health in general, highlighting prior findings from studies in China.

Associations between Religion, Health, and Mortality

Research has demonstrated robust associations between religion and mortality (e.g., Hummer et al. 2004; Jarvis and Northcott 1987; Oman and Reed 1998), physical health (e.g., George et al. 2000; Koenig, King, and Carson 2012), mental health (e.g., Levin and Chatters 1998; Hackney and Sanders 2003; Koenig 2009), and behavioral health (e.g., Ellison and Levin 1998; Hill et al. 2006). In general, studies show that religious involvement decreases mortality risks (Kim, Smith, and Kang 2015; Krause 2006; Oman and Reed 1998; Sullivan 2010) and improves the physical health and psychological well-being of individuals across the life course (Cotton et al. 2006; Koenig 2009, 2015; Powell, Shahabi, and Thoresen 2003). Although most studies show that religion is associated with better health outcomes, some forms of religious involvement may include negative religious coping, congregational conflict, and high demands, which can be associated with poorer health outcomes (Ellison and Levin 1998; Pargament et al. 1988, 2004).

The limited research in China on religion's associations with health and mortality has produced mixed results. In general, the evidence suggests that religious involvement decreases mortality and improves physical health but is detrimental to mental health. Several research studies demonstrate that religious participation is associated with decreased risk of dying in older adults (Zeng, Gu, and George 2011; Zhang 2008). Older adults who participate in religious activities also have better self-reported physical health (Yi, Gu, and Land 2007). In the general population, one study indicates that Buddhists, Protestants, and individuals who indicate that religion is "very important" in their lives have better self-rated health (Zhang et al. 2020), whereas another study found no associations (Kim and Chung 2019). Religious affiliation and higher levels of religiosity are associated with increased risk of mental health disorders (Wang et al. 2015) and psychological distress (Wang et al. 2016), as well as reduced subjective well-being (Brown and Tierney 2009). The adverse mental health effects of religious involvement may be due to China's harsh political environment in which religion is actively suppressed by strict state regulations (Brown and Tierney 2009; Cheung and Leung 2007).

Mechanisms Linking Religious Ecology and Health

Given the lack of research on religious ecology and health, no one has systematically delineated the mechanisms and pathways that explain the ecological effects of religion on health; more research is needed to establish these. However, by integrating social epidemiological frameworks and established social mechanisms linking individual religion and health, we can identify potential mechanisms and pathways through which the religious environment might impact health. Because many of the explanatory mechanisms for the effects of individual religion on health are either themselves social phenomena or closely tied to social connection among individual, Berkman's (2000:847) conceptual model (see Figure 1) provides a useful basis for considering how the religious environment impacts health through the influence of social relationships.

The mechanisms and pathways that scholars have identified to explain the associations between religion and health are generally grouped into the following categories: 1) health and lifestyle behaviors; 2) social resources; 3) coping resources and behaviors; and 4) attitudes, beliefs, and emotional states and feelings (Chatters 2000; Ellison and Levin 1998; George, Ellison, and Larson 2002). To more explicitly conceptualize how the social nature of religion impacts the health of individuals, Idler (2014) has used the categories of social support, social control, and social capital. These categories correspond highly with Berkman's (2000:847) model which illustrates the role of social networks in linking macro-level socio-ecological conditions with health through psychosocial mechanisms and health pathways such as social support, health behaviors, social influence, social engagement, and access to resources. Therefore, I propose that the religious environment is an aspect of the macro-level context that affects the structure and characteristics of social relationships which impact health via the aforementioned mechanisms and pathways to impact health (illustrated in Figure 3).

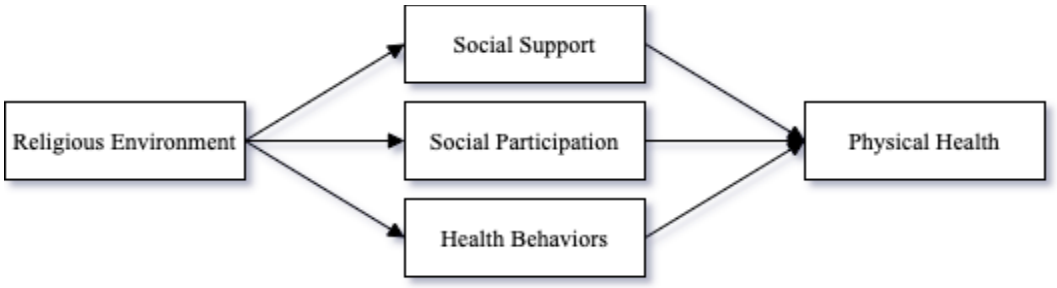

Figure 3. A conceptual model with social support, social participation, and health behaviors as mechanisms linking the religious environment with physical health outcomes.

Prior studies of religious ecology and health have focused on public health infrastructure (Blanchard et al. 2008), social capital (Blanchard et al. 2008; Nie 2021; Stroope and Baker 2018), network ties (Blanchard et al. 2008; Stroope and Baker 2018), social identity (Stroope and Baker 2018), and social influence (Bartkowski et al. 2011) as primary explanatory mechanisms. For this dissertation, I focus on social support, social participation, social identity, and health behaviors, which I briefly describe below as potential mechanisms and factors that link religious ecology with health outcomes.

Social Support and Social Participation

Religious involvement provides opportunities for social ties, social support, social interaction, and social capital that empirical evidence indicates have health promoting benefits (Chatters 2000; Cohen 2004; Ellison and George 1994; Ferraro and Koch 1994; George et al. 2002; Yeary et al. 2012). A large body of literature has demonstrated associations between social connectedness and health, suggesting that increased religiosity increases social relationships. In fact, this research shows that social relationships are as influential on one's risk of mortality as smoking or alcohol consumption and are even more influential than physical inactivity and obesity (Holt-Lunstad, Smith, and Layton 2010). Furthermore, religious involvement is associated with larger and denser networks (Ellison and George 1994) and more frequent social interaction (Ellison and George 1994). Participation in social activities in general (Blazer 1982; Douglas, Georgiou, and Westbrook 2017; Hyyppä and Mäki 2003; Lee et al. 2008; Morrow-Howell and Gehlert 2012) and religious participation (Krause 2002, 2008; Yi et al. 2007) has health benefits especially for older adults. Among older adults in China, religious activities are associated with decreased risk of functional limitations, cognitive impairment, and poor self-rated health (Yi et al. 2007), and the

effect of religious participation on mortality risk is partially mediated by participation in social activities (Zhang, Hannum, and Wang 2008). Because religion tends to facilitate social interaction, communities with more religious adherents may have greater overall levels of social participation.

The effects of social support on health and well-being have been well-documented (Berkman and Kawachi 2000; Seeman 1996; Uchino 2004), and religious involvement facilitates social relationships in which all four types of social support—emotional, instrumental, appraisal, and informational—can be accessed (Ellison and Levin 1998). In particular, religious participation is associated with greater social and material support (Chatters 2000; Ellison and George 1994; Koenig et al. 1997; Krause 2006; van Olphen et al. 2003) as well as with norms and beliefs that promote helping behaviors (Chatters 2000; Ellison and Levin 1998). The giving of social support also has health benefits (Krause et al. 1999). Studies of older adults in China indicate that emotional support is associated with better physical health (Liu, Liang, and Gu 1995), household support is associated with lower mortality risk (Zhang, Li, and Silverstein 2005), and general social support is associated with higher subjective well-being (Deng et al. 2010). Religious social support has not been well-studied in China, but a study of university students suggests that religious social support reduces psychological distress (Wang et al. 2016). A lack of social relationships also has harmful effects on health and well-being among older Chinese adults (Liang et al. 2000; Luo and Waite 2014; Sun and Liu 2008). Therefore, in communities with greater religious involvement, overall levels of social support may increase through networks with more religious individuals.

Health Behaviors

Religious involvement shapes behaviors that have consequences for physical and mental health. Many religions proscribe behaviors that have health risks (e.g., diet, substance use) and prescribe behaviors that promote health (e.g., exercise) (Chatters 2000; Ellison and Levin 1998; George et al. 2002). The ways that religion encourage or discourage these normative behaviors include: 1) self-monitoring via internalized religio-ethical norms, 2) fear of sanctions for violating norms, and 3) emulating influential group members (Ellison and Levin 1998). The behavioral health norms of certain religious groups may more strongly influence the health behaviors of the community where there are high concentrations of adherents from those religious groups in that community. Findings indicate that religious involvement is associated with less frequent alcohol use (Brown et al. 2001; Hill et al. 2006; Michalak, Trocki, and Bond 2007), less frequent substance

use (Alzyoud et al. 2015; Hill et al. 2006; Wallace et al. 2003; Widyaningrum and Yu 2018), healthy behaviors such as exercise and sleep (Hill et al. 2006), and greater health care utilization (Benjamins and Brown 2004; Schiller and Levin 1988). Although religion mostly promotes good health behaviors, some religious groups or communities encourage poor health behaviors, including faith-based refusal of treatment (Vess et al. 2009) and refusal of help-seeking from mental health professionals (Abe-Kim, Gong, and Takeuchi 2004).

Studies from China show that religious involvement is associated with lower levels of smoking (Brown et al. 2009; Wang et al. 2016; Wang et al. 2015) and drinking (He et al. 2016; Wang et al. 2016), particularly among Muslims (Liu et al. 2014; Pan and Shallcross 2016; Wang, Koenig, and Al Shohaib 2015); and, in a study of older adults, the effect of religious participation on mortality risk was partially mediated by exercise (Zhang et al. 2008). A vegetarian diet is also associated with lower prevalence of hypertension among Tibetans and Tibetan Buddhists in China (Meng et al. 2018). Areas with greater religious involvement may have lower overall levels of harmful health behaviors like smoking and drinking.

Social Identity

Studies also show that benefits of religion for health and well-being also depend on the "person-society fit" (Diener et al. 2011) or their level of social integration. This could be attributable to several potential explanations. First, self-categorization theory suggests that individuals will have greater well-being when their social identity is concordant with a social group that has widely accepted norms, values, ideals, and behaviors (Turner et al. 1987). Identifying with a social group that has more dominant social position will have greater positive effects. Conversely, identifying with a social group that has a minority social position or that is marginalized may have negative effects (Turner et al. 1987). Research indicates religion has greater benefits for health and well-being in more religious contexts than in less religious contexts (Stroope and Baker 2018) and that the consequences of identifying with a religious minority group for health and well-being may depend on how dominant the religious majority is (May and Smilde 2016). Second, the role of government regulation of religion may affect the associations between religious involvement and well-being. In societies with greater religious regulation, *personal* religiosity is associated with greater well-being, but *public* religious participation is associated with worse well-being (Elliott and Hayward 2009). In societies in which religion is heavily regulated and in which overall

religious adherence is low, local communities with higher levels of religious involvement and greater numbers of religious minorities may experience worse health outcomes.

Religion in Mainland China

Most research on the ecological effects of religion has focused on studies in the United States, a Western society notable for its high level of adherence to Christianity. Whether there are similar ecological effects of religion on health and mortality in other societies has yet to be determined. Because of China's low level of religiosity, high level of religious diversity, and strict regulation of religion, it serves as a particularly helpful contrast to prior work in the United States. Below, I introduce aspects of the Chinese religious and political context relevant to this study.

Low Levels of Religiosity in China

Historically, China has a rich religious culture, but anti-traditionalist movements since the beginning of the last century—particularly the Communist Revolution (1949) and the Cultural Revolution (1966-1976)—nearly eradicated religion entirely. But beginning with China's major economic and social reforms in 1978, religion in China has revived, growing rapidly throughout the country (e.g., Overmyer 2003; Yang 2011). The guiding ideology of the ruling Chinese Communist Party (CCP), Marxism-Leninism-Mao Zedong Thought, rejects religion and formally embraces atheism; therefore, China's religion policy heavily regulates and monitors religion with hopes of reducing its overall influence on Chinese society. In 1982, "Document 19" sanctioned Buddhism, Daoism, Catholicism, Islam, and Protestantism as official religions in China but had very limited provisions for freedom of religious belief and practice (Yang 2011). In addition to these official "red market" religions, Chinese society also has a "gray market" of semi-legal religions like Confucianism, folk religion, and unregistered Protestant and Catholic churches as well as a "black market" of illegal religious groups or "evil cults" (*xiejiao* 邪教) (Yang 2011; Yang 2018a).

Despites the rapid resurgence of religion in China, it remains one of the least religious countries in the world. Nearly half of China's population is religiously unaffiliated (Pew Research Center 2014) and only about 3 percent say that religion is "very important" to them (Pew Research Center 2018). Although many report having religious beliefs and participating in occasional

religious practices, overall levels of religiosity are very low. In contrast, nearly 85 percent of the United States' population identifies with a religious group (Pew Research Center 2014) and about 53 percent say that religion is "very important" (Pew Research Center 2018).

What can we learn about the ecological effects of religion on health by studying a society with such low levels of overall religiosity? Because the national context may moderate associations between the religious environment and health, I propose that as a more secular society with less overall religious participation, the religious environments of local geographic areas in China will exert a smaller influence on health than they would in a more religious national context. Although I do not aim to test this hypothesis, the possibility that the ecological effects of religion may differ in a society like China—where being religious is less "normal"—is an important reason why China may be a helpful contrast to the ecological effects of religion in the United States. Determining how local religious environments affect health and mortality in a very secular society like China could also provide insights into these processes in other societies with low overall levels of religiosity.

Religious Diversity and Non-exclusivity in China

China is one of the most religiously diverse countries in the world. In 2010, China had a Religious Diversity Index score (RDI) of 7.3, ranking it the 9th most religiously diverse country in the world and placing it in the "Very High" range (top 5 percent) of RDI scores. The RDI of the United States was 4.1 or "Moderate" and ranked 68th out of 232 countries (Pew Research Center 2014). In contrast, China's largest religious group is the religiously unaffiliated at 52.2 percent and has 3 major religions that comprise more than 5 percent of the Chinese population: Folk religion 21.9 percent, Buddhism 18.2 percent, and Christianity (combined Protestant and Catholic) 5.1 percent. Only 1.8 percent of the Chinese population identifies as Muslim (Pew Research Center 2014). In considering how the religious environment might impact population health and mortality, a major question is whether there are differences in the ecological effects between different religious groups. For example, does the concentration of Buddhists in local areas impact mortality rates greater than the concentration of Muslims? If denominational differences matter in the ecological influence of religion on health in the United States (e.g., Blanchard et al. 2008), perhaps the differences between world religions matter even more for the ecological influence of religion on health. A major aim of this dissertation is to examine how the presence of Buddhism,

Catholicism, Daoism, Islam, and Protestantism in local Chinese areas are similar or different in their influences on population health.

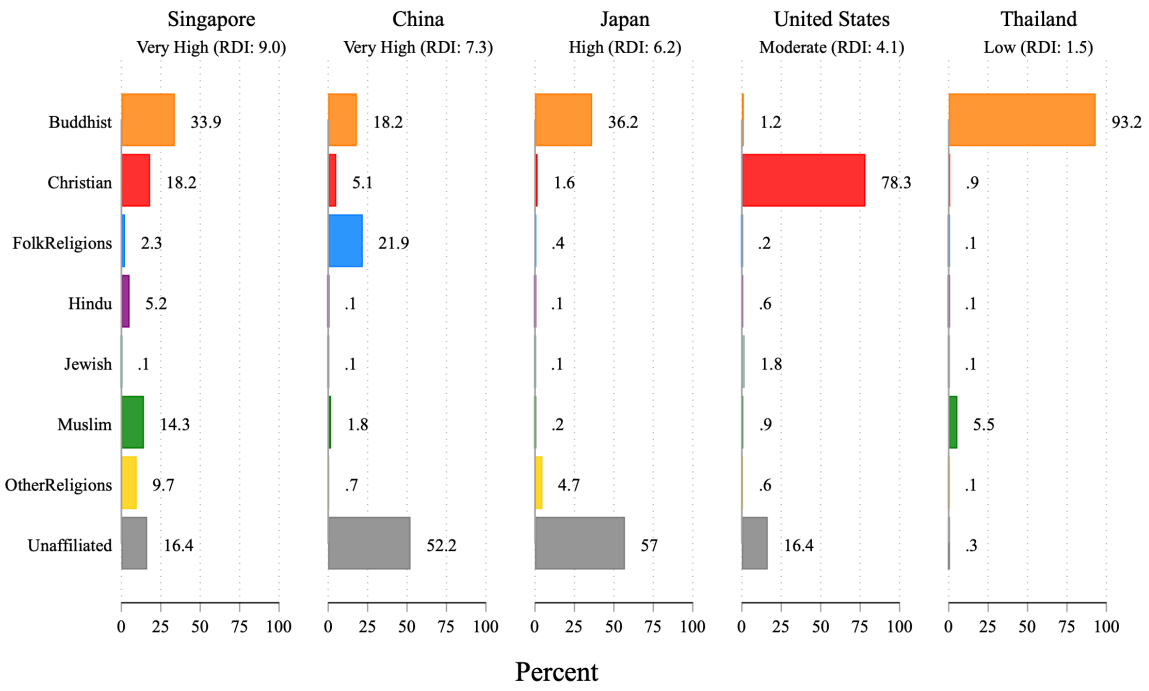

Figure 4. Religious Diversity Index and religious composition of China and comparison countries in 2010. Data: Appendix 2. Religious Diversity Index Scores and Religious Adherents by Region and Country, Global Religious Diversity (Pew Research Center 2014).

Related to China's religious diversity is the non-exclusive nature of religion in East Asian societies and cultures, where being Buddhist or Daoist, for example, does not preclude someone from identifying or engaging with other religions as well (Cornille 2010; Oostveen 2019). A common behavior among religious adherents in China is borrowing or integrating beliefs and practices from a variety of religious traditions, especially Buddhism, Daoism, Confucianism, and local village religions. This results in a broad spectrum of syncretic religious combinations, ranging from the complex mixing of the Three Teachings (*sanjiao* 三教; Confucianism, Daoism, and Buddhism) traditionally associated with the Chinese elite to the folk religious beliefs, practices, and superstitions traditionally associated with the common people. A potential implication of the non-exclusivity of religion in China is that the ecological effects of religion may be more broadly influential, that is more people—because of their openness to drawing on aspects of different

religions—may be more susceptible to the influence of other religions and their presence in their community. For example, the health of Buddhists or non-affiliated respondents may be more affected by the presence of Daoism in their area than they would be in a society with a culture of exclusive religious identities. Although the non-exclusivity of religion in China may be ingrained in Chinese culture more broadly, it is also primarily a characteristic of Chinese religions (i.e., Buddhism, Daoism, Confucianism, and local village religions), suggesting that the influence between religions is not likely to be bidirectional. For example, individuals who identify as Buddhists (and likely *more* open to other religions) may be impacted more by the presence of Protestant religion in their area than individuals who identify as Protestants (and likely *less* open to other religions) are by the presence of Buddhist religion in their area.

Distribution of Religions in China

Buddhism, Protestantism, Catholicism, Daoism, and Islam are the only officially recognized religions. However, there are a variety of religious beliefs and practices diffused throughout Chinese society and culture that are broadly characterized as "folk religion", but which draw considerably from Daoism and Buddhism. Additionally, the ethical philosophy of Confucianism, which includes religious elements, heavily influences traditional Chinese culture. Although Daoism is the only of the official religions that is "native" to China, Buddhism is also considered to be a "Chinese religion" whereas Protestant and Catholic Christianity as well as Islam are often denigrated by Chinese authorities as "foreign religions" despite having long histories in China.

Buddhism

In China today, more people self-identify as followers of Buddhism (*fojiao* 佛教) than any other religion. The 2007 Spiritual Life Survey of Chinese Residents indicates that about 18 percent of Chinese (approximately 200 million adults) identify as Buddhist, although many more report believing Buddhist ideas or practicing Buddhist rituals (Chao and Yang 2018). According to a 2018 white paper, there were 33,500 Buddhist temples and monasteries and 222,000 Buddhist monks and nuns in 2012 (P.R.C. State Council 2018). The Online Spiritual Atlas of China (OSAC) records more than 16,500 Buddhist sites in 2004 (Yang et al. 2019). In general, Buddhism is

practiced throughout the country, although higher concentrations of Buddhists and Buddhist temples are found in the southeastern and southwestern regions of China (see Figure 5). Three major branches of Buddhism are prevalent in China. Han (Mahayana) Buddhism is the largest branch and is practiced throughout the country, Tibetan Buddhism is primarily concentrated in Tibet, and Southern (Theravada) Buddhism is almost exclusively found among the Dai ethnic minority in Yunnan Province (Yang 2018a).

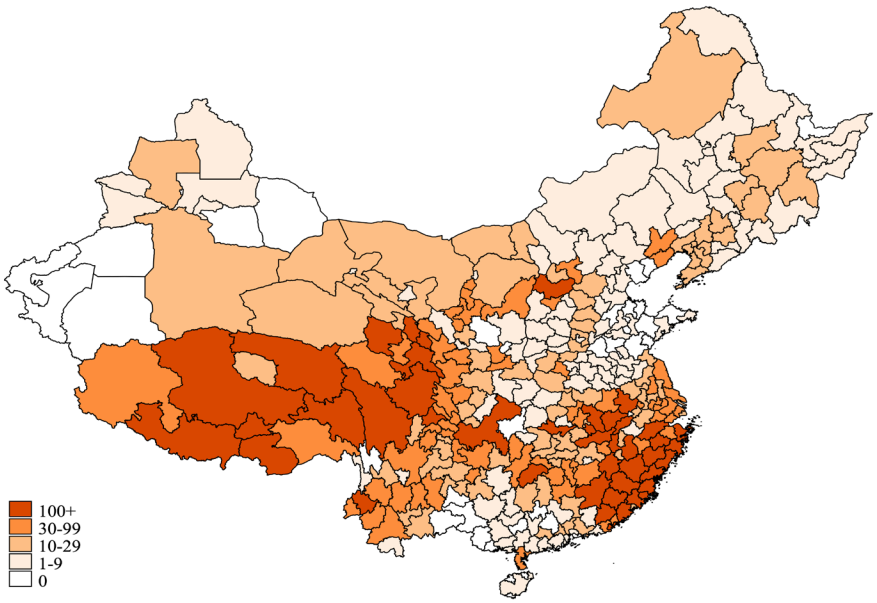

Figure 5. Number of Buddhist sites in Chinese prefectures, 2004. Data: Online Spiritual Atlas of China (OSAC) 2019 (Yang et al. 2019).

Buddhists of all three traditions seek to reach a state of enlightenment or transcendence and participate in rituals such as meditation, reading and singing/chanting Buddhist scriptures, and making offerings of food, flowers, money, and incense at temples. Communal activities such as temple festivals for events such as Buddha Day and pilgrimages to sacred mountains are also important aspects of Buddhist religious life. Buddhists also believe in karma, that their deeds and actions in both their present and previous lives determine their fate in future lives in which their souls transmigrate into the body of another human or animal. Vegetarianism is also commonly observed among Chinese Buddhists (Kieschnick 2005).

Catholicism

Official estimates in 2018 stated that there are 6 million followers of Catholicism (*tianzhujiao* 天主教) in China (P.R.C. State Council 2018). Because there are many Catholics who worship in unregistered Catholic communities, this number is likely much higher. Some estimates indicate that there may be as many as 9-12 million Catholics (Charbonnier 2014; Pew Research Center 2011). In 2018, there were 98 Catholic dioceses, 6,000 churches, and 8,000 clergy (P.R.C. State Council 2018). The Online Spiritual Atlas of China (OSAC) has data for about 2,400 Catholic churches in China (Yang et al. 2019). Higher numbers of Catholic churches are found in China's southeast, central, and northeast regions (see Figure 6). In general, the beliefs and practices of Chinese Catholics closely resemble that of Catholics around the world. The seven sacraments of baptism, confirmation, confession, the Eucharist, anointing the sick, ordination, and marriage are of great importance. Chinese Catholics regularly participate in mass, which are worship services led by a Catholic priest and include scripture readings, teaching, prayers, and the Eucharist (Yang 2018a).

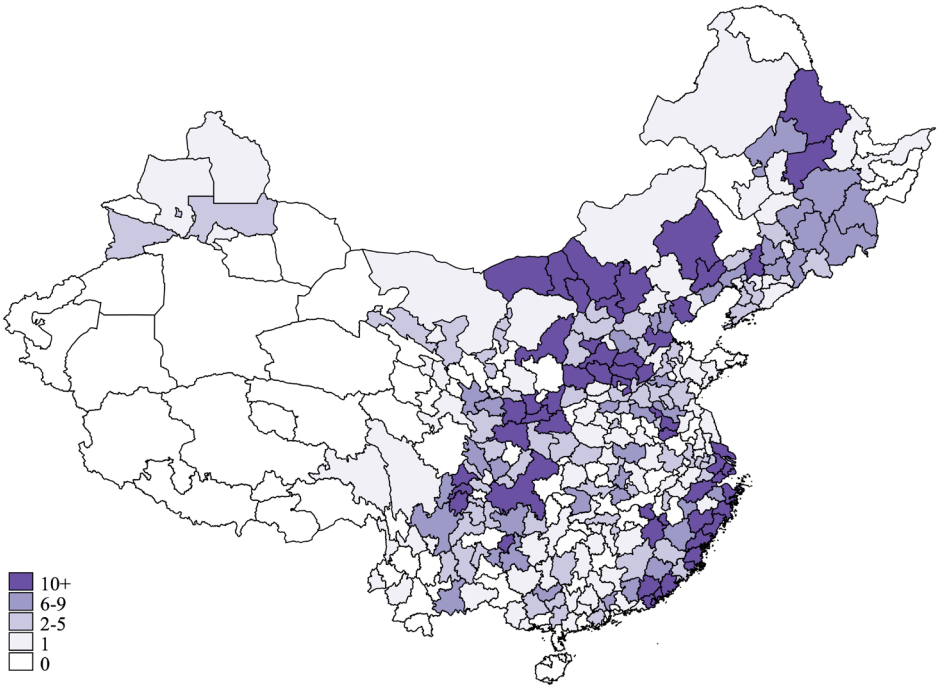

Figure 6. Number of Catholic sites in Chinese prefectures, 2004. Data: Online Spiritual Atlas of China (OSAC) 2019 (Yang et al. 2019).

Daoism

Although Daoism (*daojiao* 道教) is the only of the five major religions to be indigenous to China, few people in China explicitly identify as Daoist. In the 2007 Spiritual Life Survey of Chinese Residents, only about 1 percent self-identified as Daoists (about 11 million people). However, Daoist thought and practices underlie much of China's traditional religious and spiritual culture, contributing many elements to the more diffused folk religion. The transition to modern urban lifestyles has seen Daoism's role in traditional community life shrink dramatically, but estimates suggest that hundreds of millions still hold Daoist beliefs or perform Daoist practices. There were more than 9,000 Daoist temples in 2018 and about 40,000 Daoist clergy (P.R.C. State Council 2018). OSAC has records of about 4,900 Daoist sites, which stretch across country; however, fewer Daoist sites are in the northern and western regions of China (Yang et al. 2019). The distribution of Daoist sites across China are shown in Figure 7.

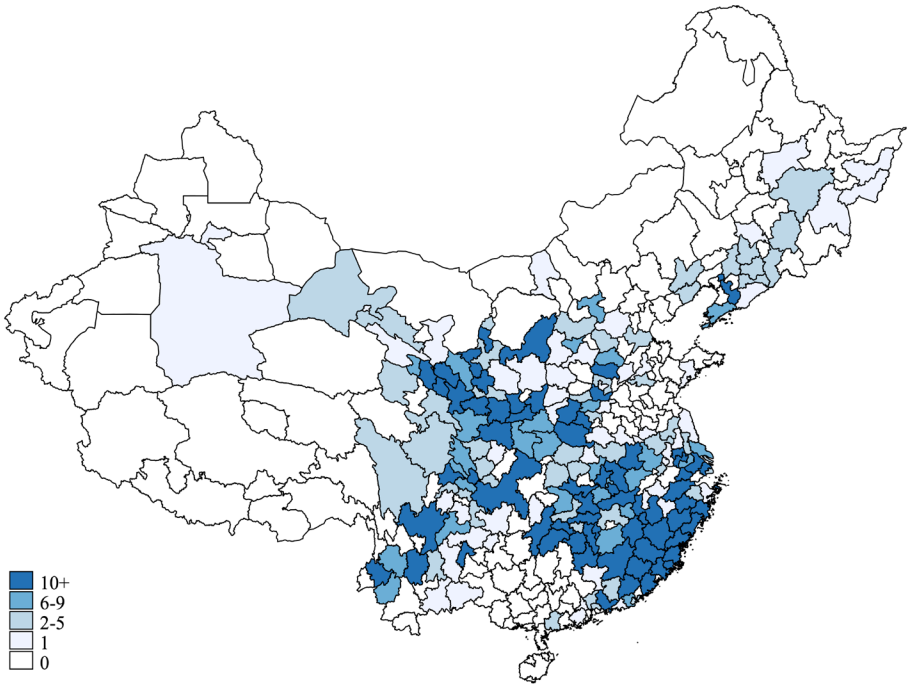

Figure 7. Number of Daoist sites in Chinese prefectures, 2004. Data: Online Spiritual Atlas of China (OSAC) 2019 (Yang et al. 2019).

Central to Daoism is the Dao, the mystical Way or Flow of Nature. Daoism emphasizes the unity and natural order of the universe, including a continuity between humans and nature. Achieving transcendence as an immortal by cultivating virtue and becoming united with the Dao is a major aim. Daoist rituals include offerings, reciting scriptures, and meditation. Rituals are performed by both priests and lay practitioners for a variety of purposes including giving thanks, exorcising demons, making supplications, communicating with ancestors, and burying loved ones. These rituals can involve singing, chanting, and dancing, purification, and reciting scriptures. Daoist self-cultivation and body cultivation practices which include meditation, breathing exercises, and physical movements are believed to promote health and longevity and are broadly popular (Yang 2018a). Traditional Chinese Medicine (TCM), traditional Chinese thought regarding health and illness, and Daoism share in their notions of *yin yang*, a complex dualistic concept in which two opposing but complementary forces comprise all aspects of life (Shih 1996; Xu and Yang 2009).

Islam

Estimates indicate that there are about 20 million followers of Islam (*yisilanjiao* 伊斯兰教) in China in 2018 (P.R.C. State Council 2018), less than 2 percent of China's population. There are 35,000 large and small mosques across the country which are served by 57,000 imams and other clerics (P.R.C. State Council 2018). The Online Spiritual Atlas of China (OSAC) records over 34,000 religious sites associated with Islam (Yang et al. 2019). More than 23,000 of these are in the provincial-level autonomous region of Xinjiang in northwest China. Figure 8 shows that most of the prefectures with large numbers of Muslim sites are in China's northwest region. In recent years, the Chinese party-state has launched harsh crackdowns on Muslims, particularly on the Uyghurs in Xinjiang, where authorities have employed mass detention and reeducation camps as well as surveillance measures to prevent extremism (Raza 2019).

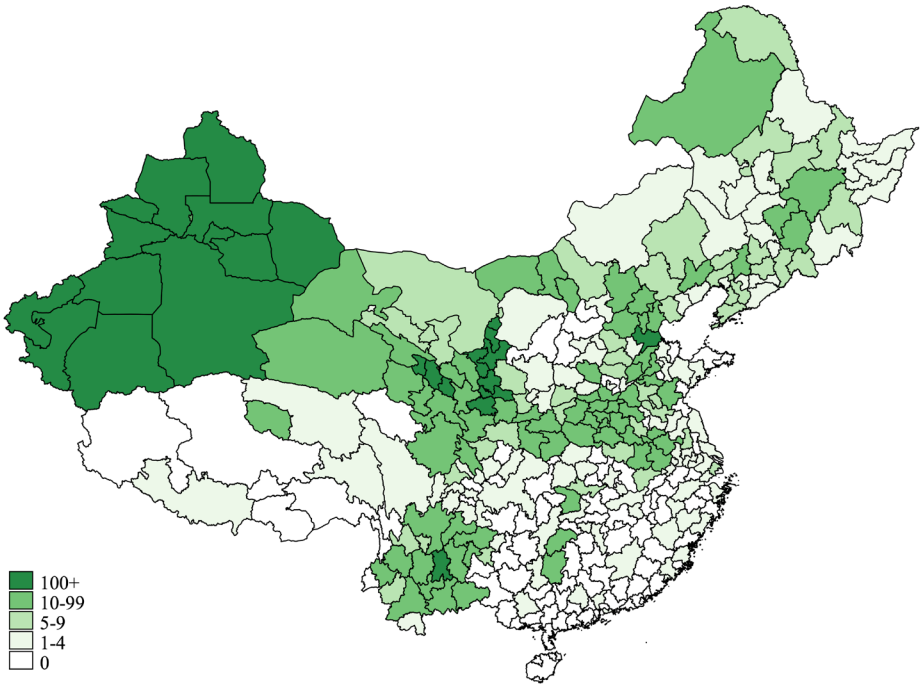

Figure 8. Number of Muslim sites in Chinese prefectures, 2004. Data: Online Spiritual Atlas of China (OSAC) 2019 (Yang et al. 2019).

Most Muslims in China belong to one of China's 55 ethnic minority groups, ten of which are traditionally identified as Muslim.[1] The majority of these Muslims belong to the Qadim tradition which is in the Sunni family of Islamic belief and practice (Yang 2018a). Muslims in China regard the Qur'an as Allah's sacred revelation to the prophet Muhammad, and they follow it for spiritual guidance and recite it during their 5 daily prayers. Like Muslims around the world, Chinese Muslims adhere to the Five Pillars of Islam: 1) professing the faith by affirming Allah as the only true God; 2) reciting prayers five times each day; 3) giving alms to the poor and needy; 4) fasting during the month of Ramadan; and 5) making the pilgrimage to Mecca. Chinese Muslims also regularly attend communal prayer gatherings on Fridays at local mosques where they hear teachings, worship Allah, and recite prayers. Most Muslims in China observe Islam's dietary laws, only consuming *halal* (*qingzhen* 清真) food and drink and avoiding pork and alcohol (Sai, Fischer, and Bergeaud-Blackler 2015; Wu, Yang, and Chiu 2014). Smoking is also strongly discouraged (Pan and Shallcross 2016).

[1] The ten ethnic minority groups that have traditionally following Islam include the Hui, Uyghur, Kazakh, Uzbeks, Kyrgyz, Tajik, Tatar, Salar, Bonan, and Dongxiang.

Protestantism

Official statistics from 2018 reported that there are 38 million followers of Protestant Christianity (*jidujiao* 基督教) in China (P.R.C. State Council 2018). Independent estimates, however, suggest that there were as many as 60 or 80 million Protestants in 2011 (Asia Harvest 2011; Pew Research Center 2011). These figures are difficult to obtain with much confidence and precision due to the tens of millions of Chinese Protestants that gather in unregistered churches and faith communities. In 2018, there were 60,000 official Protestant churches, the majority of which began after 1979[2] and 57,000 clergy (P.R.C. State Council 2018). Nearly 14,500 officially registered Protestant sites are recorded in OSAC (Yang et al. 2019), with greater densities of Protestant churches in northeast, central, and southeast China (see Figure 9). The beliefs and practices of Protestants in China are similar to Protestants in other parts of the world. They believe in a creator God and in Jesus Christ who offers forgiveness of sin and eternal salvation. They study and follow the teachings of the Bible, communicate with God through prayer, attend congregational worship services, and evangelize others. Both baptism and communion rituals are important aspects of the Protestant practice in China.

[2] This figure also includes registered meeting points where individuals gather for Protestant activities under the guidance of a church and its pastoral staff.

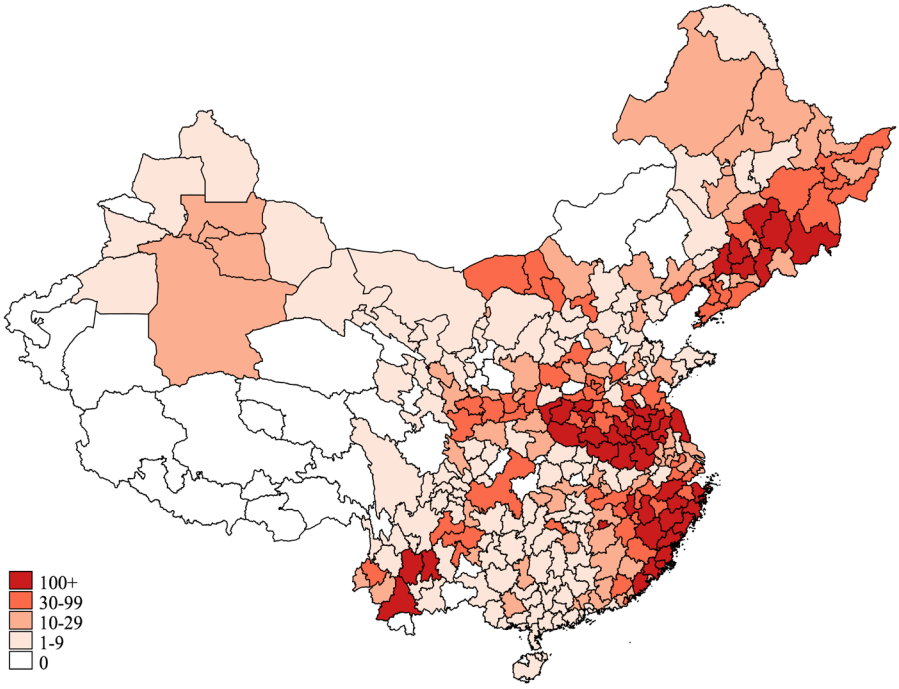

Figure 9. Number of Protestant sites in Chinese prefectures, 2004. Data: Online Spiritual Atlas of China (OSAC) 2019 (Yang et al. 2019).

Folk Religion

Folk religion or popular religion (*minjian zongjiao* 民间宗教) is a broad, less organized category of traditional religious beliefs and practices that are widespread and diffused throughout Chinese culture and society. There is great variation in folk religious beliefs and practices across China, but in general folk religion includes elements such as ancestor worship, shamanism, divination, beliefs in gods and ghosts, sacrificial rituals, and temple worship of local deities but can also draw from the beliefs and practices of Buddhism (i.e., karma and reincarnation), Daoism (i.e., geomancy, yin-yang), and Confucianism (i.e., filial piety). In recent Chinese history, much of Chinese folk religion has been regarded as superstition; and despite being prevalent all over China, folk religion is not officially recognized as a religion. Estimates based on the 2007 Spiritual Life Survey of Chinese Residents (SLSC) suggest that about 578 million people in China (55.5 percent) are practice or believe Chinese folk religion, many of whom may also identify with other religions like Buddhism and Daoism (Yang and Hu 2012:514).

Confucianism

Although Confucianism (*ruxue* 儒学 or *rujiao* 儒教) is not officially recognized as a religion in China, aspects of Confucianism's philosophy and ritual practices are religious in nature. Temple worship of Confucius and ancestor worship are among the most practiced rituals, and ancestor worship or ancestor veneration is widely practiced throughout China and among adherents from all different religions. Rooted in the teachings of Confucius (Kongzi 孔子, 551–479 BCE) and his followers, the basic tenets of Confucianism, are the "three cardinal guides and the five constant virtues" (*sangang wuchang* 三纲五常). The three cardinal guides are that a ruler should guide their subjects, a father should guide his children, and a husband should guide his wife, and the five constant virtues are benevolence, righteousness, propriety, wisdom, and fidelity (*renyilizhixin* 仁义礼智信).

Religious Regulation in China

Religion in China is heavily controlled. According to the Government Restrictions Index (GRI), China is among the countries with the most restrictive laws and policies toward religious freedom, the most limits on religious activities of religious groups and individuals, and the highest levels of government harassment of religious groups (Pew Research Center 2019). Additionally, China has a moderate level of social hostility toward religion with a social hostility index (SHI) in the top 40% of countries (Pew Research Center 2019). Because Buddhism and Daoism are traditional Chinese religions, they are viewed as more concordant with the overall socio-cultural environment of Chinese society and are more tolerated by the party-state. Protestantism, Catholicism, and Islam are commonly characterized as "foreign religions" and less concordant with traditional Chinese society. The modern Chinese party-state has recently been less tolerant of Protestant, Catholic, and Muslim religion (e.g., Leung and Wang 2016; Raza 2019; Yang 2018b). Prior research has shown that the positive associations found between personal religiosity and well-being depends on the level of government restrictions on religion and the overall religious climate (Elliott and Hayward 2009; Hayward and Elliott 2014). As a society with very limited freedoms of religion and with active suppression of religious activity, China is a particularly useful case (and comparison with the U.S.) for examining how local religious environments impact health under these conditions. And because some religious groups in China are targeted more than others

(Leung and Wang 2016; Palmer 2007; Raza 2019; Yang 2018), China's restrictive political environment may impact the ecological effects of some religions more than others. Findings from this study may be applicable to other societies that heavily restrict religion, particularly communist societies that impose state-sponsored atheism.

CHAPTER 3: THE LOCAL RELIGIOUS ENVIRONMENT AND POPULATION MORTALITY IN CHINA

Introduction

Understanding variation in mortality across a population has been a major goal of epidemiologists and demographers (e.g., Blazer 1982; Cutler, Deaton, and Lleras-Muney 2006; Manton 1982). In recent decades, the "social determinants of health" movement has demonstrated that characteristics of the local social environment such as socioeconomic resources, education quality, access to health care, and neighborhood conditions affect the health of the people living there (Link and Phelan 1995; Mair, Diez Roux, and Galea 2008; Diez Roux and Mair 2010; Sellström and Bremberg 2006; Yen, Michael, and Perdue 2009). However, despite the known associations between individual-level religiosity and mortality risk (e.g., Jarvis and Northcott 1987; McCullough et al. 2000; Oman and Reed 1998), only a few studies—mostly based in the U.S.—have examined how characteristics of the local religious environment impact mortality (e.g., Blanchard et al. 2008; Dwyer, Clarke, and Miller 1990; Garcia, Bartkowski, and Xu 2017). This study aims to expand our understanding of the ecological effects of religion on mortality by extending this area of research to mainland China: How is the religious environment of local geographic areas in China associated with population mortality rates and do these associations depend on the spatial scale of the religious environment?

Background

Since the 1970s, the mortality rate of China has remained between about 6 and 7 deaths per 1,000 people (National Bureau of Statistics of China 2018). Prior to the founding of the People's Republic of China in 1949, the mortality rate in China was between 25 and 33 deaths per 1,000 (Fang 1993); and, except for the years of the Great Chinese Famine (1959-1961), mortality quickly declined during China's socialist transformation between 1949 and the late 1970s (see Figure 10). Despite these reductions, China's mortality rate is projected to increase to about 14.5 deaths per 1,000 over the next half century, largely due to its aging population and rapid urbanization (United Nations 2019, 163).

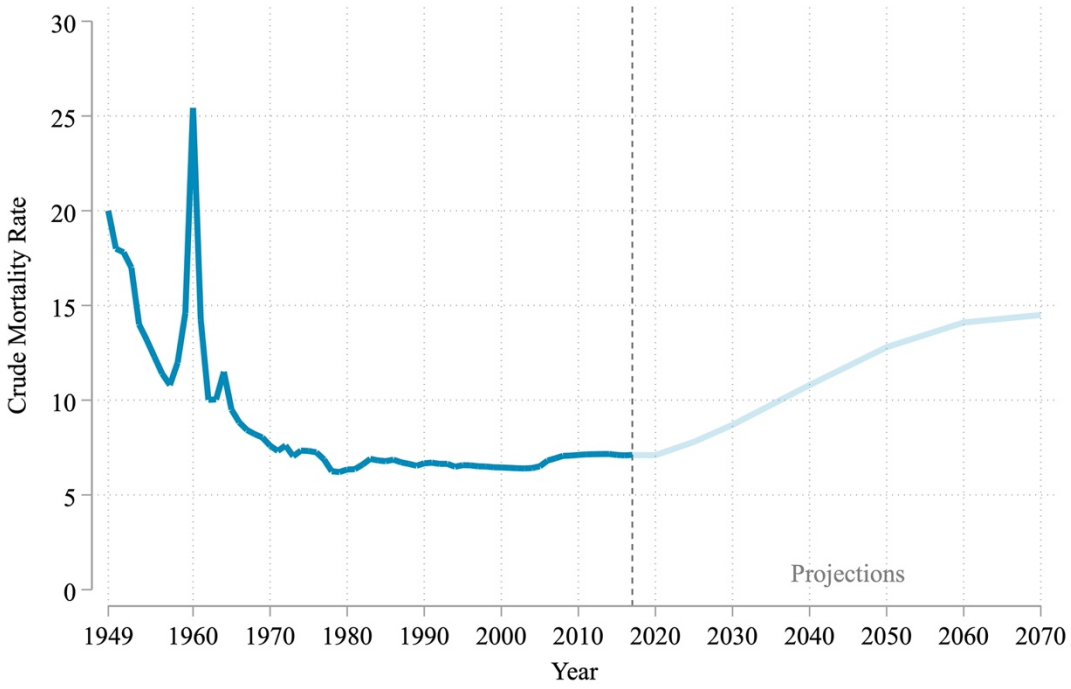

Figure 10. All-cause mortality rate and projections in China from 1949-2070. Data: China Statistical Yearbook 1983 & 2018 (National Bureau of Statistics of China 1983, 2018) & World Population Prospects 2019, Volume I: Comprehensive Tables (United Nations 2019)

Today, the leading causes of mortality in China are strokes, heart disease, cancer, chronic obstructive pulmonary disease (COPD), and accidental injury (Zhou et al. 2019; Zhu et al. 2019). Estimates from 2017 indicate that strokes caused 1.59 deaths per 1,000 people and heart disease caused 1.24 deaths per 1,000 people (Zhou et al. 2019). The leading individual risk factors contributing to mortality and morbidity in China are high blood pressure, smoking, high-sodium diet, and particulate matter air pollution (Zhou et al. 2019). In 2017, high blood pressure accounted for more than 2.5 million deaths, smoking for more than 2.25 million deaths, high-sodium diet for more than 1.7 million deaths, and air pollution for more than 1.1 million deaths (Zhou et al. 2019). In addition, social factors such as low income/wealth (Yang, Martikainen, and Silventoinen 2016), low education (Luo, Zhang, and Gu 2015; Zhou et al. 2019; Zhu and Xie 2007), non-Han ethnicity (Li, Luo, and Klerk 2008; Ren et al. 2017; Yusuf and Byrnes 1994), unmarried marital status (Poston and Min 2008; Sun and Liu 2008) and lack of social relationships (Liang et al. 2000; Luo and Waite 2014; Sun and Liu 2008) are also significant mortality risks in mainland China. Geographical variation in Chinese mortality rates has also been well documented (e.g., Fang 1993).

Prior research shows that aspects of the community environment such as socioeconomic inequality (Banister and Zhang 2005; Fang et al. 2010; Wang et al. 2019; Yu and Zhang 2020; Zhao 2006; Zimmer, Kaneda, and Spess 2007), availability and utilization of healthcare resources (Fang et al. 2010; Li et al. 2018; Pan and Shallcross 2016; Zhang and Zhang 2017; Zhao 2006), education levels (Banister and Zhang 2005; Zhou et al. 2019), community resources (Zimmer, Kaneda, and Spess 2007), ethnic minority population (Hannum and Wang 2010) and rural-urban status (Banister and Zhang 2005; Yu and Zhang 2020) contribute to these geographic disparities.

Variation in the religious social environment across China may also be a factor related to differences in mortality rates. Previous research—mostly in the U.S.—has shown that the denominational composition of counties is associated with cancer mortality (Dwyer, Clarke, and Miller 1990), infant mortality (Bartkowski, Xu, and Garcia 2011; Garcia, Bartkowski, and Xu 2017; Liczbińska 2011), and all-cause mortality (Blanchard et al. 2008; Jaffe et al. 2005). To date, no published studies have examined the *ecological* effects of religion on mortality in mainland China, and the limited research in China on *individual* religion and its associations with health and mortality has produced mixed results. Religious involvement in mainland China is found to be associated with lower mortality and better physical health but worse mental health. Several research studies demonstrate that religious participation is associated with decreased risk of dying in older adults (Zeng, Gu, and George 2011; Zhang 2008), and older adults who participate in religious activities also report better physical health (Yi, Gu, and Land 2007). In the general population, one study indicates that Buddhists, Protestants, and individuals who indicate that religion is "very important" in their lives have better self-rated health (Zhang et al. 2020), whereas another study found no associations (Kim and Chung 2019). Religious affiliation and higher levels of religiosity are positively associated with mental health disorders (Wang et al. 2015), psychological distress (Wang et al. 2016), and reduced subjective well-being (Brown and Tierney 2009). The negative mental health effects of religious involvement may be due to China's harsh political environment in which religion is actively suppressed by strict state regulations (Brown and Tierney 2009; Cheung and Leung 2007).

Hypotheses

Because of the lack of research on religious geography and mortality in China, this study is primarily exploratory in nature. Instead of testing hypotheses of specific theories developed from

prior studies in Western societies, I list only several general expectations below. Drawing on theoretical, conceptual, and empirical insights from socio-ecological approaches to health, ecological studies of religion, studies of associations between religion and health, and studies of religion in Chinese society (outlined in Chapter 2), I developed a series of potential explanations for the range of possible findings this study may produce, both for the mortality effects of the overall religious environment of local areas and the mortality effects of each separate religion. For the findings produced by these analyses, I refer to and elaborate on these potential explanations in the discussion section. In the following paragraphs, I outline some general expectations.

First, due to religion's overall association with better health for older adults (e.g., Krause 2002, 2008; Zhang, Hannum, and Wang 2008), the role of religion in providing social resources (i.e., social support, social interaction) (Chatters 2000; Cohen 2004; Ellison and George 1994; Ferraro and Koch 1994; George, Ellison, and Larson 2002; Yeary et al. 2012), and the positive health behaviors associated with religion (Chatters 2000; Ellison and Levin 1998; George, Ellison, and Larson 2002), I expect that local geographic areas with a greater overall presence of religion will be associated with better health outcomes and thereby lower mortality rates. Because of considerable differences between the various religions in China, it may be more likely that some religious groups have a greater ecological impact on individual health than others. For example, congregational religions such as Protestantism, Catholicism, and Islam may have a unique ability to provide social resources that extend beyond adherents to other community members. Or perhaps Buddhism and Daoism, which are generally regarded as "traditional Chinese religions," have greater ecological influences on health because of how well integrated they are into the broader Chinese culture or because of their associations with a special diet (e.g., vegetarianism), embodied practices (e.g., internal alchemy, *qigong*), herbal remedies.

Conversely, prior studies have shown that religion is associated with worse health in societies with less religious freedom (e.g., Elliott and Hayward 2009; Hayward and Elliott 2014). Therefore, local geographic areas with a greater presence of religion may experience worse mortality rates due to higher levels of stress. Government regulations on religions vary greatly across religious groups. Given that Catholicism and Protestantism, for example, have been specifically targeted by

Chinese government policies on religion, local areas with a greater presence of these religious groups may experience detrimental health effects and consequently higher mortality rates.[3]

The ecological effects of religion on mortality may, however, differ by the spatial scale of local areas under examination. Does the religious environment of Chinese counties or prefectures matter more for the mortality of the people living in them?[4] Given that social networks play an important role in the theoretical casual chain that links the religious environment to health and mortality and that social networks tend to be denser in smaller geographic areas (McPherson, Smith-Lovin, and Cook 2001), the religious features of Chinese counties—which are smaller administrative divisions and spatial units than prefectures—may have a stronger influence on mortality rates. Alternatively, because government policies related to religion play a major role in the experience and practice of religion in China, Chinese prefectures—which exercise greater administrative power than counties—may have a stronger structural influence on mortality rates.

Data & Methods

Data

To test these hypotheses, I created two datasets—one for Chinese prefectures and one for Chinese counties—constructed by merging data from the Online Spiritual Atlas of China (OSAC) (Yang et al. 2019) and the 2000 China Population Census. For this study, I compare Chinese prefectures and counties as the primary units of analysis. Correspondingly, the first data set includes data aggregated at the county level and the second data set includes data aggregated at the prefecture level.

The Online Spiritual Atlas of China (OSAC) is a project of the Center on Religion and the Global East (CRGE)[5] at Purdue University that cleaned, verified, and labeled information collected during China's 2004 Economic Census for 72,887 officially registered religious sites in 2,871 Chinese counties (or county-level cities and urban districts) nested in 336 prefectures (or

[3] The harsh government crackdowns on Uyghurs (2014-present) have taken place more recently than when the data used in this study were collected (2000 and 2004). Between 1976 and the beginning of the Xi Jinping era (2012-present), government policies toward Islam and traditionally Muslim people groups (e.g., Uyghurs) were quite relaxed, and Muslim adherents enjoy considerable freedom.

[4] There are five basic administrative levels of local government in China. From largest to smallest, the nested levels are province, prefecture, county, township, and village.

[5] Formerly the Center on Religion and Chinese Society (CRCS).

prefecture-level cities or urban districts) (Yang et al. 2019). The 2004 census recorded the name, location, leader's name, number of employees, and reported annual revenue of each religious site. Using this information, a CRGE research team geocoded the religious sites and categorized them as Buddhist, Catholic, Daoist, Muslim, or Protestant.[6] Table 1 presents the distribution of religious sites by religion in China. The majority of these sites are temples, churches, mosques, and shrines, and a few are administrative facilities, training centers, or schools. Thirty-nine sites were determined to be governmental administrative offices for religion and are therefore excluded from these analyses, as well as sites in areas for which there was no available data on mortality rates or other demographic characteristics. One limitation of these data is that the 2004 China Economic Census did not include all of China's religious sites, either because they are not registered (e.g., Protestant and Catholic "house" churches) or because they failed to meet the economic criterion (e.g., annual revenue minimum) to be counted in this economic census by the State Statistics Bureau of China. Despite this limitation, the distribution pattern of the religious sites included in the OSAC appears to accurately represent China's religious landscape and is consistent with the ethnographic observations of many scholars.

Table 1. Number of religious sites for the five official religions in China, 2004.

Religion	Number of Sites
Buddhism	16,588
Catholicism	2,408
Daoism	4,907
Islam	34,305
Protestantism	14,447
Total	72,665

Data: Online Spiritual Atlas of China (OSAC) (Yang et al. 2019).

The 2000 China Population Census gathered information on all Chinese citizens and published aggregated socio-demographic information by province, prefecture, and county. The data from OSAC and the 2000 China Population Census were merged using county and prefecture GB (*guobiao* 国标) codes, China's national standard for identifying administrative units. The units of analysis in this study are individual prefectures and counties; however, given that neither

[6] Sites associated with folk religion were categorized as Daoist by the OSAC research team.

mortality rates nor the numbers of religious sites are likely to have changed considerably in the years between 2000 (the year of the census) and 2004 (the year in which the OSAC data was collected), the concern that possible unmeasured changes between 2000 and 2004 introduce bias into the associations is minimal. In addition, these analyses include gross domestic product information (GDP) for Chinese counties and prefectures from the *Statistic Materials of Public Finance of Cities and Counties* report (2004).

Variables

The dependent variables in these analyses are the all-cause crude mortality rates per 1,000 people from the 2000 China Population Census at the county and prefecture levels.

The focal independent variables in these analyses represent the religious environment of Chinese counties/prefectures, which is operationalized as the presence of religion in Chinese counties/prefectures and measured both by the total number of religious sites for all religions per 100,000 people and the number of religious sites (i.e., temples, mosques, and churches) per 100,000 people for each of China's five official religions (Buddhism, Catholicism, Daoism, Islam, and Protestantism) from the Online Spiritual Atlas of China (OSAC). Most prior research examining religious ecology has used the number of adherents for different religious groups as the primary measure of the religious ecology of local geographic areas (e.g., Beyerlein and Hipp 2005; Dwyer, Clarke, and Miller 1990; Olson 2019). Counting religious believers in China has been notoriously difficult, and presently, reliable and precise figures at any geographic level (i.e., national, provincial, county) do not exist. Following other studies of religious ecology, these analyses will instead use religious sites to represent the religious environment and include a separate variable with the number of religious sites in counties/prefectures for each of the five major religious groups (Bartkowski, Xu, and Garcia 2011; Blanchard et al. 2008; Tong, Sennott, and Yang 2021). Figure 11 and Figure 12 map the religion with the most sites per 100,000 people in each Chinese county and prefecture.

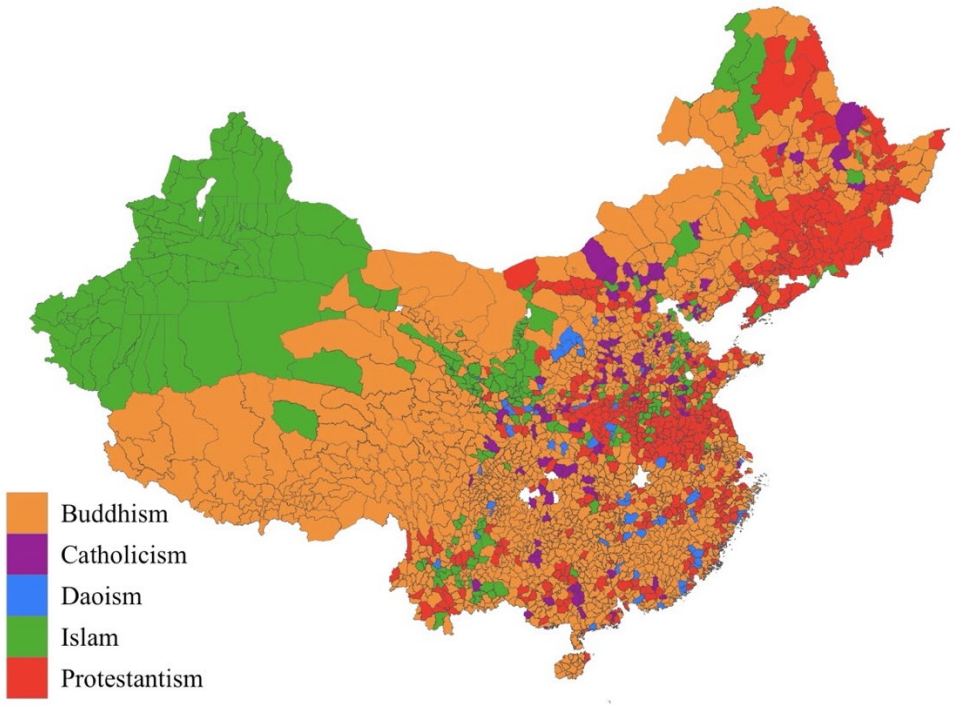

Figure 11. Religion with the most sites per 100,000 people in Chinese counties, 2004.

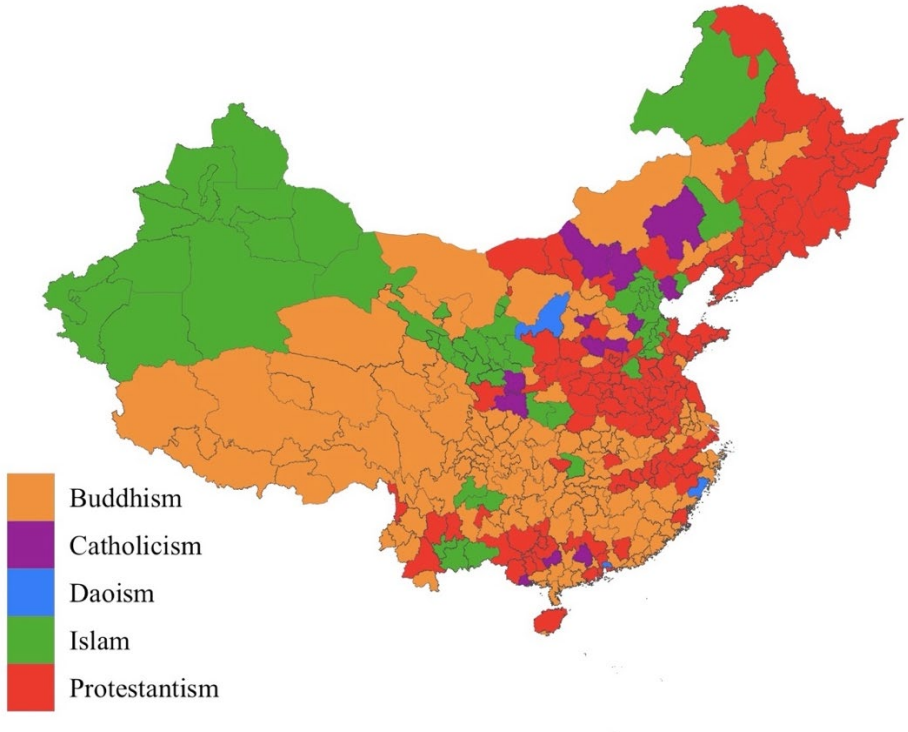

Figure 12. Religion with the most sites per 100,000 people in Chinese prefectures, 2004.

I also include a selection of county- and prefecture-level control variables in the analysis models. Gross domestic product (GDP) as a measure of economic development is included to account for area differences in wealth and income inequality that impact health, access to health care, and mortality in China (Li and Zhu 2008; Yu and Zhang 2020; Zhao 2006) and that may also be related to the religious environment. Logged GDP per capita is included as a measure of economic development, and percent with a high school education or above is included as a measure of education level to account for variation in educational level across areas (Zhang and Kanbur 2005) and the association between education and health in China (Xie and Mo 2014). I include percent of the population under the age of 5 and the percent above the age of 65 as measures of the age structure, as associations between religion and health have been found specifically in older Chinese adults (Brown and Tierney 2009; Zhang, Hannum, and Wang 2008). I include percent urban to account for known health and health care disparities between China's urban and rural population (Fang, Chen, and Rizzo 2009; Sun et al. 2011; World Health Organization 2000; Meng et al. 2015) and between geographic regions (Fang et al. 2010). I also include a measure for county/prefecture logged total population size.

In addition, I also include the presence of ethnic minority groups in counties/prefectures. Ethnicity is a potential confounder in the relationship between the religious environment and area mortality rates. Because religion is closely tied to ethnicity in China—especially for Tibetan Buddhism and Islam, possible associations between the religious environment and mortality rates might be due to a common association with the percentage of the population belonging to various ethnic minority groups. Several China-based studies show variation in health outcomes among ethnic minority groups in China (Li, Luo, and Klerk 2008; Ouyang and Pinstrup-Andersen 2012). In addition, mortality rates may also be a product of the age structure of the population. China's One-Child Policy (1979-2015), which primarily limited parents of Han ethnicity living in urban areas to having only one child, was not enforced among ethnic minority populations who were allowed to have at least two children. By consequence the age structure of ethnic minority groups in contemporary China has trended younger than that of the Han majority; however, mortality rates tend to be higher among ethnic minority populations than among Han even after adjusting for age (Yusuf and Byrnes 1994). To address the potential for the presence of ethnic populations to confound these relationships, I include variables measuring the percent of the country/prefecture population that is Han as well as the percent that is Tibetan or Mongolian (both of which are

traditionally adherents of Tibetan Buddhism) and the percent that is Hui, Uyghur, Kazak, or Kyrgyz (all of which are traditionally adherents of Islam).

The merged county-level dataset has partial information for 2,876 Chinese counties. Counties with missing data for any of the analysis variables are dropped using list-wise deletion for a final analysis sample size of 2,750. At the prefecture-level, information was available for all 343 Chinese prefectures or prefecture-level administrative divisions. Also, Taiwan, Hong Kong, and Macau are not included in these analyses, as information for these areas is not included in either the 2000 Chinese Population Census or the 2004 Economic Census (from which the OSAC dataset is derived).

Analytic Strategy

Defining the Context

The spatial scale, definition of geographic areas, and the operationalization of local contexts are important considerations for investigations of area effects on population health (Diez Roux 2001; Kwan 2012; Macintyre, Ellaway, and Cummins 2002; Riva et al. 2009; Diez Roux and Mair 2010; Spielman and Yoo 2009). Studies show that area effects on health are sensitive to the measurement scale of the context under investigation (i.e., the size of areas and the location of are boundaries) (Riva et al. 2009; Root 2012; Spielman and Yoo 2009). Both the *modifiable areal unit problem* (MAUP)—which describes the unpredictability of estimates as the scale and aggregation pattern of a given area changes (Fotheringham and Wong 1991; Openshaw 1977; Spielman and Yoo 2009)—and similarly, the *uncertain geographic context problem* (UGCoP)—which describes the variation in estimates due to "the spatial uncertainty in the actual areas that exert the contextual influences under study" are of concern (Kwan 2012: 958).

In addition, some social contexts do not have geographical boundaries and cannot be well-defined geographically (Diez Roux 2001; Macintyre, Ellaway, and Cummins 2002). Social life often extends beyond administrative areas (e.g., census tracts, counties), across the boundaries of contextual units (e.g., neighborhoods), and over time (Cummins 2007; Basta, Richmond, and Wiebe 2010; Vallée et al. 2010; Kwan 2018). The "true causally relevant" contextual unit, particularly in studies of health, is usually unknown (Diez Roux 2001: 134), and often the geographic scale at which we have the observed data (i.e., religious sites and mortality rates in

counties/prefectures) may not be the scale at which social processes operate. Defining the spatial context should primarily be guided by proposed causal explanations and theoretical arguments (Macintyre, Ellaway, and Cummins 2002; Diez Roux 2001).

In the case of the religious environment in China, the county and prefecture administrative divisions in the government system both hold state power and have a degree of autonomy both in making and enforcing state policy. Between the beginning of China's reform era in 1978 to the early 2000s, the prefecture level of government has gained considerable political and economic power. Most former prefectures—which were primarily dispatch offices to implement provincial policies—were converted to prefecture-level municipalities, subsuming counties and becoming "the core of the country's economic growth" (Donaldson 2017: 115). Although counties continued to play an important role in implementing policy, much of the policymaking, particularly economic policy but also religion policy, is happening at the prefecture level. Whether the religious environment is impacted more by county-level policy implementation or prefecture-level policymaking may determine whether the ecological effects of religion on health and mortality are greater at the county or prefecture level. To determine whether the religious environment impacts mortality rates differently at the prefecture and county levels in this study, I conduct two separate analyses, one with county-level measures for all variables and one with prefecture-level measures for all variables.[7]

Modeling Strategy

For this study, I first produce descriptive statistics to examine the county- and prefecture-level data, and I map the county/prefecture mortality rates to show its spatial distribution. Next, I conduct exploratory spatial data analysis (ESDA) to examine whether there is spatial autocorrelation (or spatial dependence), which in this case is the systematic spatial variation of mortality rates due to either social or natural factors (Legendre 1993). In other words, is there clustering of mortality rates across Chinese counties/prefectures in which "groups" of counties/prefectures have more similar mortality rates. To measure the spatial relationships between counties/prefectures, I use a first-order contiguity spatial weight matrix (or queen's

[7] Because the county-level administrative division in China is subsumed by the prefecture-level division, analyses to determine which spatial scale matters most for mortality rates will compare whether the larger division (prefecture) or its constituent parts (counties) is the most relevant scale for how the religious environment influences mortality rates.

contiguity matrix), which specifies counties/prefectures that share a common border as contiguous and, therefore, more likely to be related to one another than counties/prefectures that do not share a border (Anselin and Rey 2014). Then, I formally test for both general and local spatial autocorrelation at the county and prefecture levels (Anselin 1995). More specifically, I use the Global Moran's *I* to examine the overall clustering pattern in the data, and I use local Moran's *I* to identify and map the specific areas where clustering is present.

Then, I use linear regression models to begin examining associations between the religious environment and mortality rates—first using counties then using prefectures as the primary units of analysis. To test whether the *overall* religious environment is associated with mortality rates, I specify a set of models with the total number of religious sites as the focal independent variable, and to test whether each of China's five major religions differ in their association with mortality rates, I also specify a set of models with the number of religious sites for each religion as separate independent variables. For each set, I first regress mortality rates only on the religious environment variable(s) in linear regression models, which do not account for spatial dependencies. If spatial autocorrelation exists in the residuals of these models, however, they violate the regression assumption that the errors of individual observations are independent.

To adjust for the spatial autocorrelation in the data, I then specify spatial regression models. The spatial clustering of data can be due to either an autoregressive process of spatial diffusion—in which a characteristic in one area "spills over" into and influences another area—or to a process of spatial heterogeneity—in which there are influential characteristics that vary across regions (Anselin 2001). I use the Lagrange Multiplier (LM) test to aid in choosing which type of spatial regression model is most appropriate for these data. The LM test provides evidence in choosing between the spatial error model (SEM), which treats the autocorrelation of errors as a nuisance, and the spatial lag model (or spatial autoregressive model, SAR), which treats spatial patterns as evidence of a substantively meaningful spatial process in the outcome of interest (Anselin 2001; Anselin and Rey 1991). Based on the results of an LM test, my final models are SEM models with the following general equation

$$Y = \beta X + \lambda W \mu + \epsilon$$

in which λ (*lambda*) is the spatial error coefficient, W is the spatial weight matrix, μ is a spatially dependent error term, and ϵ is a vector of spatially uncorrelated error terms (Anselin and Rey 1991; Ward and Gleditsch 2018). This model represents the typical linear regression model but is complemented by the $\lambda W\mu$ term, which specifies the spatial structure that captures the spatial dependencies among the errors.

The second model in each set of analyses is a spatial regression model that only includes the religious environment independent variables. The third is a spatial regression model that adds demographic control variables, and the final model adds the percentage of the population belonging to a set of ethnic minority groups traditionally associated with Buddhism or Islam.

Results

Table 2 and Table 3 show descriptive statistics for all model variables at the county and prefecture levels. Based on the China Population Census in 2000, the mean number of deaths per 1,000 in 2000 was 6.02 at the county level and 5.85 at the prefecture level.

Although these independent variables were included to capture a range of relevant county- and prefecture-level characteristics, they are unsurprisingly correlated with one another. Therefore, I examine whether the inclusion of these variables introduces multicollinearity and influences the estimates. The final columns in Table 2 and Table 3 suggest that multicollinearity is not a major concern in these analyses, as none of the variance inflation factors (VIF) are particularly high (i.e., greater than 10) (Kutner, Nachtsheim, and Neter 2004).

Exploratory Spatial Data Analysis

The spatial distribution of county-level mortality rates is presented in Figure 13 and the spatial distribution of prefecture level mortality rates is presented in Figure 14. Both figures reveal that substantial spatial clustering of mortality rates exist among Chinese counties and prefectures. Notably, there are clusters of higher mortality rates in western, southwestern, and central China, and there are clusters of lower mortality rates in eastern, northwestern, and northeastern China.

Table 2. County-level variable descriptions and sample descriptive statistics (N = 2,750).

Variable	Description	Source	Mean	SD	Min.-Max.	VIF
Crude Mortality Rate	Number of deaths per 1,000 people	CPC 2000	6.02	1.45	0-12.24	–
Logged Total Religious Sites	Logged number of religious sites per 100,000 people	OSAC 2004	1.24	1.29	0-6.05	–
Logged Buddhist temples	Logged number of Buddhist sites per 100,000 people	OSAC 2004	0.62	0.98	0-5.18	3.22
Logged Catholic churches	Logged number of Catholic sites per 100,000 people	OSAC 2004	0.12	0.29	0-2.96	1.12
Logged Daoist temples	Logged number of Daoist sites per 100,000 people	OSAC 2004	0.15	0.42	0-4.94	1.63
Logged Islamic mosques	Logged number of Muslim sites per 100,000 people	OSAC 2004	0.35	0.97	0-6.05	5.00
Logged Protestant churches	Logged number of Protestant sites per 100,000 people	OSAC 2004	0.43	0.67	0-3.71	1.25
Logged GDP per capita	Logged GDP per capita (in 1,000 yuan)	CPC 2000	2.00	0.63	0.2-4.33	1.46
% Urban	Percentage of population living in an urban area	CPC 2000	36.61	30.68	0-100	3.01
Average Education Level	Mean years of education	CPC 2000	7.36	1.49	0.63-11.85	5.78
% Under Age 5	Percentage of population under 5 years of age	CPC 2000	5.90	1.84	0.19-14.39	2.36
% Over Age 65	Percentage of population over 65 years of age	CPC 2000	6.72	1.66	0.39-13.82	1.56
Logged Population	Logged Total 2000 Population	CPC 2000	12.64	0.90	6.25-14.72	1.87
% Han Ethnicity	Percentage of population – Han	CPC 2000	83.30	29.53	0.22-100	2.56
% Tibetan Ethnicity	Percentage of population – Tibetan	CPC 2000	4.42	19.32	0-99.72	4.33
% Mongolian Ethnicity	Percentage of population – Mongolian	CPC 2000	0.87	5.56	0-89.55	1.16
% Hui Ethnicity	Percentage of population – Hui	CPC 2000	1.20	5.23	0-96.88	2.35
% Uyghur Ethnicity	Percentage of population – Uyghur	CPC 2000	1.34	9.99	0-99.09	3.20
% Kazak Ethnicity	Percentage of population –Kazak	CPC 2000	0.39	4.06	0-75.61	1.31
% Kyrgyz Ethnicity	Percentage of population – Kyrgyz	CPC 2000	0.08	2.27	0-87.31	1.11

Table 3. Prefecture-level variable descriptions and sample descriptive statistics (N = 2,750).

Variable	Description	Source	Mean	SD	Min.-Max.	VIF
Crude Mortality Rate	Number of deaths per 1,000 people	CPC 2000	5.85	1.13	0.99-9.04	–
Logged Total Religious Sites	Logged number of religious sites per 100,000 people	OSAC 2004	1.44	1.17	0-5.83	–
Logged Buddhist temples	Logged number of Buddhist sites per 100,000 people	OSAC 2004	0.69	0.36	0-4.38	4.62
Logged Catholic churches	Logged number of Catholic sites per 100,000 people	OSAC 2004	0.15	0.22	0-2.96	1.28
Logged Daoist temples	Logged number of Daoist sites per 100,000 people	OSAC 2004	0.18	0.38	0-2.91	2.33
Logged Islamic mosques	Logged number of Muslim sites per 100,000 people	OSAC 2004	0.47	1.42	0-5.83	7.86
Logged Protestant churches	Logged number of Protestant sites per 100,000 people	OSAC 2004	0.56	0.61	0-2.72	1.41
Logged GDP per capita	Logged GDP per capita (in 1,000 yuan)	CPC 2000	0.70	0.31	–0.32-1.44	2.02
% Urban	Percentage of population living in an urban area	CPC 2000	36.88	19.09	7-100	3.71
Average Education Level	Mean years of education	CPC 2000	7.40	1.17	1.56-10.28	7.35
% Under Age 5	Percentage of population under 6 years of age	CPC 2000	5.88	1.66	2.91-11.64	2.57
% Over Age 65	Percentage of population over 65 years of age	CPC 2000	6.66	1.55	1.23-12.44	1.73
Logged Population	Logged Total 2000 Population	CPC 2000	14.80	0.88	11.25-16.62	2.31
% Han Ethnicity	Percentage of population - Han	CPC 2000	84.79	25.73	1.97-99.96	2.87
% Tibetan Ethnicity	Percentage of population – Tibetan	CPC 2000	3.61	16.60	0-97.54	5.26
% Mongolian Ethnicity	Percentage of population – Mongolian	CPC 2000	0.86	4.22	0-45.35	1.16
% Hui Ethnicity	Percentage of population – Hui	CPC 2000	1.36	4.59	0-47.66	3.93
% Uyghur Ethnicity	Percentage of population – Uyghur	CPC 2000	1.44	9.78	0-96.43	4.15
% Kazak Ethnicity	Percentage of population - Kazak	CPC 2000	0.32	3.17	0-51.38	1.38
% Kyrgyz Ethnicity	Percentage of population - Kyrgyz	CPC 2000	0.09	1.53	0-28.32	1.21

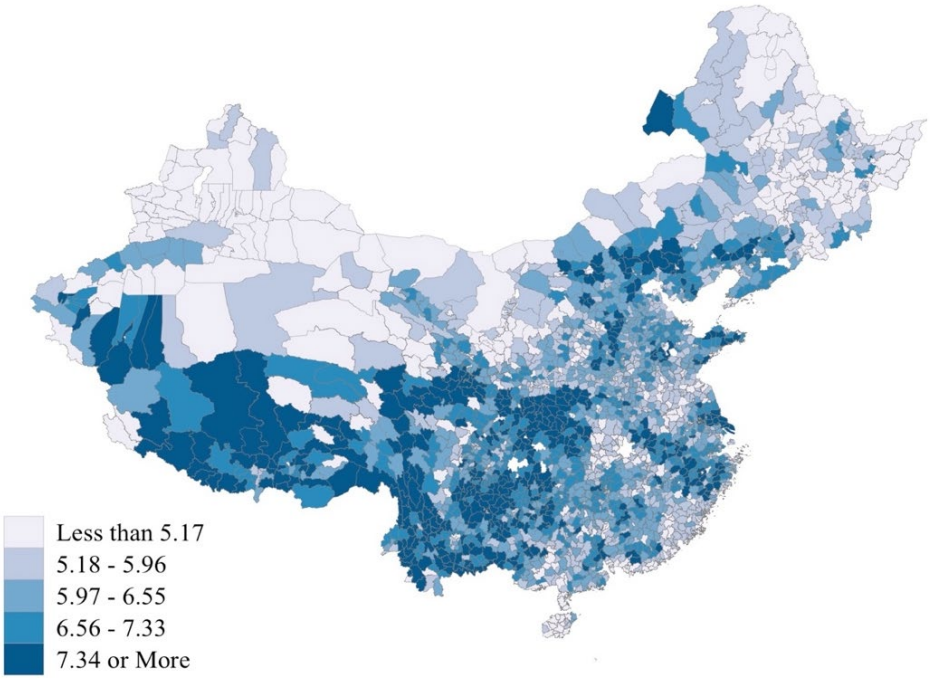

Figure 13. All-cause mortality rate per 1,000 people in Chinese counties, 2000 (color breaks signify quintiles).

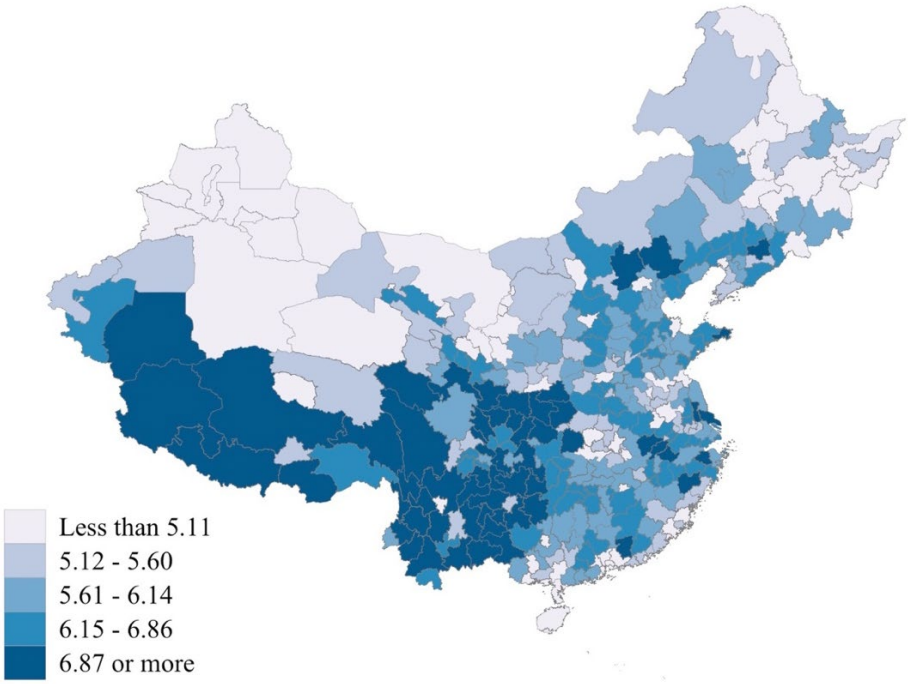

Figure 14. All-cause mortality rate per 1,000 people in Chinese prefectures, 2000 (color breaks signify quintiles).

To formally test for the presence of spatial autocorrelation (clustering of mortality rates) in these data, I calculated both global and local spatial autocorrelation statistics. The Global Moran's *I* statistic at the county level is .506 ($p < .001$), which confirms a statistically significant level of overall clustering for China's county mortality rates in 2000.[8] Similarly, the Global Moran's *I* statistic at the prefecture level is .500 ($p < .001$), which confirms a statistically significant level of overall clustering for China's prefecture mortality rates in 2000.

This positive spatial autocorrelation indicates that counties/prefectures with higher mortality rates neighbor counties/prefectures with higher mortality rates, and conversely that counties/prefectures with lower mortality rates neighbor counties/prefectures with lower mortality rates. Figure 15 and Figure 16 show counties and prefectures with significant local spatial autocorrelation (local Moran's *I*; $p < .05$). The maps in both figures show high-high clusters—where counties/prefectures with high mortality rates have neighbors with high mortality rates—as well as low-low clusters—where counties/prefectures with low mortality rates have neighbors with low mortality rates. More specifically, these high-high clusters are present among counties/prefectures in Tibet, southern Qinghai and Gansu, and in central China where contiguous areas of Shaanxi, Hubei, Sichuan, and Chongqing neighbor. Low-low clusters are present in Xinjiang, Inner Mongolia, and Ningxia, with several small clusters in the provinces of northeastern China and in Hainan. The presence of these significant spatial clusters indicates that there is some spatial process(es), whether natural or social, that plays an important role in shaping health and mortality in China. Furthermore, regressions models that do not adjust for these spatial dependencies are likely biased.

[8] The Moran's *I* statistic typically falls between –1 and 1. Positive values indicate positive spatial autocorrelation in which nearby areas are more like one another, whereas negative values indicate negative spatial autocorrelation in which there is significant spatial heterogeneity. Zero represents the presence of no spatial autocorrelation.

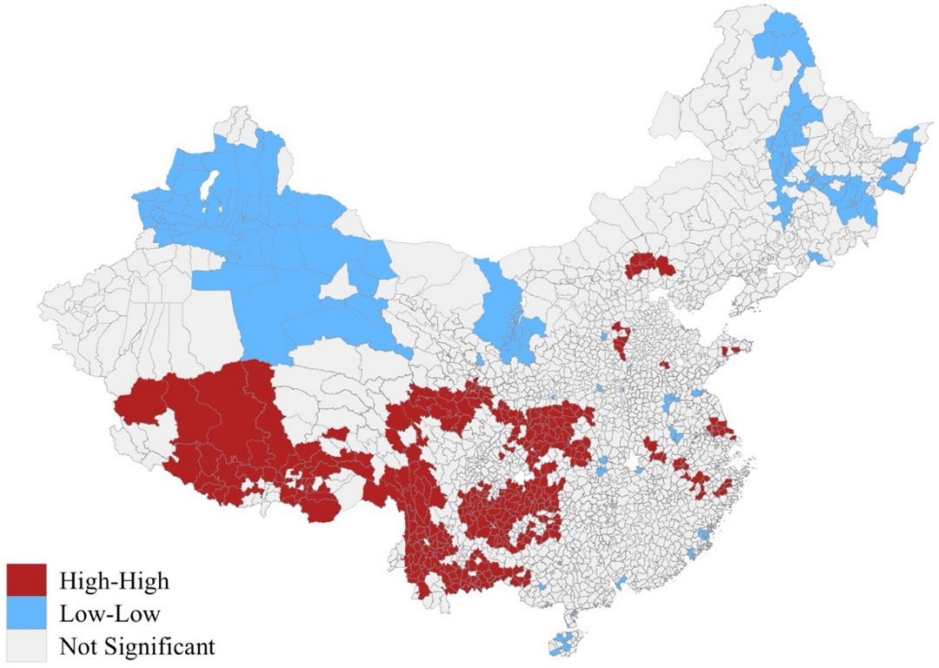

Figure 15. Map of local spatial autocorrelation in Chinese counties indicating high-high and low-low clusters as identified by local Moran's *I*.

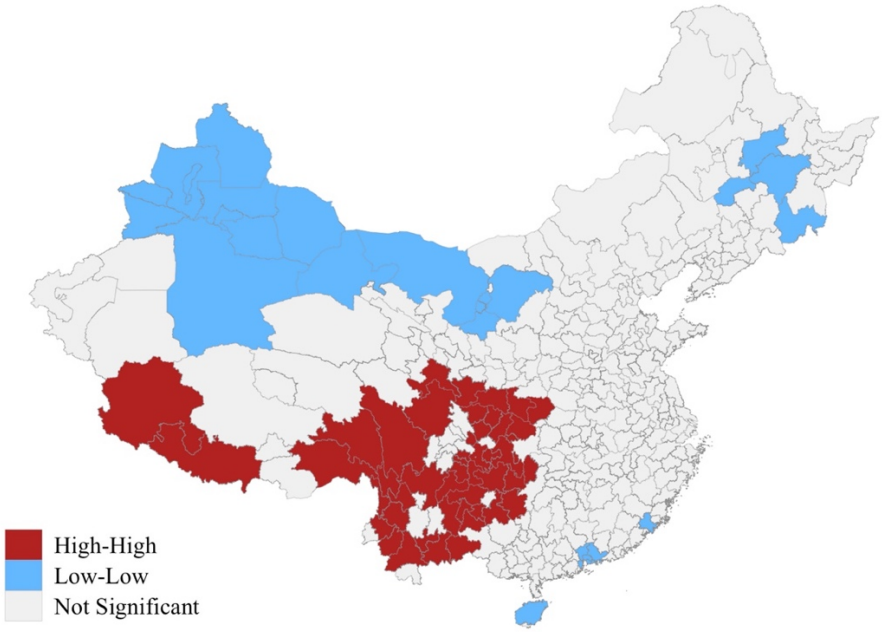

Figure 16. Map of local spatial autocorrelation in Chinese prefectures indicating high-high and low-low clusters as identified by local Moran's *I*.

Spatial Regression Analysis

Table 4 presents the results of the LM test for county-level and prefecture-level models that include all analysis variables. At the county level, as indicated by statistically significant test statistics for both the LM_{ERROR} (1,089.80, $p < 0.001$) and LM_{LAG} (552.88, $p < 0.001$) models, the LM test suggests that both spatial diffusion and spatial heterogeneity may be important factors responsible for the clustering of mortality rates. The Robust LM_{ERROR} model (538.56, $p <0.001$), however, produces a test statistic that is larger than the Robust LM_{LAG} model (1.58, p = n.s.), suggesting that spatial heterogeneity is the most important contributor to spatial clustering of county mortality rates and that the SEM model is preferred. Similarly at the prefecture level, as indicated by statistically significant test statistics for both the LM_{ERROR} (139.01, $p < 0.001$) and LM_{LAG} (53.29, $p < 0.001$) models, the LM test suggests that both spatial diffusion and spatial heterogeneity may be important factors responsible for the clustering of mortality rates. The Robust LM_{ERROR} model (85.79, $p < 0.001$) also produces a test statistic that is larger than the Robust LM_{LAG} model (0.07, p = n.s.), indicating that spatial heterogeneity is the most important contributor to spatial clustering of prefecture mortality rates and that the SEM model is also preferred at the prefecture. In summary, at both the county and prefecture levels, LM tests provide evidence that SEM models best account for the spatial dependencies in models of mortality rates in China.

Table 4. LM tests for spatial dependence for linear regression models with controls.

Test	df	County Level	Prefecture Level
LM_{ERROR}	1	1,089.80***	139.01***
LM_{LAG}	1	552.88***	53.29***
Robust LM_{ERROR}	1	538.56***	85.79***
Robust LM_{LAG}	1	1.58	0.07

Note: *** p < .001

Total Religious Sites

Table 5 and Table 6 show the results from regression models predicting county mortality rates by the total number of religious sites— aggregating across all religions—for counties and prefectures respectively. The first model is a linear regression model (+ Religious Environment) only includes a measure of the religious environment: total religious sites. At neither the county

or prefecture level is there a significant bivariate association between the overall religious environment and mortality rates. The second regression model in Table 5 and Table 6 (+ Spatial Error) are SEM models which account for the spatial autocorrelation discovered among the mortality rates of Chinese counties and prefectures using the Global and local Moran's *I* statistics. In these SEM models, the overall presence of religion is associated with higher mortality rates at the county level ($\beta = 0.082$, $p < 0.01$) but is not associated with mortality rates at the prefecture level ($\beta = -0.045$, p = n.s.). Lamba (λ), the spatial error coefficient, is 0.736 in counties and 0.700 in prefectures (both $p < 0.001$), which is further evidence of a significant level of spatial autocorrelation.

The third regression model in Table 5 and Table 6 (+ Controls) introduces the set of demographic control variables. After accounting for demographic characteristics in these SEM models, total religious sites in both counties and prefectures are associated with lower mortality rates. These models show that the overall presence of religion is associated with lower mortality at both the county ($\beta = -0.059$, $p < 0.001$) and prefecture levels ($\beta = -0.161$, $p < 0.001$). These results suggest that the effect of the overall religious environment on mortality rates may be greater in prefectures. In addition, all control variables have a statistically significant relationship with county-level mortality, but only percent over 65 and education level do in prefectures.

The final model in Table 5 and Table 6 (+ Ethnicity) include variables for the percentage of the county or prefecture population belonging to major ethnic minority groups traditionally associated with Tibetan Buddhism or Islam. After accounting for these ethnic populations, which may confound the relationship between the religious environment and mortality rates, these SEM models show that the overall presence of religion is associated with lower mortality rates at both the county ($\beta = -0.138$, $p < 0.01$) and prefecture levels ($\beta = -0.116$, $p < 0.05$).

To test whether this final model effectively accounts for spatial autocorrelation, I calculated a Global Moran's *I* statistic specifically for the residuals in these SEM models. The Global Moran's *I* of these residuals is –0.028 ($p < 0.05$) at the county level and –0.040 (p = n.s.) at the prefecture level, suggesting that these models are effective at accounting for nearly all the spatial autocorrelation (by reducing the Moran's *I* statistic to nearly zero in both instances). According to the Akaike information criterion (AIC), this final SEM is the best fitting model for both counties and prefectures, as it has the lowest value of the four models in each table (Akaike 1974). The R^2 values also improve to more than 0.72 in both.

Table 5. Regression estimates (total sites) for county-level mortality rates (N = 2,750).

	+ Religious Environment	+ Spatial Error	+ Controls	+ Ethnicity
Religious Environment				
Logged Total Sites	0.011	0.082**	–0.059***	–0.138**
	(0.022)	(0.026)	(0.018)	(0.049)
Control Variables				
Percent Urban			–0.010***	–0.008***
			(0.001)	(0.001)
Percent aged 65 or older			0.445***	0.460***
			(0.015)	(0.015)
Percent under 5			0.031^{+}	0.036*
			(0.018)	(0.018)
Mean Years of Education			–0.445***	–0.473***
			(0.028)	(0.030)
Logged Population			–0.172***	–0.147***
			(0.025)	(0.025)
Logged GDP per capita			–0.166***	–0.141***
			(0.039)	(0.039)
Country Ethnicity				
Percent Han				–0.008***
				(0.001)
Percent Tibetan				–0.009***
				(0.002)
Percent Mongolian				0.009*
				(0.004)
Percent Hui				–0.027***
				(0.004)
Percent Uyghur				0.010**
				(0.003)
Percent Kazak				0.005
				(0.006)
Percent Kyrgyz				0.010
				(0.007)
Constant	6.002***	5.683***	9.043***	9.346***
	(0.039)	(0.082)	(0.398)	(0.421)
Spatial Error (λ)		0.736***	0.652***	0.660***
Moran's I	0.504***			
Pseudo–R^2	0.054	0.392	0.710	0.723
Log Likelihood	–4,883.108	–4,250.305	–3,227.766	–3,139.087
Akaike Inf. Crit.	9,772.215	8,508.610	6,475.531	6,312.173
Wald Test (df = 1)		2,320.995***	1,304.005***	1,370.242***
LR Test (df = 1)		1,360.296***	866.973***	831.592***

Note: + p < .10; * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

Table 6. Regression estimates (total sites) for prefecture-level mortality rates (N = 343).

	+ Religious Environment	+ Spatial Error	+ Controls	+ Ethnicity
Religious Environment				
Logged Total Sites	–0.060	–0.045	–0.161***	–0.116*
	(0.052)	(0.065)	(0.043)	(0.047)
Control Variables				
Percent Urban			–0.006^{+}	–0.003
			(0.003)	(0.003)
Percent aged 65 or older			0.377***	0.393***
			(0.033)	(0.032)
Percent under 5			0.044	0.057*
			(0.038)	(0.038)
Mean Years of Education			–0.517***	–0.570***
			(0.067)	(0.077)
Logged Population			0.013	0.024
			(0.050)	(0.049)
Logged GDP per capita			–0.128^{+}	–0.093
			(0.076)	(0.074)
Country Ethnicity				
Percent Han				–0.010***
				(0.002)
Percent Tibetan				–0.016***
				(0.004)
Percent Mongolian				–0.010
				(0.009)
Percent Hui				–0.029***
				(0.009)
Percent Uyghur				0.006
				(0.007)
Percent Kazak				0.003
				(0.012)
Percent Kyrgyz				–0.017
				(0.019)
Constant	5.939***	5.760***	7.408***	8.205***
	(0.097)	(0.176)	(0.909)	(0.928)
Spatial Error (λ)		0.700***	0.622***	0.646***
Moran's I	0.504***			
Pseudo–R^2	0.001	0.366	0.738	0.759
Log Likelihood	–526.12	–448.528	–297.038	–282.902
Akaike Inf. Crit.	1058.24	905.056	614.076	597.804
Wald Test (df = 1)		240.937***	143.747***	168.351***
LR Test (df = 1)		155.188***	104.852***	107.142***

Note: + p < .10; * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

After accounting for spatial dependence in the SEM models as well as for demographic characteristics and ethnic minority populations, the coefficients for logged total religious sites remain statistically significant. A one-unit increase in logged total religious sites per 100,000 people is associated with a 0.138 decrease in the number of deaths per 1,000 people in counties and a 0.116 decrease in the number of deaths per 1,000 people in prefectures, controlling for other factors (both $p < 0.001$). This means that a 10 percent increase in the total number of religious sites in counties is associated with a 0.013 (= –0.138*log(1.1)) decrease in county mortality rates, and a 10 percent increase in the total number of religious sites in prefectures is associated with a 0.011 (= –0.185*log(1.1)) decrease in prefecture mortality rates. The effect size at the county and prefecture levels are roughly equivalent, suggesting that the overall religious environment has a similar impact on mortality at both geographic levels. The results of these SEM models also show that the effect size of total religious sites at both levels is as large or larger than the effect size of GDP per capita, suggesting that the religious environment has as an important effect on mortality rates as the economic environment. Given the important health impact attributed to the economy, this is notable as it demonstrates how potentially important the religious environment is for population health and mortality.

Separate Religions

Because each religion may be associated with mortality rates differently than other religions, Table 7 and Table 8 show the results from models predicting county and prefecture mortality rates by the number of religious sites for each of the five official religions in China. The first model is a linear regression model (+ Religious Environment) that only includes the religious environment variables. At the county level, only the presence of Catholic churches is not associated with mortality rates, whereas the presence of Daoist ($\beta = –0.247$, $p < 0.001$), Islamic ($\beta = –0.193$, $p < 0.001$), and Protestant ($\beta = –0.141$, $p < 0.001$) sites are associated with lower mortality and the presence of Buddhist sites ($\beta = 0.294$, $p < 0.001$) is associated with higher mortality. Similarly, at the prefecture level, Islamic ($\beta = –0.243$, $p < 0.001$) and Protestant ($\beta = –0.228$, $p < 0.05$) sites are associated with lower mortality, and Buddhist sites ($\beta = 0.249$, $p < 0.001$) are associated higher mortality. These associations between each religion and mortality rates adjust for the presence of other religions, as the number of religious sites for all five religions is included in the models together.

Table 7. Regression estimates for county-level mortality rates (N = 2,750).

	+ Religious Environment	+ Spatial Error	+ Controls	+ Ethnicity
Religious Environment				
Logged Buddhist temples	0.294***	0.175***	–0.072**	–0.050^{+}
	(0.030)	(0.040)	(0.028)	(0.031)
Logged Catholic churches	–0.098	0.006	0.029	0.020
	(0.096)	(0.080)	(0.056)	(0.055)
Logged Daoist temples	–0.247***	–0.058	–0.024	0.003
	(0.072)	(0.070)	(0.049)	(0.049)
Logged Islamic mosques	–0.193***	–0.080^{+}	–0.024	0.027
	(0.028)	(0.041)	(0.027)	(0.037)
Logged Protestant churches	–0.141**	0.062	–0.014	–0.018
	(0.043)	(0.041)	(0.028)	(0.028)
Control Variables				
Percent Urban			–0.010***	–0.008***
			(0.001)	(0.001)
Percent aged 65 or older			0.445***	0.463***
			(0.015)	(0.015)
Percent under 5			0.030^{+}	0.037*
			(0.018)	(0.018)
Mean Years of Education			–0.451***	–0.471***
			(0.028)	(0.030)
Logged Population			–0.173***	–0.141***
			(0.025)	(0.025)
Logged GDP per capita			–0.166***	–0.148***
			(0.039)	(0.038)
County Ethnicity				
Percent Han				–0.007***
				(0.001)
Percent Tibetan				–0.009***
				(0.002)
Percent Mongolian				0.009**
				(0.004)
Percent Hui				–0.033***
				(0.004)
Percent Uyghur				0.005
				(0.004)
Percent Kazak				0.003
				(0.006)
Percent Kyrgyz				0.006
				(0.007)
Constant	6.010***	5.697***	9.082***	9.222***
	(0.037)	(0.078)	(0.403)	(0.417)

Table 7 continue

	+ Religious Environment	+ Spatial Error	+ Controls	+ Ethnicity
Spatial Error (λ)		0.725***	0.652***	0.663***
Moran's I	0.504***			
Pseudo–R^2	0.054	0.395	0.710	0.723
Log Likelihood	–4,853.27	–4,241.310	–3,227.638	–3,164.554
Akaike Inf. Crit.	9,718.54	8,498.619	6,483.276	6,371.108
Wald Test (df = 1)		2,143.108***	1,304.816***	1,415.780***
LR Test (df = 1)		1,221.920***	860.282***	850.426***

Note: + p < .10; * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

Table 8. Regression estimates for prefecture-level mortality rates (N = 343).

	+ Religious Environment	+ Spatial Error	+ Controls	+ Ethnicity
Religious Environment				
Logged Buddhist temples	0.249***	0.063	–0.241***	–0.123
	(0.075)	(0.090)	(0.065)	(0.079)
Logged Catholic churches	–0.198	0.002	0.108	0.078
	(0.289)	(0.251)	(0.164)	(0.160)
Logged Daoist temples	0.005	0.149	–0.048	–0.008
	(0.189)	(0.177)	(0.117)	(0.120)
Logged Islamic mosques	–0.243***	–0.153+	–0.089+	–0.141
	(0.057)	(0.081)	(0.053)	(0.095)
Logged Protestant churches	–0.228*	–0.140	0.010	–0.035
	(0.105)	(0.105)	(0.069)	(0.069)
Control Variables				
Percent Urban			–0.005	–0.004
			(0.003)	(0.003)
Percent aged 65 or older			0.375***	0.392***
			(0.033)	(0.032)
Percent under 5			0.048	0.058
			(0.039)	(0.038)
Mean Years of Education			–0.572***	–0.566***
			(0.050)	(0.030)
Logged Population			0.020	0.021
			(0.050)	(0.050)
Logged GDP per capita			–0.095	–0.088
			(0.075)	(0.074)
Prefecture Ethnicity				
Percent Han				–0.009**

Table 8 continued

	+ Religious Environment	+ Spatial Error	+ Controls	+ Ethnicity
				(0.003)
Percent Tibetan				–0.014*
				(0.006)
Percent Mongolian				0.007
				(0.009)
Percent Hui				–0.019
				(0.014)
Percent Uyghur				0.006
				(0.007)
Percent Kazak				0.006
				(0.012)
Percent Kyrgyz				–0.015
				(0.019)
Constant	5.951***	5.784***	7.554***	8.084***
	(0.096)	(0.164)	(0.929)	(0.931)
Spatial Error (λ)		0.680***	0.637***	0.648***
Moran's I	0.500***			
Pseudo–R^2	0.093	0.376	0.743	0.759
Log Likelihood	–510.84	–445.955	–293.677	–282.440
Akaike Inf. Crit.	1035.68	907.910	615.354	606.879
Wald Test (df = 1)		210.680***	158.308***	175.110***
LR Test (df = 1)		129.744***	110.023***	106.907***

Note: + p < .10; * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

The second regression model in Table 7 and Table 8 (+ Spatial Error) is a SEM model which accounts for the spatial autocorrelation discovered among the mortality rates of Chinese counties and prefectures using the Global and local Moran's *I* statistics. In these SEM models, only Buddhism (β = 0.175, p < 0.001) and Islam (β = –0.080, p < 0.10) are associated with mortality rates at the county level, and at the prefecture level, only Islam is associated with lower mortality rates (β = –0.153, p < 0.10). Lamba (λ), the spatial error coefficient, is 0.725 in counties and 0.680 in prefectures (both p < 0.001), which is further evidence of a significant level of spatial autocorrelation.

The third regression model in Table 7 and Table 8 (+ Controls) is a SEM model introduces a set of demographic control variables. After adjusting for these variables, the association between

the presence of Buddhist sites and lower mortality rates reverses direction, such that an increase in Buddhist temples is associated lower mortality in both Chinese counties ($\beta = –0.072, p < 0.001$) and prefectures ($\beta = –0.241, p < 0.001$).[9] In addition, the association between the presence of Islam and mortality rates is reduced in both counties ($\beta = –0.024$, p = n.s.) and prefectures ($\beta = –0.089$, $p < 0.10$). All control variables have a statistically significant relationship with county-level mortality rates, but only percent over 65 and education level do in prefectures.

The final model in Table 7 and Table 8 (+ Ethnicity) includes variables for the percentage of the county or prefecture population belonging to major ethnic minority groups traditionally associated with Tibetan Buddhism or Islam. After accounting for these ethnic populations which may confound the relationship between the religious environment and mortality rates, these SEM models show that the presence of none of the five major religion in Chinas are significantly associated with mortality rates at either the county or prefecture level using a 0.05 confidence level. The presence of Buddhism, however, has a negative association with mortality ($\beta = –0.050$, $p < 0.10$) in counties but only at the 0.10 confidence level. These results suggest that the associations of Buddhism and Islam with lower mortality in the previous models are confounded by the presence of ethnic minority populations that are traditionally Buddhist or Muslim.

To test whether this final model effectively accounts for spatial autocorrelation, I calculated a Global Moran's *I* statistic specifically for the residuals in these SEM models. The Global Moran's *I* of these residuals is –0.028 ($p < 0.05$) at the county level and –0.041 (p = n.s.) at the prefecture level, suggesting that these models are effective at accounting for nearly all the spatial autocorrelation (by reducing the Moran's *I* statistic to nearly zero in both instances). According to the Akaike information criterion (AIC), this final SEM is the best fitting model for both counties and prefectures, as it has the lowest value of the four models in each table (Akaike 1974). The R^2 values also improve to more than 0.72 in both.

In summary, the overall presence of religion is associated with lower mortality rates in both Chinese counties and prefectures with similar effect sizes. This suggests that the influence of the religious environment on mortality is similar at the larger prefecture level as it is at the smaller county level.[10] However, the effect of the overall presence of religion is likely driven by the effect

[9] Auxiliary analyses suggest that a moderate negative correlation ($r = –0.544$) between education and number of Buddhist temples is largely responsible for the reversal of the effect from the first model to the second.

[10] In comparing the effects between the larger prefecture-level division and the smaller country-level division, it is important to note that counties are the constitutive parts of prefectures. The effects found in the county-level

of some religious groups but not others. Therefore, I specified models that specify separate associations between each of China's five major religions and mortality rates. These models, after accounting for spatial dependences, demographic characteristics, and ethnic populations, do not provide strong evidence that the separate presence of each religion influences mortality rates in counties or prefectures. The associations between the religious environment and mortality appear to be due to common associations with the presence of ethnic minority populations.

Robustness Check

Given the large numbers of Buddhist temples and practicing Buddhists in Tibet as well as the large numbers of Islamic mosques and Muslims in Xinjiang, it is possible that results from these analyses (Buddhism and Islam's negative effects on mortality rates in some models) are driven by large negative effects in these specific autonomous regions. In addition, possible omissions or incomplete data in the OSAC dataset, particularly in counties/prefectures that report zero religious sites, may also be a source of bias in the results. For these reasons, I estimated auxiliary models that the exclude Tibet, Xinjiang, and counties/prefectures with zero total religious sites as a robustness check. These models do not produce substantively different results from the models presented above, showing no statistically significant associations in the final models examining the separate effects of each religion.

Discussion

For several decades, epidemiologists and demographers have sought to understand why variation in mortality across a population (e.g., Blazer 1982; Cutler, Deaton, and Lleras-Muney 2006; Manton 1982). Characteristics of the local social environment such as socioeconomic resources, education quality, access to health care, and neighborhood conditions have been found to influence the health of the people living there (Link and Phelan 1995; Mair, Diez Roux, and Galea 2008; Diez Roux and Mair 2010; Sellström and Bremberg 2006; Yen, Michael, and Perdue 2009). And although associations between individual-level religion and mortality risk have been well documented (e.g., Jarvis and Northcott 1987; McCullough et al. 2000; Oman and Reed 1998),

analyses are essentially "aggregated" at the prefecture-level; therefore, the county-level effects and the prefecture-level effects should not be considered distinctly different processes but overlapping effects that are both accounting for some degree of the same variation in mortality rates across China.

very little research—especially outside of the United States and Europe—has examined how community-level religion impacts mortality (e.g., Blanchard et al. 2008; Dwyer, Clarke, and Miller 1990; Garcia, Bartkowski, and Xu 2017).

This study provides evidence that mortality rates in local geographic areas in China may be related to the religious environment of those areas but that this relationship is partly due to associations with ethnic minority populations. More specifically, these analyses demonstrate that the overall presence of religion in both Chinese counties and prefectures—as measured by the total number of religious sites per 100,000 people—is associated with lower mortality rates. In addition, the presence of Buddhism and Islam are separately associated with lower levels of mortality in counties and prefectures, but this association appears to be cofounded by common links to the presence of ethnic minorities traditionally associated with Tibetan Buddhism and Islam. In addition, there is no evidence that the effect of the religious environment is greater at the prefecture level than at the county level. For the final models testing associations between the overall religious environment (i.e., total religious sites) and mortality rates, the effect sizes are equivalent.

These findings lend some preliminary support to my overall argument that the religious environment is an important—yet overlooked—macro-level socio-ecological characteristic that impacts population health and mortality. Prior studies of the ecological effects of religion on mortality have primarily focused on the United States and have found differences in the effects of different types of Christianity (e.g., Blanchard et al. 2008; Garcia, Bartkowski, and Xu 2017). Interestingly, these analyses suggest that the overall presence of religion is associated with population mortality in China. In addition, the presence of Catholicism and Protestantism are not associated with population mortality in the context of mainland China but that Buddhism and Islam—one of which is a "Chinese" religion widely practiced throughout China and the other of which is primarily practiced among marginalized ethnic minority groups—may be related to lower levels of mortality.

Possible Explanations

Among the reasons to expect Buddhist to be associated with better health and lower mortality are Buddhism's health-promoting meditative practices, emphasis on compassionate behavior, and vegetarianism (Kwok et al. 2000; Meng et al. 2018); however, these are all predominately *individual-level* practices, which may or may not have significant spill-over into

the non-Buddhist community. Buddhism is the most common religion with which individuals in China identify, is often regarded as a "Chinese" religion, and perhaps has the friendliest relationship with the Chinese government.

The role of Buddhist temples in the community differs between rural and urban areas. In rural areas, a local temple may be a central hub for important local festivals, events, social services, etc. whereas in urban areas Buddhist temples may provide limited opportunities for social participation (i.e., volunteering, scripture study) but be less influential in the overall social life of the community. Buddhist philanthropy has also increased in recent years (Laliberté 2012), so where there are more Buddhists, there may be more charitable activities that have health promoting benefits. In recent years, reports indicate that wealthy, upper class Chinese have developed a particular affinity for Buddhism (Gu 2015; Osburg 2020; Sudworth 2015). There may be more Buddhist temples and Buddhist adherents in more affluent and economic developed areas. If there are associations between Buddhism and economic development, then the associations between Buddhism and health may be confounded by the level of economic resources in local areas. The models in this study, however, adjust for the economic development of local areas.

Although Islam has recently endured strict and oppressive government policies, the period during which these data were collected (mortality rates are from China's population census in 2000 and the religious sites data are from China's 2004 economic census) was prior to the most recent crackdowns on Muslim Uyghurs in Xinjiang in 2014. Therefore, political tension was not likely a major factor in the health of the people living in areas with high concentrations of Muslim adherents. In fact, the models in this study reveal that the presence of Islam is associated with lower mortality rates. A possible explanation for this finding might be the salubrious health effects associated with Muslim food laws and community norms which restrict Muslim adherents from eating pork, consuming alcohol, and smoking tobacco. In areas with more Muslims, these norms of the Muslim subculture may influence the larger subcultures through structural and social network processes. For example, the availability of alcohol or tobacco is more limited in communities with a larger Muslim presence.

In addition, Islam in China is closely tied to ethnicity. Most Muslims in China belong to one of China's 55 ethnic minority groups, ten of which are traditionally identified as Muslim.[11]

[11] The ten ethnic minority groups that traditionally follow Islam include the Hui, Uyghur, Kazakh, Uzbeks, Kyrgyz, Tajik, Tatar, Salar, Bonan, and Dongxiang.

These traditionally Muslim ethnic minority groups also tend to be heavily concentrated in certain regions of China. For example, Uyghurs are mostly found in Xinjiang. By living closely together in communities with high percentages of Muslim adherent, a common religion and ethnicity among these groups may be a strong source of social integration, which is associated with health benefits. The models in this study adjusted for the presence of ethnic minorities in Chinese counties and prefectures. That the presence of Islam affects mortality over and above the potential effect of ethnic enclaves on health and mortality suggests that the religious influences of Islam extend beyond ethnic communities.

In this study, the presence of Catholicism, Daoism, and Protestantism in Chinese counties or prefectures were not found to have a significant relationship with population mortality. Overall, there are fewer total Catholic and Daoist religious sites in China, particularly in comparison to Buddhist or Muslim sites (see Table 1). Additionally, the limited variation in Catholic, Daoist, and Protestant sites across geographic areas may have prevented the models in these analyses to detect a significant effect for Catholicism, Daoism, and Protestantism. The range of religious sites in prefectures for Catholicism (0–2.96), Daoism (0–2.91), and Protestantism (0–2.72) is smaller than for Buddhism (0–4.38) and Islam (0–5.83) (from Table 3).

Limitations

Counties and prefectures were the only two available geographic scales available in these data to conduct these analyses. The modifiable area unit problem (Fotheringham and Wong 1991; Openshaw 1977; Spielman and Yoo 2009) and the uncertain geographic context problem (Kwan 2012) argue that estimates from geographic analyses are potentially unstable or biased due to variation in the scale of the effect under study or to uncertainty about the scale at which the phenomenon of interest actually operates. In particular, the influence of macro-level socio-ecological features (e.g., the religious make-up of local areas) on health and mortality via theorized social network influences and psycho-social mechanisms (Berkman et al. 2000) is not limited to the geographic boundaries of administrative units like counties or prefectures in China. Analyses of smaller area units such as neighborhoods may produce substantively different results. Future research using alternative geographic scales are necessary to more definitively determine the scale at which the religious environment is most influential for population mortality.

In addition, the contextual effects of religion identified in this study may simply be compositional effects due to the characteristics of the individuals in the social environment rather than of the social environment itself. In other words, are the results here a product of aggregating individual level data in which associations between individual religion and mortality are present. Because the data used in this study does not aggregate individual-level religious affiliations but rather uses actual characteristics of the areas—the number of religious sites—this problem may be avoided. However, to address this potential concern, I conduct multilevel analyses in Chapter 4 in which I test whether the religious environment of Chinese prefectures influences individual-level health outcomes while controlling for individuals' religious identities. This approach distinguishes the effect of the religious environment from the effect of individual-level religion, thereby disentangling contextual and compositional effects.

The cross-sectional nature of these data and analyses are subject to several potential issues. First, this study is unable to establish a causal relationship between the religious environment and mortality in China. In addition, that the data used to measure the religious environment was collected in 2004 but the mortality rates are from the year 2000 is of some concern. In the span of four years, however, neither patterns of religious sites nor mortality rates in local Chinese areas are likely to have changed substantially on average. Nonetheless, analyses that examine the relationship between changes in the religious environment over time and changes in mortality rates over time would provide stronger evidence of the ecological effect of religion on mortality.

CHAPTER 4: THE EFFECTS OF LOCAL RELIGIOUS ECOLOGY ON THE PHYSICAL HEALTH OF OLDER ADULTS IN CHINA

Introduction

Research has well-documented the physical health effects of *personal* religious involvement (e.g., Chatters 2000; Ellison and Levin 1998; Koenig, King, and Carson 2012), particularly for older adults (Krause 2002, 2008; Zhang, Hannum, and Wang 2008); but, we know little about whether the religious characteristics of the social environment influence health and whether this influence is dependent on the religious identity of individuals (Stroope and Baker 2018), particularly in societies other than the United States. In the previous chapter, I show that the religious composition of Chinese counties and prefectures is associated with county- and prefecture-level mortality rates. Those analyses, however, cannot determine whether the effects are compositional or contextual. In this chapter, I extend the study of religion's ecological effects on health by examining how the religious make-up of prefectures affects the physical health of individual older adults in China. As a multi-level analysis that adjusts for respondents' individual religious identities, this study isolates the contextual effect of religion from the compositional to determine whether and how the religious composition of local geographic areas impacts the health of individuals living in them. For this study, I aim to answer the following research question: Is prefecture-level religious ecology associated with individual-level health outcomes among older adults in China? Do these associations vary by individual religious identity?

Background

China's aging population is growing rapidly. In 2017, the number of people in China aged 60 or over was about 229 million—about 16 percent of China's total population. As shown in Figure 17, this number is projected to more than double to about 479 million or about 35 percent of China's total population by 2050 (United Nations 2017: 28). Due to steep declines in fertility—the goal of China's One-Child Policy introduced by Deng Xiaoping in 1979 and ended by Xi Jinping in 2015—and increases in life expectancy, this massive shift in the age structure of China's population will lead to considerable economic, health, and healthcare challenges (Fang et al. 2015).

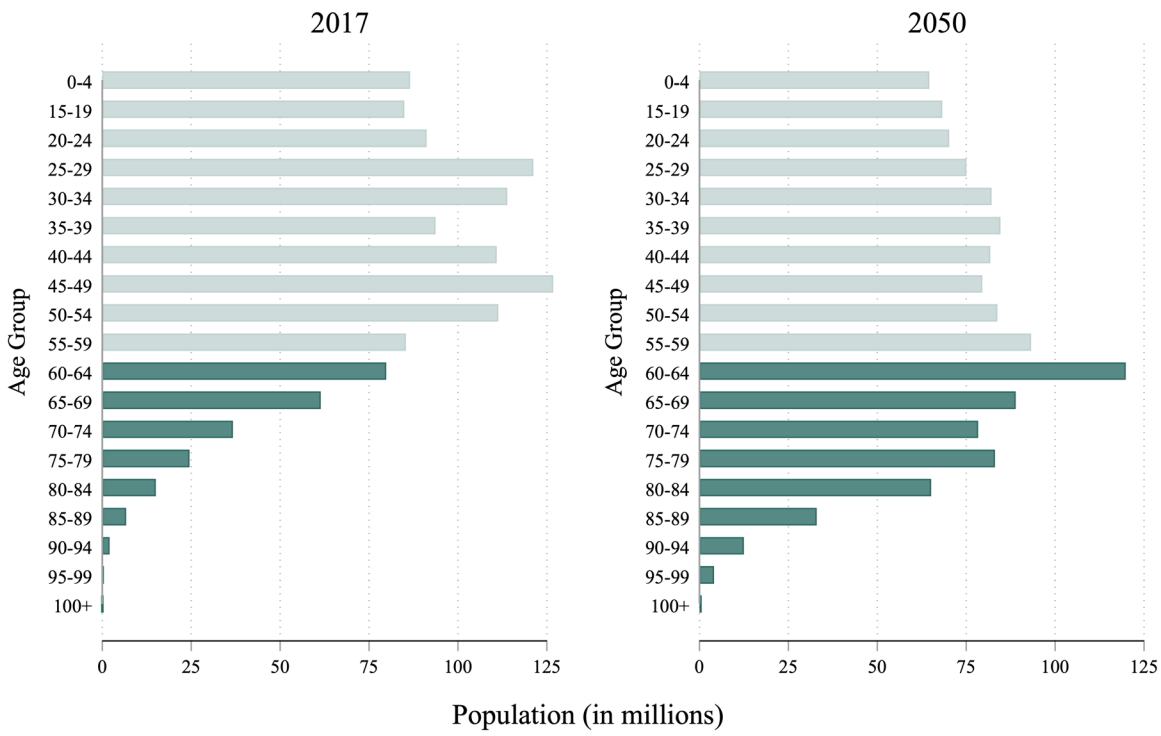

Figure 17. Chinese population (in millions) by age group in 2017 and projections in 2050. Data: World Population Prospects 2019, Volume I: Comprehensive Tables (United Nations 2019).

As the population ages, China is expected to see increases in the prevalence of chronic non-communicable diseases (CNCDS) such as stroke, cardiovascular disease, chronic obstructive pulmonary disease (COPD), diabetes, and hypertension, which burden older adults at higher levels (Chatterji et al. 2008; Fang et al. 2015). Over the next several decades as China addresses the economic and health care challenges of an older population with greater health care needs, it will become increasingly important to understand the factors associated with the health and well-being of its older adults population. Some of the major determinants of health in older adults include age, ethnicity, gender, marital status, income/wealth, education, employment, health insurance, diet, exercise, and social interaction (Cai, Coyte, and Zhao 2017; Fan et al. 2019; Lu et al. 2019). In addition to these individual factors, characteristics of the social environment play a major role in population health (Gu et al. 2019; Lei et al. 2014). Studies show geographic variation (e.g., regional, provincial, rural/urban) in self-rated health (Fan et al. 2019; Feng et al. 2012; Gu et al. 2019; Yiengprugsawan et al. 2019), in functional limitations (Yiengprugsawan et al. 2019) and in the prevalence of chronic diseases such as diabetes (Zhou et al. 2015), respiratory diseases (Guan et al. 2016; Yin et al. 2011), hypertension (Guan et al. 2020; Van de Poel, O'Donnell, and Van

Doorslaer 2009; Reynolds et al. 2003), and stroke (Liu et al. 2007). Some of these health differences are attributed to area-level influences such as levels of economic development (Fan et al. 2019), employment (Pi et al. 2018), socioeconomic inequality (Fan et al. 2019; Gu et al. 2019; Lei et al. 2014; Pi et al. 2018), education (Fan et al. 2019; Pi et al. 2018), access to quality health care services (Fan et al. 2019; Gu, Zhang, and Zeng 2009; Zhang and Zhang 2017), health infrastructure (Smith, Tian, and Zhao 2013), among other unknown factors (Lei et al. 2014). These area-level factors are known to be particularly salient for the health of older adults (Diez-Roux 2002; Krause 1996; Robert and Li 2001).

Although not research has yet explored how the religious environment impacts the health of older adults, studies in China have shown important associations between individual-level religiosity and health in older adults. Participation in religious activities is associated with decreased risks of functional limitations, cognitive impairment, and poor self-rated health (Yi, Gu, and Land 2007; Zhang 2010). In the general population, one study found that Buddhists, Protestants, and individuals who indicate that religion is "very important" in their lives have better self-rated health (Zhang et al. 2020), whereas another study found no associations (Kim and Chung 2019). Religious behaviors among Chinese Buddhists are associated with decreased risk of hypertension (Meng et al. 2018).

Over the next several decades, it will become increasingly important to understand factors associated with the health of older adults in China. A few studies focused on the United States and Europe have found how the religious characteristics of local areas affect population health and mortality (e.g., Blanchard et al. 2008; Garcia, Bartkowski, and Xu 2017; Huijts and Kraaykamp 2011; Stroope and Baker 2018), but whether the religious environment is determinant of health in China is not yet known. In this study, I test whether the religious features of local social environments are an important community-level influence on the health of older adults in China and whether this influence varies for different religious groups and by the religious identity of individuals.

Hypotheses

Because this study is primarily exploratory in nature, I do not list specific theoretical hypotheses to test beyond several general expectations outlined below. Rather, drawing on theoretical, conceptual, and empirical insights from socio-ecological approaches to health,

ecological studies of religion, studies of associations between religion and health, and studies of religion in Chinese society (outlined in Chapter 2), I have developed a series of potential explanations for the range of possible findings this study may produce, both for the health effects of the overall religious environment of local areas and of each separate religion. For the findings produced by these analyses, I refer to and elaborate on these potential explanations in the discussion section. In the following paragraphs, I outline some general expectations.

First, due to the overall positive associations between religion and health for older adults (e.g., Krause 2002, 2008; Zhang, Hannum, and Wang 2008), the role of religion in providing social resources (i.e., social support, social interaction) (Chatters 2000; Cohen 2004; Ellison and George 1994; Ferraro and Koch 1994; George, Ellison, and Larson 2002; Yeary et al. 2012), and the positive health behaviors associated with religion (Chatters 2000; Ellison and Levin 1998; George, Ellison, and Larson 2002), I expect that local geographic areas with a greater presence of religion will be associated with better health outcomes. Because of considerable differences between the various religions in China, it may be more likely that some religious groups have a greater ecological impact on individual health than others. For example, congregational religions such as Protestantism and Catholicism may have a unique ability to provide social resources that extend to other members of their local communities. Or perhaps Buddhism and Daoism, which are generally regarded as "Chinese religions," have greater ecological effects on health because of how well integrated they are into the broader Chinese culture. In the previous chapter, the presence of Buddhism and Islam were both associated with lower mortality rates, so it is reasonable to expect that both will be associated with better health outcomes in this study.

Conversely, prior studies have shown that religion is associated with worse health in societies with less religious freedom (e.g., Elliott and Hayward 2009; Hayward and Elliott 2014). Therefore, local geographic areas with a greater presence of religion may experience worse overall health outcomes. Government regulations on religions vary greatly across religious groups. Given that Catholicism, Islam, and Protestantism, for example, have been specifically targeted by Chinese government policies on religion—particularly during the years immediately preceding the 2015 wave of the CHARLS survey—local areas with a greater presence of Christianity and Islam may experience negative health effects because of heightened levels of socio-political stress.

The ecological effects of religion on health may however be different for followers of religion or for followers of specific religions than for others (i.e., non-followers of religion or followers of

different religions). The light-switch hypothesis suggests that individual-level religion interacts with the religious environment in their effects (Regnerus 2003; Stroope and Baker 2018). Therefore, I expect the associations between the religious environment and health outcomes will be stronger for religious adherents than for non-adherents. I also expect the ecological effects of each separate religion to be greater for followers of that specific religion that for followers of other religions or for nonreligious individuals (e.g., the ecological effect of Buddhism will be greater for Buddhists than for non-Buddhists).

Data and Methods

Data

For this study, I use a multilevel dataset constructed by merging data from the Online Spiritual Atlas of China (OSAC) (Yang et al. 2019) and the China Health and Retirement Longitudinal Study (CHARLS) (Zhao et al. 2020). The Online Spiritual Atlas of China (OSAC) is a project of the Center on Religion and the Global East (CRGE) at Purdue University that cleaned, verified, and labeled information collected during China's 2004 Economic Census for 72,887 officially registered religious sites in 2,871 Chinese counties and 336 prefectures.[12] Religious sites are physical locations where individuals and groups practice religions and include churches, mosques, and temples. A breakdown of the number of religious sites in China for each of the five major religions is presented in Table 9.

Table 9. Number of religious sites for the five official religions in China, 2004.

Religion	Total Number of Sites	Prefecture Range per 100k people
Buddhism	16,588	0–78.99
Catholicism	2,408	0–3.14
Daoism	4,907	0–17.36
Islam	34,305	0–338.19
Protestantism	14,447	0–14.22
Total	72,665	0–338.19

Data: Online Spiritual Atlas of China (OSAC) (Yang et al. 2019).

[12] A more detailed description of the OSAC dataset is included in the Data & Methods section of Chapter 3.

The Chinese Health and Retirement Longitudinal Study (CHARLS) is a four-wave longitudinal survey (2011, 2013, 2015, and 2018) of a nationally representative sample of Chinese residents ages 45 and older (Zhao et al. 2020). The baseline wave in 2011 used a stratified multi-stage probability sampling design to survey 17,708 individuals (respondents and spouses) in 10,257 households from different 450 neighborhoods (villages/urban communities). These neighborhoods are nested in 126 prefectures from all of China's provinces and provincial-level administrative divisions except for Hainan, Hong Kong, Macau, Ningxia, and Tibet (*Xizang*). The first follow-up survey was in 2013 and interviewed 18,604 individuals. The second follow-up was in 2015 and interviewed 21,057 individuals in 12,450 households. In 2014, CHARLS also administered a special life history survey to 20,542 individuals. Because respondents' religious identity was only asked during the 2014 Life History Survey, these analyses use data from the 2015 follow-up wave to ensure that the respondents' religious identities (measured in 2014) precede their health outcomes (measured in 2015).

Responses were collected using face-to-face computer-assisted personal interview (CAPI) and the response rate of the 2011 baseline survey was 80.5% (Zhao et al. 2014). The CHARLS questionnaire includes items related to socio-demographics, household roster, health status and functioning, health history (before age 16), chronic illnesses, lifestyle and health behaviors, activities of daily living (ADL), instrumental activities of daily living (IADL), cognitive functioning, depression, health care, caregiving, employment, retirement and pension, and household economy (income, assets, consumption). In addition to these survey items, detailed blood and non-blood biomarkers were collected at each wave. The 2104 Life History Survey gathered information about the respondents' childhoods and educational, occupational, and histories. In 2011, community and village offices in each of the 450 neighborhoods were also surveyed for information about health care facilities, community resources & services, infrastructure, and demographics.

The data from OSAC and CHARLS are merged by matching the prefecture names between the two datasets.[13] All 126 prefectures in CHARLS were successfully matched with prefectures in OSAC. The resulting merged dataset includes four-levels (prefecture, community/village,

[13] The CHARLS data set does not identify the counties or neighborhoods in which their respondents live; respondent's prefecture is the smallest level that is publicly available and which can be matched with the OSAC data set.

household, and individuals). The data were subset to only included respondents aged 60 and older and list-wise deletion was performed to remove observations with missing data on model variables.

Variables

Dependent Variables

The dependent variables for this study are individual-level physical health outcomes measured in the 2015 wave of CHARLS. Because health is a broad, multi-dimensional concept, I examine two of the major indicators of overall physical health among older adults: self-rated health and chronic illnesses.

Self-rated Health: Self-rated health is known to be a reliable indicator of overall health and a strong predictor of both morbidity (Idler and Kasl 1995; Idler, Russell, and Davis 2000; Latham and Peek 2013; Lee 2000) and mortality (DeSalvo et al. 2006; Idler and Benyamini 1997; Jylhä 2009; Schnittker and Bacak 2014). Self-rated health in CHARLS was measured by asking respondents, "What do you think of your health? Is it excellent, very good, good, fair, or poor?" I collapse the top two categories ("excellent" and "very good") and I recode self-rated health as 1 = "poor," 2 = "fair," 3 = "good," and 4 = "very good." The final analysis sample size for models of self-rated health is n = 6,948.

Chronic Illness: Another measure of the physical health of older adults is the number of chronic illnesses they have (Liu et al. 2019; Silverstein, Gong, and Kendig 2020). CHARLS respondents were asked, "Have you been told by doctors, or do you know that you have at least one of the following 14 diseases: hypertension, dyslipidemia, diabetes/high blood sugar, cancer or other malignant tumors, chronic lung disease, liver disease, heart disease, stroke, kidney disease, digestive system diseases, emotional or psychiatric disorders, memory disorders, arthritis/rheumatism, or asthma?" I sum the number of affirmative responses to obtain a total number of chronic illnesses reported by each respondent. The final analysis sample size for models of chronic illness is n = 7,688.

Focal Independent Variables

The focal independent variable is the religious environment of Chinese prefectures, which is operationalized as the religious composition of Chinese prefectures and measured by the number

of religious sites[14] (i.e., temples, mosques, churches, and shrines) per 100,000 people for both all religions combined and separately for Buddhism, Christianity,[15] Daoism, and Islam from OSAC.[16] Because most prefectures have just a few religious sites and only a few have a greater number of religious sites, I use a natural logarithmic transformation to reduce the skewness of the distribution.

Other Covariates

Respondents' religious identities were surveyed in the 2014 CHARLS Life History questionnaire with the following question: "What religion do you believe in?" Response options included: "Christianity (Protestantism, Catholicism, Eastern Orthodoxy)," "Buddhism," "Islam," "Daoism," and "Other religion." Because so few respondents chose the "Daoism" (n = 13) and "Other religion" (n = 8) categories, these observations combined into a single "Other religion category" (n = 21).

The following individual-level control variables are included in all presented models: gender (man/woman), age (in years), marital status (married, separated/divorced, widowed, never married), educational attainment (less than middle school, middle school, high school, and more than high school), annual household expenditures per capita (in Chinese yuan) (Strauss et al. 2010; Yip et al. 2007), Han ethnicity (e.g., Ouyang and Pinstrup-Andersen 2012), and smoking habit (currently smoke, used to smoke but quit, and never smoked).

[14] Except for Daoism, the number of religious sites in Chinese prefectures (from OSAC) has modest or high correlations with the proportions of CHARLS respondents in Chinese prefectures identifying with each religious group. The correlation between the number of Buddhist sites in prefectures and proportion of Buddhist adherents in prefectures from CHARLS is 0.74. The correlation between Christian sites and Christian adherents is 0.34, and the correlation between Islamic sites and Muslims is 0.83. For Daoism, the correlation is only 0.06, but this is likely explained by the fact that few individuals in China will identify themselves as Daoist, as doing so implies ordination or a level of commitment typically reserved for Daoist priests. In addition, folk religion temples in the OSAC dataset were labeled as Daoist; however, folk religion was not a response option in the CHARLS survey.

[15] Because the CHARLS questionnaire does not distinguish between Catholicism and Protestantism when asking about individual respondents' religious identity, I combine the number of Protestant and Catholic churches in each prefecture (from OSAC) into a single measuring of the number of Christian sites in each prefecture.

[16] A more detailed description of this measure is included as a part of the Data & Methods section of Chapter 3.

Table 10. Descriptive statistics for all model variables (N = 7,688).

Variable	Mean/Prop.	Freq.	SD	Min.	Max.
Individual-level Health Outcomes					
Self-Rated Health					
Poor	0.25	1,832			
Fair	0.53	3,831			
Good	0.11	810			
Very Good	0.11	756			
Number of Chronic Illnesses	1.70		1.58	0.00	10.00
Prefecture-level Religious Environment					
Logged Total Religious Sites per 100k	1.22		0.95	0.00	5.06
Logged Buddhist temples per 100k	0.60		0.73	0.00	4.07
Logged Christian churches per 100k	0.66		0.62	0.00	2.68
Logged Daoist temples per 100k	0.22		0.41	0.00	2.15
Logged Islamic mosques per 100k	0.28		0.67	0.00	5.06
Individual-level Control Variables					
Religious Identity					
Christianity	0.03	225			
Buddhism	0.06	477			
Islam	0.01	65			
Other	0.00	31			
None	0.90	6,900			
Woman	0.50	3,840			
Age	68.61		7.07	60.00	105.00
Marital Status					
Married	0.79	6,051			
Separated/Divorced	0.01	50			
Widowed	0.20	1,513			
Never Married	0.01	74			
Highest Level of Education					
Less than Middle School	0.76	5,842			
Middle School	0.16	1,233			
High School	0.03	262			
More than High School	0.05	351			
Annual Household Expenditures per capita	4,376.61		11,708.58	0.00	381,623.00
Han Ethnicity	0.92				
Smoking Habit					
Currently smoke	0.28	2,121			
Used to smoke but quit	0.16	1,238			
Never smoked	0.56	4,317			
Prefecture-level Control Variables					
Population Density (person/km^2)	2,603.72		5,391.42	0.03	20,000.00
Percent with HS Degree	19.95		14.22	0.00	83.30
Percent Han Ethnicity	91.98		21.35	0.00	100.00
Percent Over 65	19.58		48.69	0.80	750.00
Logged Income per capita	7.97		1.08	0.47	10.83
Percent Migrant	7.10		18.08	0.00	175.00
Urban	0.36				

Community-level control variables also included in all presented models are: total population, population density (persons/km2, top-coded at 20,000), percent of the population with a high school degree (Zhang and Kanbur 2005), percent Han ethnicity (Li, Luo, and Klerk 2008; Ouyang and Pinstrup-Andersen 2012), percent aged 65 or older (Brown and Tierney 2009), logged per capita income (Li and Zhu 2008; Yu and Zhang 2020; Zhao 2006), percent that are migrants (Chen, Liu, and Mair 2011; Hesketh et al. 2008), and whether community is considered urban or rural (Brown and Tierney 2009). Table 10 presents descriptive statistics for all model variables.

Analytic Strategy

Modeling Strategy

A multilevel modeling strategy was used for statistical analyses in this study. There are two primary reasons for choosing multilevel models. First, multilevel models allow me to test for the theorized effects of an independent variable at one level on a dependent variable at another level. For this study, the primary theoretical relationships of interest are between prefecture-level religion and individual-level health outcomes. In addition, multilevel models allow me to account for dependencies found in nested data structures (Luke 2004; Rabe-Hesketh and Skrondal 2008). For this study in particular, dependencies among individuals within the same prefectures, communities, and households need to be adjusted for to avoid violating the assumption of independence of observations in traditional linear regression models. To test whether such dependencies existed in a dataset with a nested structure, the intraclass correlation coefficient (ICC) is the conventional measure used to determine whether multilevel analyses are warranted.

Table 11 presents the estimated unconditional intraclass correlation coefficients (ICC) from variance components models for each of the dependent variables at each level of clustering. The ICCs indicate the proportion of the total variance in the dependent variable that is accounted for by the clustering of the observations at each of the levels.[17] The variance component models estimate that 2.7 percent of the variance in self-rated health and 3.6 percent of the variance in number of chronic illnesses is due to prefecture-level clustering. Slightly more variance is due to community-level clustering with 4.6 percent for self-rated health and 5.4 percent for number of

[17] Because it is not possible to calculate intraclass correlation coefficients for negative binomial models, the ICCs from a variance components model of the reported number of chronic illnesses were calculated using a linear model.

chronic illnesses. And more than 20 percent of the variance in both self-rated health and number of chronic illnesses is due to household-level clustering. Although these values, particularly at the prefecture and community levels, are small, the levels of clustering present warrant a multilevel design, especially given that the theoretical relationships of interest are cross-level.

Table 11. Intraclass correlation coefficients (ICC) at each level clustering from variance components models for both dependent variables.

Level	Self-rated Health	Number of Chronic Illnesses
Prefecture	0.027	0.036
Community	0.046	0.054
Household	0.232	0.248

Note: Standard errors in parentheses.

Using this multilevel modeling strategy for each of the dependent variables, I first estimate models to examine whether the logged number of religious sites per 100,000 people at the prefecture-level—both for total religious sites combined and for each of the four major religious groups[18]—is associated with each individual-level health outcome, controlling for individual and community characteristics. These base models do not adjust for individual religious identity, thereby possibly conflating the compositional and contextual effects of religion at the prefecture level. Next, I estimate models that include respondents' individual religious identities, which accounts for the individual-level effect of religion on the health outcomes and isolates the contextual effect of the religious environment variables from their compositional effect (i.e., the aggregation of the individual-effect of religion). Finally, I estimate interactive models with cross-level interaction terms between the number of religious sites in prefectures and individual religious identity to examine whether the associations between the religious environment and health outcomes differ by individual religious identity. For example, the variable measuring the presence of Buddhist temples is interacted with a variable that indicates whether the respondent identifies

[18] All the models in these analyses that examine an independent effect of the four major religious groups include all four variables with the number of religious sites for each religious group simultaneously. Because the ecological effect of one religious group on individual health outcomes may be associated with that of another religious group, I included all of them in each model to eliminate possible confounding. Checks confirm that multicollinearity is not present, although modest positive correlations exist between the number of religious sites of different religions, except for Islam. In general, prefectures with more religious sites from one group tend to also have more religious sites from other groups. The number of Islamic mosques; however, is not correlated with the number of sites from any other religion.

with Buddhism, some other religion, or no religion. Because of how few respondents reported being Daoist (n = 14) in the analysis sample from CHARLS, there is not enough statistical power in interactive models with these variables to detect a significant association. For testing possible differences in the effect of Daoism by individual religious identity, I use a broader measure of whether a respondent reports a religious identity or reports having no religious identity.

Because each of the dependent variables in this study represent different levels of measurement, I estimate multilevel models appropriate for each variable. Self-rated health is an ordinal categorical variable; however, because ordinal logistic regressions models with these data do not pass tests of ordinality (multinomial models produce substantially different results and ordinal models produce statistically significant brant tests), I employ multilevel multinomial logistic regression models using the self-rated health dependent variable. I conduct these analyses using the `gsem` framework in Stata 17.0. For number of chronic illnesses, which I treat as a count variable, I used a multilevel negative binomial model[19] using the `menbreg` command in Stata 17.0.

Marginal Effects

To test the associations and interpret the results from these models, I use a marginal effects approach, which summarizes the effect of an independent variable as the difference between two model predictions, a marginal effect (Long and Freese 2014; Williams 2012; Mize, Doan, and Long 2019). This approach has several advantages. First, it provides a straightforward summary measure of an independent variable's effect in the natural metric of the dependent variable, as opposed to more complex metrics like odds ratios or incident rate ratios. Second, it avoids the identification problems due to scaling in logit/probit models (Ai and Norton 2003; Long and Freese 2014). Third, the significance tests for the coefficients of the interaction terms in non-linear models are not reliable. Tests using marginal effects, however, are reliable indicators of statistically significant effects (Mize 2019). Finally, it allows me to interpret the models using a similar language across the various dependent variables in my analyses (e.g., "the effect of a standard deviation increase in the independent variable is…"). To calculate average marginal effects (AMEs), I first make a model prediction for the observed value of the independent variable (i.e., logged number of religious sites per 100k people) and then subtract this from a prediction for a

[19] Both likelihood ratio tests and AIC/BIC statistics indicate that a negative binomial model fits better than a Poisson model.

value of the independent variable that is 1 standard deviation greater holding all control variables at their observed values. After doing this for each observation in the data, the differences are averaged to obtain the AME. Tables of average marginal effects and figures of model predictions are presented and interpreted in the Results section below. Tables of regression coefficients relative risk ratios (self-rated health) and incident rate ratios (chronic illnesses) are included in Appendix A.

Results

Self-Rated Health

Base Models

A multilevel multinomial logistic regression model predicting self-rated health, which does not adjust for respondents' individual religious identities, reveals that a greater overall presence of religion in Chinese prefectures is not associated with self-rated health in older Chinese adults. However, a base model examining the separate effect of the presence of each religion on self-rated health suggests that a greater presence of Buddhism and Islam is associated with *worse* self-rated health and that greater presence of Daoism and Christianity is associated with *better* self-rated health, adjusting for other factors (but not individual religious identity). Table 12 shows average marginal effects (AMEs) of a standard deviation increase in the total number of religious sites on the probability of reporting each category of self-rated health. Tables A1 and A3 in Appendix A presents the relative risk ratios (RRR) for these models.

Table 12. Average marginal effects of a standard deviation increase in religious sites (logged) on predicted probabilities of reporting categories of self-rated health from models (without controls for individual religious identity).

	Poor		Fair		Good		Very Good	
	AME	SE	AME	SE	AME	SE	AME	SE
Total Sites	0.006	(0.006)	–0.007	(0.007)	–0.001	(0.004)	0.001	(0.007)
Buddhism	0.018+	(0.009)	0.026*	(0.01)	–0.017*	(0.007)	–0.027**	(0.009)
Christianity	0.003	(0.007)	–0.026**	(0.008)	–0.002	(0.005)	0.024**	(0.009)
Daoism	–0.019*	(0.010)	0.002	(0.011)	0.019*	(0.009)	–0.002	(0.011)
Islam	0.010	(0.006)	–0.017*	(0.007)	–0.003	(0.004)	0.003	(0.005)

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; AMEs calculated holding all control variables at their observed values.

Full Models

A multilevel multinomial logistic regression model predicting self-rated health, which does adjust for respondents' individual religious identities, also reveals that a greater overall presence of religion in Chinese prefectures is not associated with self-rated health in older Chinese adults. However, a model examining the separate effect of the presence of each religion on self-rated health suggests that a greater presence of Buddhism and Islam is associated with *worse* self-rated health and that greater presence of Daoism and Christianity is associated with *better* self-rated health, adjusting for other factors.

Figure 18 shows the predicted probabilities for a model of self-rated health with the total number of religious sites in Chinese prefectures as the focal independent variable. The predictions from this model indicate that the overall religious environment of prefectures does not affect individuals' self-rated health adjusting for other community-level and individual-level characteristics. The likelihood of reporting each level of self-rated health remains relatively constant as the overall presence of religion increases in Chinese prefectures: the predicted probabilities of reporting "good" or "very good" health is about 0.10 across the range of religious sites.

The first row of Table 13 presents average marginal effects (AMEs) of a standard deviation increase in the total number of religious sites on the probability of reporting each category of self-rated health. None of AMEs for the total number of religious sites is significantly different from zero, suggesting that a greater overall presence of religion has no impact on the self-rated health of older adults. Table A2 in Appendix A presents the relative risk ratios (RRR) for this model.

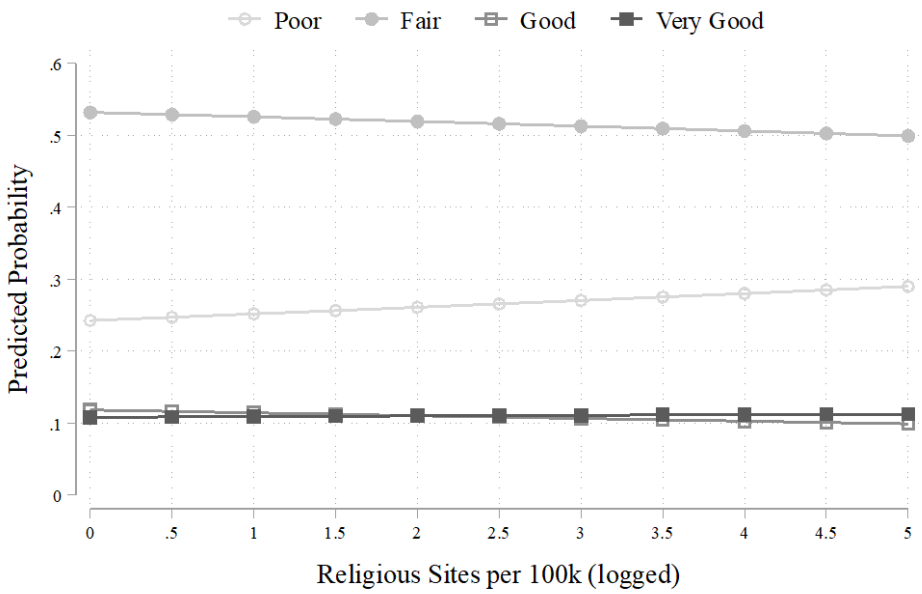

Figure 18. Predicted probabilities of self-rated health for the total number of religious sites in Chinese prefectures.

Table 13. Average marginal effects of a standard deviation increase in religious rites on predicted probabilities of reporting categories of self-rated health from models (with controls for individual religious identity).

	Poor		Fair		Good		Very Good	
	AME	SE	AME	SE	AME	SE	AME	SE
Total Sites	0.008	(0.007)	–0.006	(0.007)	–0.004	(0.004)	0.001	(0.007)
Buddhism	0.011	(0.010)	0.029**	(0.011)	–0.015*	(0.007)	–0.025**	(0.009)
Christianity	0.004	(0.007)	–0.027**	(0.008)	–0.002	(0.005)	0.025**	(0.009)
Daoism	–0.016^{+}	(0.009)	0.001	(0.011)	0.017*	(0.008)	–0.002	(0.010)
Islam	0.011^{+}	(0.006)	–0.016*	(0.007)	–0.000	(0.004)	0.005	(0.006)

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; AMEs calculated holding all control variables at their observed values.

Figure 19 shows predicted probabilities from a multilevel multinomial logistic regression model predicting self-rated health with the number of sites for each major religion in Chinese prefectures as separate independent variables. These graphs demonstrate that different religious groups have different associations with the self-rated health of older adults: the presence of Buddhism and Islam has an overall negative association with self-rated health and the presence of Daoism and Christianity has an overall positive association with self-rated health, controlling for other factors. As the number of Buddhist temples and Islamic mosques increases, older adults

report worse self-rated health, and as the number of Daoist temples and Christian churches increases, older adults report better self-rated health. The statistical tests for these associations are conducted using AMEs which are presented in Table 13.

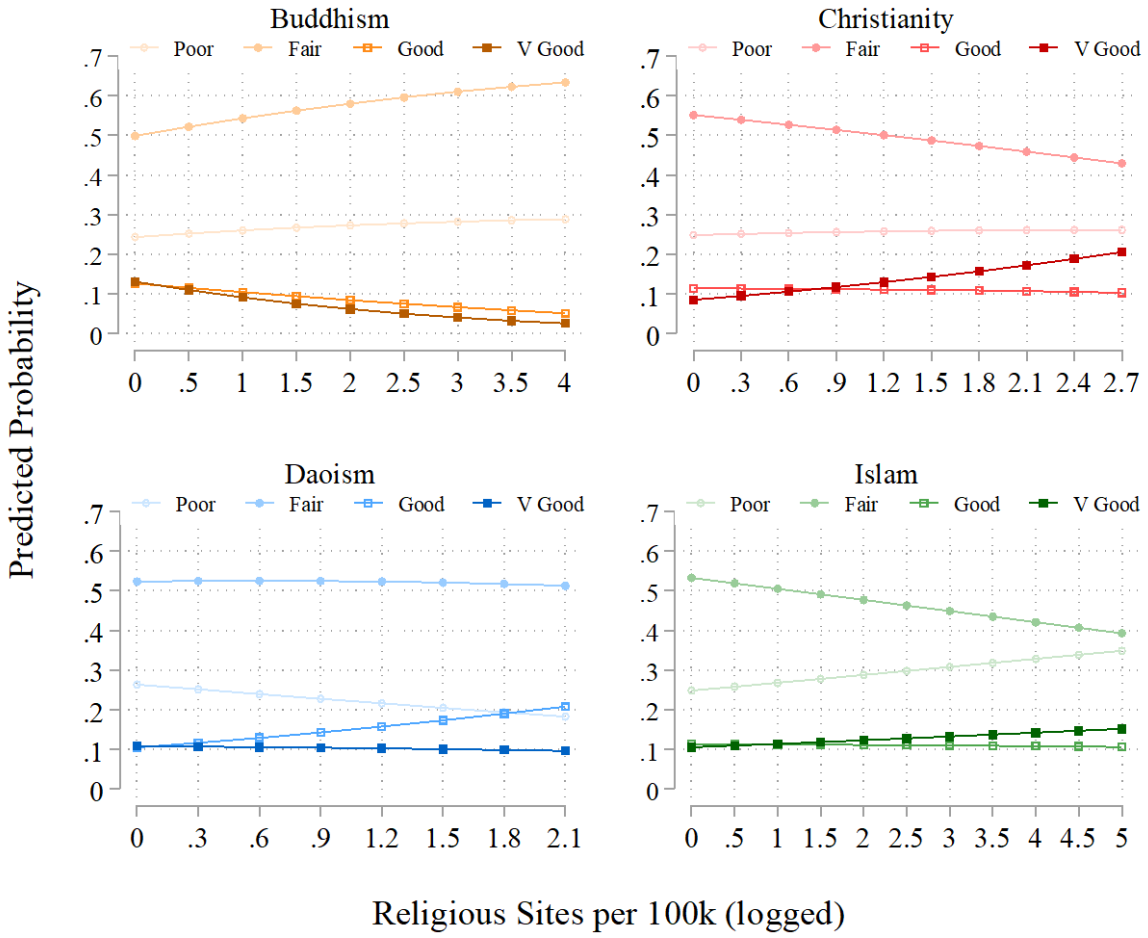

Figure 19. Predicted probabilities of self-rated health for the number of religious sites in Chinese prefectures, by religion.

Using Buddhism as an example, an increase in the presence of Buddhism is associated with a lower probability of reporting "good" and "very good" health and a higher probability of reporting "fair" health. This is a net negative ecological effect of Buddhism on self-rated health, as the probabilities for reporting better health categories decrease while the probabilities for reporting worse health categories increases. As shown in Figure 19, the probability of reporting "fair" health in prefectures with no Buddhist temples is predicted to be about 0.50, whereas the probability of reporting "fair" health in prefectures with the greatest number of Buddhist temples

in the data set is 0.630 ($\Delta = 0.13$, $p < 0.05$). Similarly, the probability of reporting "very good" health in prefectures with no Buddhist temples is predicted to be about 0.13, and the probability of reporting "very good" health in prefectures with the greatest number of Buddhist temples is 0.025 ($\Delta = -0.11$, $p < 0.001$). In summary, as the number of Buddhist temples increases across prefectures, respondents are increasingly likely to report "fair" health and decreasingly likely to report "good" and "very good" health.

Also shown in Figure 19, an increase in the number of Christian churches is associated with a lower probability of reporting "fair" health, and a higher probability of reporting "very good" health, which is a net positive ecological effect of Christian on self-rated health. An increase in the presence of Daoism is significantly associated with a lower probability of reporting "poor" health and a higher probability of reporting "good" health, which represents a net positive effect. For a greater presence of Islam, there is a lower probability of reporting "fair" health and a higher probability of reporting "poor" health, a net negative effect on self-rated health for Islam. In short, these results indicate that the presence of Buddhism and Islam have an overall *negative* association with self-rated health, and the presence of Daoism and Christianity have an overall *positive* association with self-rated health.

In terms of marginal effects, a standard deviation increase in the number of Daoist temples in Chinese prefectures is associated with a 0.016 decrease in the probability of reporting poor health ($p < 0.10$), no change in the probability of reporting "fair" health, a 0.017 increase in the probability of reporting "good" health ($p < 0.05$), and no change in the probability of reporting "very good" health. The other AMEs in Table 13 confirm that a greater presence of Buddhism and Islam is associated with a decrease in the probabilities of reporting better health categories and an increase in the probabilities of reporting worse health categories. In addition, a greater presence of Daoism and Christianity is associated with a decrease in the probability of reporting worse health categories and an increase in the probability of reporting better health categories. Table A4 in Appendix A presents the relative risk ratios (RRR) for this model.

Interactive Models

A multilevel multinomial logistic regression model with an interaction term between the total presence of religion in prefectures (total religious sites) and whether respondents report an individual religious identity show that there is no association between the overall religious

environment of prefectures and physical health outcomes in older adults, neither for religious individuals nor nonreligious individuals. The overall presence of religion impacts neither the health of religious people nor nonreligious people, as there is no difference in the effect of the religious environment between these two groups. Table A5 in Appendix A reports the relative risk ratios from this model.

Multilevel multinomial logistic regression models with interaction terms between the presence of each of China's major religions in prefectures and the individual religious identities of older adults show that associations between the religious environment and self-rated health do not depend on the religious identity of individuals. In other words, the influence of the presence of a particular religion on self-rated health (as previously shown in Figure 19 and Table 13) is no different for followers of some religions than for others. The association between the presence of Buddhism in prefectures and worse self-rated health is statistically the same for Buddhists, followers of non-Buddhist religions, and religious nones. Similarly, the association between the presence of Islam in prefectures and worse self-rated health is the same for Muslims, followers of non-Muslim religions, and religious nones. In addition, the association between the presence of Daoism in prefectures and better self-rated health is the same whether older adults are religious or not, and the association between the presence of Christianity in prefectures and better self-rated health is the same for Christians, followers of non-Christian religions, and religious nones. Tables A6-A9 presenting relative risk ratios from these interactive models are included in Appendix A.

Number of Chronic Illnesses

Base Models

A base multilevel negative binomial regression model predicting respondents' number of chronic illnesses reveal that a greater overall presence of religion in Chinese prefectures is not associated with the number of chronic illnesses reported by older adults. However, a base model examining the effect of the presence of each religion on the number of chronic illnesses suggests that a greater presence of Daoism is associated with fewer chronic illnesses and a greater presence of Islam is associated with more chronic illnesses. These base models adjust for individual and community characteristics but not for individual religious identity.

The first column of Table 14 shows the AMEs of the overall presence of religious sites (Total Sites) and the AMEs of the presence of each religion on the number of chronic illnesses among older Chinese adults, adjusting for personal and community characteristics. Again, these AMEs represent the average change in the number of chronic illnesses of older adults for a standard deviation increase in the number of religious sites in prefectures. The AME of the total number of religious sites on the number of chronic illnesses is not significantly different from zero (0.022, p = n.s.), suggesting that a greater overall presence of religion has no impact on the number of chronic illnesses experienced by older adults.

The AMEs for the chronic illnesses in Table 14 also show that, without adjusting for individual religious identity, both Daoism and Islam have significant associations with chronic illnesses. On average, a standard deviation increase in the number of Daoist temples in Chinese prefectures is associated with a 0.126 decrease in the number of chronic illnesses ($p < 0.05$) and a standard deviation increase in the number of Islamic mosques in Chinese prefectures is associated with a 0.035 increase in the number of chronic illnesses ($p < 0.05$). The presence of Buddhism and Christianity in prefectures appear to be unrelated to chronic illnesses in older Chinese adults. Incident ratios for these models are available in Models 1 and 2 of Table A10 in Appendix A.

Table 14. Average marginal effects of a standard deviation increase in religious sites(logged) on number of chronic illnesses.

	Models without individual religious identity		Models with individual religious identity	
	AME	SE	AME	SE
Total Sites	0.022	(0.038)	0.004	(0.040)
Buddhism	0.102	(0.063)	0.068	(0.062)
Christianity	–0.008	(0.034)	0.019	(0.029)
Daoism	–0.126*	(0.055)	–0.118*	(0.056)
Islam	0.035*	(0.018)	0.037	(0.023)

Note: * p < .05; AMEs calculated holding all control variables at their observed values.

Full Models

In full multilevel negative binomial regression models predicting respondents' number of chronic illnesses and adjusting for respondents' individual religious identity, the contextual effect of religion is isolated from the compositional effect of religion. In terms of the overall presence of religion, a full model with the total number of religious sites as the focal independent variable

shows that a greater overall presence of religion in Chinese prefectures is still not associated with the number of chronic illnesses reported by older adults. However, a full model examining the separate effect of the presence of each religion on the number of chronic illnesses suggests that only a greater presence of Daoism has an association with chronic illnesses, adjusting for individual religious identity and other factors. After accounting for the religious identities of respondents, the association between Islam and more chronic illnesses is no longer statistically significant.

The second column of Table 14 shows the AMEs of the overall presence of religious sites (Total Sites) and the AMEs of the presence of each religion on the number of chronic illnesses among older Chinese adults, adjusting for individual religious identity and other personal and community characteristics. The AME of the total number of religious sites on the number of chronic illnesses is not significantly different from zero (0.004, p = n.s.), showing that, controlling for individual religious identity and other variables, a greater overall presence of religion has no impact on the number of chronic illnesses experienced by older adults.

The AMEs for the chronic illnesses in the second column of Table 14 also show that, after adjusting for individual religious identity, only Daoism has a significant association with chronic illnesses. On average, a standard deviation increase in the number of Daoist temples in Chinese prefectures is associated with a 0.118 decrease in the number of chronic illnesses ($p < 0.05$). The presence of Buddhism, Christianity, and Islam appear to be unrelated to chronic illnesses in older Chinese adults. Figure 20 shows the negative relationship between the presence of Daoist temples in Chinese prefectures and the number of chronic illnesses. For prefectures with no Daoist temples, older adults are predicted to report having 1.74 chronic illnesses, whereas for prefectures with the greatest number of Daoist temples in the sample (2.1), older adults are predicted to report having 1.24 chronic illnesses, nearly half an illness fewer ($\Delta = -0.49$, $p < 0.05$). Incident ratios are available in Models 3 and 4 of Table A10 in Appendix A.

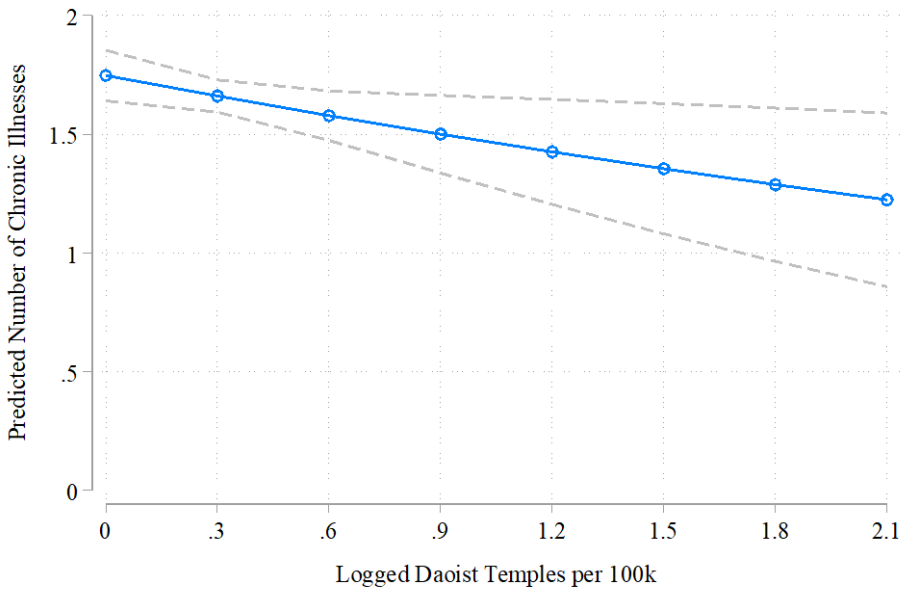

Figure 20. Predicted number of chronic illnesses for the number of Daoist sites (logged) in Chinese prefectures.

Interactive Models

Interactive models with product terms between the religious environment variables and the religious identities of respondents indicate that the association between the religious environment and number of chronic illnesses is not conditional on the religious identities of respondents. The effect of total religious sites on number of chronic illnesses does not differ between older adults who report a religious identity and those who do not (i.e., the association for neither group is significantly different from zero). In addition, models examining whether the effect of the presence of each religion is different between adherents and non-adherents of each religious group show no variation in the effect by the religious identities of respondents. For example, the presence of Christian churches in prefectures has no association with chronic illness, neither for self-identified Christians nor for others (followers of other religions and religious nones). Table A11 in Appendix A presents the incident rate ratios from these interactive models.

Results Summary

Table 15 provides a summary of the findings from the full models of both dependent variables. Viewing the results altogether can provide a better overall picture of how the religious

environment is related to the physical health of older Chinese adults. First, an increased presence of overall religion in Chinese prefectures, as measured by the logged total number of religious sites per 100,000 people in Chinese prefectures, has no association with the self-rated health and chronic illnesses of older adults, regardless of their religious identities. Next, the effect of the religious environment on health outcomes varies both by religion and by the measure of health. More specifically, an increased presence of Buddhism and Islam are associated with worse self-rated health among older adults but have no association with chronic illness. Christianity (which includes both Protestant and Catholic churches) is associated with better self-rated health but not chronic illness, and Daoism is associated with better self-rated health and fewer chronic illnesses.

Table 15. Direction of significant associations between prefecture-level religious sites and measures of individual health.

	Self-Rated Health	Chronic Illnesses
Total Sites		
Buddhism	–	
Christianity	+	
Daoism	+	–
Islam	–	

Note: Higher values of self-rated health represent better health, whereas higher values of chronic illnesses represent worse health.

In addition, slight differences between models that do and do not control for respondents' individual religious identity suggest that, although it is important to isolate the contextual effect from the compositional effect, the contextual effect of religion on health outcomes is the predominant statistical relationship responsible for the ecological effect of religion in prefectures on the physical health of older adults.

Discussion

The aim of these analyses has been to examine whether the religious environment of Chinese prefectures affects the physical health outcomes of older Chinese adults. The little scholarship previously conducted on associations between the religious environment of local areas and individual health outcomes has demonstrated that both the overall presence of religion and the presence of specific religions or denominations impact health (e.g., Huijts and Kraaykamp 2011;

Stroope and Baker 2018); however, a major limitation of prior research on this topic is that studies have almost exclusively focused on the United States and Europe, which have many cultural and political similarities and which are predominately Christian. The present study extends this work by 1) investigating the ecological effects of religion on health in China, 2) examining the ecological effect non-Christian world religions, and 3) providing evidence of religion's contextual effects distinct from its compositional effects.

Overall, the findings from these analyses confirm that religion is indeed an overlooked characteristic of the social environment that has a considerable impact on individual health of older adults in China. More specifically, all the major religions in China have a significant ecological effect on health (as shown in Table 15), even after accounting for the individual religious identities of respondents. In short, the prefecture-level presence of religion has contextual effects on health, impacting the self-rated health and number of chronic illnesses of individual older adults in addition to any impact that their individual religious involvement may have and regardless of what their individual religious identity might be. These analyses show that the presence of Daoism and Christianity in prefectures is associated with better self-rated health (for religious adherents and non-adherents in the case of Daoism and for Christians and non-Christians), whereas the presence of Buddhism and Islam is associated with worse self-rated health (for Buddhists and non-Buddhists and for Muslims and non-Muslims). Only, the presence of Daoism was related to chronic illness, reducing the number of chronic illnesses in prefectures with more Daoist temples. In contrast, the overall presence of religion (the combined presence of the major religions) had no associations with individual self-rated health or chronic illness. It is likely that because some religions (Daoism and Christianity) are associated with better health and some religions (Buddhism and Islam) are associated with worse health, the net effect of religion in total is zero.

Possible Explanations

Because this study was primarily exploratory, only broad hypotheses were initially posed about the ecological effects of religion on health in China. Below I provide more detailed *post hoc* explanations that may possibly account for the findings of this study. Because these analyses uncovered differences in the ecological effects of different religions, I organize these explanations by religious group.

Buddhism

As demonstrated in the findings of the study, the presence of Buddhism in the local religious environment is associated with worse self-rated health. This finding is quite surprising. Among the reasons to expect Buddhist to be associated with *better* physical health outcomes are Buddhism's health-promoting meditative practices, emphasis on compassionate behavior, and vegetarianism; however, these are all predominately *individual-level* practices, which may or may not have significant spill-over into the non-Buddhist community. Buddhism is also the most common religion with which individuals in China identify, is often regarded as a "Chinese" religion, and has a friendly relationship with the atheist Chinese government.

In terms of possible explanations for the association between Buddhism and worse health outcomes, there may be some aspect of the Buddhist belief system that leads to a greater focus on spiritual cultivation than on the physical body or living healthier lifestyles. Additionally, Buddhist beliefs, norms, and values may be influencing the psychological process of an individual rating their own health instead of influencing their health directly. For example, perhaps a greater influence of Buddhist worldviews—the focus on an "inner spirituality" in areas where there are more Buddhists—is causing all individuals to have a more negative *view* towards their own health and therefore report worse self-rated health (which may or may not accurately represent their physical health statuses). Finally, this may be a case of reverse causation in which difficult life circumstances (and its corollary poor health) may be leading more people to practice Buddhism and therefore lead to an overall increase of Buddhism in these areas. Among the most common topics about which Buddhist and Daoist temple-goers will pray are health and wealth. All these explanations, however, are not consistent with prior studies which found that religious participation in general (e.g., Yi, Gu, and Land 2007; Zhang 2010) and individual-level adherence to Buddhist and Protestantism in particular (Zhang et al. 2020) are associated with better health outcomes.[20] Uncovering the explanation for how the presence of Buddhism is associated with worse individual health in older adults is certainly an opportunity for further research.

[20] The poorer health outcomes (Deng et al. 2020) and heavy presence of Buddhism in Tibet may have produced strong enough associations to produce the findings here. Tibet, however, was not included in the CHARLS studies, so it is not represented in any of the models here.

Daoism

For both dependent variables in these analyses, the presence of Daoism in the local religious environment is associated with better health among older adults. The religious culture of Daoism may be particularly influential on the health in the non-religious subcultures of local areas because it is a traditional Chinese religion that is well-integrated into broader Chinese culture and that heavily informs the philosophy and practice of traditional Chinese medicine (TCM). As a "religion of the body", Daoism and its norms, values, and behaviors that promote health (Cheng 2017)—which are already found in various forms and to various degrees throughout China—may be more diffused across the prefectures where there is a greater presence of Daoism. Daoism's philosophy and practices focused on promoting health and longevity—generally referred to as *yangsheng* ("nourishing life")—and Daoist influences in *daoyin*, *qigong*, *taichi*, and other health-promoting body cultivation practices (Chen et al. 2019, Palmer 2007) may be partially responsible for the association between prefecture-level Daoism and individual-level health. In addition, Daoist temples are increasingly serving as sources of herbal remedies and traditional healing, which have been attracting visitors and tourists by the busload (Pettit 2020). Although there is mixed scientific evidence that the therapeutic use of these practices are effective at treating disease and illness, Daoism's overall health promoting messages may encourage other positive health behaviors, and the social communities that form to practice these exercises may foster social connection and social support, which are known to be associated with better health. It is also possible that a greater presence of TCM hospitals and clinics may be associated with greater healthcare utilization overall in local Chinese areas.

Islam

Islam's association with worse self-rated health in areas whether there are greater numbers of Islamic mosques might be explained by the oppressive policies undertaken by the Chinese government beginning during the Xi Jinping era to crackdown on extremist, terrorist, and separatist movements, primarily among the predominately Muslim ethnic minority group, the Uyghurs who live in Xinjiang (Pingua 2017). In May 2014, government efforts were intensified with the launching of a new campaign called the "Strike Hard Campaign against Violent Terrorism" (严厉打击暴力恐怖活动专项行动) which enacted a variety of oppressive policies in Xinjiang

including the detention, torture, and political "reeducation" of as many as one million Uyghurs in the region (Human Rights Watch 2018). The most forceful government policies have been carried out in Xinjiang in the years since 2012, so the high levels of political stress and social tension in areas where there are substantial populations of Muslim adherents may be resulting in poorer health outcomes for people living in these areas. To test whether strong associations between the presence of Islam and individual health outcomes among the observations among prefectures in Xinjiang may be responsible for the associations in the full analysis sample, I conducted auxiliary analyses excluding observations from Xinjiang province to compare with the models presented above. The coefficient of logged Islamic mosques per 100k people in models without observations from Xinjiang are not significantly different from models with observations from Xinjiang. This suggests that the ecological effect of Islam on health might be due to how these policies directed at Muslims in Xinjiang are indicative of greater social and political tensions in prefectures where Muslims live. Alternatively, these policies may not be affecting health at all, and the association is due to some other mechanism.

Christianity

In these analyses, the presence of Protestantism and Catholicism in the local religious environment is associated with better self-rated health. This association might be due to several reasons. First, the congregational nature of Protestant and Catholic churches may be an important "hub" for social interaction in Chinese communities, especially in rural areas. Both Christians and non-Christians may benefit from the social integration that churches encourage between community members. Second, although China has strict limits on the work of religious NGOs, Protestant and Catholic organizations–alongside of churches–are important providers of social welfare and charitable activities in the some of China's neediest areas. Services include providing disaster relief, elder care, resources to vulnerable migrant populations, disability services, education, environmental protection, certain limited medical care, and poverty alleviation. It is also possible that the strict and suppressive regulation of religion in China, historically targeted at Protestantism and Catholicism, may negate the health-promoting ecological effects of Christianity in local communities.

Study Limitations and Future Research

Several study limitations warrant mention. First, because religion is a multi-dimensional phenomenon, the single individual religious identity item in the 2014 CHARLS Life History Survey is limited in its measurement of the religious lives of older Chinese adults. Future studies that include measures of religious salience, frequency of religious practice(s), or levels of religious belief in the interactive models of these analyses may reveal that the effect of religious ecology on physical health outcomes varies differently across other dimensions of religion. In addition, the contextual effect of a given religion may not be entirely isolated from the compositional effect, if for example, a prefecture with more Daoist temples, is home to many respondents who practice Daoism but who did not identify as Daoist in the CHARLS survey. Considering alternative ways of measuring religion and religious involvement is especially important for studies in China and other East Asian societies, where individuals are more likely to practice religion or hold religious beliefs than they are to publicly identify or affiliate with religion. Only about 10 percent of CHARLS respondents in the analysis sample reported a religious identity (6 percent are Buddhist); however, evidence from other national surveys in China (e.g., Spiritual Life Survey of Chinese Residents 2007) reveal that about half practice religion in some form. Despite the possible reluctance of Chinese people, particularly followers of traditional Chinese religions, to publicly identify with a specific religious tradition, their responses on the religious identity survey item in the CHARLS survey are likely to still be useful and informative for this study. For example, respondents who select Buddhism in the CHARLS survey item can be assumed to either be exclusively Buddhist or predominately Buddhist, suggesting that Buddhism may play a particularly important role in their lives (or health).

Second, the religious sites data from OSAC which were used to represent the religious environment were collected in 2004, whereas the CHARLS survey began data collection in 2011. Because religion has been growing in China, there are many new religious sites across China that are not available in these data. I conduct these analyses, however, with the assumption that although the number of religious sites has increased, the relative patterns of religious ecology in China, the distribution of religion across prefectures, and influence of religion on health has not changed substantially since 2004. Future research that includes alternative measures of the religious environment (i.e., number of religious adherents) that are more proximate in time to the

measures of individual respondents' health outcomes could aid the validation of the findings presented here.

Third, examining the effect of the religious environment on alternative measures of physical health outcomes is another proposed extension of this research. Although self-rated health has been affirmed as a reliable measure of individual health and as good predictor of individual morbidity (Idler and Kasl 1995; Idler, Russell, and Davis 2000; Latham and Peek 2013; Lee 2000; Leung, Tang, and Lue 1997), its subjective nature may make it vulnerable to religion's influences on individuals' attitudes, beliefs, and emotional states and feelings. Does the religious environment impact health itself or does it impact individuals' perceptions, ratings, or assessments of their health? The additional measure of the health (chronic illnesses) of older Chinese adults included in this study has aimed to address this possibility, but further analyses that include another health indicators such as biomarkers and blood markers would provide additional results to better understand how the religious environment is impacting the health of older adults.

Fourth, because these analyses are cross-sectional in nature, it is possible that selection effects are present or that the direction of the proposed association is reversed, such that individual health determine levels of religious participation—and by consequence demand for religious venues—in local geographic areas. Studies of how the religious environment impacts health trajectories using multilevel longitudinal data of both the religious environment and individual-level health outcomes would provide stronger evidence of religion's ecological effects on health and rule out the possibility of selection effects or that health is driving changes in the religious characteristics of local geographic areas. Prior studies on this issue, however, suggest that health may not be an important determinant of religious participation (e.g., Ellison et al. 2014; George, Ellison, and Larson 2002).

Finally, the exploratory nature of this study has limited it to uncovering associations between the make-up of local religious environments in China and health outcomes. Why these associations exist remains to be explained. Future research should more explicitly test a wide variety of possible theoretical mechanisms—such as those outlined above—that may explain the associations discovered here. In Chapter 5 of this dissertation, I conduct mediation analyses to test a few such mechanisms.

CHAPTER 5: SOCIAL PARTICIPATION, SOCIAL SUPPORT, AND HEALTH BEHAVIORS AS MEDIATORS OF THE ECOLOGICAL EFFECTS OF RELIGION ON THE PHYSICAL HEALTH OF OLDER ADULTS IN CHINA

Introduction

As broadly conceptualized in Chapter 2 and demonstrated empirically for the mainland Chinese context in Chapters 3 and 4, the religious environment is a socio-cultural feature of local geographic areas that influences the health and mortality of the people living there. Scholars proposing an ecosocial framework—for explaining how macro-level characteristics of a social environment affect individual health—have theorized that psycho-social resources (e.g., social support, social participation) and health behaviors (e.g., substance use, diet, exercise) are among the mechanisms that link characteristics of local areas and to individual-level health outcomes (e.g., Berkman et al. 2000). These same mechanisms have also been found to play an important role in explaining how individual-level religious involvement affects individual health (e.g., George, Ellison, and Larson 2002; Idler 2014). Given this overlap in the theoretical and empirical work of these two bodies of literature, I argue that the social participation, social support, and health behaviors are ways by which the religious environment where someone lives can impact their physical health. In this study, I build on the analyses in Chapter 4 to examine potential mechanisms that link the religious environment to physical health outcomes. Using the same dataset and variables, I conduct mediation analyses to determine whether social participation, social support, and health behaviors explain associations between the religious composition of Chinese prefectures and health outcomes among older adults: *Do social participation, social support, and health behaviors mediate the associations between the religious composition of Chinese prefectures and physical health outcomes among older adults?*

Background

An ecosocial framework for understanding how the social-structural conditions of local areas are related to individual-level health highlights the role of social networks and social relationships in a chain of influence (Berkman et al. 2002). In Berkman et al.'s (2002) conceptual model, macro-level features of a social environment (e.g., cultural, socioeconomic, and political

factors) condition the structure, function, and attributes of social network ties, which in turn provide opportunities for interpersonal contact, social support, social influence, social engagement, and access to resources. These then impact health outcomes via health behavioral, psychologic, or physiologic pathways. I have argued that the religious environment of a local area—namely its religious composition—is an important and overlooked macro-level socio-cultural characteristic that fits within this conceptual model. Although a few studies have demonstrated links between the religious environment and health and mortality (e.g., Blanchard et al. 2008; Dwyer, Clarke, and Miller 1990; Garcia, Bartkowski, and Xu 2017; Stroope and Baker 2018), no published research has established the mechanisms responsible for these associations.

Research on the ecological effects of religion on health is limited, but the large body of work on the individual effects of religion on health provides helpful insights into the likely mechanisms linking the religious environment to health. Scholars have identified the following major links between individual religious involvement and health: 1) health and lifestyle behaviors; 2) social resources; 3) coping resources and behaviors; and 4) attitudes, beliefs, and emotional states and feelings (Chatters 2000; Ellison and Levin 1998; George, Ellison, and Larson 2002). These overlap considerably with the mechanisms proposed in the conceptual model proposed by Berkman et al. (2002), suggesting that these same mechanisms might play an important role in explaining how the religious environment influences individual health.

Although relatively few studies in China have explicitly examined the mechanisms by which individual religion is associated with health, evidence suggests that social participation and social support have positive health benefits for older adults in China. Emotional support is associated with better physical health (Liu, Liang, and Gu 1995; Liu et al. 2016; Xu 2019; Yip et al. 2007), household support is associated with lower mortality risk (Liang et al. 2000; Zhang, Li, and Silverstein 2005), and general social support is associated with higher subjective well-being and life satisfaction (Deng et al. 2010; Shen and Yeatts 2013). Similarly, participation in social activities has also been linked with better physical health (Gao et al. 2018; Liu et al. 2019), mental health (Guo, Bai, and Feng 2018), and overall well-being (Li et al. 2018; Zhang and Zhang 2015). A study of religious participation found that social activities partially mediated the effect of religious involvement on mortality risk (Zhang, Hannum, and Wang 2008). Other community factors such as social cohesion, neighborhood satisfaction, and safety also have strong associations with physical health outcomes for aging adults in China (Wen et al. 2010; Zhang and Zhang 2017).

In terms of health behaviors, religious involvement is associated with lower levels of smoking (Brown and Tierney 2009; Wang, Koenig, and Al Shohaib 2015) and drinking (He et al. 2016; Wang et al. 2015). In particular, traditionally Muslim ethnic minority groups in China have lower prevalence of tobacco and alcohol use than non-Muslim Han in northwest China (Liu et al. 2014; Pan and Shallcross 2016).

Integrating these theoretical, conceptual, and empirical insights, I argue that the presence of religion in general and/or the presence of certain religious groups in particular helps shape the "social fabric" of geographic areas and communities. The religious environment contributes to the social integration of local areas by providing opportunities for social connections (e.g., social gatherings, cultural events, community cohesion) and network ties which either directly provide psycho-social resources (e.g., social support, material support, non-profit services, sense of belonging, trust) or provide means by which religious ideas, norms, and behaviors (e.g., health practices and behaviors) are diffused throughout the broader public subculture. Prior empirical work in China shows that individuals with access to these kinds of social support resources (e.g., Deng et al. 2010; Liu, Liang, and Gu 1995; Zhang, Li, and Silverstein 2005), networks with high levels of social trust (Feng et al. 2016), and exposure to religious norms—like those regarding smoking and drinking (e.g., Brown et al. 2009; He et al. 2016; Wang et al. 2015)—have better health outcomes. In this study, I suggest that the religious environment may be linked to physical health via these same pathways that individual religion is linked to physical health.

To illustrate how the religious environment may impact individual health via these proposed mechanisms, I provide a few possible examples. First, individuals who live in areas with a greater presence of Daoism are more likely to have social connections (i.e., network ties) with adherents of Daoism. Through these social connections, Daoist thought, norms, and practices that have health implications (e.g., body cultivation, traditional Chinese medicine) may diffuse beyond the Daoist community, such that even non-Daoists experience health benefits/consequences of a local public subculture influenced by Daoism. As another example, individuals who live in areas with a greater presence of Islam may experience negative health consequences due to the recent political situation of Uyghurs, a traditionally Muslim ethnic minority group. Because of oppressive government policies directed at Uyghurs in China, most notably in the Xinjiang autonomous region, communities with a substantial Muslim population are likely to be characterized by political and social tensions that disrupt social bonds in the community and operate as social stressors with

negative health effects, not only for Muslims but also for non-Muslims. A final example involves Chinese folk religion, which is extremely diverse across China, and which has traditionally played an important community role, especially in rural areas. Local folk religion temples (labeled as Daoist in the OSAC dataset) have been a major hub of community life, serving as sites for local deity worship, communal rituals, annual ceremonies, and festival activities, all of which contribute to social solidarity and build social ties between individuals (Yang and Hu 2012). These social relationships may encourage greater levels of social support and social engagement by all members of the community, which may in turn have health benefits.

By examining the mechanisms by which the religious environment impacts health, the analyses in this chapter contribute to both research on the social determinants of health—by drawing attention to how religion in general and the religious environment in particular influence health—and to research on the persistent links between religious involvement and health. Given the strong associations between religion and social relationships, between social relationships and health, and between religion and health behaviors, it is important to investigate the ways that these associations are linked together to influence health outcomes. Whereas the previous chapter demonstrated that the religious environment is an overlooked social factor that has significant associations with the health of older Chinese adults, this chapter seeks to explain why the associations exist and by what processes the religious environment of local areas impacts physical health. In the analyses that follow, I examine social participation, social support, and health behaviors as such potential mechanisms.

Hypotheses

Drawing on theoretical, conceptual, and empirical insights from socio-ecological approaches to health, ecological studies of religion, and studies of associations between religion and health outlined in Chapter 2, I have developed the following hypotheses.

Due to the salubrious health effects of social participation in China (e.g., Gao et al. 2015) and the opportunities for social participation provided by religion and religious institutions (e.g., Ellison and George 1994), I expect:

H1: *Social participation will partially mediate associations between the religious ecology of prefectures and physical health outcomes of older adults.*

Due to the salubrious health effects of social support (e.g., Liu et al. 1995, 2016; Xu 2019) and the opportunities for social support provided by religion and religious institutions (e.g., Koenig et al. 1997; Krause 2006), I expect:

H2: *Social support will partially mediate associations between the religious ecology of prefectures and physical health outcomes of older adults.*

Due to the detrimental health effects of smoking and drinking behaviors as well as religious norms related to smoking and drinking in China (e.g., Brown and Tierney 2009; Liu et al. 2014; Wang et al. 2015), I expect:

H3: *Smoking and drinking behaviors will partially mediate associations between the religious ecology of prefectures and physical health outcomes of older adults.*

Data & Methods

This study uses the same multilevel dataset as the study in Chapter 4, which I constructed by merging data from the Online Spiritual Atlas of China (OSAC) (Yang et al. 2019) and the China Health and Retirement Longitudinal Study (CHARLS) (Zhao et al. 2020). The same dependent, focal independent, control variables, and analysis sample (n = 7,688) from Chapter 4 are used here. To test whether social participation, social support, and health behaviors are pathways through which the religious environment influences the health of older adults, I include the mediating variables highlighted below.

Mediating Variables

Social Participation

Number of Social Activities: To measure the number of social activities respondents participated in: CHARLS asked respondents, "Have you done any of these activities in the last month?" The following response options were given: "(a) interacted with friends; (b) played Mahjong, played chess, played cards, or gone to a community club; (c) provided help to family, friends, or neighbors who do not live with you; (d) gone to a sport, social, or other kind of club; (e) taken part in a community-related organization; (f) done voluntary or charity work; (g) cared

for a sick or disabled adult who does not live with you; and (h) attend an educational or training course." I sum the total number of affirmative responses (Liu et al. 2019).[21]

Frequency of Social Activity: As a follow-up to the previous question, CHARLS asked respondents, "How often in the last month did you [do voluntary or charity work/cared for a sick or disabled adult/provided help to family, friends or neighbors/ played mahjong or chess/interacted with friends /go to a sport, social or other kind of club/taken part in a community-related organization/attend an educational or training course]?" Response options for each question include: 1 = "not regularly," 2 = "almost every week," and 3 = "almost daily." To get a measure of overall frequency of social activity, I sum these responses.[22]

Social Support

Perceived Availability of Future Social Support: To measure anticipated social support, CHARLS asked respondents, "Suppose that in the future, you needed help with basic daily activities like eating or dressing. Do you have relatives or friends (besides your spouse/partner) who would be willing and able to help you over a long period of time?" Respondents answered "yes" or "no." (Cheng et al. 2016; Silverstein, Gong, and Kendig 2020).[23]

Financial Support: An alternative measure of social support is financial support provided by non-coresident relatives and friends. CHARLS asked respondents two questions, one regarding cash gifts and one regarding other in-kind financial support: 1) "In the past year, how much cash gift did you or your spouse receive from your non-coresident other relatives or friends? Total money and in-kind support in yuan (for example, marriage and funeral/move to new house/newborn/going to university, and aid after falling ill or difficulties in daily life, but not including borrowing money)" and 2) "In the past year, how much financial support did you or your spouse receive from your non-coresident other relatives or friends, excluding cash gift? Total

[21] Auxiliary analyses show that individuals who identify with Christianity participate in more social activities than individuals who identify with no religion.
[22] Auxiliary analyses show that individuals who identify with Islam participate social activities less frequently than individuals who identify with no religion.
[23] Auxiliary analyses show that individuals who identify with Islam are more likely to indicate the availability of future social support than individuals who identify with no religion.

money and in-kind support in yuan." I create a new binary variable indicating whether respondents received any cash gift or other in-kind support.[24]

Health Behaviors

Alcohol Use: To measure alcohol use, CHARLS asked respondents, "Did you drink any alcoholic beverages, such as beer, wine, or liquor in the past year? How often?" Response options included: "drink more than once a month," "drink but less than once a month," and "none" (Li et al. 2019). A measure of former alcohol use "Did you ever drink alcoholic beverages in the past? How often?" with the same response options as above. Respondents who drink monthly were asked "How often did you drink [liquor/beer/wine] per month in the last year?" in three separate questions. Response options include: "Once a month, 2-3 times a month, Once a week, 2-3 times a week, 4-6 times a week, Once a day, Twice a day, More than twice a day." Using these measures, I created a new variable measure the frequency of current alcohol use with former drinkers and current non-drinkers coded as 0, less than monthly drinkers coded as 1, and current monthly or more drinkers coded as 2—9 (2 = "Once a month", 3 = "2-3 times a month", 4 = "Once a week", 5 = "2-3 times a week", 6 = "4-6 times a week", 7 = "Once a day", 8 = "Twice a day", 9 = "More than twice a day"). This variable is treated as continuous in the analyses.[25]

Smoking: To measure smoking behavior, CHARLS asked respondents, "Have you ever chewed tobacco, smoked a pipe, smoked self-rolled cigarettes, or smoked cigarettes/cigars?" Respondents answered "yes" or "no" and were prompted to answer "yes" if they have smoked more than 100 cigarettes in their life. A follow-up question asked respondents, "Do you still have the habit, or have you totally quit?" Response options include "Still have" or "Quit." Using these items, I categorize respondents into 2 categories of "former/current smokers" and "never smokers."[26]

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[24] Auxiliary analyses show that individuals who identify with Islam are more likely to indicate receiving financial support from non-coresident relatives and friends than individuals who identify with no religion.

[25] Auxiliary analyses show that individuals who identify with Islam report less frequent alcohol use than individuals who identify with no religion.

[26] Auxiliary analyses show that individuals who identify with Islam are more likely and individuals who identify with Christianity are less likely to be smokers than individuals who identify with no religion.

In addition, exercise was considered as a potential mediating factor between the religious environment and physical health outcomes in older adults. The CHARLS survey, however, only presented questions about the amount, intensity, and frequency of physical exercise activities to half of their survey respondents. Therefore, the analysis sample size for models examining physical exercise as a mediation was too small to feasibly conduct the multilevel mediation analyses in this study.

Analytic Strategy

To test for whether social participation, social support, and health behaviors are mechanisms by which the religious composition of Chinese prefectures influences physical health outcomes in older adults, I conduct mediation analyses using the multilevel structural equation modeling (MSEM) framework. Other approaches are found to produce estimates that conflate the between- and within-level components of the model used to determine indirect effects (Preacher, Zyphur, and Zhang 2010; Zhang, Zyphur, and Preacher 2009). This leads to biased and unreliable tests of mediation.

For these analyses, I first estimate intraclass correlation coefficients (ICC) from variance components models to examine whether there is variation in the mediating variables at the various levels of data. Table 16 presents these ICCs which indicate what proportion of the variation in these mediators is accounted for by the clustering of the observations at each of the levels. Because I argue that the prefecture level religious environment impacts individual health via these proposed mediators, I expect these mediators to vary across prefectures (as well as communities and households). The ICCs in Table 16 show that between about 3 and 10 percent of the variance in each of these proposed mediators is attributed to factors at the prefecture-level.

Table 16. Intraclass correlation coefficients (ICC) at each level clustering from variance components models for proposed mediating variables.

Level	Prefecture	Community	Household
Number of Social Activities	0.040 (0.009)	0.067 (0.010)	0.269 (0.250)
Frequency of Social Activity	0.043 (0.010)	0.071 (0.011)	0.272 (0.025)
Perceived Availability of Future Social Support	0.069 (0.014)	0.070 (0.014)	0.544 (0.290)
Financial Support	0.099 (0.032)	0.330 (0.047)	0.330 (0.047)
Alcohol Use	0.043 (0.227)	0.043 (0.029)	0.043 (0.029)
Never Smoked	0.031 (0.010)	0.031 (0.010)	0.031 (0.010)

Note: Standard errors in parentheses.

Next, I estimate the MSEM models. Because the focal independent variables are at prefecture level (Level 2)[27] and the mediating and outcome variables are at the individual level (Level 1), the

[27] The initial modeling strategy for this project attempted to use the same data structure and variables and the models in Chapter 4; however, given the complexity of the data structure (i.e., four nested levels), I did not have success achieving model convergence with 4-level MSEM models. Because auxiliary analyses from Chapter 4 showed that

MSEM models in these analyses follow a 2-1-1 design (Preacher et al. 2010).[28] I test for mediation by calculating the indirect effect—using the product of coefficients approach—of the religious environment variables on the physical health outcome variables via each proposed mediator above. Separate models are run for each combination of physical health outcome and mediating variable, and an indirect effect is calculated for each of the four variables measuring the composition of Chinese prefectures for each of China's major religions (Buddhism, Christianity,[29] Daoism, and Islam). There are two dependent variables and six mediators to test, resulting in a total of 12 different models. I test the indirect effects for each of the four religions for each model, resulting in 48 individual coefficients to examine.[30]

Results

Descriptive statistics for all model variables are found in Table 10 in Chapter 4. Table 17 below shows descriptive statistics for the proposed mediating variables used in these analyses. The mean number of social activities (out of a total of 8 possible) participated in by respondents is 0.59, and the mean score on the total frequency of social activity is 1.17 (out of a possible 24 points). Two-thirds of respondent indicated having a non-spousal relative or friend who they believed could help them out in the future should they need assistance with basic daily activities for an extended period. About 29 percent indicated receiving financial assistance from non-coresident friends or family. In terms of health behaviors, the mean level of alcohol usage is 1.59 (on the 0-7 scale or about 68 percent drank alcohol in the past year), and about 57 percent of respondents report having never smoked (maximum of 100 cigarettes in their lifetime).

2-level models produced nearly identical results as 4-level models, specifying simplified 2-level MSEM models are sufficient for the mediation analyses performed here.

[28] For these models, all dependent variables are treated as continuous variables.

[29] As described in Chapter 4, the CHARLS questionnaire item measuring individual religious identity does not distinguish between Protestantism and Catholicism, collapsing the two into a single response option "Christianity." Therefore, in all models in Chapter 3 and Chapter 4, I combine the number of Protestant and Catholic churches into a single measure capturing the presence of Christianity in Chinese prefectures.

[30] Not all these coefficients are of real interest, because many are testing for the mediation of relationships that were not statistically significant in Chapter 4. For example, the presence of Buddhism was not associated with number of chronic illnesses in Chapter 4, so I do not expect to find indirect effects of Buddhism on chronic illnesses through the proposed mediators in this study. A suppression effect is possible, but I do not have theoretically derived hypotheses for these.

Table 17. Descriptive statistics for proposed mediating variables (N = 7,688).

Variable	Mean/Prop.	Freq.	SD	Min.	Max.
Number of Social Activities	0.59		0.03	0	7
Frequency of Social Activity	1.17		1.91	0	16
Perceived Availability of Future Social Support	0.67	5,146			
Financial Support	0.29	2,227			
Alcohol Use	1.59		2.83	0	9
Never Smoked	0.57	4,377			

Table 18-Table 23 present the indirect effects calculated from MSEM models. In summary, none of the indirect effects calculated tested here provide evidence that any of the six proposed mediators in these analyses are responsible for the associations between the religious environment and measures of self-rated health and chronic illness. The purpose of these analyses was to explain the associations found in Chapter 4 using mediating variables chosen based on the theoretical models and empirical studies outlined in Chapter 2. However, the findings from these mediation analyses suggest that there are no indirect effects between the religious composition of Chinese prefectures and individual health via these measures of social support, social participation, and health behaviors. The following tables present the indirect effects of the religious environment variables on the self-rated health and then number of chronic illnesses via the proposed mediators. None of the indirect effect coefficients in these tables are statistically significant from zero, indicating that none of these variables mediated the associations found between the religious environment and health in Chapter 4.

Table 18. Indirect effect of religious environment variables on self-rated health and the number of chronic illnesses via frequency of social activities.

	Self-rated Health	Chronic Illnesses
Buddhism	0.007 (0.009)	–0.007 (0.010)
Christianity	0.004 (0.005)	–0.004 (0.006)
Daoism	–0.000 (0.007)	0.001 (0.041)
Islam	0.001 (0.003)	–0.005 (0.007)

Note: * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

Table 19. Indirect effect of religious environment variables on self-rated health and the number of chronic illnesses via number of social activities.

	Self-rated Health	Chronic Illnesses
Buddhism	0.004 (0.004)	–0.004 (0.005)
Christianity	–0.000 (0.001)	–0.001 (0.008)
Daoism	–0.000 (0.003)	0.002 (0.019)
Islam	0.000 (0.001)	–0.002 (0.003)

Note: * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

Table 20. Indirect effect of religious environment variables on self-rated health and the number of chronic illnesses via perceived availability of future social support.

	Self-rated Health	Chronic Illnesses
Buddhism	0.002 (0.002)	–0.002 (0.003)
Christianity	0.000 (0.000)	–0.000 (0.004)
Daoism	0.003 (0.004)	–0.016 (0.013)
Islam	0.000 (0.001)	–0.002 (0.002)

Note: * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

Table 21. Indirect effect of religious environment variables on self-rated health and the number of chronic illnesses via non-coresident financial support.

	Self-rated Health	Chronic Illnesses
Buddhism	–0.001 (0.004)	0.001 (0.004)
Christianity	0.001 (0.002)	–0.001 (0.003)
Daoism	–0.003 (0.005)	0.014 (0.020)
Islam	–0.001 (0.001)	0.002 (0.002)

Note: * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

Table 22. Indirect effect of religious environment variables on self-rated health and the number of chronic illnesses via alcohol use.

	Self-rated Health	Chronic Illnesses
Buddhism	–0.015 (0.015)	0.015 (0.017)
Christianity	0.001 (0.006)	–0.001 (0.003)
Daoism	–0.043 (0.043)	0.196 (0.108)
Islam	–0.000 (0.007)	–0.009 (0.014)

Note: * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

Table 23. Indirect effect of religious environment variables on self-rated health and the number of chronic illnesses via smoking.

	Self-rated Health	Chronic Illnesses
Buddhism	–0.003 (0.002)	0.003 (0.003)
Christianity	–0.000 (0.001)	0.000 (0.001)
Daoism	–0.000 (0.001)	0.000 (0.008)
Islam	0.000 (0.000)	0.000 (0.001)

Note: * p < .05, ** p < .01, *** p < .001; Standard errors in parentheses.

Discussion

The findings from these mediation analyses suggest that the ecological effect of religion on the health of older adults in China may not be due to mechanisms related to social participation, social support, and health behaviors. How the presence of Buddhism and Islam are associated with worse health and the presence of Daoism and Christianity are associated with better health remains unexplained. Below I outline possible explanations for these findings and alternative explanations for how the religious environment impacts health in China.

Possible Explanations

Several possible alternatives explanations may account for the null findings of this study. First, most of the prior theoretical and empirical work on both religious ecology in general and its relationship to health in particular has been done in Western contexts. The relationships in question may function differently in Chinese society, possibly due to major cultural differences or to the political situation of religion in China. Cultural norms related to interpersonal relationships may impact the characteristics of social network structures in China and thereby the role of social connections in the association between the religious environment and physical health. In general, Chinese people have high degrees of trust in members of their own family and in a few close friends (members of their "ingroup") but tend to distrust others outside of their family or circle of close friends (members of their "out group") (Yang et al. 1993). In addition, studies of social support in China show that close kinship ties provide more instrumental support whereas close friends or coworkers provide more emotional support (Ruan et al. 1997). Given the nature and function of social ties in China, the local religious environment may not encourage social

connections in ways that promote high enough levels of social support and social engagement to benefit individual health.

In addition to differences in social network structures in China, the political climate in which religion operates in China may limit religion's capacity for social influence. In fact, the religion policy of the Chinese government aims at limiting the influence of religion on broader Chinese society. The strict regulation of religion in China likely weakens the effect of local religious subcultures on local public subcultures via interpersonal relationships and social network influences, particularly in a society where individuals are less public about their own personal religious beliefs and practices and where a large proportion of the population is not religious. Given both the cultural functions of social ties and social support in China, as well as the political climate in China that suppresses religion and reduces the ways religion connects people to one another, these mechanisms may not operate in the Chinese context as they do in the United States where the theoretical models were constructed.

The mechanisms examined in this study to explain how the religious composition of Chinese prefectures is associated with self-rated health and chronic illness have only included those that operate via network ties and social relationships. Structural mechanisms, however, are another category of mechanisms by which the religious environment might impact health. For example, perhaps the presence of certain religious group affects the quality and availability of health care resources. Throughout China, both Protestant and Catholic groups have established social service organizations and facilities particularly for elder care and disability services (Gao 2021). In addition, traditional Chinese medicine (TCM) hospitals and clinics as well as sources of traditional herbal remedies and healing techniques may be more prevalent in areas with a greater presence of Daoism. The stressors associated with the harsh policies targeting Islam may also affect the health of individuals in predominately Muslim areas more directly or via pathways unrelated to social ties and social support. Future research on the ecological effects of religion on health should consider structural factors as potential mechanisms.

Although the results from this study indicate that the effect of the religious environment on physical health is not via indirect associations with social participation, social support, and health behaviors, these mediators may still play an important role. Because this topic has been understudied, future research is required for a more complete understanding of how the religious environment affects health outcomes both in China and elsewhere. It is possible that data

limitations are a factor in the results of this study. In particular, the measures of the social support and social participation, although adequate, are not ideal. Improved measures of social support would better represent the kind(s) of social support that is most likely to operate as a mechanism of religion's ecological influence on health. and a survey item measuring frequency of participation in religious groups and religious activities is an important variable not included in this dataset.

Limitations

In measuring both the number and frequency of participation in social activities, the mediation analyses in this chapter captures a broad range of social activities, many of which people may be more likely to participate in because of the presence of religious norms and values in a community (e.g., interact with friends, provide help, volunteer or charity work, care for sick). My argument in this dissertation is that the presence of religion in a community may help facilitate social connection between community members both through both religious activities and non-religious activities. For these analyses, I assume that participation in more of these different activities reflects greater social integration, which I argue has health benefits. A weakness of these measures is the absence of an item asking about participation in religious activities and items measuring frequency of participation in each activity (the questionnaire only asks for overall frequency of participation in social activities. Having this additional information would allow for the separation of the possible mediating effects of social engagement via religious activities and social engagement via nonreligious activities as well as determine how much participation in each activity influences health outcomes.

In terms of social support, the prominent role and strong expectation of the family (adult children and their spouses) in caring for older adults in Chinese culture (i.e., filial piety), the measure of perceived availability of social support may not have enough variation, as most respondents will likely expect an adult child to help care for them. Were it more common in China for non-family members to assist older adults with basic daily activities, it may be more likely that the religious environment impacts health through the kind of instrumental support measured by this item. Notably absent from the CHARLS survey are items capturing emotional support, either currently received or anticipated in the future. In addition to support for daily activities and financial support, I also expect that emotional support is an important mechanism by which the

religious environment affects health outcomes. Prior research indicates that individual religious involvement is associated with increased emotional support (e.g., Edgell, Tranby, and Mather 2013), emotional support is associated with better physical health (e.g., Reblin and Uchino 2008; Lyyra and Heikkinen 2006), and emotional support partially mediates the relationships between individual religious involvement and physical health (e.g., Holt et al. 2013; Krause, Ellison, and Marcum 2002).

In addition, an ideal set of data would also include variables with information about respondents' social networks. Without his information we know little about the people with whom respondents are interacting during the above social activities. Are their ties religious or non-religious? How many and how dense are their social ties? Because these data do not include network information outside of respondents' families, it is not possible to determine whether indirect effects of the religious environment on health operate via the structure and characteristics of respondents' social networks. Future research on this topic should aim to include information about respondents' social networks as well as alternative measures of social support and social participation.

CHAPTER 6: CONCLUSION

Summary and Discussion of Findings

This dissertation is the first empirical study to investigate the ecological effects of religion on health and mortality in China. Because the research literature on the health effects associated with the religious environment is small, I integrated theoretical, conceptual, and empirical insights from socio-ecological approaches to health, ecological studies of religion, and studies of associations between religion and health to develop a theoretical case for how the religious environment is an important determinant of health. Then, I presented empirical analyses examining associations between the religious environment and population health and mortality in China. In Chapter 3, I investigate associations between the religious environment and population mortality using census data aggregated at different geographic levels. In Chapters 4 and 5, I examine whether religion has contextual effects on individual health outcomes using a nationally representative sample of older Chinese adults, and I test whether social support, social participation, and health behaviors are mechanisms that link the religious environment to individual health. Overall, this dissertation draws attention to religious ecology as an important—yet overlooked—determinant of population health and mortality in China.

In Chapter 3, I use spatial regressions models to examine associations between the religious composition of Chinese counties and prefectures—as measured by the number of religious sites—and their all-cause mortality rates. These analyses also investigate whether these associations differ by geographic scale—whether the religious environment of Chinese counties or prefectures differ in their effects on mortality rates. After accounting for spatial dependencies, the findings suggest that the overall presence of religion in Chinese counties and prefectures is associated with population mortality. In addition, models in which different religions are examined separately, the presence of Buddhism and Islam are associated with lower mortality rates, but these associations are due to common links with the presence of ethnic minority populations.

In Chapter 4, I conduct multilevel analyses examining the effects of the religious composition of Chinese prefectures on physical health outcomes of older Chinese adults. The findings from these models show that areas with a greater presence of Daoism have better self-rated health and fewer chronic illnesses. The presence of Christianity is associated with better self-

rated health but not number of chronic illnesses, whereas the presence of Buddhism and Islam—in contrast to associations with lower mortality rates in Chapter 3—is associated with worse self-rated health. By controlling for respondents' individual religious identities, these models demonstrate that religion has its own contextual effect independent of the effect of respondents' individual religious involvement. In addition, interaction models indicate that these contextual effects are no different for religious adherents than for non-adherents, meaning that the composition of the religious environment impacts the health of older adults regardless of their religious identities.

The findings that the presence of Buddhism and Islam in Chinese prefectures is related to lower population mortality rates (from Chapter 3) but worse self-rated health in older adults (from Chapter 4) appear to be contradictory. One might expect to have found either lower mortality rates together with better self-rated health or higher mortality rates together with worse self-rated health. These findings may be for several reasons. First, measures of self-rated health are subjective and reflect how individual respondents feel about their own health. Although respondents' self-rated health is predictive of their mortality (Jylhä 2009; Leung, Tang, and Lue 1997; Lorem et al. 2020), the self-rated health responses of older adults in a local geographic area may not be as directly related with its all-cause population mortality rates as one might first assume. The all-cause mortality rate of a geographic area are not only the product of the health and mortality of older adults but also the product of other factors such as infant mortality, disease rates among younger residents, accidental deaths, and the age structure of the population. Furthermore, how individuals rate their health may be influenced by the religious teachings they follow. For example, because Buddhism teaches its followers to embrace suffering (including physical ailments), individuals influenced by Buddhism may be more likely to rate their health as worse. In contrast, Christianity encourages its followers to adopt a more positive outlook on life and health; therefore, individuals influenced by Christianity may be more likely to rate their health as better.

Second, the mortality rates used in Chapter 3 are from 2001 whereas the self-rated health measures are from 2015. During the 14 years between the collection of these two measures, the demographics of these areas and the health statuses of the people living there may have changed substantially, especially considering how rapidly China has modernized, urbanized, and developed its economy. Many regions will have undergone substantial economic and demographic

transformations in ways that may have affected the associations between the religious environment and health during that time.

Finally, over the past decade the political situation of traditionally Muslim ethnic minority groups has deteriorated due to oppressive policies initiated during the Xi Jinping era. The social stressors experienced by Muslims and others living in predominantly Muslim areas may have changed the direction of the relationship between Islam and health and led to reports of worse self-rated health. Future research that examines other demographic groups (i.e., younger cohorts), alternative measures of health, and multiple other sources of data will provide clarity on how the presence of Buddhism and Islam are associated with health and mortality.

The presence of Daoism and Christianity are both associated with better health in these analyses, with Daoism also related to fewer chronic illnesses. Daoism's promotion of health and longevity through self-cultivation practices and traditional herbal remedies (i.e., TCM) may be an important way that Daoism and Daoists influence local subcultures and subsequently health outcomes in the local geographic areas where they are most prominent. Christianity's congregational structure may provide hubs of social connection for their communities, and an increase in organized Protestant and Catholic efforts to provide social services such as elder care and disability services may also improve health outcomes particularly among older adults in areas where there are larger Christian populations.

In this dissertation, I drew on an ecosocial conceptual model of health and empirical studies of the religion-health connection to hypothesize that social participation, social support, and health behaviors are potential mechanisms that link the religious environment to individual health in general and the findings of Chapter 4 in particular. I test these mechanisms in Chapter 5 using mediation analysis techniques in the multilevel structural equation modeling framework, finding that there are no indirect effects of the religious environment on self-rated health or chronic illnesses via these measures of social participation, social support, and health behaviors. Despite these null findings, much more research is needed to establish that these mechanisms are not part of the causal chain between the religious environment and health. Additional studies using alternative measures of these psychosocial mechanisms and using measures of other forms of social connection will provide more insight into these relationships and determine whether the ecosocial framework is the most useful tool for conceptualizing the ecological effects of religion on health and mortality, both in China and in other societies.

Limitations

In Chapters 3, 4, and 5, I acknowledged limitations specific to the study presented in each chapter; however, a limitation that characterizes all three studies and that warrants discussion here relates to the measurement of religion, both at the ecological level (i.e., the religious environment) and at the individual level (i.e., respondents' religious identities, beliefs, and practices). Although the measurement of religion is a limitation for nearly all contemporary research on topics related to religion in China, it is nevertheless important to disclose how the deficiencies in these measurements may be consequential for the current study.

In this dissertation, I have defined the religious environment as the demographic presence and socio-cultural influence of religion(s) in a social environment, most commonly a geographic area (Blanchard et al. 2008:1595). Often operationalized as the religious composition of a geographic area, the most common measure of religious ecology has been the number of adherents/members (or religious congregations) for each religious group in a given geographic area adjusted for area population (e.g., Blanchard et al. 2008; Lim and MacGregor 2012; Olson 2019). Given the unavailability of data with reliable counts of the number of adherents for each religious group in China (or with information about the religious beliefs and participation of Chinese people), this dissertation follows several other China-based studies of the religious environment (e.g., Li and Xu 2020; Tong 2020; Tong, Sennott, and Yang 2021; Xu et al. 2017) and uses the number of officially registered religious sites as a proxy measure of the presence and influence of religion in Chinese counties and prefectures.

Despite being the best measurement currently available, the number of religious sites for each religion in each geographic area may not always correlate to the number of adherents of that religion living in that geographic area nor the level of its influence. For example, the phenomenon of Buddhist tourism in Asia (e.g., Bruntz and Schedneck 2020; Shepherd 2016) and the economic incentives driving the construction of Buddhist temples in China (e.g., Chan and Lang 2014; Fisher 2011) suggest that the presence and influence of Buddhism in areas with Buddhist temples may be predominately among tourists and other transient individuals than among actual residents. Although for Buddhism, Christianity, and Islam, the number of sites in prefectures (from OSAC) has modest or high correlations with the proportion of CHARLS respondents identifying with each respective religion in prefectures, more precise measures—not only of religion's presence but also of the degree of its influence—are needed to continuing assessing the effect of the religious

environment on health and other important outcomes. Potential alternatives that may be informative for this purpose include: proportion of a geographic context that adheres to various religions (Olson and Li 2015; Stark, Kent, and Doyle 1982); measures of religious homogeneity/diversity (Lim and MacGregor 2012; Olson and Li 2015; Ulmer and Harris 2013); and aggregate measures of religious service attendance, beliefs, practices, and salience or a composite index of religiosity (Ransome et al. 2019; Stroope and Baker 2018).

In addition to potential concerns with measures of the religious environment, the measures of the individual religious lives of older Chinese adults used in the analyses in Chapters 4 and 5 are also a limitation. As is typical for most social surveys conducted in China, the Chinese Health and Retirement Longitudinal Study (CHARLS) only includes a single measure of respondent religion: a questionnaire item which asks for respondents' religious identity and which only allows respondents to choose one option. Although this item gestures towards possible religious beliefs and behaviors that may characterize the religious lives of CHARLS respondents, this religious identity measure provides little information about how influential religion may be in their lives. Other variables that measure religious salience, level of religious belief, frequency of religious practice/participation, belief/participation in multiple religions, and specific religious attitudes would provide important details for determining how religion and the religious environment are associated with health in China. These additional variables would be especially helpful for determining whether there is a difference in how the religious environment impacts the health between individuals who are more religious and individuals who are less religious, as well as whether certain types of individual religious beliefs, practices, and participation condition the process.

Contributions

This dissertation makes several contributions to the research literature on the social determinants of health, the religion and health connection, and religious ecology. It does so by: 1) confirming that the religious environment is an important social determinant of population health and mortality (perhaps as important as area level GDP); 2) accounting for spatial dependencies and disentangling the contextual and compositional effects of religion; and 3) extending research on this topic to national and political context very different from the United States. In addition, it

has several important practical implications for improving public health both in China and more broadly.

In the social determinants of health literature, religion has been a neglected factor (Idler 2014), and studies that do examine the role of religion reduce it to an individual-level attribute. The studies in this dissertation emphasize the social character of religion and additionally conceptualize it as a property of local geographic areas and communities. The findings here advanced our understanding of the health and mortality consequences associated with the socio-cultural characteristics of local areas. They provide further evidence that the religious environment is an important determinant of health—distinct from the individual religious involvement of individuals—that contributes to public health and geographic health disparities (Idler 2014). As such, the religious environment can impact the health of everyone in an area, not just the individuals who are religious or who are followers of specific religions.

This dissertation also makes several methodological contributions to this area of study. First, prior studies on this topic have used geographic data but have not accounted for spatial dependencies that likely exist (e.g., Bartkowski, Xu, and Garcia 2011; Blanchard et al. 2008; Garcia, Bartkowski, and Xu 2017). By using spatial regression models instead of standard linear regression models in Chapter 3, I essentially control for possible "spill over" effects between neighboring geographic areas and avoid over- or underestimating the effects of the religious environment on mortality rates in Chinese counties and prefectures. Next, Chapter 4 provides evidence confirming that the contextual effects of religion on the health of individuals are distinct from the compositional effects of religion. Prior studies (e.g., Bartkowski et al. 2011; Blanchard et al. 2008; Garcia et al. 2017) have primarily examined *community-level* outcomes (as I do in Chapter 3). A potential weakness of this approach, however, is the possibility of conflating contextual effects and compositional effects (Cummins 2007; Macintyre, Ellaway, and Cummins 2002). By controlling for individual religious identity in the models presented in Chapter 4, I demonstrate that religion has contextual effects in additional to any effects due to respondents' individual religious affiliations. In other words, these findings demonstrate that the religious environment has separate effects on health beyond the aggregation of the effects of individual-level religion, thus providing more reliable evidence that religion is a contextual factor in health outcomes.

As one of the first studies to show that religion has ecological effects on health and mortality in a context outside of the United States, this dissertation also provides new angles from which to understand this topic. Because prior studies have almost exclusively been U.S.-based, findings have been limited to demonstrating the effect of the religious environment on health in the unique social, political, religious, and cultural context of the U.S. and only for different types of Christian religion (e.g., Bartkowski et al. 2011; Blanchard et al. 2008; Garcia et al. 2017). By examining this topic in mainland China, I show that religion can have ecological effects on health even in national contexts in which there are low overall levels of religiosity and in which there are strict religious regulations aimed at limiting the social influence of religion. This points to the durability of the religious environment as a social influence and may suggest that religion has similar ecological effects in other societies where religion is less popular or where religion(s) is actively suppressed.

In addition, these findings from the Chinese context demonstrate the ecological health consequences of other major world religions—including Buddhism, Christianity, Daoism, and Islam. How these religions might be related to health outcomes in other countries has yet to be determined; however, this dissertation has extended this work beyond the study of Christianity, showing that other religions also have ecological effects on health and mortality. These findings also suggest that the ecological effects of these religions may differ from one another not only because of inherent differences in their beliefs and practices but also because of interactions with other characteristics of the social environment. For example, religion in general or a particular religion may function differently under suppression. In this study the negative health effects associated with the presence of Islam may be due to harsh Chinese government policies and actions targeting the suppression of Chinese Muslims rather than due to a specific characteristic inherent to Islam.

This dissertation also has important implications for public health efforts in China to reduce inequalities in health and identify opportunities for disease prevention. Knowing that the religious environment is a factor in public health is particularly important in China where in the past few decades religion has been growing rapidly (Yang 2011). If religion continues to grow in China, the demographic presence and sociocultural influence of religion may increase and have even greater health consequences. And as Chinese society continues a trajectory of rapid aging, it will continue to face serious health and healthcare challenges (Chatterji et al. 2008; Fang et al. 2015). Therefore, understanding all factors associated with the health and well-being of older adults in

China is an increasingly urgent matter. Furthermore, a better understanding of factors associated with who gets sick, where they get sick, and why they get sick is essential for reducing China's geographic health inequalities (Fang et al. 2010; Liu and Zhang 2019). This study confirms the religious environment as one of these factors and can provide additional insight into the socio-cultural aspects of China's geographic health disparities and potentially aid policy makers and public health officials in making decisions, particularly about the regulation of religion, involving religious groups in efforts to promote health, and developing social and cultural strategies to facilitate healthy lifestyles. In summary, the role of the religious environment needs to be considered, both as a potential resource for improving health and as a potential contributor to negative health outcomes. However, understanding exactly *why* the religious environment is related to health and mortality—by identifying the mechanisms involved—is necessary before developing practical applications based on these findings.

Recommendations for Future Research

There are three major areas I recommend for future research on this topic. First, identifying the mechanisms that link the religious environment in local geographic areas to the health and mortality of the people living there is essential for increasing our understanding of how religious ecology impacts health in the U.S., China, and elsewhere. In Chapter 5, this dissertation tested whether social participation, social support, and health behaviors play a role in the mainland Chinese context. I found no evidence that the ecological effects of religion on health operate through these mechanisms; however, more research is needed to expand this area of work by confirming these findings with alternative measures and different data sources as well as by examining other possible mechanisms. In this study, I investigated mechanisms related to social connection and health behaviors following an ecosocial model of how macro-level features of the social environment impact health via social network ties and psycho-social pathways (Berkman and Kawachi 2000). Other possible explanations and mechanisms focused on institutional and structural processes need to be investigated in future studies.

Because this dissertation focused on a single national context, it could not test how the national context of China itself impacts the relationship between the religious environment and health and mortality. Cross-national research that compares countries across societal characteristics—like religious regulation, overall levels of religiosity, social hostility towards

religion, and system of government for example—could help establish some of the other contextual factors that condition how the religious environment impacts health.

Finally, as mentioned above, extensions of this work that use alternative measures of the religious environment would also provide greater clarity on this topic. Different operationalizations and measurements of the religious environment could produce more nuanced findings regarding religion's ecological effects on health. For example, a potential alternative measurement of the religious environment is the level of religious diversity in geographic areas. Do areas with greater religious diversity have better or worse health and mortality outcomes than areas with less religious diversity? And does the presence of other religious groups in a society affect how strongly any one particularly religious group might impact the health of the people in that area? Further investigations into research questions like these can expand how we understand what the religious environment is and how it influences public health.

APPENDIX A. REGRESSION TABLES

Table A1. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health by total number of religious sites (without controls for individual religious identity).

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Total Sites	0.956	0.959	0.985
	(0.035)	(0.057)	(0.098)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.791**	0.810	0.544***
	(0.068)	(0.108)	(0.108)
Age	0.981***	0.998	0.971***
	(0.005)	(0.008)	(0.008)
Married	ref.	ref.	ref.
Separated/Divorced	0.919	1.268	0.326
	(0.345)	(0.680)	(0.277)
Widowed	0.942	0.947	0.951
	(0.076)	(0.124)	(0.140)
Never Married	0.501*	0.492	0.137*
	(0.146)	(0.254)	(0.111)
Less than Middle School	ref.	ref.	ref.
Middle School	1.265**	1.297+	0.981
	(0.113)	(0.180)	(0.149)
High School	1.361	3.247***	1.849*
	(0.270)	(0.834)	(0.524)
More than High School	1.595**	2.027**	2.064**
	(0.276)	(0.493)	(0.524)
Ethnic Minority	ref.	ref.	ref.
Han Ethnicity	1.268+	1.219	1.295
	(0.156)	(0.249)	(0.313)
Currently Smoke	ref.	ref.	ref.
Quick Smoking	0.726***	0.586***	0.613**
	(0.069)	(0.090)	(0.098)
Never Smoked	0.956	0.889	0.885
	(0.088)	(0.127)	(0.133)
Community-level Control Variables			
Population	1.000	1.000	1.000
	0.000	0.000	0.000
Population Density (person/km^2)	1.000	1.000	1.000
	0.000	0.000	0.000
Percent with HS Degree	1.002	1.005	1.008+

	(0.003)	(0.004)	(0.005)
Percent Over 65	1.000	0.999	0.999
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.108**	1.133*	1.289***
	(0.037)	(0.062)	(0.092)
Rural	ref.	ref.	ref.
Urban	1.361***	1.186	1.328+
	(0.127)	(0.173)	(0.225)
Percent Migrant	0.999	0.997	0.998
	(0.002)	(0.003)	(0.004)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	–11.669	592.626
	(.)	(78.849)	(2507.135)
Community-level Intercept	1.000	1.439*	0.747*
	(.)	(0.568)	(0.293)
Household-level Intercept	1.000	–1.07e+05	–1.29e+05
	(.)	(4.01e+05)	(4.87e+05)
Household-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Community-level Variance	0.106	0.106	0.106
	(0.043)	(0.043)	(0.043)
Prefecture-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Constant	2.958*	–2.045**	–1.478+
	(1.267)	(0.700)	(0.864)
Log-likelihood	–7,863.636	–7,863.636	–7,863.636
N	6,948	6,948	6,948
AIC	15,869.272	15,869.272	15,869.272
BIC	16,355.353	16,355.353	16,355.353

Table A2. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health by total number of religious sites (with controls for individual religious identity).

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Total Sites	0.950	0.925	0.968
	(0.037)	(0.059)	(0.101)
Individual Religious Identity			
Christian	ref.	ref.	ref.
Buddhist	1.274	0.871	0.546+
	(0.288)	(0.300)	(0.197)
Muslim	1.165	1.895	0.787
	(0.516)	(1.258)	(0.623)
Other	0.829	0.371	0.426
	(0.543)	(0.462)	(0.564)
Religious None	1.182	0.749	0.533*
	(0.222)	(0.213)	(0.145)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.787**	0.817	0.556***
	(0.068)	(0.110)	(0.078)
Age	0.981***	0.998	0.971***
	(0.005)	(0.008)	(0.008)
Married	ref.	ref.	ref.
Separated/Divorced	0.921	1.253	0.323
	(0.346)	(0.673)	(0.276)
Widowed	0.943	0.949	0.954
	(0.076)	(0.124)	(0.141)
Never Married	0.497*	0.494	0.140*
	(0.144)	(0.255)	(0.114)
Less than Middle School	ref.	ref.	ref.
Middle School	1.264**	1.293+	0.977
	(0.113)	(0.180)	(0.149)
High School	1.363	3.271***	1.873*
	(0.270)	(0.841)	(0.532)
More than High School	1.594**	2.030**	2.088**
	(0.275)	(0.494)	(0.531)
Ethnic Minority	ref.	ref.	ref.
Han Ethnicity	1.279+	1.370	1.354
	(0.163)	(0.304)	(0.346)
Currently Smoke	ref.	ref.	ref.
Quit Smoking	0.730***	0.580***	0.597**
	(0.069)	(0.089)	(0.096)
Never Smoked	0.958	0.880	0.881
	(0.089)	(0.126)	(0.133)

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Population	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Community-level Control Variables			
Population Density (person/km^2)	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.002	1.005	1.008+
	(0.003)	(0.004)	(0.005)
Percent Over 65	1.000	0.999	0.999
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.108**	1.128*	1.283***
	(0.037)	(0.062)	(0.092)
Rural	ref.	ref.	ref.
Urban	1.360**	1.149	1.300
	(0.127)	(0.171)	(0.222)
Percent Migrant	0.999	0.997	0.998
	(0.002)	(0.003)	(0.004)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	4,342.020	–21,593.831
	(.)	(16624.200)	(81,652.384)
Community-level Intercept	1.000	1.299*	0.818**
	(.)	(0.516)	(0.304)
Household-level Intercept	1.000	–112,808.600	–139,772.412
	(.)	(866,820.900)	(1.07+e6)
Household-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Community-level Variance	0.103	0.103	0.103
	(0.037)	(0.037)	(0.037)
Prefecture-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Constant	1.060*	–1.581*	–0.783
	(0.479)	(0.767)	(0.897)
Log-likelihood	–7,856.442	–7,856.442	–7,856.442
N	6,948	6,948	6,948
AIC	15,878.884	15,878.884	15,878.884
BIC	16,447.119	16,447.119	16,447.119

Note: $^+$ p < .10, * p < .05, ** p < .01, *** p < .001; Relative risk ratios presented; Standard errors in parentheses.

Table A3. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health by each religion (without controls for individual religious identity).

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Buddhism	0.965	0.665**	0.537**
	(0.067)	(0.087)	(0.104)
Christian	0.901	1.014	1.520**
	(0.059)	(0.108)	(0.237)
Islam	0.893*	0.992	1.030
	(0.047)	(0.083)	(0.129)
Daoism	1.228	1.836**	1.201
	(0.161)	(0.402)	(0.392)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.789**	0.802+	0.546***
	(0.066)	(0.106)	(0.076)
Age	0.980***	0.996	0.969***
	(0.005)	(0.008)	(0.008)
Married	ref.	ref.	ref.
Separated/Divorced	0.944	1.192	0.301
	(0.340)	(0.625)	(0.254)
Widowed	0.946	0.929	0.980
	(0.075)	(0.120)	(0.142)
Never Married	0.540*	0.506	0.138*
	(0.151)	(0.259)	(0.112)
Less than Middle School	ref.	ref.	ref.
Middle School	1.255**	1.274+	0.986
	(0.110)	(0.175)	(0.147)
High School	1.296	3.017***	1.719+
	(0.249)	(0.758)	(0.478)
More than High School	1.488*	1.984**	1.965**
	(0.252)	(0.475)	(0.493)
Currently Smoke	ref.	ref.	ref.
Quit Smoking	0.732***	0.591***	0.594***
	(0.068)	(0.089)	(0.094)
Never Smoked	0.970	0.914	0.874
	(0.088)	(0.129)	(0.129)
Ethnic Minority	ref.	ref.	ref.
Han Ethnicity	1.196	1.161	1.150
	(0.146)	(0.239)	(0.275)
Community-level Control Variables			
Population	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)

Population Density (person/km^2)	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.002	1.004	1.007
	(0.003)	(0.004)	(0.005)
Percent Over 65	1.000	0.999	0.999
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.092**	1.104+	1.277***
	(0.036)	(0.060)	(0.088)
Rural	ref.	ref.	ref.
Urban	1.416***	1.268	1.276
	(0.131)	(0.184)	(0.210)
Percent Migrant	0.998	0.994+	0.996
	(0.002)	(0.003)	(0.003)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	3,917.938	–2.41e+04
	(.)	(19,730.765)	(1.20e+05)
Community-level Intercept	1.000	1.432**	0.905**
	(.)	(0.481)	(0.312)
Household-level Intercept	1.000	–1.32e+05	0.000
	(.)	(5.76e+05)	0.000
Household-level Variance	9.09+e11	9.09+e11	9.09+e11
	(1.40+e9)	(1.40+e9)	(1.40+e9)
Community-level Variance	0.106	0.106	0.106
	(0.039)	(0.039)	(0.039)
Prefecture-level Variance	8.96+e10	8.96+e10	8.96+e10
	(6.78+e09)	(6.78+e09)	(6.78+e09)
Constant	3.812**	–1.635*	–1.100
	(1.631)	(0.704)	(0.843)
Log-likelihood	–8,134.269	–8,134.269	–8,134.269
N	6,948	6,948	6,948
AIC	16,426.538	16,426.538	16,426.538
BIC	16,970.466	16,970.466	16,970.466

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; Relative risk ratios presented; Standard errors in parentheses.

Table A4. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health by each religion (with controls for individual religious identity).

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Buddhism	1.015	0.719*	0.576**
	(0.077)	(0.096)	(0.115)
Christianity	0.894+	0.989	1.495*
	(0.060)	(0.107)	(0.236)
Islam	0.875*	0.926	1.021
	(0.052)	(0.090)	(0.142)
Daoism	1.192	1.757**	1.189
	(0.160)	(0.383)	(0.391)
Individual Religious Identity			
Christian	ref.	ref.	ref.
Buddhist	1.147	0.924	0.630
	(0.263)	(0.322)	(0.227)
Muslim	1.550	1.749	0.683
	(0.750)	(1.269)	(0.561)
Other	0.811	0.347	0.399
	(0.531)	(0.430)	(0.527)
Religious None	1.159	0.758	0.558*
	(0.218)	(0.216)	(0.152)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.794**	0.825	0.558***
	(0.068)	(0.111)	(0.079)
Age	0.981***	0.997	0.971***
	(0.005)	(0.008)	(0.008)
Married	ref.	ref.	ref.
Separated/Divorced	0.920	1.265	0.321
	(0.346)	(0.679)	(0.274)
Widowed	0.948	0.943	0.956
	(0.077)	(0.123)	(0.141)
Never Married	0.487*	0.495	0.138*
	(0.141)	(0.256)	(0.112)
Less than Middle School	ref.	ref.	ref.
Middle School	1.272**	1.292+	0.966
	(0.114)	(0.179)	(0.147)
High School	1.375	3.300***	1.859*
	(0.273)	(0.847)	(0.527)
More than High School	1.606**	2.070**	2.070**
	(0.278)	(0.503)	(0.526)
Ethnic Minority	ref.	ref.	ref.
Han Ethnicity	0.729***	0.579***	0.593**

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
	(0.070)	(0.089)	(0.096)
Currently Smoke	0.947	0.871	0.871
Quit Smoking	(0.088)	(0.124)	(0.131)
	ref.	ref.	ref.
Never Smoked	1.263+	1.239	1.204
	(0.165)	(0.271)	(0.303)
Community-level Control Variables			
Population	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Population Density (person/km^2)	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.001	1.005	1.008
	(0.003)	(0.004)	(0.005)
Percent Over 65	1.000	0.999	0.999
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.097**	1.114+	1.284***
	(0.038)	(0.061)	(0.090)
Rural	ref.	ref.	ref.
Urban	1.407***	1.207	1.285
	(0.134)	(0.177)	(0.216)
Percent Migrant	0.999	0.996	0.998
	(0.002)	(0.003)	(0.004)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	4,342.020	–2.16e+04
	(.)	(16,624.204)	(81,652.380)
Community-level Intercept	1.000	1.299*	0.818**
	(.)	(1.299)	(0.304)
Household-level Intercept	1.000	–1.13e+05	–1.40e+05
	(.)	(8.67e+05)	(1.07e+06)
Household-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Community-level Variance	0.106	0.106	0.106
	(0.039)	(0.039)	(0.039)
Prefecture-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Constant	1.060*	–1.581*	–0.783
	(0.478)	(0.767)	(0.897)
Log-likelihood	–7,839.839	–7,839.839	–7,839.839
N	6,948	6,948	6,948
AIC	15,861.677	15,861.677	15,861.677
BIC	16,484.682	16,484.682	16,484.682

Note: $^+$ p < .10, * p < .05, ** p < .01, *** p < .001; Relative risk ratios presented; Standard errors in parentheses.

Table A5. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health with interaction between prefecture-level religion (total sites) and religious identity.

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Total Religious Sites	0.921*	0.911	0.933
	(0.033)	(0.058)	(0.088)
Individual Religious Identity			
No Religious Identity	ref.	ref.	ref.
Has Religious Identity	0.879	1.206	1.444
	(0.157)	(0.314)	(0.393)
Religious Environment x Individual Religious Identity			
Total Religious Sites x Religious none	ref.	ref.	ref.
Total Religious Sites x Has religious identity	1.093	1.034	0.951
	(0.085)	(0.127)	(0.129)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.782**	0.813+	0.568***
	(0.065)	(0.101)	(0.071)
Age	0.981***	0.997	0.971***
	(0.005)	(0.007)	(0.007)
Married	ref.	ref.	ref.
Separated/Divorced	0.940	1.314	0.344
	(0.333)	(0.624)	(0.268)
Widowed	0.935	0.932	0.971
	(0.072)	(0.110)	(0.123)
Never Married	0.529*	0.573	0.163*
	(0.145)	(0.268)	(0.122)
Less than Middle School	ref.	ref.	ref.
Middle School	1.230*	1.249+	0.984
	(0.105)	(0.159)	(0.130)
High School	1.275	2.683***	1.567+
	(0.241)	(0.619)	(0.386)
More than High School	1.471*	1.811**	1.841**
	(0.244)	(0.403)	(0.407)
Ethnic Minority	ref.	ref.	ref.
Han Ethnicity	1.251*	1.334	1.287
	(0.140)	(0.255)	(0.264)
Currently Smoke	ref.	ref.	ref.
Quit Smoking	0.736***	0.627***	0.645**
	(0.067)	(0.088)	(0.089)
Never Smoked	0.992	0.968	0.936
	(0.088)	(0.126)	(0.123)
Community-level Control Variables			
Population	1.000	1.000+	1.000

	(0.000)	(0.000)	(0.000)
Population Density (person/km^2)	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.002	1.005	1.007+
	(0.002)	(0.004)	(0.004)
Percent Over 65	1.000	0.999	1.000
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.110***	1.093+	1.231***
	(0.031)	(0.054)	(0.073)
Rural	ref.	ref.	ref.
Urban	1.339***	1.223	1.261+
	(0.105)	(0.164)	(0.175)
Percent Migrant	0.998	0.996	0.997
	(0.001)	(0.003)	(0.003)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	12.126	–305.003
	(.)	(228.036)	(6,030.223)
Community-level Intercept	1.000	–1.51e+04	–2,113.018
	(.)	(83,937.879)	(12,201.669)
Community-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Constant	1.102**	–1.640**	–0.681
	(0.388)	(0.625)	(0.723)
Log-likelihood	–8,184.435	–8,184.435	–8,184.435
N	6,948	6,948	6,948
AIC	16,516.870	16,516.870	16,516.870
BIC	17,026.372	17,026.372	17,026.372

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; Relative risk ratios presented; Standard errors in parentheses.

Table A6. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health with interaction between prefecture-level Buddhism and religious identity.

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Buddhism	1.038	0.595**	0.477**
	(0.109)	(0.115)	(0.120)
Christianity	0.902	0.950	1.393*
	(0.057)	(0.096)	(0.196)
Islam	0.904+	0.992	1.000
	(0.047)	(0.082)	(0.115)
Daoism	1.268+	1.855**	1.136
	(0.164)	(0.394)	(0.341)
Individual Religious Identity			
Buddhist	ref.	ref.	ref.
Other religion	0.997	0.700	0.976
	(0.287)	(0.284)	(0.407)
No religion Religious None	1.107	0.658	0.634
	(0.233)	(0.193)	(0.213)
Religious Environment x Individual Religious Identity			
Buddhism x Buddhist	ref.	ref.	ref.
Buddhism x Other religion	0.886	1.658	1.069
	(0.257)	(0.671)	(0.489)
Buddhism x Religious none	0.879	1.167	1.292
	(0.102)	(0.222)	(0.285)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.790**	0.820	0.577***
	(0.066)	(0.102)	(0.072)
Age	0.980***	0.995	0.970***
	(0.005)	(0.007)	(0.007)
Married	ref.	ref.	ref.
Separated/Divorced	0.952	1.292	0.340
	(0.342)	(0.617)	(0.265)
Widowed	0.943	0.942	0.973
	(0.074)	(0.111)	(0.123)
Never Married	0.533*	0.581	0.164*
	(0.148)	(0.273)	(0.123)
Less than Middle School	ref.	ref.	ref.
Middle School	1.251*	1.270+	0.978
	(0.109)	(0.162)	(0.130)
High School	1.300	2.689***	1.565+
	(0.248)	(0.623)	(0.386)
More than High School	1.491*	1.842**	1.838**

	(0.251)	(0.411)	(0.408)
Currently Smoke	ref.	ref.	ref.
Quit Smoking	0.737***	0.615***	0.637**
	(0.068)	(0.087)	(0.088)
Never Smoked	0.967	0.942	0.912
	(0.087)	(0.124)	(0.120)
Ethnic Minority	ref.	ref.	ref.
Han Ethnicity	1.238+	1.194	1.251
	(0.151)	(0.236)	(0.262)
Community-level Control Variables			
Population	1.000	1.000+	1.000
	(0.000)	(0.000)	(0.000)
Population Density (person/km^2)	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.002	1.004	1.007
	(0.003)	(0.004)	(0.004)
Percent Over 65	1.000	0.999	1.000
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.096**	1.086	1.233***
	(0.035)	(0.056)	(0.074)
Rural	ref.	ref.	ref.
Urban	1.409***	1.269+	1.250
	(0.126)	(0.176)	(0.179)
Percent Migrant	0.998	0.995+	0.997
	(0.002)	(0.003)	(0.003)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	2,934.560	–1.71e+04
	(.)	(11,903.095)	(68,362.803)
Community-level Intercept	1.000	1.870**	0.954**
	(.)	(0.601)	(0.329)
Community-level Variance	0.075	0.075	0.075
	(0.038)	(0.038)	(0.038)
Prefecture-level Variance	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Constant	1.168*	–0.896	–0.170
	(0.484)	(0.730)	(0.812)
Log-likelihood	–8,157.639	–8,157.639	–8,157.639
N	6,948	6,948	6,948
AIC	16,493.278	16,493.278	16,493.278
BIC	17,106.057	17,106.057	17,106.057

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; Relative risk ratios presented; Standard errors in parentheses.

Table A7. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health with interaction between prefecture-level Christianity and religious identity.

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Buddhism	0.960	0.697**	0.592**
	(0.067)	(0.087)	(0.103)
Christianity	0.612+	1.099	1.620
	(0.169)	(0.419)	(0.591)
Islam	0.897*	0.974	1.006
	(0.046)	(0.080)	(0.115)
Daoism	1.207	1.828**	1.163
	(0.154)	(0.385)	(0.341)
Individual Religious Identity			
Christian	ref.	ref.	ref.
Other religion	0.753	1.227	1.071
	(0.279)	(0.657)	(0.574)
Religious none	0.793	0.948	0.784
	(0.256)	(0.446)	(0.345)
Religious Environment x Individual Religious Identity			
Christianity x Christian	ref.	ref.	ref.
Christianity x Other religion	1.682+	0.855	0.739
	(0.524)	(0.372)	(0.316)
Christianity x Religious none	1.475	0.858	0.855
	(0.412)	(0.330)	(0.304)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.787**	0.825	0.577***
	(0.066)	(0.103)	(0.072)
Age	0.980***	0.996	0.970***
	(0.005)	(0.007)	(0.007)
Married	ref.	ref.	ref.
Separated/Divorced	0.940	1.276	0.337
	(0.337)	(0.609)	(0.264)
Widowed	0.944	0.940	0.978
	(0.074)	(0.111)	(0.124)
Never Married	0.542*	0.577	0.167*
	(0.151)	(0.271)	(0.125)
Less than Middle School	ref.	ref.	ref.
Middle School	1.252*	1.275+	0.978
	(0.109)	(0.163)	(0.130)
High School	1.295	2.709***	1.572+
	(0.247)	(0.627)	(0.388)
More than High School	1.483*	1.848**	1.837**
	(0.250)	(0.413)	(0.408)

Currently Smoke	ref.	ref.	ref.
Quit Smoking	0.736***	0.618***	0.637**
	(0.068)	(0.087)	(0.088)
Never Smoked	0.972	0.937	0.913
	(0.087)	(0.123)	(0.120)
Ethnic Minority	ref.	ref.	ref.
Han Ethnicity	1.208	1.213	1.202
	(0.146)	(0.239)	(0.250)
Community-level Control Variables			
Population	1.000	1.000+	1.000
	(0.000)	(0.000)	(0.000)
Population Density (person/km^2)	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.002	1.004	1.007
	(0.003)	(0.004)	(0.004)
Percent Over 65	1.000	0.999	1.000
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.089**	1.083	1.237***
	(0.035)	(0.056)	(0.074)
Rural	ref.	ref.	ref.
Urban	1.418***	1.276+	1.258
	(0.127)	(0.177)	(0.180)
Percent Migrant	0.998	0.995+	0.997
	(0.002)	(0.003)	(0.003)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	–2.014	19.953
	(.)	(4.460)	(27.150)
Community-level Intercept	1.000	1.340**	0.745*
	(.)	(0.509)	(0.311)
Household-level Intercept	1.000	–37,351.882	–45,760.331
	(.)	(129,537.603)	(158,667.442)
Household-level Variance	8.35+e10	8.35+e10	8.35+e10
	(5.79+e9)	(5.79+e9)	(5.79+e9)
Community-level Variance	0.104	0.104	0.104
	(0.0439)	(0.0439)	(0.0439)
Prefecture-level Variance	0.001	0.001	0.001
	(0.004)	(0.004)	(0.004)
Constant	1.055*	–1.275	–0.827
	(0.505)	(0.800)	(0.959)
Log-likelihood	–8,157.507	–8,157.507	–8,157.507
N	6,948	6,948	6,948
AIC	16,493.014	16,493.014	16,493.014
BIC	17,105.793	17,105.793	17,105.793

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; Relative risk ratios presented; Standard errors in parentheses.

Table A8. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health with interaction between prefecture-level Daoism and religious identity.

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Buddhism	1.013	0.754*	0.611**
	(0.071)	(0.093)	(0.111)
Christian	0.886+	0.929	1.393*
	(0.057)	(0.095)	(0.202)
Islam	0.894*	0.962	0.998
	(0.046)	(0.077)	(0.116)
Daoism	1.209	1.842**	1.286
	(0.168)	(0.404)	(0.401)
Individual Religious Identity			
Religious none	ref.	ref.	ref.
Has Religious Identity	0.977	1.323	1.551*
	(0.126)	(0.240)	(0.280)
Religious Environment x Individual Religious Identity			
Daoism x Religious none	ref.	ref.	ref.
Daoism x Has Religious Identity	0.979	0.804	0.616
	(0.164)	(0.194)	(0.165)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.797**	0.840	0.576***
	(0.068)	(0.106)	(0.073)
Age	0.981***	0.998	0.972***
	(0.005)	(0.007)	(0.007)
Married	ref.	ref.	ref.
Separated/Divorced	0.931	1.315	0.348
	(0.348)	(0.639)	(0.273)
Widowed	0.946	0.952	0.948
	(0.076)	(0.114)	(0.122)
Never Married	0.496*	0.570	0.162*
	(0.143)	(0.269)	(0.121)
Less than Middle School	ref.	ref.	ref.
Middle School	1.270**	1.291*	0.961
	(0.113)	(0.166)	(0.130)
High School	1.380	2.908***	1.659*
	(0.272)	(0.686)	(0.417)
More than High School	1.608**	1.908**	1.918**
	(0.276)	(0.433)	(0.431)
Currently Smoke	1.000	1.000	1.000
Quit Smoking	0.732***	0.606***	0.650**
	(0.069)	(0.087)	(0.092)
Never Smoked	0.950	0.903	0.918

	(0.087)	(0.120)	(0.122)
Ethnic Minority	1.000	1.000	1.000
Han Ethnicity	1.248+	1.207	1.273
	(0.153)	(0.240)	(0.268)
Community-level Control Variables			
Population	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Population Density (person/km^2)	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.001	1.004	1.008+
	(0.003)	(0.004)	(0.004)
Percent Over 65	1.000	0.999	1.000
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.100**	1.099+	1.240***
	(0.036)	(0.057)	(0.076)
Rural	1.000	1.000	1.000
Urban	1.413***	1.237	1.294+
	(0.129)	(0.172)	(0.189)
Percent Migrant	0.998	0.996	0.998
	(0.002)	(0.003)	(0.003)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	–2.304	19.196
	(.)	(4.796)	(26.622)
Community-level Intercept	1.000	1.288**	0.732*
	(.)	(0.473)	(0.306)
Household-level Intercept	1.000	–26,363.694	–32,475.68
	(.)	(80,773.537)	(99,474.371)
Household-level Variance	1.69+e9	1.69+e9	1.69+e9
	(1.04+e8)	(1.04+e8)	(1.04+e8)
Community-level Variance	0.106	0.106	0.106
	(0.038)	(0.038)	(0.038)
Prefecture-level Variance	0.001	0.001	0.001
	(0.004)	(0.004)	(0.004)
Constant	1.212**	–1.875**	–1.319
	(0.440)	(0.714)	(0.864)
Log-likelihood	–7,872.287	–7,872.287	–7,872.287
N	6,948	6,948	6,948
AIC	15,912.574	15,912.574	15,912.574
BIC	16,487.656	16,487.656	16,487.656

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; Relative risk ratios presented; Standard errors in parentheses.

Table A9. Relative risk ratios from multilevel multinomial regression models predicting categories of self-rated health with interaction between prefecture-level Islam and religious identity.

	Fair vs. Poor	Good vs. Poor	Very Good vs. Poor
Religious Environment			
Buddhism	1.026	0.721*	0.565**
	(0.077)	(0.095)	(0.114)
Christianity	0.891+	0.996	1.526**
	(0.061)	(0.107)	(0.247)
Islam	0.909	1.142	1.675
	(0.174)	(0.333)	(0.601)
Daoism	1.182	1.735*	1.176
	(0.160)	(0.377)	(0.395)
Individual Religious Identity			
Muslim	ref.	ref.	ref.
Other religion	0.823	1.237	6.588
	(0.671)	(1.610)	(9.690)
Religious none	0.887	1.033	4.805
	(0.718)	(1.334)	(7.016)
Religious Environment x Individual Religious Identity			
Islam x Muslim	1.000	1.000	1.000
Islam x Other religion	0.970	0.854	0.565
	(0.227)	(0.315)	(0.264)
Islam x Religious none	0.957	0.786	0.550
	(0.193)	(0.245)	(0.217)
Individual-Level Control Variables			
Man	ref.	ref.	ref.
Woman	0.792**	0.825	0.555***
	(0.068)	(0.111)	(0.078)
Age	0.981***	0.997	0.970***
	(0.005)	(0.008)	(0.008)
Married	ref.	ref.	ref.
Separated/Divorced	0.921	1.256	0.311
	(0.347)	(0.675)	(0.266)
Widowed	0.948	0.943	0.955
	(0.077)	(0.123)	(0.141)
Never Married	0.487*	0.489	0.133*
	(0.141)	(0.254)	(0.108)
Less than Middle School	ref.	ref.	ref.
Middle School	1.268**	1.289+	0.965
	(0.113)	(0.179)	(0.147)
High School	1.363	3.271***	1.832*
	(0.270)	(0.840)	(0.519)
More than High School	1.598**	2.057**	2.054**
	(0.277)	(0.501)	(0.522)

Currently Smoke	ref.	ref.	ref.
Quit Smoking	0.727***	0.580***	0.596**
	(0.069)	(0.089)	(0.096)
Never Smoked	0.949	0.871	0.867
	(0.088)	(0.125)	(0.130)
Ethnic Minority	ref.	ref.	ref.
Han Ethnicity	1.271+	1.255	1.204
	(0.167)	(0.276)	(0.305)
Community-level Control Variables			
Population	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Population Density (person/km^2)	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.001	1.005	1.008
	(0.003)	(0.004)	(0.005)
Percent Over 65	1.000	0.999	0.999
	(0.001)	(0.001)	(0.001)
Logged Per Capita Income	1.094**	1.109+	1.279***
	(0.038)	(0.062)	(0.091)
Rural	ref.	ref.	ref.
Urban	1.403***	1.208	1.287
	(0.134)	(0.178)	(0.217)
Percent Migrant	0.999	0.996	0.998
	(0.002)	(0.003)	(0.004)
Annual Household Expenditures Per Capita	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)
Prefecture-level Intercept	1.000	–2.209	15.775
	(.)	(3.951)	(18.301)
Community-level Intercept	1.000	1.349**	0.742**
	(.)	(0.496)	(0.312)
Household-level Intercept	1.000	–15,641.938	–19,166.342
	(.)	(5,6312.341)	(68,990.584)
Household-level Variance	4.75+e9	4.75+e9	4.75+e9
	(3.42+e8)	(3.42+e8)	(3.42+e8)
Community-level Variance	0.105	0.105	0.105
	(0.039)	(0.039)	(0.039)
Prefecture-level Variance	0.002	0.002	0.002
	(0.005)	(0.005)	(0.005)
Constant	1.345	–1.856	–2.040+
	(0.907)	(1.455)	(1.683)
Log-likelihood	–7,840.194	–7,840.194	–7,840.194
N	6,948	6,948	6,948
AIC	15,866.389	15,866.389	15,866.389
BIC	16,503.086	16,503.086	16,503.086

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; Relative risk ratios presented; Standard errors in parentheses.

Table A10. Incident rate ratios (IRR) from multilevel negative binomial regression models predicting number of chronic illnesses.

	Model 1	Model 2	Model 3	Model 4
Religious Environment				
Total Sites	1.014	1.002		
	(0.024)	(0.025)		
Buddhism			1.085+	1.070
			(0.053)	(0.052)
Christianity			0.992	0.989
			(0.032)	(0.032)
Islam			1.032*	1.031
			(0.017)	(0.020)
Daoism			0.834*	0.844*
			(0.068)	(0.071)
Individual Religious Identity				
Christian		ref.		ref.
Buddhist		0.991		0.989
		(0.080)		(0.080)
Muslim		0.948		0.911
		(0.162)		(0.178)
Other		0.627		0.630
		(0.230)		(0.233)
Religious None		0.904		0.905
		(0.058)		(0.059)
Individual-Level Control Variables				
Man	ref.	ref.	ref.	ref.
Woman	1.015***	1.111***	1.105***	1.111***
	(0.024)	(0.025)	(0.024)	(0.025)
Age	1.008***	1.008***	1.008***	1.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Married	ref.	ref.	ref.	ref.
Separated/Divorced	1.110	1.133	1.109	1.132
	(0.114)	(0.120)	(0.114)	(0.120)
Widowed	0.958	0.958	0.958	0.957
	(0.026)	(0.026)	(0.025)	(0.026)
Never Married	0.911	0.926	0.910	0.926
	(0.099)	(0.104)	(0.100)	(0.105)
Less than Middle School	ref.	ref.	ref.	ref.
Middle School	1.012	1.016	1.013	1.016
	(0.032)	(0.033)	(0.032)	(0.033)
High School	0.884+	0.890+	0.884+	0.889+
	(0.061)	(0.062)	(0.061)	(0.062)
More than High School	1.037	1.028	1.037	1.027
	(0.069)	(0.069)	(0.069)	(0.069)

	Model 1	Model 2	Model 3	Model 4
Ethnic Minority	ref.	ref.	ref.	ref.
Han Ethnicity	1.005	1.013	1.004	1.010
	(0.073)	(0.074)	(0.073)	(0.074)
Community-level Control Variables				
Population	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Population Density (person/km^2)	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.000	1.000	1.000	1.000
	(0.001)	(0.001)	(0.001)	(0.001)
Percent Han Ethnicity	1.000	1.000	1.000	1.001
	(0.001)	(0.001)	(0.001)	(0.001)
Percent Over 65	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Logged Per Capita Income	0.985	0.985	0.988	0.988
	(0.014)	(0.014)	0.013)	(0.014)
Rural	ref.	ref.	ref.	ref.
Urban	1.020	1.017	1.013	1.008
	(0.041)	(0.044)	(0.041)	(0.043)
Percent Migrant	1.001	1.001	1.001	1.001
	(0.001)	(0.001)	(0.001)	(0.001)
Annual Household Expenditures Per Capita	1.000	1.000+	1.000	1.000+
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.921	1.036	0.860	0.970
	(0.208)	(0.250)	(0.188)	(0.229)
Alpha (overdispersion)	–3.124	–2.920	–3.126	–3.118
	(0.591)	(0.508)	(0.592)	(0.588)
Prefecture-level Variance	0.036	0.037	0.033	0.033
	(0.008)	(0.009)	(0.008)	(0.008)
Community-level Variance	0.014	0.014	0.014	0.013
	(0.008)	(0.009)	(0.005)	(0.005)
Household-level Variance	0.160	0.156	0.160	0.159
	(0.017)	(0.018)	(0.017)	(0.017)
Log-likelihood	–13,039.763	–12,534.633	–13,036.901	–13,033.317
N	7,688	7,688	7,688	7,688
AIC	2,6125.531	25,123.267	26,125.801	25,125.298
BIC	26,285.287	25,309.757	26,306.407	25,331.510

Note: $^+$ p < .10, * p < .05, ** p < .01, *** p < .001; Incident rate ratios; Standard errors in parentheses.

Table A11. Incident rate ratios (IRR) from multilevel negative binomial regression models predicting number of chronic illnesses with interactions.

	Model 1	Model 2	Model 3	Model 4
Religious Environment				
Buddhism	1.033	1.071	1.072	1.069
	(0.069)	(0.049)	(0.053)	(0.053)
Christianity	0.988	0.945	0.988	0.988
	(0.033)	(0.091)	(0.032)	(0.032)
Islam	1.027	1.021	1.026	0.990
	(0.018)	(0.016)	(0.017)	(0.053)
Daoism	0.832*	0.848*	0.848*	0.843*
	(0.071)	(0.066)	(0.070)	(0.070)
Individual Religious Identity				
Buddhist	ref.			
Other religion	0.916			
	(0.093)			
Religious none	0.853*			
	(0.065)			
Christian		ref.		
Other religion		1.018		
		(0.131)		
Religious none		0.860		
		(0.103)		
Religious none			ref.	
Religious			1.099*	
			(0.051)	
Muslim				ref.
Other religion				0.932
				(0.247)
Religious none				0.851
				(0.221)
Religious Environment x Individual Religious Identity				
Buddhism x Buddhist	ref.			
Buddhism x Other religion	1.065			
	(0.122)			
Buddhism x Religious none	1.058			
	(0.053)			
Christianity x Christian		ref.		
Christianity x Other religion		0.952		
		(0.114)		
Christianity x Religious none		1.060		
		(0.106)		
Daoism x Religious none			ref.	

Daoism x Religious adherent			0.973	
			(0.055)	
Islam x Muslim				ref.
Islam x Other religion				1.041
				(0.062)
Islam x Religious none				1.052
				(0.058)
Individual-Level Control Variables				
Man	ref.	ref.	ref.	ref.
Woman	1.108***	1.109***	1.108***	1.108***
	(0.024)	(0.024)	(0.024)	(0.024)
Age	1.007***	1.007***	1.007***	1.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Married	ref.	ref.	ref.	ref.
Separated/Divorced	1.115	1.113	1.112	1.114
	(0.114)	(0.114)	(0.114)	(0.115)
Widowed	0.960	0.959	0.960	0.960
	(0.026)	(0.026)	(0.025)	(0.025)
Never Married	0.913	0.912	0.913	0.913
	(0.100)	(0.100)	(0.100)	(0.100)
Less than Middle School	ref.	ref.	ref.	ref.
Middle School	1.012	1.012	1.013	1.013
	(0.032)	(0.032)	(0.032)	(0.032)
High School	0.884+	0.884+	0.884+	0.884+
	(0.061)	(0.061)	(0.061)	(0.061)
More than High School	1.038	1.038	1.039	1.038
	(0.069)	(0.069)	(0.069)	(0.069)
Ethnic Minority	ref.	ref.	ref.	ref.
Han Ethnicity	1.012	1.017	1.015	1.013
	(0.072)	(0.072)	(0.072)	(0.073)
Community-level Control Variables				
Population	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Population Density (person/km^2)	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Percent with HS Degree	1.001	1.001	1.000	1.000
	(0.001)	(0.001)	(0.001)	(0.001)
Percent Han Ethnicity	1.000	1.001	1.001	1.001
	(0.001)	(0.001)	(0.001)	(0.001)
Percent Over 65	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Logged Per Capita Income	0.988	0.989	0.988	0.989
	(0.013)	(0.013)	(0.013)	(0.013)
Rural	ref.	ref.	ref.	ref.
Urban	1.011	1.009	1.010	1.011

	(0.041)	(0.041)	(0.041)	(0.041)
Percent Migrant	1.001	1.001	1.001	1.001
	(0.001)	(0.001)	(0.001)	(0.001)
Annual Household Expenditures Per Capita	1.000	1.000	1.000	1.000
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	1.028	0.990	0.864	1.017
	(0.235)	(0.237)	(0.188)	(0.341)
Alpha (overdispersion)	–3.129	–3.133	–3.125	–3.126
	(0.597)	(0.598)	(0.592)	(0.593)
Prefecture-level Variance	0.033	0.032	0.033	0.033
	(0.008)	(0.008)	(0.008)	(0.008)
Community-level Variance	0.013	0.013	0.013	0.013
	(0.005)	(0.005)	(0.005)	(0.005)
Household-level Variance	0.160	0.160	0.160	0.160
	(0.017)	(0.017)	(0.017)	(0.017)
Log-likelihood	–13,033.930	–13,032.928	–13,034.500	–13,034.343
N	7,688	7,688	7,688	7,688
AIC	26,127.860	26,125.856	26,124.999	26,128.687
BIC	26,336.251	26,334.247	26,319.498	26,337.078

Note: $^{+}$ p < .10, * p < .05, ** p < .01, *** p < .001; Incident rate ratios; Standard errors in parentheses.

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