UNIVERSITY OF CALIFORNIA,
IRVINE

Religion During Demographic Expansion:
Fertility and Mortality Among Utah Latter-day Saints, 1847 to 1940

DISSERTATION

Submitted in partial satisfaction of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

In Public Health

by

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Dissertation Committee:
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ABSTRACT OF THE DISSERTATION

Religion During Demographic Expansion:

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Professor Tim A. Bruckner, Chair

This study examines religion's role in population fertility and mortality during a time of demographic transition. As all societies desire either sustainment or growth, I utilize functionalist social theory to approach religion as an emergent property of society, one that directs behavior to advance social objectives. To further describe this relationship, I propose three constructs that mediate religion's ability to shape society: beliefs, rules, and community. As a case study of this framework, I utilize 19th and early 20th century Utah based upon its history as an incipient society comprised of religious individuals who experienced population expansion. Specifically, the Church of Jesus Christ of Latter-day Saints (hereafter called "the Church") attempted to influence Utah's population through directives concerning tobacco consumption, community support of families, and a theology encouraging polygamy. Utilizing the Utah Population Database, this dissertation employs three tests to consider how religion might shape fertility and mortality in expanding populations: 1) an examination of the Church's 1921 anti-tobacco policy and comparative changes in morbidity and mortality amongst active and inactive Latter-day

Saint participators, 2) a comparison of fertility rates among active Latter-day Saint females according to the religious density of their community, and 3) an analysis concerning the correlation between infant mortality rates and the polygamous status of the infant's mother.

Aim 1 demonstrates a reduced hazard risk ratio (HRR) of tobacco related death (Female HRR = 0.88, Male HRR= 0.67. $p<.05$) and increased life span (Female = 3.64 years, Male = 5.18 years, all $p<.05$) for active Latter-day Saint individuals compared to inactive Latter-day Saint individuals after the initiation of the 1921 tobacco policy. The results from Aim 2 suggest that fertility among active Latter-day Saint females correlates positively with the religious intensity of their enumeration district (.027, $p = <.0001$). This implies that an active female in an enumeration district with 67% active Latter-day Saints will have 0.44 more children than active Latter-day Saint women in a district with 27% active Latter-day Saints. Finally, while the offspring of polygamous wives in Aim 3 do face increased infant mortality risks (β= 0.089, $p <.0001$) compared to offspring of monogamous wives, some evidence suggests weakening risk for later cohorts, although the population of polygamists decreases during this time period, leaving inference difficult. Although not all tests support their hypothesis, in general these results suggest that in historic Utah, religion served greater social objectives of expanding society through religion's belief, rules, and community.

CHAPTER 1

Introduction

Both public health and religious institutions maintain beliefs and practices that support population expansion. Whereas public health institutions systematically aim for positive health outcomes surrounding fertility and survival (Kass, 2001), religious beliefs and rules that influence these same endpoints often emerge as a reaction to contemporary circumstances (Baumard & Boyer, 2013; Radnitsky & Bartley, 1987; Trinitapoli, 2015). The Church of Jesus Christ of Latter-day Saints' (Latter-day Saints)[1] history as a leading institution in the state of Utah provides a modern context to examine how religious beliefs, rules, and community may develop to support broader social objectives. As such, Utah's transformation from a mid-19th century frontier outpost to a 20th century industrialized state offers an inviting case-study to consider whether religion can inform public health.

Through applications of social theory, I argue that religion, through its beliefs, rules, and community, may increase fertility and reduce mortality in highly religious societies (see Figure 1.1). This proposed relation offers a testable means with which to consider religion's role in public health. I investigate this hypothesis through examinations of fertility and mortality among mid-19th to early-20th century Utah Latter-day Saints. This epoch possesses special significance as it represents a time of well-recorded modernization by a highly religious society (Arrington, 2005). Likewise, these analyses employ mortality and fertility outcomes not only because they constitute fundamental demographic variables in population expansion, but also because Utah's health profile now shows some of the nation's highest fertility and lowest mortality rates. (Coale & Trussell, 1996; *Median Age by State 2024*, 2024; *Stats of the State of Utah*, 2019; *Utah's*

[1] Various names have been used to describe The Church of Jesus Christ of Latter-day Saints, the most common being "Mormon". The Church has asked the public to no longer use this term when describing the institutional church or its members (*Style Guide — The Name of the Church*, 2022). Thus, I use "the Church" to describe the institution and "Latter-day Saints" to describe its members in accordance with its own style guide. The term "LDS" is used in place of "the Church" only in instances where a clear descriptor is needed, but space is limited, such as in figures and models.

Fertility Rate Continues to Drop, Now Fourth Highest in the Nation - Kem C. Gardner Policy Institute, 2022; Zick & Smith, 2006). Thus, a study of Utah's Latter-day Saints offers an exceptional opportunity to consider how religion affects with population health.

To test these claims, I propose separate analyses of each of the three religious influences: rules, community, and belief. In consideration of how religious rules might reduce mortality, I test how the 1921 Latter-day Saint policy banning tobacco use correlates with changing rates of lung cancer and tobacco-related death. Next, using census enumeration districts as indicators of community, I test how the local density of religiously active people may have affected fertility rates of active Latter-day Saint women. Finally, considering the changing attitudes towards Latter-day Saint polygamy during the study's time frame, I investigate how rates of infant mortality among active Latter-day Saint mothers change across time according to their participation in plural marriage. In sum, through an examination of religious and environmental factors that could affect population health outcomes, I hope to outline how a specific religion, the Church of Jesus Christ of Latter-day Saints, strengthened the health profile of its members.

Framework

Functionalist theory holds that institutions like religion serve as a mechanism with which society maintains order, responds to changes, and increase its interests (Durkheim, 1912; Stark & Bainbridge, 1997; Weber, 1930). These social concerns may include issues of economics (Becker et al., 2021; Weber, 1930), politics (Greenberg, 2000), or health (Chatters, 2000). Sociologists hypothesize that religion proves effective in resolving these concerns due to the supernatural essence of its beliefs and rules (Azra et al., 2010; Durkheim, 1912; Fitouchi & Singh, 2022; Singh et al., 2021). Consequently, we may find religious beliefs, rules, and community to emerge as part of the ecology that supports social functioning and growth within societies dominated by faith.

Historical research supports this sociologic approach to the Latter-day Saint faith. Both historians and sociologists argue that much of the late 19th and early 20th century Church developments were responses to the social and physical environments of the time (Arrington, 2005; Arrington & Bitton, 1992; Mauss, 1994b; Quinn, 1997). Specifically, both Utah's harsh climate and the Latter-day Saint conflicts with the federal government forced early church members to insulate and strengthen their society (Arrington, 2005; Arrington & Bitton, 1992) through communalism (Israelsen, 1982; Miller, 2016), agriculture (Arrington & May, 1975; Kay & Brown, 1985), immigration (Henrichsen et al., 2010; Larson, 1931), and fertility (Bean et al., 1990; Bean et al., 1983; Spicer & Gustavus, 1974). Today, this history informs contemporary Latter-day Saint identity. Church leaders regularly emphasize the many challenges of this historic period as formative to the faith's current status as a robust international religion (*A Period of Testing and Trials*, n.d.; *International Government and Religious Leaders Visit Church Headquarters*, 2023; Park, 2023).

Public Health Significance

Examinations of religion contain much relevance to public health. Pew Research predicts that religious-oriented individuals will drive world population growth in the 21st-century (Pew Research Center, 2022). As secularization is associated with smaller family size, the number of children born to non-religious families will constitute a decreasing portion of the population. Thus, considerations of historical events surrounding population change have implications for social theory, policy, and planning.

Theory suggests that medical institutions offer a vital role in shaping social attitudes towards health behavior (Clarke & Shim, 2011; Leeming, 2001; Link et al., 1989). Surprisingly, no analogous theory exists for religion. Likewise, religion is an under-represented component in demographic expansion models (Lehrer, 2004). Although secularization is highly associated with population deacceleration and decline, religion's efforts to induce population growth can provide novel research and policy approaches. Additionally, despite the efforts of classical theorists such as Durkheim and Weber to position religion as a preeminent social determinant (Bennion, 1992; Durkheim, 1897, 1912; Weber, 1930), the public health literature regarding religion remains limited (Smith et al., 2013). And when scholars focus on religion and health, the religious oriented epidemiologic studies typically views religion as an individual lifestyle factor rather than a macro-level social force (Chatters, 2000; Merrill & Thygerson, 2001; VanderWeele, 2017a). In light of the current literature, quantitative explorations of religion within a social theory framework may offer new dimensions to the study of population health.

Outside of theory, studies of religion can inform health efforts from the local to the international level. Within local communities, interventionists with specialties from fertility to sexually transmitted diseases might work with congregational leaders to leverage specific theologies or customs (Trinitapoli, 2015). On the other hand, as the religiously unaffiliated comprise an increasing portion of the industrialized yet low-fertility world, immigrants from more religious nations will compose a greater portion of these secular societies. These immigrants will face the unique dynamic of acculturating as religious people into a secular context (Güngör et al., 2013; Steffen & Merrill, 2011a). Therefore, understanding whether and how religion contributes to health offers important insights in terms of politics, economics, and public health.

Dataset: The Utah Population Database

The primary data set for this dissertation is the Utah Population Database (UPDB). The genealogical richness of the UPDB partially results from the Latter-day Saints' belief in record keeping as a sacred duty (Snow, 2019). In 1975, The Utah Genealogical Society (UGS) provided copies of 185,000 three-generation genealogic documents to the University of Utah concerning all individuals who had a demographic event (birth, marriage, reproduction, or death) on the Mormon Trail or in Utah. These genealogies, kept over many generations by Latter-day Saints, represented approximately 1.9 million individuals. This donation included nearly all baptized Latter-day Saints found in Utah prior to 1975 (Smith & Mineau, 2021). Through these and other genealogies along with information acquired from state vital, census, hospital, and other records, the UPDB now contains information on over 11 million individuals from the late 1700s until today. This dissertation's current data access from the UPDB yields 723,993 individuals (and their immediate families) who had a demographic event in Utah between 1847-1940 and appear on the original UGS genealogies donation. Thus, Utah's distinct religious profile, coupled with its high-quality historical health data, afford this dissertation a unique vantage point to consider religion and health on a demographic level.

The UPDB possesses both baptism and endowment ceremony participation dates for each individual found in the original UGS donation. Regarding baptism, the Latter-day Saints consider a child old enough at age 8 to make their own public statement of faith through baptism. Once baptized, an individual is considered an official member of the Church. Although this ritual serves as an act of commitment to life-long church activity, for those baptized at age 8 (mean age

= 8.54) the ceremony may better represent familial commitment to raise the child within the institution. For those who remain active after baptism, the endowment ceremony would provide the opportunity to make further religious promises during young adulthood.

Performed within a Latter-day Saint temple, the endowment ceremony provides a post-baptism timepoint of religious activity. This ritual, generally performed in early adulthood prior to marriage or missionary service (mean age = 25.12 years), allows baptized Latter-day Saint adults to formalize their loyalty to the church and its behavioral standards. As such, the endowment constitutes a greater form of dedication believed to lead to salvation (*About the Temple Endowment*, n.d.). As a measure of readiness, the church requires the individual to obtain a worthiness "recommend" from their local ecclesiastical leader. This process includes an interview concerning one's fealty to Latter-day Saint rules and beliefs (*Church Updates Temple Recommend Interview Questions*, 2019). Therefore, UPDB researchers assume that those individuals baptized but not endowed were less likely to have remained active in the Church during adulthood (Mineau et al., 2004).

Religion and Health

In late 19th and early 20th century, social forces within America, such as the modernization of science (Bud et al., 2018; Starr, 1982), the increased sense of social awareness (Fogel, 2000), and rising protestant fundamentalist (Carpenter, 1980) fueled scientific interest in religious practice (Ferngren, 2014, p. 165). Consequently, a body of religious-oriented health research developed that included applications to suicide (Durkheim, 1897), mental health and moral control (Brown, 1920), psychological well-being (James, 1902) and nutrition (Kellogg, 1902). As researchers began to consider the various social contexts of health in the latter-half of the 20th century (Daniels et al., 1999; Lalonde, 1974; Wilkinson & Marmot, 1998), a place developed for religion as a social determinant of health (Hummer et al., 1999; Ironson et al., 2006; McCullough et al., 2000; VanderWeele, 2017d).

Despite the increased scientific interest in religion, key issues remain concerning its analysis within population health (Kawachi, 2020). For instance, selection into religion might exaggerate religious benefits as healthy people may be more likely to participate (Balbuena et al., 2014; Maselko et al., 2012; Regnerus & Smith, 2005). This consideration is supported by research findings that demonstrate certain psychologies predict religious conversion and deconversion (Bleidorn et al., 2023; Dengah et al., 2019a; Granqvist & Kirkpatrick, 2004; Hui et al., 2017; Ullman, 1982). Thus, greater understanding of who selects into religion can lead to better inference regarding individual health outcomes.

The lack of consensus regarding theoretical mechanisms between religion and health offers another analytical hurdle. This deficit heightens vulnerability to unknown confounders (Kawachi, 2020). Furthermore, some suggested religious mechanisms, such as social support, abound in non-religious environments (Callaghan & Morrissey, 1993; Kaplan et al., 1977; Schwarzer & Leppin, 1991). As such, religion may exist within a greater phenomenon (e.g., social capital, social supports), being determined by larger processes (Abbott, 2009; Trinitapoli, 2015, 2023).

Finally, the limits of data collection constrain avenues of religious-health research. The original religious studies in public health relied upon self-reported survey data that often employed cross-sectional designs to compare religiosity (e.g., regular prayer or church service attendance) to health outcomes (Lee-Poy et al., 2016; Maselko & Kubzansky, 2006; Norton et al., 2008; Strawbridge et al., 2001). Data such as this, while producing illuminative studies regarding lifestyle and health, do not provide the appropriate means to consider how religion may affect society-at-large. Therefore, greater need exists for studies that consider religious selection, employ population wide data, and focus upon well-theorized processes by which religion could affect health (Kim & VanderWeele, 2019; Morton et al., 2017).

Latter-day Saint health

Previous research establishes a firm health advantage for Latter-day Saints across a range of behaviors, conditions, and diseases (Badanta et al., 2020; Bartz et al., 2010; Bush, 2022; Cranney, 2017; Daniels, 2004; de Diego Cordero & Badanta Romero, 2017; Hawkes et al., 2007; Lyon, 2013; Norton et al., 2008, 2010). Although researchers attribute multiple factors to this phenomenon (Lindahl-Jacobsen et al. 2013; Merrill, 2004), many credit a Latter-day Saint culture that prohibits tobacco and alcohol (Enstrom & Breslow, 2008; Merrill & Lyon, 2005; Merrill & Thygerson, 2001), espouses pronatalism (Heaton, 1986; Skolnick et al., 1978), and offers strong community support (Norton et al., 2006; Steffen & Merrill, 2011b). While the literature maintains a relation between Latter-day Saint identification and better health, in my view health researchers have not fully leveraged the opportunities afforded by Latter-day Saint record keeping.

For health scholars of religion, providing a definition of "religiously active" remains challenging (Cutting & Walsh, 2008). Research often employs self-reported church service attendance whose validity as a proxy of a devoted religious life remains questionable (Chatters, 2000; Hall et al., 2008; Kim & VanderWeele, 2019, 2019; Smith, 1998; VanderWeele, 2017d). For Latter-day Saint research, meticulous record keeping practices (Snow, 2019) present alternative options. Previous research highlights some of these avenues to a limited extent as epidemiologists and demographers have operationalized church activity in the form of Latter-day Saint member/non-member status (Lyon et al., 1994; Williams et al., 1979) or rank in the lay priesthood (Enstrom & Breslow, 2008; Gardner & Lyon, 1982). Yet, these tactics have their own shortcomings. For instance, the Church determines membership by baptism status, which primarily occurs at age 8. As such, measurement of religiosity by membership standing (or baptismal date) would precede important adolescent and early adult behavioral decisions. The alternatively employed measurement, advancement in the male lay priesthood, the leadership organization of the church, allows for adult comparisons of health behaviors, but precludes females. Consequently, both member/non-member status and rank in the male-priesthood have limited value when addressing population level outcomes.

Latter-day Saint record keeping also offers the ability to study health changes over time. Prior literature's use of Latter-day Saint lifestyle characteristics rather than temporal changes limits inference concerning institutional responsibility (Badanta et al., 2020; de Diego Cordero & Badanta Romero, 2017; Merrill, 2004; Merrill & Salazar, 2002). For example, Merrill (2004) investigates what proportion of Latter-day Saint increased life expectancy during 1994 to 1998 in Utah is due to decreased smoking among Latter-day Saint people. Merrill determines that decreased tobacco consumption accounts for 1.5 years of the additional 7.3 years of period life-expectancy found amongst Latter-day Saint males compared to non- Latter-day Saint adult males. Although this study offers strong evidence regarding the health quality benefits of Latter-day Saint culture during the mid-1990s, it does not establish a clear link between how institutional objectives cause changes in population mortality. As such, greater use of longitudinal data over key cohorts that includes Latter-day Saint ceremonies such as baptism and endowment can strengthen internal validity of these inferences.

In recognition of these gaps in the literature, this dissertation proposes three ways in which religion could affect population health. Additionally, I utilize population-wide data linked across multiple generations. By combining these proposed mechanisms with data from the UPDB, one can better infer how specific Latter-day Saint doctrines, rules, and community characteristics preceded the historic improvements in health that characterize Utah during the demographic transition.

Proposed mechanisms

Based upon Durkheim's hypotheses (Durkheim, 1912) and previous literature (Cohen et al., 2009; Daniels, 2004; de Diego Cordero & Badanta Romero, 2017; Elkalmi et al., 2016; Johnstone et al., 2012; Regnerus, 2003), I identify three key mechanisms employed by religion to shape individual choices and behaviors, and thus population health outcomes: beliefs, rules, and community (see figure 1.1).

> ***Beliefs:*** The theological paradigm an individual employs to interpret events and make decisions (Hammond, 1988; Madge et al., 2014; Tajfel, 1974; Ysseldyk et al., 2010; Smith, 2014).
>
> ***Rules:*** The codes of conduct, either formal or normative, that define acceptable individual behavior (Young et al., 2013; O'Dea, 1954).

Community: A collective of individuals, often defined by geography, with an agreed upon theological paradigm, code of conduct, and unified institutional loyalty (Durkheim, 1912; McMillan & Chavis, 1986; Stroud et al., 2015).

Dissertation Structure

This dissertation offers a framework of religion as an agent of social cohesion and growth through its rules, community, and beliefs. As such, I offer three quantitative studies that explore each potential mechanism, individually, in its relation to either fertility or mortality.

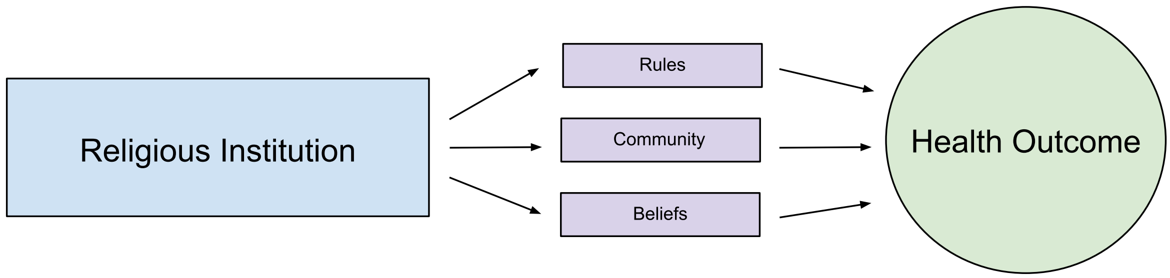
Chapter 2: Rules. This chapter examines how religious rules shape morbidity and mortality. Concerned about the onset of cigarette use in Latter-day Saint youth during the early 20th century, the Church banned tobacco consumption as prerequisite to temple worship in 1921. As Latter-day Saint temple participation initiates during one's 20s, this policy offers a finite time point with which to measure the introduction of religious belief during a time of modern health record keeping. As such, I analyze how mortality and morbidity rates respond to changes in tobacco use across birth cohorts before and after the policy's introduction.

Chapter 3: Community. This study examines the relation between the concentration of religious affiliation in communities and fertility. Throughout the 19th and 20th centuries the Latter-day Saint church promoted a culture of high fertility through pronatalist theology. This endorsement included a range of beliefs and doctrines from an emphasis on God's charge in the Garden of Eden to "be fruitful and multiply the earth" to a pre-earthly life where all souls must be born into physical bodies, therefore promoting fertility as a divine mandate. I maintain that these doctrines resulted in a community and culture that incentivized and supported fertility among the faithful of early 20th century Utah. To test this claim, I examine fertility among active Latter-day Saint women in relation to the density of active Latter-day Saint people within the female's census enumeration district during the 1900 to 1940 censuses.

Chapter 4: Beliefs. The final analytic chapter analyzes the theological influences upon infant mortality. Latter-day Saint scripture holds polygamy as the highest form of marriage. Yet, social attitudes towards polygamy became increasingly hostile, forcing the Latter-day Saint church to abandon the practice. This chapter investigates how the conflict between theology and politics affected infant mortality according to the mother's activity in polygamy and the time period of birth.

Figures

Figure 1.1: Conceptual model of mechanisms between religious institutions and health outcomes.



CHAPTER 2:

Rules: Tobacco abstention and late-life mortality

Introduction

Both public health and religious institutions maintain practices that induce population expansion. While public health research approaches reductions in morbidity and mortality as a fundamental ethic (Kass 2001), religious beliefs and rules that influence longevity often emerge from other concerns (Baumard & Boyer 2013; Radnitsky & Bartley 1987). The Church of Jesus Christ of Latter-day Saints' smoking-abstention policy of 1921 provides a modern example of how institutional rules may unintentionally promote mortality-reducing behavior. As such, this early 20th century health code offers an opportunity to consider whether the interests of religion may have led to improvements in public health.

Previous research establishes a firm health advantage for Latter-day Saints across a range of diseases and medical conditions (Bartz et al. 2010; Bush 2022; Daniels 2004; Hawkes et al. 2007; Lyon 2013; Norton et al. 2010). Although research attributes multiple factors to this phenomenon (Lindahl-Jacobsen et al. 2013; Merrill 2004), many credit a Latter-day Saint culture that eschews tobacco and alcohol (Enstrom & Breslow 2008; Merrill & Lyon 2005; Merrill & Thygerson 2001). Studies interested in the relation between religion and health (and for Latter-day Saint health in particular) must address to some degree selection into religion as highlighted in previous studies (Dengah et al. 2019; Francis & Katz 2000; Jokela & Laakasuo 2023; Scheitle & Adamczyk 2010). Consequently, I set out to examine the association between religious policies and population health through both a theoretic framework (Dew 2015; Popper 1987; Weber 1930) and a quasi-experimental design (Campbell & Stanley 2011) provided by the nature of an early 20th century policy. To do so, I offer a formal test of the introduction of Latter-day Saint tobacco abstention to changes in all-cause and cause-specific morbidity and mortality among baptized members of the Church.

Background

Religion and Demography

Social theory holds that the supernatural essence of religion's beliefs and rules fuels its authority to direct behavior (Azra et al. 2010; Durkheim 1912; Fitouchi & Singh 2022; Singh et al. 2021). If survival or expansion ranks as a key objective of a society, I expect the emergence of local religious doctrines and directives that support these goals (Popper 1987). This evolution of religious tenets would presumably shape demographic forces that create population change via the number of individuals who enter the population through birth and immigration compared to those who exit through emigration and death (Coale 1989; Coale & Trussle 1996). Consequently, in highly religious societies one may expect fertility and mortality trajectories to reflect local religious beliefs.

Health as Latter-day Saint Identity

Both the Church's history of assimilation with the outside world and its theology paved the way for the 1921 anti-tobacco policy. In 1847, three years after the killing of church founder Joseph Smith, the Latter-day Saints migrated westward to escape persecution and find independence (Arrington 2005; Brown 1980). Once settled in the Utah territory, their seclusion was tested by the 19th century transnational railroad's expansion that transformed the isolated religious colony into an inter-mountain crossroads (Farmer 2015; Kucharski 2017). The territory's subsequent industrialization left church leaders struggling to protect the unique local identity against cosmopolitism and government intervention. Scholars now argue that this cultural struggle created tensions between national assimilation and institutional orthodoxy, out of which a 20th century Latter-day Saint identity emerged (Bowman 2012; Mauss 1994a, 1994b). A once insular religious society often at odds with the federal government, yet increasingly interested in national acceptance, soon was characterized by teetotaling, business acumen, and traditional family values (Arrington & Bitton 1992).

In 1833, Church founder Joseph Smith introduced a theology of health called "The Word of Wisdom" (WoW). The Latter-day Saints initial understanding of this scripture regarded its prescriptions concerning healthy living as advice (Hoskisson 2012; *The Doctrine and Covenants,* Section 89). Thus, this nascent rule was marked by varying interpretations in the 1800's that paradoxically left tobacco and alcohol as both taboo and ubiquitous within the church (Alexander 1981; Eddington 2023; Peterson 1972). By the early 20th century, emerging social forces such as the evangelic temperance movement, a post-polygamy desire for acceptance among mainstream American Christianity, and the national rise in cigarette uptake produced the circumstances to solidify how the Church interpreted the Word of Wisdom (Alexander 1996).

In 1921, the church settled upon complete abstention from tobacco, alcohol, coffee, and tea as a prerequisite to participation in the endowment ceremony. This ritual, performed during early adulthood (median age= 25.12, see Table 2.10) within Latter-day Saint temples, consists of further promises to God, including fealty to the Church and its leaders (*About the Temple Endowment*, n.d.). While today it may seem self-evident that a religious rule concerning tobacco may influence certain health outcomes, this policy preceded current scientific understanding that supports tobacco as a carcinogen by at least thirty years (Cornfield et al. 1959; Doll & Hill 1950; Khuder, 2001). Accordingly, church leaders of the 1920's argued that prohibiting tobacco would combat the perceptions of decreased productivity and increased social deviance associated with cigarettes (Peterson 1972). For the next two decades church leaders solidified this new paradigm through speeches and printed media aimed at Latter-day Saint youth. By 1940, obeying the WoW was a matter of orthodox identity for the endowed individual.

Religion and Health

Much literature finds a relation between religious identity and lower tobacco use. Identity measured through church service attendance (Bowie et al. 2017; Brown et al. 2014; Gillum 2005; Hofstetter et al. 2010), belief in God (Elkalmi et al. 2016; Gmel et al. 2013; Sanchez et al. 2011), prayer (Alzyoud et al. 2015; McFadden et al. 2011), and religious social-networks (Andres-Sanchez et al. 2021; Bailey et al. 2015) display inverse associations with tobacco consumption. Latter-day Saints display similar findings. These individuals exhibit lower levels of smoking uptake (Koenig et al. 1998; Merrill & Thygerson 2001), lower levels of all-cause and tobacco-specific cancers (Enstrom 1975, 1978, 1980; Enstrom & Breslow 2008; Gardner & Lyon 1982; Lyon et al. 1980; Merrill 2004; Merrill & Lyon 2005), and increased life expectancy (Lindahl-Jacobsen et al. 2013; Mineau et al. 2004) compared to non- Latter-day Saint populations, even when controlling for church attendance.

Despite evidence that indicates Latter-day Saint activity is associated with reduced tobacco use, this body of work leaves two important constructs unexamined: 1) group versus individual health behavior, and 2) religious rules as health policy. Although past research suggests Latter-day Saint religious participation positively benefits individual health outcomes, specific examinations concerning this 1921 policy and changes in group behavior remains elusive. As such, this discrete policy provides a unique opportunity to examine whether religious rules may be reflected in cohort morbidity and mortality rates.

Religious Policy Considerations

When investigating the potentially causal health effects of a religious policy, two empirical considerations require careful attention: defining Latter-day Saint religiosity and establishing temporal order. Regarding religiosity, investigators often use self-reported survey responses of church service attendance (Chatters 2000; Hall et al. 2008; Kim & VanderWeele 2019; T. W. Smith 1998; VanderWeele 2017). For the Latter-day Saint faith, however, health researchers benefit from the faith's belief in, and practice of, meticulous record keeping (Snow 2019). For epidemiologic and demographic studies, this high-quality record keeping often permits operationalization of church activity in the form of Church member/non-member status (Lyon et al. 1994; Williams et al. 1979) or rank in the lay priesthood (Enstrom & Breslow 2008; Gardner & Lyon 1982). Yet, these approaches have their own shortcomings.

For instance, the Church determines membership by baptism status, which occurs at age 8 (median age= 8.54, see Table 2.10) for those born into the faith. As such, previous studies that determine religiosity by Church membership status might preclude adolescent behavioral decisions and thus instead portray parental religious identification. In addition, advancement in the male lay priesthood ranks (the Church uses unpaid "lay" clergy- the priesthood- for local and regional leadership), allows for adult comparisons of health behaviors, but precludes females. Consequently, studies that employ member/non-member status and rank in the male-priesthood have limited value when addressing a church-wide policy.

As prior literature concerns Latter-day Saint lifestyle characteristics more than policy effects, it does not consider temporal events (Badanta et al. 2020; de Diego Cordero & Badanta Romero 2017; Merrill 2004; Merrill & Salazar 2002). While these studies illuminate how religious involvement affects health, they do not consider the role of institutional mandates/edicts/policies. For example, Merrill (2004) investigates how much of Latter-day Saint increased life expectancy during 1994 to 1998 in Utah is due to decreased smoking. The author determines that decreased tobacco consumption accounts for only 1.5 years of the additional 7.3 years of period life-expectancy at birth found among Latter-day Saint males compared to non-Latter-day Saint males. Although this study offers strong evidence regarding the health effects of Latter-day Saint culture during the mid-1990s, it does not establish a clear link between institutional objectives and behavior. As such, the need exists for studies that determine whether, and to what extent, specific church rules precede improvements in health outcomes.

Here, I extend previous research by investigating the WoW as a precursor to Latter-day Saint health behavior. I consider sex-specific differences in cohort-specific rates of all-cause mortality and smoking-related disease and death between individuals of varying levels of church affiliation and how they may respond differently to the 1921 Latter-day Saint anti-tobacco policy. I extend past efforts addressing the connection of religion and health through the application of a historically informed theoretic framework paired with an extensive genealogic dataset that allows for both within-religious and across-time comparisons.

Outcomes

We anticipate that endowed church members, born between 1900 to 1920, will experience greater life expectancy past age 50, a lower hazard of tobacco-related cancer, and decreased all-cause and cause-specific mortality compared to inactive Latter-day Saint members of the same birth cohorts. For individuals from the 1880 to 1899 birth cohorts, I expect no difference in these outcomes according to religious activity. I employ the year 1900 as a nexus point given that authorities in 1921 were most concerned with changing tobacco patterns in Latter-day Saint youth, rather than in older adults for whom they made allowances (Peterson 1972). Psychological and substance-abuse literature that identifies adolescence as a key age for identity and decision-making offers additional support for this age choice (Amos & Bostock 2007; Arnett 1997, 2000; Currie et al. 2004; Sowden & Stead 2003). I further test these hypotheses through a falsification test that employs prostate and breast cancers as health outcomes. For these tests, I expect smaller (or no) differences in non-tobacco related cancer diagnoses rates based upon religious activity but not tied to a 1900 inflection point.

Methods

Data

The Utah Population Database (UPDB), one of the world's most comprehensive computerized genealogies, serves as my data source. The UPDB links population information of over 11 million individuals from the late 1700s until today that includes genealogical data matched to census, vital records, hospital records, and more (Smith & Mineau 2021). For a given individual, UPDB provides, when known, information of residences, occupations, marriages, births, baptisms, and endowment records. Thus, the ability to match social and health information over many generations stands as a key strength of the UPDB. I know of no other data set of its kind, in terms of historical accuracy and completeness dating back to the 19th century, in the United States.

Population

My population consists of 139,542 baptized members of the Church who survived at least to age 50, born in Utah between 1880 to 1920, and who either died or were last documented in Utah. These cohorts enjoy advantages in the UPDB as 1905 marks the inaugural year of the Vital Records Office in Utah when official birth and death certificates were introduced. Also, 1975 is the year when religious ordinance data (baptisms, endowments) in the Church of Jesus Christ of Latter-day Saints were made available by the Utah Genealogical Society upon the initiation of the UPDB. Further, the 1880 to 1920 cohorts were between the ages of zero to 41 during both the 1921 policy and the early 20th century boom in cigarette smoking (Brandt 2007; Jackson 1950). To control for similarity of exposure to church culture, I include only baptized Latter-day Saint individuals and those whose birth and death (or last recorded) states were Utah.

Based upon exploratory data and prior literature, four factors justify the inclusion criteria of survival to age 50. First, 90% of endowments among Utah birth cohorts from 1880 to 1920 occurred prior to age 50. As 1975 constitutes the year recorded endowments from Latter-day Saint genealogies were provided to the UPDB, one can observe individuals from the final birth cohort (1920) to be endowed by age 50. Second, 97% of all tobacco-related deaths occur after age 50 among this UPDB cohort. Third, the requirement of survival to age 50 avoids the high prevalence of unintentional injuries among younger ages that may affect life expectancy differences between active and inactive Latter-day Saint members (*WISQARS Leading Causes of Death Visualization Tool* 2023). Fourth, research demonstrates that a male who quits smoking at age 50 will return to at or near baseline lung cancer risk in their 70s (Halpern et al. 1993; Peto et al. 2000; Saito et al. 2017). Overall, this age inclusion requirement allows sufficient time for an individual to forsake or cease smoking and be endowed, renders them less likely to suffer accidental death, and yet still captures nearly all tobacco-related deaths across the population of interest.

Mechanisms

The variables in this analysis derive from proposed mechanisms between religion and fertility. Based upon Durkheim's assertions (Durkheim, 1912) and previous literature (Cohen et al., 2009; M. Daniels, 2004; de Diego Cordero & Badanta Romero, 2017; Elkalmi et al., 2016; Johnstone et al., 2012; Regnerus, 2003), I identify three key mechanisms employed by religion to shape individual choices and behaviors, and thus population health outcomes: beliefs, rules, and community. Figure 2.7a illustrates the proposed relation between religion and population health outcomes. More specifically, Figure 2.7b illustrates this same relation with regards to infant mortality and beliefs.

Variables

My dependent variables are life expectancy in years past age 50, the hazard rate for smoking-related death, and the hazard rate for lung and bronchus cancer. I focus on tobacco because it serves as the majority cause of a specific class of disease (aerotract cancers), unlike other substances prohibited in the WoW (Hall et al. 2008; Kuper et al. 2002; United States Office on Smoking and Health 1979; Zhou et al. 2021). Further, cigarette smoking during the mid-20th century grew exponentially. Without an intervention, one would expect tobacco-related disease and mortality to climb in concert between active and inactive Latter-day Saints (Gershon 2022). I define tobacco-related deaths as deaths whose primary cause is either chronic obstructive pulmonary disease (COPD) or tobacco-related cancers of the lung, bronchial, trachea, or esophagus (see Table 2.9).

When measuring morbidity, I utilize the UPDB's variable of "lung or bronchus" cancer diagnosis, as the primary endpoint. As a test of falsification, I consider diagnosis of prostate and breast cancers. The UPDB's data for cancer diagnosis is supplied by the Utah Cancer Registry (UCR), which began systematic surveillance in 1966 and entered the Surveillance, Epidemiology, and End Results (SEER) program in 1973 (*About Utah Cancer Registry* 2022). For cancer data prior 1966, incidences reported to the UPDB by the UCR were compiled by UCR founder Dr. Charles Smart, MD. I include Dr. Smart's pre-1966 data in my analyses, noting it's collection history, only after extensive checks for bias due to religious affiliation, geography, sex, and other factors (see Figures 2.5 and 2.6).

My study design treats religious activity as a modifying factor between the timing of a policy shift and health outcomes. Consequently, my exposure variable is whether one was born from 1880 through 1899 (coded "0" as "unexposed" pre-20 years old), or from 1900 through 1920 (coded "1" as "exposed" pre-20 years old). I reason that a Latter-day Saint born on or after 1900 fell within the policy's target age in 1921 at or before age 20. Furthermore, by confining the exposure criteria to a pre-adult age, my measurement of religiosity through a religious practice which occurs generally in one's mid-20's allows for a clear means to identify those who likely conformed to the new policy. I defined my modifying covariate, "active Latter-day Saint," as only those with "living" baptism and endowment participation dates recorded within the UPDB and "inactive Latter-day Saint" as those with only a "living" baptism date. I emphasize a "living" date as the faith practices posthumous ceremonies on behalf of deceased ancestors which were not included in this study (Lindahl-Jacobsen et al. 2013; Mineau et al. 2004; Smith et al. 2002). I stratify all models by sex due to the sex specific nature of smoking uptake (Audrain-McGovern et al. 2015; Cosgrove et al. 2014; Pierce & Gilpin 1995; Zuo et al. 2015).

This analysis employs birth cohort sex ratio (the ratio of males to females born in each birth cohort) as a measure of *in utero* environmental harshness that influences longevity and disease susceptibility. Prior literature demonstrates that lower than expected sex ratios often follow harsher prenatal conditions that cull weaker fetuses, who generally are male (Bruckner 2018; Catalano & Bruckner 2006; Schacht et al. 2021). Thus, birth cohorts with higher-than-expected sex ratios comprise more frail males that in-turn lead to higher hazard rates of disease and mortality at older ages. I also include the urbanicity of the individual's birth place as the Utah-based literature reveals worse health effects in rural areas post-industrialization (Blackburn et al. 2019; Koric et al. 2023; Ou et al. 2018; Rogers et al. 2020). The 29 counties in Utah were categorized as "urban" or "rural" based upon both past UPDB precedent and SEER definitions (Park et al. 2018; Rogers et al. 2020; *Rural-Urban Continuum Code - SEER Datasets* 2014).

Models

For tests of life expectancy, I estimate ordinary least-squares regressions (OLS) to examine years lived from age 50 years until death, Y_{itj}. I include a vector of individual background characteristics X_i that are associated with the outcome but are not caused by the Word of Wisdom policy, including birth cohort sex ratio and urban/rural status. I code sex ratio as a continuous variable. Urban/rural status is coded as 1 if born in an urban county or 0 if born in a rural county.

In Model 1, I introduce the central exposure variable as the lone covariate: whether one was born between 1880 to 1899 (0) or 1900 to 1920 (1) $WoWc_t$; β_1 is the coefficient of interest. As secular improvements in life span increase across cohorts, I expect β_1 to be greater than 0. In Model 2, I add background characteristics X_i, and religious participation $ActiveLDS_j$. I code religious participation as a binary variable that measures whether the individual was endowed (1) or not endowed (0). Model 3 adds an interaction term between $WoWc_t$ and $ActiveLDS_j$. These models take the following form:

(1) $Y_t = \alpha + \beta' \cdot WoWc_t + \varepsilon_t$

(2) $Y_{itj} = \alpha + \beta' \cdot X_i + \beta_1 \cdot WoWc_t + \beta_2 \cdot ActiveLDS_j + \varepsilon_{itj}$

(3) $Y_{itj} = \alpha + \beta' \cdot X_i + \beta_1 \cdot WoWc_t + \beta_2 \cdot ActiveLDS_j + \beta_3 (WoWc_t \cdot ActiveLDS_j) + \varepsilon_{itj}$

We employ Cox Proportional Hazard models to examine all-cause and cause-specific mortality, as well as cancer morbidity, λ_{1itj} from age 50 years until death. Let (a) denote age. I define mortality as death from a tobacco related disease (1) or death from any other cause (0). The independent variables are similar to those found in the life expectancy models. I express the hazard rate $\lambda_{1itj}(a)$ of tobacco related death in the following three models:

(4) $\lambda_{1it}(a) = \lambda_{0t}(a)\exp(\beta_1 \cdot WoWc_t + \varepsilon_{it})$

(5) $\lambda_{1itj}(a) = \lambda_{0itj}(a)\exp(\beta' * X_i + \beta_1 \cdot WoWc_t + \beta_2 \cdot ActiveLDS_j + \varepsilon_{itj})$

(6) $\lambda_{1itj}(a) = \lambda_{0itj}(a)\exp(\beta' \cdot X_i + \beta_1 \cdot WoWc_t + \beta_2 \cdot ActiveLDS_j + \beta_3 \cdot WoWc_t \text{ x } ActiveLDS_j + \varepsilon_{itj})$

Results

Tables 2.1 and 2.2 represent the descriptive statistics. The population of 139,542 includes 33,795 inactive Latter-day Saints (who were 49.41% female) and 105,170 active individuals (51.31% female). Three-quarters of inactive Latter-day Saints compared to 56.77% of active

Latter-day Saints were born after 1900. A slightly higher proportion of active Latter-day Saints, compared to inactive individuals, were urban births.

Figure 2.1 provides visual evidence in support of health effect modification due to Church activity. These figures present a striking difference between active and inactive individuals' rates of tobacco related death and lung cancer that does not appear in breast and prostate cancers. Additionally, these charts partially support 1900 as an inflection point. Overall and male life expectancy, female tobacco related death, female lung cancer, and male prostate cancer appear to show clear effect modification occurring based upon the two cohorts divided in 1900. Other outcomes, such as male tobacco related death and female life expectancy, appear to differ between 1890 and 1895 birth cohorts. Survival curves concerning tobacco related deaths (see Figures 2.2 and 2.3) confirm the exploratory findings of these charts.

Table 2.3 offers the results from the OLS regression analysis. Active Latter-day Saint males born after 1900 show 5.18 extra years of life past age 50 compared to inactive males. For females, the difference was only 3.64 years. For those born prior to 1900, active Latter-day Saints demonstrated a shorter life span than inactive members— 2 years less for females and 9 months less for males. These life expectancy differences, though lower than those reported by Enstrom (1978) and Merrill (2004), seem reasonable given that this analysis employs differences among Latter-day Saint sub-groups rather than comparisons between individuals who were and were not baptized. Additionally, Merrill considers life expectancy at birth and Enstrom considers life expectancy at age 35 whereas I consider life expectancy given survival to age 50 (Enstrom, 1978; Merrill, 2004).

Table 2.4 considers all-cause mortality. I find decreased risk for both female (HRR= 0.88) and male (HRR=0.67) active Latter-day Saints born after 1900 compared to inactive Latter-day Saints of the same birth cohorts. Prior to 1900, active Latter-day Saint females manifest an increased risk of mortality after age 50 (HRR= 1.10) and active Latter-day Saint males a decreased risk (HRR= 0.95) compared to their inactive counterparts. The increased risk demonstrated by pre-1900 active Latter-day Saint females may be due to the increased parity found among Latter-day Saint active women (Gagnon et al. 2009) and the attendant mortality risk of highly multiparous women.

Tables 2.5 through 2.7 display the results from my Cox Proportional Hazard models concerning tobacco related mortality and morbidity. These findings demonstrate significant cohort differences by religiosity among both sexes, although religion has the greatest modifying effect for males born 1900 to 1920. For the 1900 to 1920 cohorts, both sexes show a significant increase in hazard of tobacco related death (Female HRR= 2.37, Male= 1.66) and lung cancer (Female HRR= 2.99, Male= 2.17) compared to the 1880 to 1899 cohorts. Yet when accounting for religiosity, inactive Latter-day Saint individuals see the greatest increase of risk post-1900 with inactive females and males reporting increased risk in tobacco related death (Female HRR= 3.05, Male HRR 3.87) and lung cancer (Female HRR= 2.46, Male= 3.86) compared to active females and males. These findings echo previous research that suggests religious influences may modify male risk-taking (Byrnes et al. 1999; Friedl et al. 2020; Robbins & Martin 1993). The employed covariates, birth cohort sex ratio and urban birth status, show some statistical relation to the outcome but do not substantially affect the main results.

When testing for breast and prostate cancers, differences upon church activity lines reduce or disappear. The models for breast cancer show no detectable difference according to

Latter-day Saint activity no matter the birth cohort. A difference in prostate cancer risk appears after 1900 with active Latter-day Saint males demonstrating a slight non-significant increase in risk of diagnosis. This small difference in prostate cancer risk, seen in the provided exploratory charts to a greater extent, is likely an artifact of lengthened exposure time due to the increased longevity among active Latter-day Saint males and competing risks to other diseases such as lung and bronchus cancer (see Table 2.8 for distribution of prostate diagnoses by age and Figure 2.4).

Discussion

The WoW's linking of cigarette abstention to Latter-day Saint endowment participation for non-health reasons provides a unique opportunity to study how religious beliefs and rules might emerge to shape public health. As such, I tested whether the 1921 policy preceded changes in all-cause and cause-specific morbidity and mortality as modified through participation in the Latter-day Saint endowment. This test was made possible by the high quality of the historical UPDB data. The UPDB's unique capabilities allow us to compare morbidity and mortality among Utah born Latter-day Saint members according to their endowment status and birth cohort. These tests reveal that Latter-day Saint individuals who were endowed prior to age 50 enjoyed both decreased risk of tobacco-related death and lung/ bronchus cancer, and increased life expectancy compared to Latter-day Saint individuals who were not endowed. These results did not carry over into non-tobacco related health outcomes such as breast and prostate cancers. Taken together, the findings from this analysis support the inference that, whether intended or not, religious policies may act in ways that support mortality reduction in populations.

Despite religious differences in my findings, all post-1900 born individuals displayed increased cancer incidence and risk of tobacco caused death when compared to pre-1900 cohorts. This increase seems plausible given the growing popularity of smoking at the time. Yet the rise in tobacco related death and disease among those who participated in temple ceremonies appears counterintuitive. Possible explanations include increased environmental exposures (e.g., industrial pollutants and/or second-hand smoke), religious disillusionment post-endowment, and/or selective uptake of church teachings (Mumford et al. 1987; Öberg et al. 2011; Scheitle & Adamczyk 2010).

Falsification tests reveal health benefits from temple ceremony participation were not universal across outcomes. Providing further clarity to past findings that report lower breast cancer among Latter-day Saint women compared non- Latter-day Saint women (Daniels 2004), I found that within group comparisons of breast cancer diagnoses revealed no meaningful difference based upon church activity. These new results, when combined with previous studies, may point to a line of demarcation as to where the Word of Wisdom did influence health, and where other factors such as identity and social support play a more meaningful role.

Among active Latter-day Saint men, those born post-1900 displayed an increased risk of prostate cancer compared to inactive Latter-day Saint men-- a difference not found in pre-1900 birth cohorts. This change is reflected in Figure 2.1. This chart offers a visual description that seems substantially larger than the results from the proportional hazards model suggest. This may be accounted for through how Cox-Proportional Hazard models incorporate censoring (i.e., lung and bronchus varieties). Although the incidence of prostate cancer after age 50 may seem higher in the active Latter-day Saint sub-group, lower life expectancy in the comparison group due to other causes may serve to increase censoring and thus produce a more accurate description of prostate cancer risk for the remaining cohort members than is possible with a descriptive chart alone. This explanation is supported by Table 2.8 that shows a later age at prostate cancer diagnoses among active Latter-day Saint men. In sum, the total evidence suggests that those who obeyed tobacco prohibitions of the Church lived longer, which in turn shaped non-tobacco related cancer trajectories.

Limitations and Future Directions

Limitations include the generalizability of my results to other religions. I do not argue that religion in every circumstance reduces mortality risks, nor specifically does the Latter-day Saint faith. As such, further examinations within the UPDB considering Church policies of fertility, marriage, sexual morality, and economics may yield positive and negative health outcomes. Previous studies reporting negative health aspects among Latter-day Saints support this approach (Bodson et al. 2017; Merrill & Thygerson 2001) Replication studies to health outcomes among groups outside of the faith may show differing relations between religion and health.

I also note potential measurement error in Latter-day Saint activity given that a single timepoint of endowment participation does not ensure a lifetime of Latter-day Saint church activity. New research might glean additional timepoints of participation from linked offspring's baptism and endowment dates. Additionally, a network analysis of sibling's, cousin's, and parental temple participation might offer a clearer picture of family faith dynamics.

My focus upon tobacco allows for similar investigations of alcohol concerning life expectancy and digestive tract diseases. I also did not consider socioeconomic status as smoking uptake during the time of the policy was sign of modernism and spreading within all levels of society (Brandt 2007:61; Gardner 2013; Gershon 2022). But economic circumstance may have application in survival given a cancer diagnosis. As such, further research analyzing hazard differences between tobacco-related cancer and tobacco related deaths by religion or socio-economic status may prove useful. Finally, although demographic theory holds decreased mortality at older ages partially determines population expansion, its contribution is relatively small compared to mortality reductions in pre-fertile ages. Therefore, while the Word of Wisdom likely did not alter Utah's population numbers in a substantial manner, these results do suggest that religion can support demographic expansion through mortality reductions.

Conclusions

Despite my highly consistent results that link policy change to morbidity and mortality outcomes, I cannot know if the 1921 policy caused believing Latter-day Saints to forgo tobacco who would have otherwise used. The possibility remains that the WoW drove smoking inclined youth away from the church who may have remained in absence of the ban. In reality, it is likely that both occurred: some individuals who would have smoked chose not to, and others chose to smoke despite the rule and thus separated themselves from the church. The extent to which this dynamic explains overall positive trends in religious health characteristics would require additional work concerning recidivism rates. However, I note descriptively that Church membership only increased post-WoW policy (Bennion & Young 1996). Nevertheless, I await additional work to determine whether the macro-level assertions concerning religious rules and population outcomes operate through these various individual-level mechanisms.

An exploration of the Word of Wisdom as policy must recognize its historical context. The 1921 policy preceded scientific evidence regarding the harms of tobacco by almost 30 years. Intriguingly, this circumstance likely indicates that this policy had no explicit goal to improve mortality among Latter-day Saints. Thus, the nature of this research suggests that considerations of emergent beliefs and practices as specific health policies could strengthen arguments in favor of religion as a social determinant of health (VanderWeele & Chen 2020). I encourage other research using both historical and contemporary cohorts to further illuminate the extent to which religious policies—deliberately or inadvertently—could affect population health.

Tables and Figures

Table 2.1: Descriptive population characteristics of Utah births, 1880 to 1920, who either died or were last documented in Utah, according to Church activity.

	All (N = 139,542)		Inactive (N = 33,795)		Active (N= 105,747)	
	N	%	N	%	N	%
Sex						
Female	70959	50.85%	16699	49.41%	54260	51.31%
Male	68583	49.15%	17096	50.59%	51487	48.69%
Birth cohort						
1880 to 1899	54345	38.95%	8626	25.52%	45719	43.23%
1900 to 1920	85197	61.05%	25169	74.48%	60028	56.77%
Birth cohort sex ratio						
Below 1.02	19303	13.83%	4426	13.10%	14877	14.07%
1.02 to 1.03	38053	27.27%	9642	28.53%	28411	26.87%
1.04 to 1.05	27828	19.94%	7965	23.57%	19863	18.78%
1.06	18622	13.35%	3756	11.11%	14866	14.06%
1.07 and above	35736	25.61%	8006	23.69%	27730	26.22%
Urban or rural county born						
Urban	77101	55.25%	18275	54.08%	58826	55.63%
Rural	62441	44.75%	15520	45.92%	46921	44.37%

Notes: 389 individuals have death date but no cause of death data. 802 individuals whose last follow up was in Utah but without a death date.

Table 2.2: Descriptive population characteristics of Utah births, 1880 to 1920, who either died or were last documented in Utah, according to Church activity and status of tobacco related death or lung/bronchus cancer diagnosis.

	All (N = 139,542)		Inactive (N = 33,795)		Active (N = 105,747)	
	N	%	N	%	N	%
Those who died from a tobacco related death						
N	3487		1643		1844	
Sex						
Female	867	24.86%	400	24.35%	467	25.33%
Male	2620	75.14%	1243	75.65%	1377	74.67%
Birth cohort						
1880 to 1899	802	23.00%	207	12.60%	595	32.27%
1900 to 1920	2685	77.00%	1436	87.40%	1249	67.73%
Those who died without a tobacco related death						
N	134863		31845		103018	
Sex						
Female	69264	51.36%	16075	50.48%	53189	51.63%
Male	65599	48.64%	15770	49.52%	49829	48.37%
Birth cohort						
1880 to 1899	52869	39.20%	8293	26.04%	44576	43.27%
1900 to 1920	81994	60.80%	23552	73.96%	58442	56.73%
Those with a lung or bronchus cancer diagnosis						
N	1992		961		1031	
Sex						
Female	510	25.60%	212	22.06%	298	28.90%
Male	1483	74.45%	749	77.94%	734	71.19%
Birth cohort						
1880 to 1899	357	17.92%	99	10.30%	258	25.02%
1900 to 1920	1636	82.13%	862	89.70%	774	75.07%
Those without a lung or bronchus cancer diagnosis						
N	136747		32608		104139	
Sex						
Female	70449	51.52%	16487	50.56%	53962	51.82%
Male	67100	49.07%	16347	50.13%	50753	48.74%
Birth cohort						
1880 to 1899	53988	39.48%	8527	26.15%	45461	43.65%
1900 to 1920	83561	61.11%	24307	74.54%	59254	56.90%

Notes: 389 individuals have death date but no cause of death data. 802 individuals whose last follow up was in Utah but without a death date.

Table 2.3: Estimated regression coefficients for life expectancy after age 50 as a function of birth cohort sex ratio (SSR), individual participation in the Church, and the interaction between Church activity and cohort indicator of exposure to the 1921 tobacco policy.

	Female (N = 70,959)		
Variable	Model 1	Model 2	Model 3
Constant	29.582*** (0.067)	28.112*** (1.633)	31.012*** (1.640)
Born between 1900 to 1920 (a)	2.753*** (0.086)	2.848*** (0.088)	-0.124 (0.202)
Birth cohort sex ratio		0.011 (.016)	0.004 (0.016)
Urban born		-0.308** (0.084)	-0.328*** (0.084)
Active Latter-day Saint (b)		0.598*** (0.010)	-2.038*** (0.190)
Interaction between a and b			3.644*** (0.223)

	Male (N = 68,583)		
Variable	Model 1	Model 2	Model 3
Constant	25.269*** (0.070)	26.096*** (1.711)	30.250*** (1.714)
Born between 1900 to 1920 (a)	2.072*** (0.090)	2.416*** (0.092)	-1.689*** (0.198)
Birth cohort sex ratio		-0.029 (0.016)	-0.040* (0.016)
Urban born		-0.301** (0.088)	-0.328** (0.088)
Active Latter-day Saint (b)		2.870*** (0.102)	-0.749*** (0.185)
Interaction between a and b			5.177*** (0.222)

Note: Birth sex ratios scaled to .01

*P = <.05, ** P = <.001, *** P = <.0001

Table 2.4: Estimated hazard rate coefficients for all cause death as a function of the individuals birth year's relation to the 1921 tobacco policy change, and individual participation in the Church.

	Female (N = 70,959)					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	-0.223* (0.08874)	0.800 (0.788 - 0.812)	-0.232*** (0.008)	0.793 (0.781 - 0.806)	-0.047* (0.018)	0.954 (0.921 - 0.988)
Birth cohort sex ratio			-.002 (.001)	0.998 (0.996 - 1.001)	-0.001 (.001)	0.999 (0.996– 1.002)
Urban born			0.028** (0.008)	1.028 (1.013 - 1.044)	0.029*** (0.008)	1.029 (1.014 - 1.045)
Active LDS member (b)			-0.065*** (0.009)	0.937 (0.921 - 0.954)	0.097*** (0.017)	1.102 (1.065 - 1.139)
Interaction between a and b					-0.229*** (0.020)	0.795 (0.765 - 0.827)
	Male (N = 68.583)					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	-0.197** (0.008)	0.821 (0.808 - 0.834)	-0.215*** (0.008)	0.806 (0.794 - 0.819)	0.054*** (0.017)	1.055 (1.021 - 1.091)
Birth cohort sex ratio			0.003 (0.001)	1.003 (1.00 - 1.035)	0.003* (0.001)	1.003 (1.00 - 1.006)
Urban born			0.019* (0.008)	1.019 (1.004 - 1.035)	-0.022* (0.008)	1.023 (1.007 - 1.038)
Active LDS member (b)			-0.287*** (0.009)	0.750 (0.737 - 0.764)	-0.053*** (0.016)	0.948 (0.919 - 0.979)
Interaction between a and b					-0.346*** (0.019)	0.708 (0.682 - 0.734)

Note: Birth sex ratios scaled to .01

*P = <.05, ** P = <.001, *** P = <.0001

Table 2.5: Estimated hazard rate coefficients for tobacco related death as a function of the individuals birth year's relation to the to the 1921 tobacco policy change, and individual participation in the Church.

	Female (N = 70,959)					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	0.862*** (0.08874)	2.367 (1.989 - 2.817)	0.715*** (0.091)	2.045 (1.712 - 2.442)	1.433*** (0.200)	4.191 (2.832 - 6.203)
Birth cohort sex ratio			-.001 (.013)	0.999 (0.974 - 1.025)	-0.012 (.013)	0.988 (0.963 – 1.014)
Urban born			-0.004 (0.068)	0.996 (0.871 - 1.139)	0.001 (0.068)	1.001 (0.875 - 1.144)
Active Latter-day Saint (b)			-0.976*** (0.069)	0.377 (0.329 - 0.431)	-0.114 (0.212)	0.892 (0.589 - 1.352)
Interaction between a and b					-1.000*** (0.225)	0.368 (0.237 - 0.572)
	Male (N = 68,583)					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	0.507** (0.045)	1.660 (1.519 - 1.814)	0.423*** (0.046)	1.527 (1.394 - 1.672)	0.859*** (0.081)	2.361 (2.014 - 2.767)
Birth cohort sex ratio			2.271* (0.763)	9.69 (2.171 - 43.251)	2.376* (0.764)	10.759 (2.406 - 48.116)
Urban born			-0.086* (0.039)	0.917 (0.849 - 0.991)	-0.080* (0.040)	0.923 (0.854 - 0.998)
Active Latter-day Saint (b)			-1.193*** (0.040)	0.303 (0.281 - 0.328)	-0.652*** (0.088)	0.521 (0.438 - 0.619)
Interaction between a and b					-0.700*** (0.099)	0.497 (0.409 - 0.602)

Note: Birth sex ratios scaled to .01

*P = <.05, ** P = <.001, *** P = <.0001

Table 2.6: Estimated hazard rate coefficients for female lung and breast cancer diagnoses as a function of the individuals birth year's relation to the LDS tobacco policy changes, and individual participation in the LDS Church. (N=70,959)

	Lung Cancer Diagnoses					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	1.095*** (0.124)	2.988 (2.341 - 3.813)	1.008*** (0.127)	2.739 (2.137 - 3.510)	2.229*** (0.385)	9.291 (4.368– 19.759)
Birth cohort sex ratio			0.012 (0.018)	1.012 (0.977 – 1.047)	0.013 (0.018)	1.013 (0.979 – 1.049)
Urban born			0.109* (0.089)	1.115 (0.937 - 1.327)	0.114 (0.089)	1.120 (0.941 - 1.333)
Active Latter-day Saint (b)			-0.759*** (0.091)	0.468 (0.392 - 0.559)	0.629 (0.397)	1.876 (0.861 – 4.084)
Interaction between a and b					-1.529** (0.408)	0.217 (0.097- 0.482)
	Breast Cancer Diagnoses					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	0.774*** (0.039)	2.169 (2.011 - 2.340)	0.783*** (0.039)	2.190 (2.028 - 2.365)	0.869*** (0.095)	2.385 (1.979 - 2.873)
Birth cohort sex ratio			0.012* (0.006)	1.012 (1.000 – 1.024)	0.012* (0.006)	1.012 (1.000 – 1.024)
Urban born			0.091* (0.030)	1.095 (1.032 - 1.162)	0.091* (0.030)	1.095 (1.032 - 1.162)
Active Latter-day Saint (b)			-0.031 (0.035)	0.969 (0.905 - 1.038)	0.058 (0.097)	1.045 (0.876 - 1.282)
Interaction between a and b					-0.103 (0.104)	0.902 (0.736 - 1.106)

Note: Birth sex ratios scaled to .01

*P = <.05, ** P = <.001, *** P = <.0001

Table 2.7: Estimated hazard rate coefficients for male lung/bronchus and prostate cancer diagnoses as a function of the individuals birth year's relation to the 1921 tobacco policy change, and individual participation in the Church. (N=68,583)

	Lung/Bronchus Cancer Diagnoses					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	0.866*** (0.066)	2.378 (2.088 - 2.708)	0.802*** (0.068)	2.229 (1.952 - 2.545)	1.098*** (0.112)	2.998 (2.407 - 3.734)
Birth cohort sex ratio[1]			0.051*** (0.010)	1.052 (1.031 – 1.074)	.051*** (.010)	1.053 (1.031 – 1.071)
Urban born			-0.025 (0.052)	0.976 (0.881 - 1.081)	-0.021 (0.052)	0.979 (0.883 - 1.084)
Active Latter-day Saint (b)			-1.262*** (0.052)	0.283 (0.255 - 0.314)	-0.855*** (0.127)	0.425 (0.331 - 0.545)
Interaction between a and b					-0.496** (0.140)	0.609 (0.462 - 0.801)
	Prostate Cancer Diagnoses					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	0.605*** (0.029)	1.833 (1.730 - 1.941)	0.607*** (0.030)	1.836 (1.732- 1.947)	0.582*** (0.070)	1.790 (1.560 - 2.053)
Birth cohort sex ratio[1]			.007 (.005)	1.007 (0.998 – 1.017)	.007 (.005)	1.007 (0.998 – 1.017)
Urban born			-0.009(0.024)	0.991 (0.946 - 1.039)	-0.009 (0.024)	0.991 (0.945 - 1.038)
Active Latter-day Saint (b)			-0.118*** (0.030)	0.889 (0.839 - 0.942)	-0.143* (0.070)	0.866 (0.756 - 0.994)
Interaction between a and b					0.031 (0.077)	1.031 (0.887 - 1.120)

Note: Birth sex ratios scaled to .01

*P = <.05, ** P = <.001, *** P = <.0001

Table 2.8. Distribution of age at prostate cancer diagnosis by Church activity level

	Active LDS Men	Inactive LDS Men
100% Max	101	102
99%	94	93
95%	89	88
90%	86	86
75% Q3	82	81
50% Median	77	76
25% Q1	72	71
10%	67	65
5%	64	62
1%	58	57
0% Min	39	47

Table 2.9: ICD Codes by disease group and ICD version.

Disease Group	ICD Version: Code
Esophagus	**ICD 6:** 150 **ICD 7:** 150 **ICD 8:** 150 **ICD 9:** 150, 150.0, 150.1, 150.2, 150.3, 150.4, 150.5, 150.8, 150.9 **ICD 10:** C15, C15.0, C15.1, C15.2, C15.3, C15.4, C15.5, C15.8, C15.8, C15.9
Trachea/Bronchus/Lung	**ICD 6:** 162, 163 **ICD 7:** 162, 162.1, 162.0, 162.1, 162.8 **ICD 8:** 162, 162.0, 162.1, 162.8 **ICD 9:** 162, 162.0, 162.2, 162.3, 162.4, 162.5, 162.8, 162.9 **ICD 10:** C33, C34, C34.0, C34.1, C34.2, C34.3, C34.8, C34.9
COPD	**ICD 8:** 490, 491, 492 **ICD 9:** 491, 491.0, 491.1, 491.2, 491.20, 491.21, 491.8, 491.9, 492, 492.0, 492.8 **ICD10:** J40, J41.0, J41.1, J41.8, J42, J43, J43.0, J43.1, J43.8, J43.9, J44, J44.0, J44.1, J44.8, J44.9

Table 2.10: Median age (in years) of Church ceremony participation among Utah births, 1880 to 1920, who either died or were last documented in Utah.

Median age at baptism (N=139,542)	8.54
Median age at endowment (N=105,747)	25.12

Figure 2.1: Descriptive charts of life expectancy, tobacco relate death and disease (lung and bronchus, colorectal, breast, and prostate cancers).

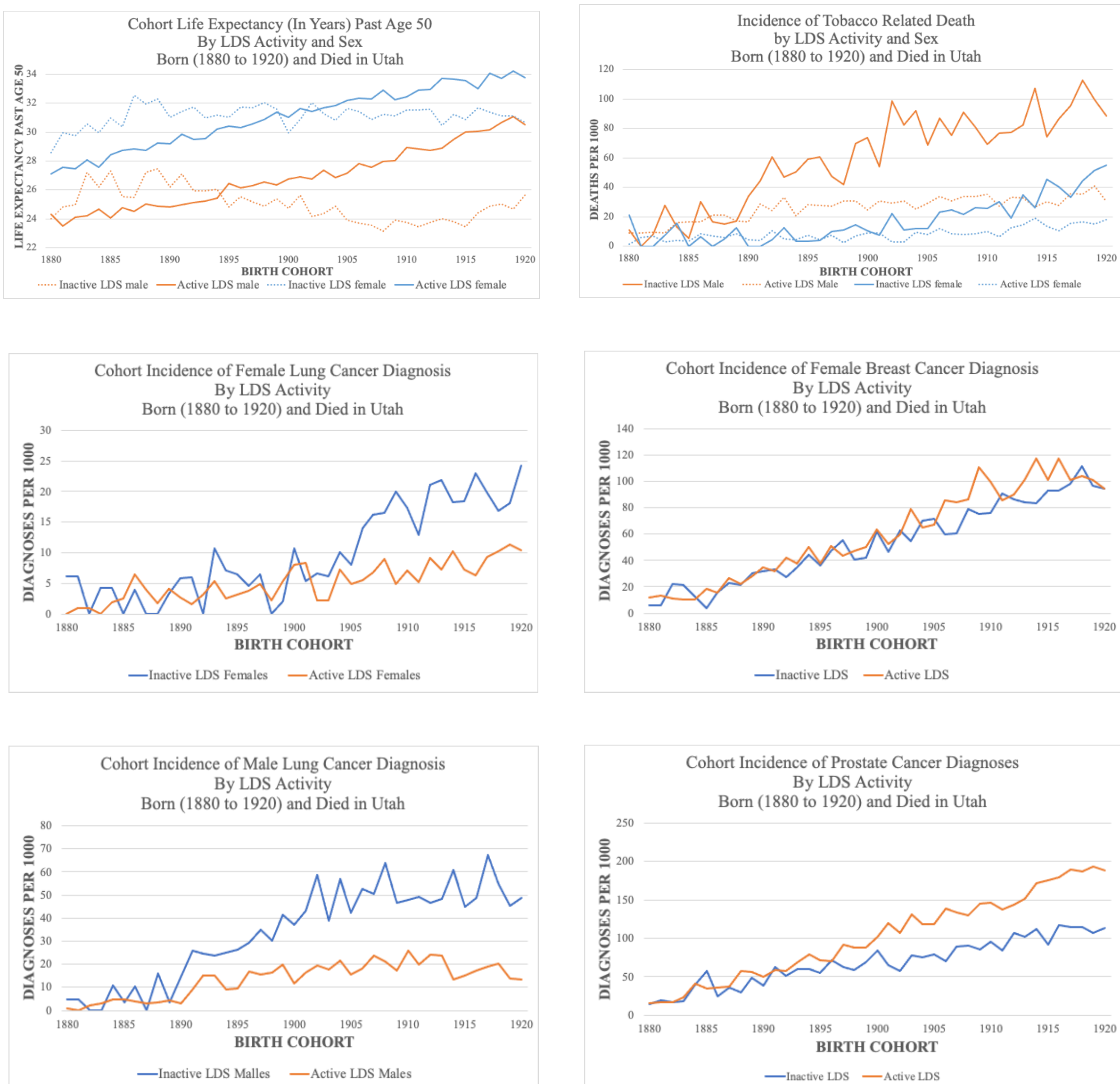
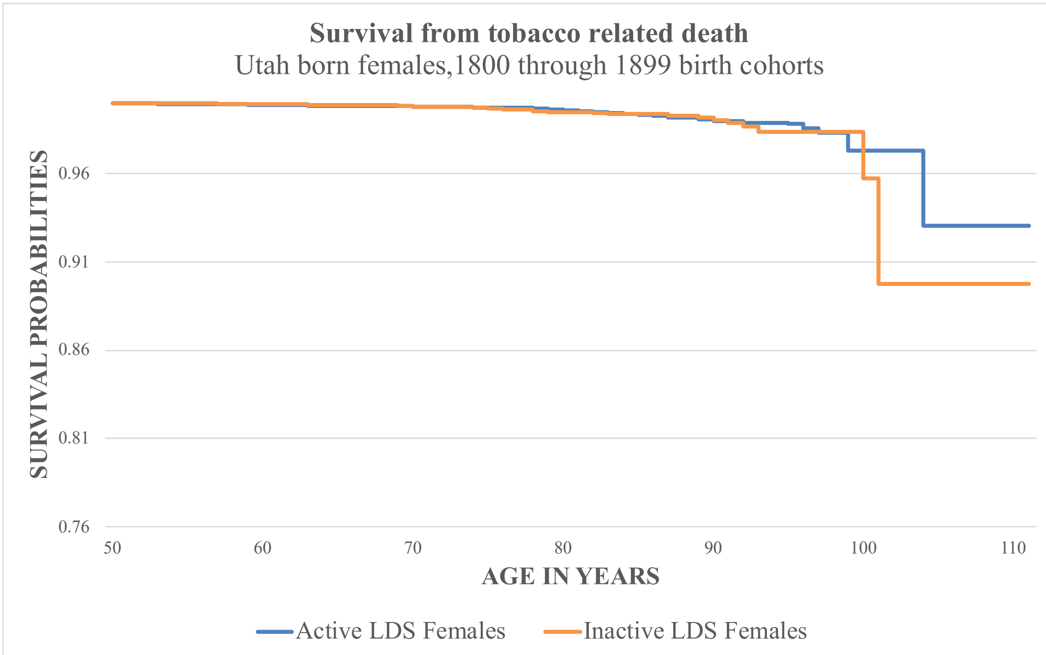
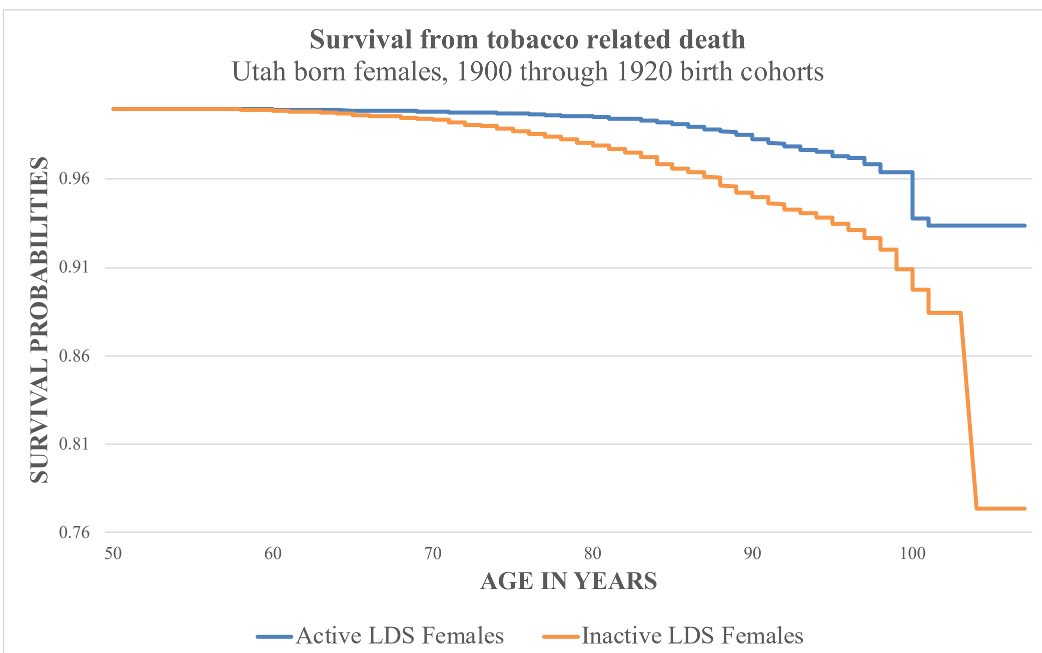


Figure 2.2a - 2.2d: Survival plots, risk of tobacco related death, by sex and Church activity status. Females appear in the top row, and males appear in the bottom row.

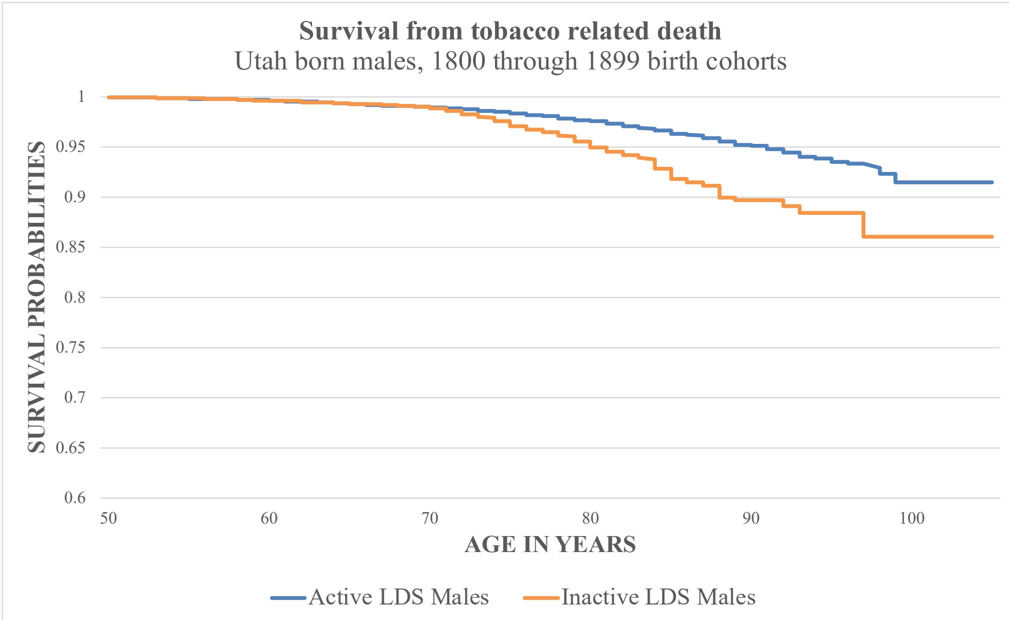
2.2a



2.2b

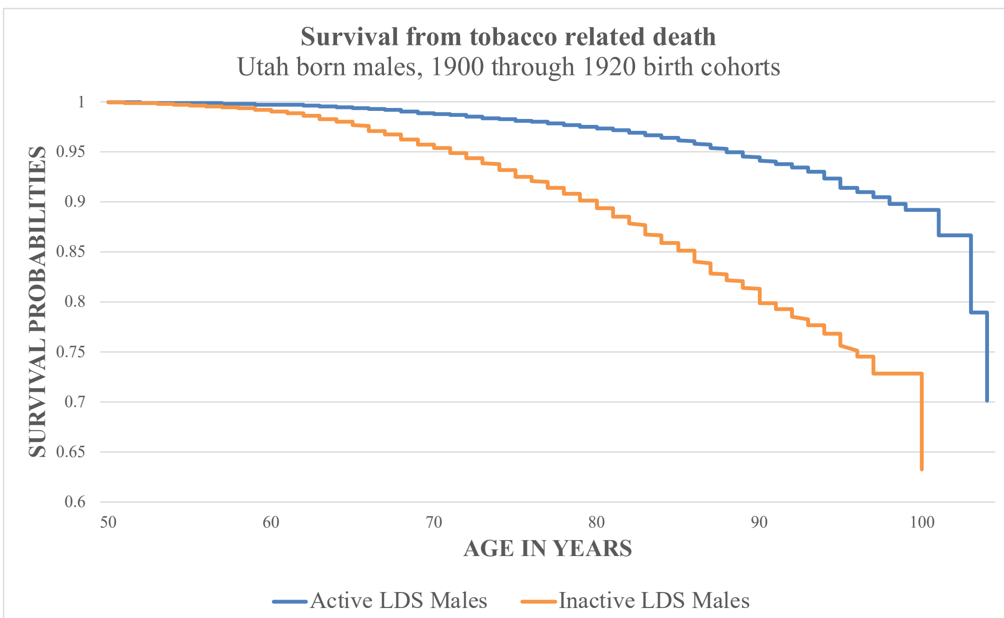


2.2c



Survival from tobacco related death
Utah born males, 1800 through 1899 birth cohorts
SURVIVAL PROBABILITIES
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
50
60
70
80
90
100
AGE IN YEARS
Active LDS Males
Inactive LDS Males

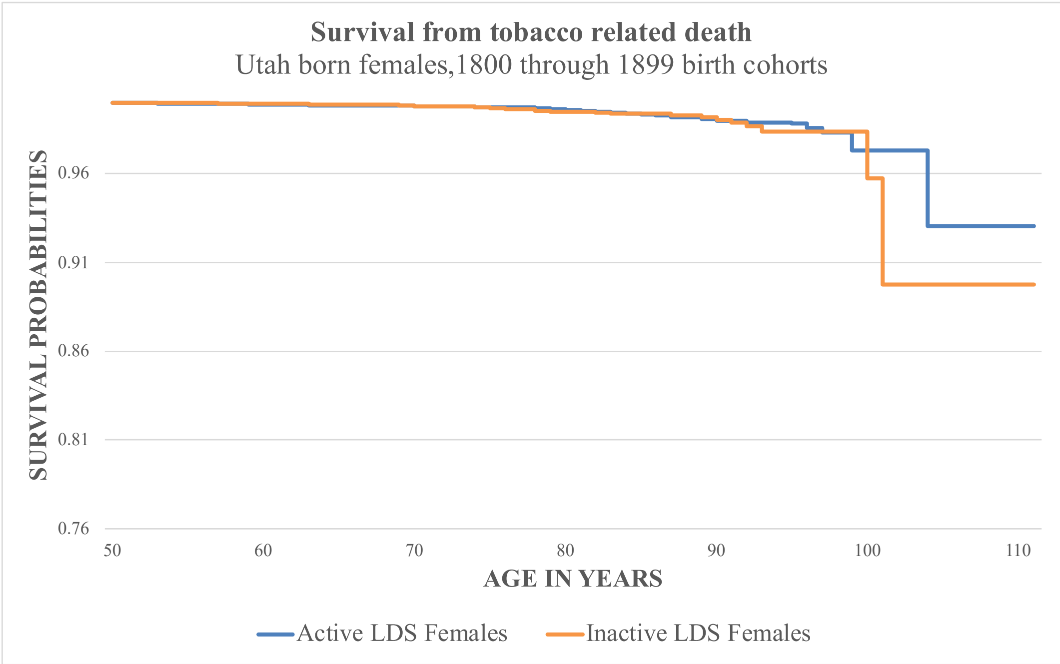
2.2d



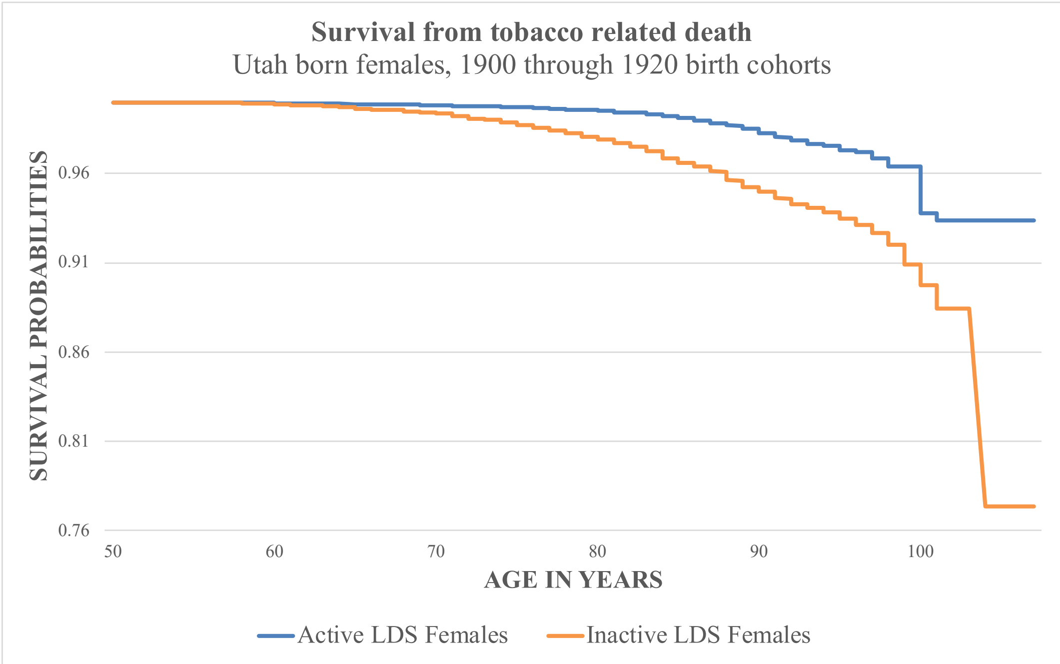
Survival from tobacco related death
Utah born males, 1900 through 1920 birth cohorts
SURVIVAL PROBABILITIES
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
50
60
70
80
90
100
AGE IN YEARS
Active LDS Males
Inactive LDS Males

Figure 2.3a - 2.3d: Survival plots, risk of tobacco related death, by sex and Church activity status. Females appear in the top row, and males appear in the bottom row.

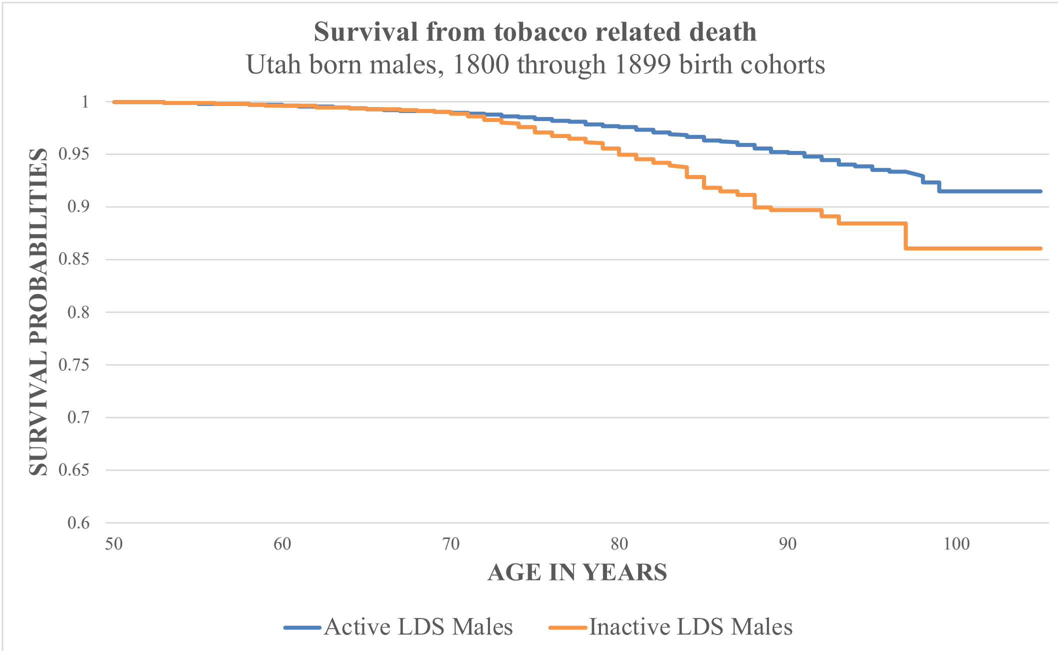
2.3a



2.3b

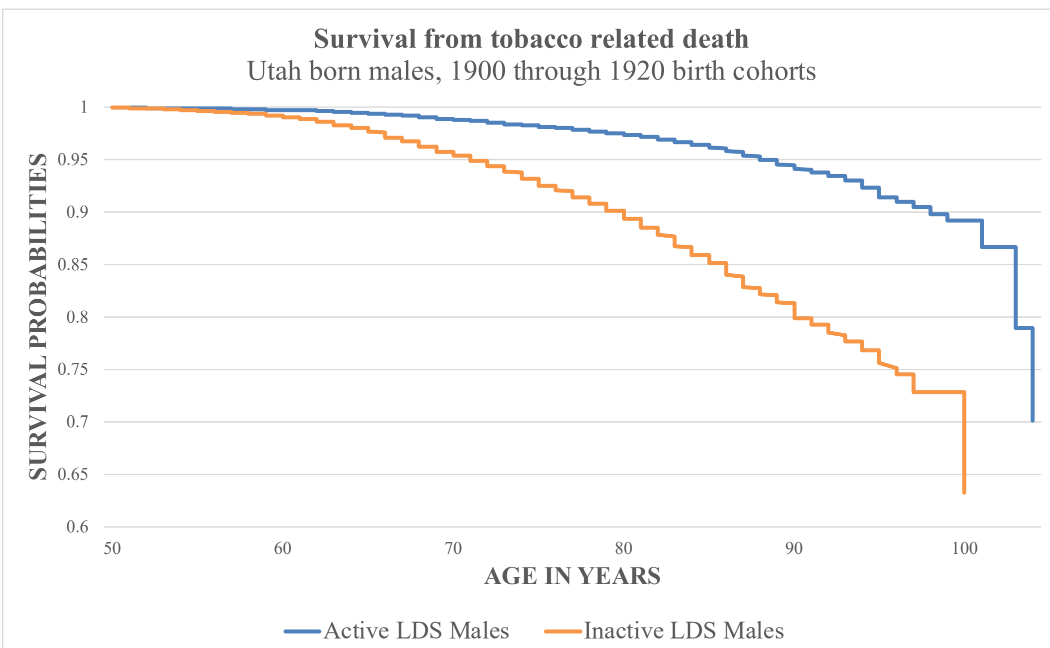


2.2c



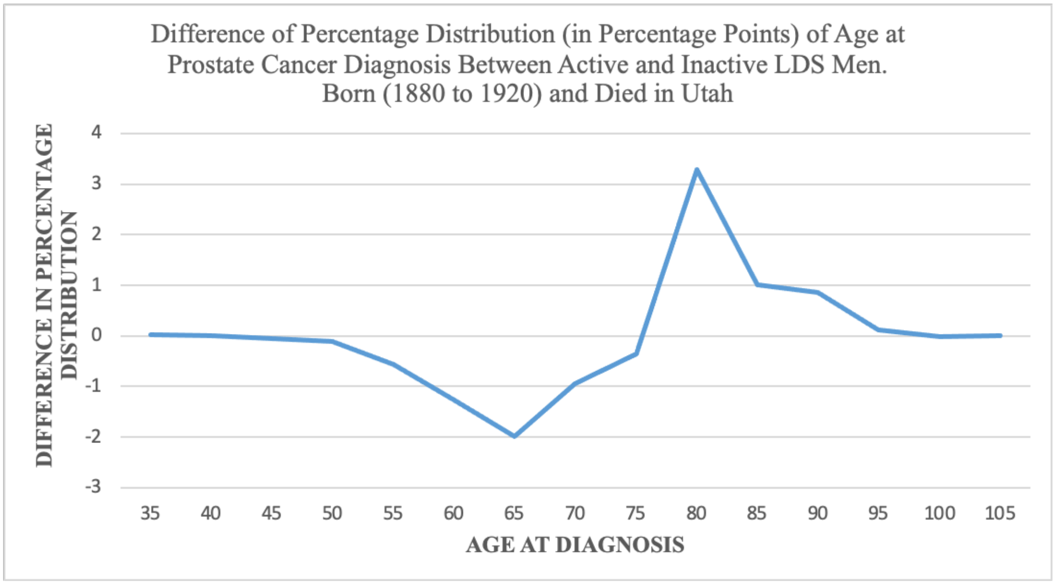
Survival from tobacco related death
Utah born males, 1800 through 1899 birth cohorts
SURVIVAL PROBABILITIES
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
50
60
70
80
90
100
AGE IN YEARS
Active LDS Males
Inactive LDS Males

2.2d



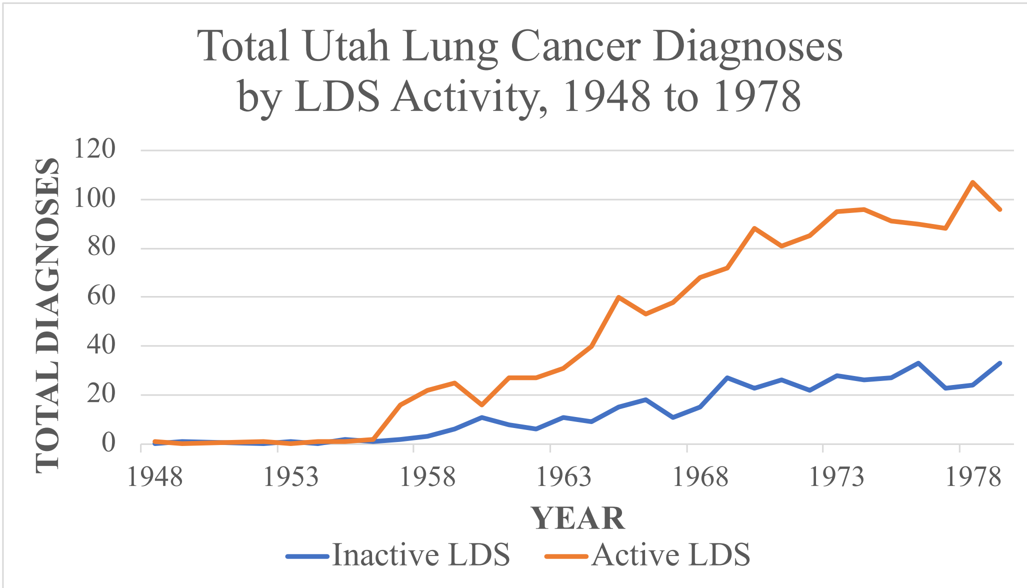
Survival from tobacco related death
Utah born males, 1900 through 1920 birth cohorts
SURVIVAL PROBABILITIES
1
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
50
60
70
80
90
100
AGE IN YEARS
Active LDS Males
Inactive LDS Males

Figure 2.4:

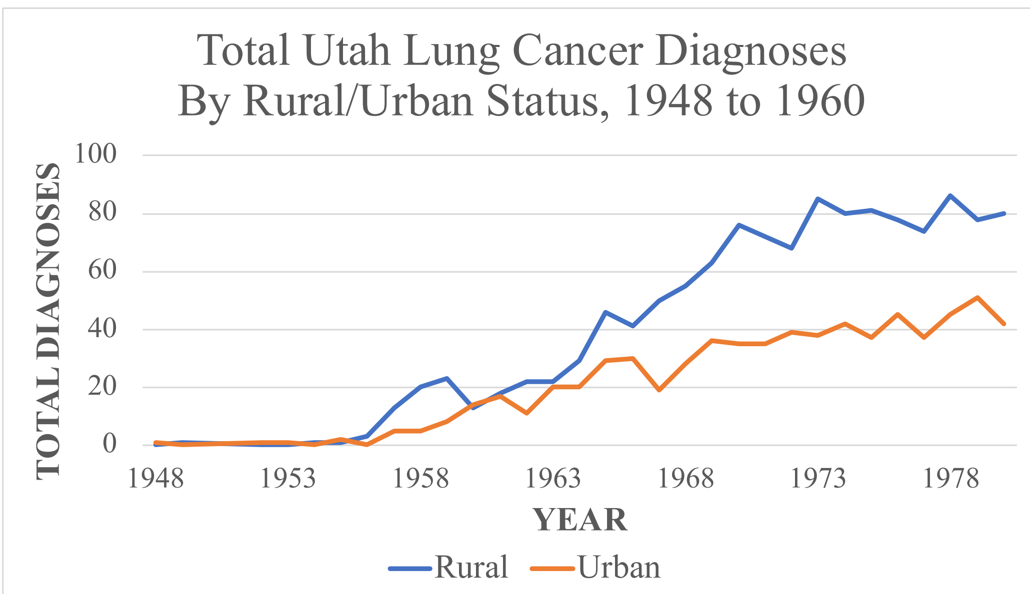

Difference of Percentage Distribution (in Percentage Points) of Age at Prostate Cancer Diagnosis Between Active and Inactive LDS Men. Born (1880 to 1920) and Died in Utah
DIFFERENCE IN PERCENTAGE DISTRIBUTION
4
3
2
1
0
-1
-2
-3
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
AGE AT DIAGNOSIS

Figures 2.5a - 2.5c: Exploratory analysis concerning reliability of pre-1966 lung cancer incidence data quality.

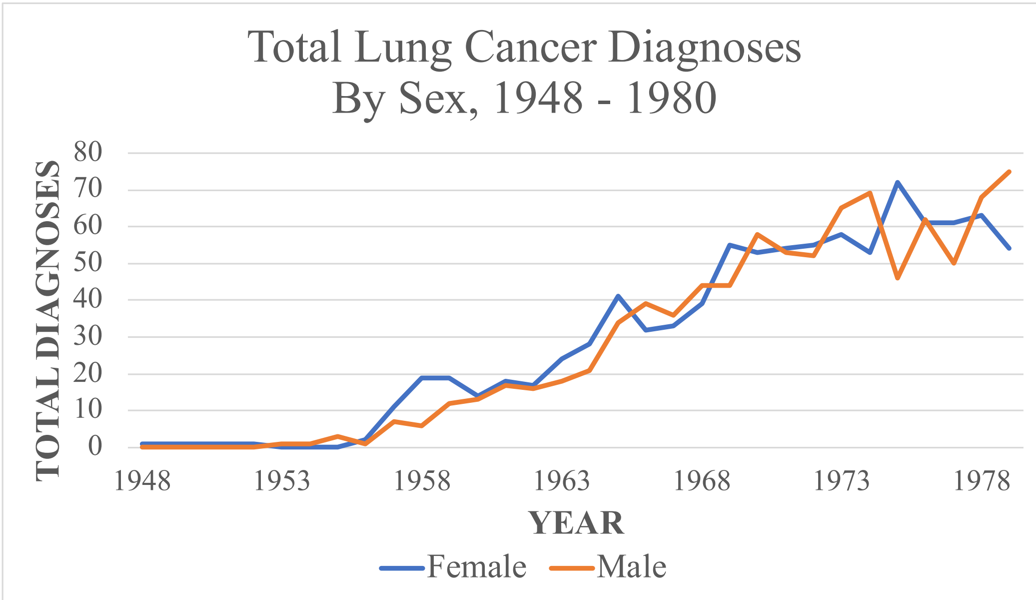
2.5a



2.5b



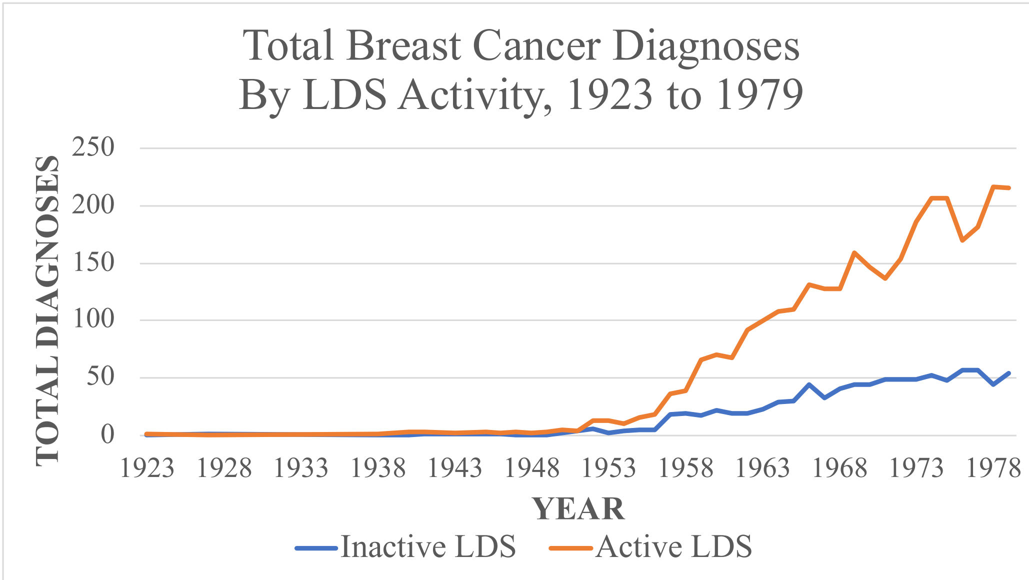
2.5c



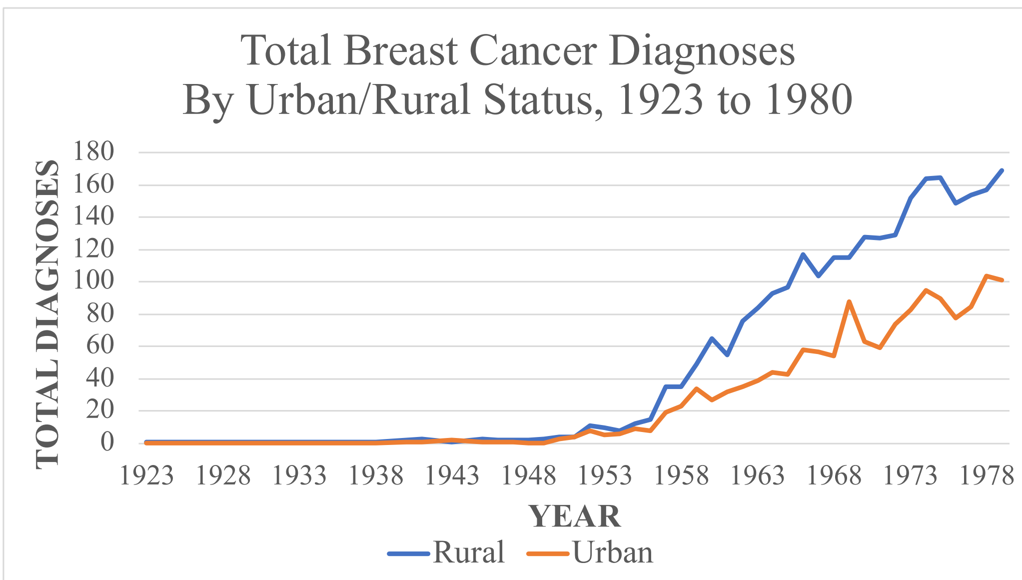
Total Lung Cancer Diagnoses
By Sex, 1948 - 1980
TOTAL DIAGNOSES
80
70
60
50
40
30
20
10
0
1948
1953
1958
1963
1968
1973
1978
YEAR
Female
Male

Figures 2.6a - 2.6d: Exploratory analysis concerning reliability of pre-1966 breast and prostate cancer incidence data quality.

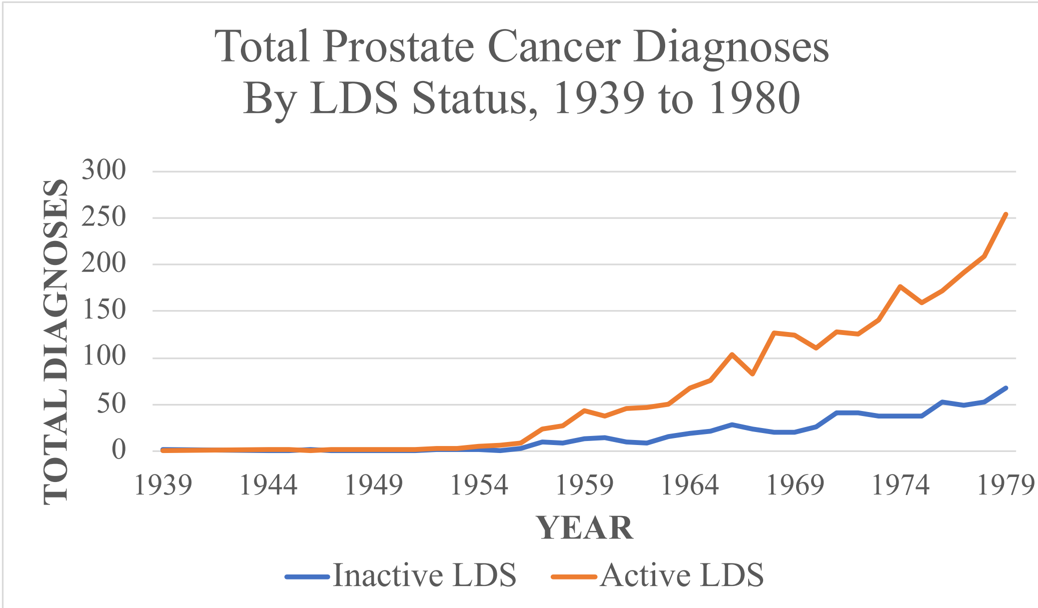
2.6a



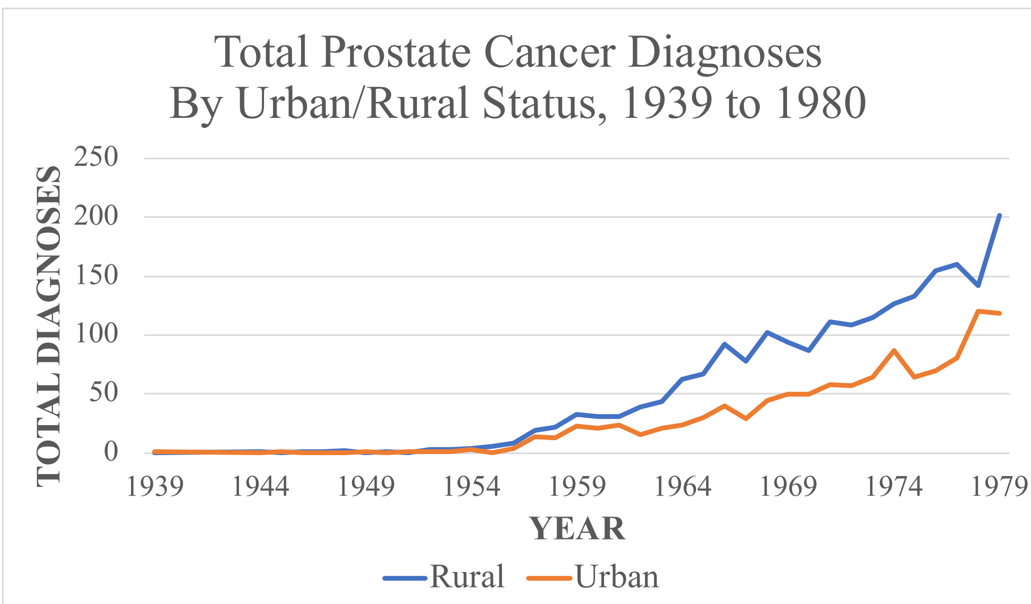
2.6b



2.6c

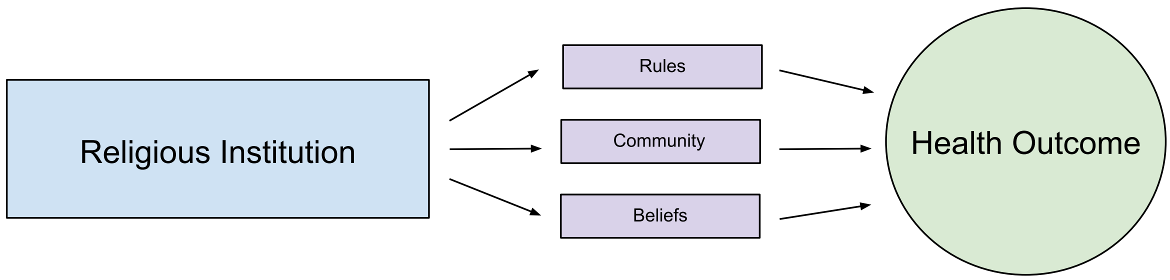

Total Prostate Cancer Diagnoses
By LDS Status, 1939 to 1980
TOTAL DIAGNOSES
300
250
200
150
100
50
0
1939
1944
1949
1954
1959
1964
1969
1974
1979
YEAR
Inactive LDS
Active LDS

2.6d

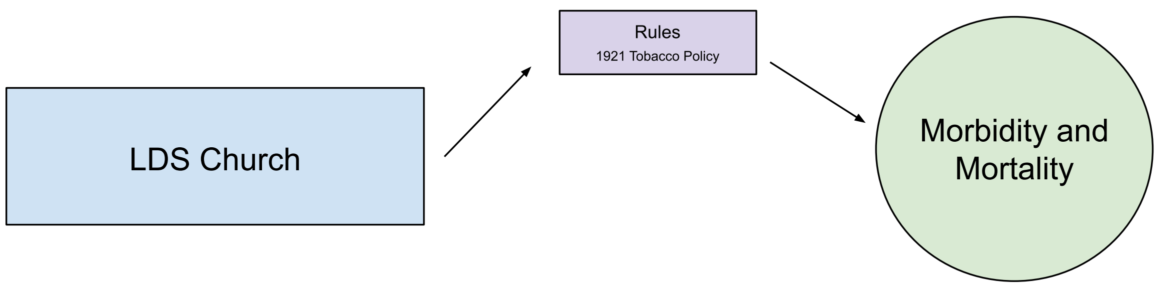

Total Prostate Cancer Diagnoses
By Urban/Rural Status, 1939 to 1980
TOTAL DIAGNOSES
250
200
150
100
50
0
1939
1944
1949
1954
1959
1964
1969
1974
1979
YEAR
Rural
Urban

Figures 2.7a - 2.7b: Conceptual models of mechanisms between religious institutions and health outcomes, including religious rules.

2.7a



2.7b



CHAPTER 3

Community: Religious environment and female fertility

Introduction

Background

The literature reports a positive relation between fertility and religious affiliation (Bein et al., 2021; Götmark & Andersson, 2020; Halimatusa'diyah & Toyibah, 2021). Pew Research also predicts religious-oriented individuals will drive world population growth in the 21st-century as secular nations manifest decreasing fertility (Pew Research Center, 2015). These forecasts suggest that, over time, the number of children born to non-religious families will constitute a decreasing portion of the population. The literature also reports a positive ecological association between religion and national fertility rates (Philipov & Berghammer, 2007) and declining fertility in secularizing cultures (Schnabel, 2021; Spolaore & Wacziarg, 2022). Yet, establishing a causal connection between religion and fertility begs the researcher to consider both the *why* and the *how*. Specifically, why would religious institutions have an interest in increased fertility, and through what mechanisms would this operate? This chapter examines a possible framework that begins to address these questions by considering the importance of religious communities in maternal fertility patterns of the American west.

The setting for this inquiry is early 20th century Utah. Utah offers unique advantages due to its modern founding by a small group of religious pioneers who were intent on expanding both their faith's numbers and its geographic reach. As the dominant cultural and social institution in the region, the Church of Jesus Christ of Latter-day Saints maintained its social influence despite environmental, economic, and governmental pressures (Arrington, 2005). Specific to this study, the Latter-day Saints are broadly known for both their tight-knit communities (De Pillis, 1991; Grava, 2011) and their large family size (Anderson, 1937; Heaton, 1988). As such, Utah's well-recorded (Ken. R. Smith & Mineau, 2021) transition from a religious colony to a thriving US state appears at least partially driven by a pronatalist religion that emphasizes community (Arrington, 2005; Bean et al., 1983; Heaton, 1988). For these reasons historical Utah provides an ideal setting to consider how religion in the community may affect fertility.

Framework

A functionalist approach holds that institutional religion serves as a mechanism with which society maintains order and increases its interests (Durkheim, 1912; Stark & Bainbridge, 1997; Weber, 1930). These social concerns may include economics (Becker et al., 2021; Weber, 1930), politics (Greenberg, 2000), or health (Chatters, 2000). Sociologists hypothesize that religion proves to be effective in its role of social cohesion due to its supernatural claims of authority which provide added strength to its directives upon the individual. (Azra et al. 2010; Durkheim 1912; Fitouchi & Singh, 2022; Singh et al. 2021). Consequently, in a society which desires population survival or expansion, one might expect religious beliefs, rules, and community that favor high levels of fertility to emerge and remain (Durkheim, 1912; Popper, 1987).

Theologies of community: Community, a key mechanism that connects religion and fertility, has been long acknowledged within (*The Mormon Ethic of Community*, 2012) and without (Cox, 2021; S. Gardner, 2016) of the church as an important part of the Latter-day Saint experience. The Latter-day Saint faith, both formally and informally, works to build an extended network of support for the Latter-day Saint individual. Formally, both Latter-day Saint "Fast Sunday", where members fast for 2 meals on the first Sunday of each month and donate the saved money to support congregational members in financial need (*Fast Sunday*, 2014), and its ministering program, where each family is assigned a male lay-priesthood holder and each woman is assigned an adult female to visit them each month, offer help, and provide friendship (*What Is Ministering?*, n.d.), act as key formal mechanisms to creating strong local religious communities. Beyond these programs, Latter-day Saint culture offers various informal methods of help. These include time honored traditions of helping fellow congregational member move (Reiss, 2015), members volunteering janitorial services for their meeting houses (Rimington, 2015), members providing *ad hoc* meals to sick or grieving families (*Mormon Food Traditions*, n.d.), and free use of chapels for wedding receptions and funerals (*LDS Wedding Reception Details*, n.d.).

These programs and culture of community support find their genesis in Latter-day Saint scriptures that teach individual responsibility to community as a core ethic. For instance, one Latter-day Saint -specific scripture teaches that a true Christian society should have "no poor among them" (The Church of Jesus Christ of Latter-day Saints, 2013, Moses 7:18). Similarly, the Book of Mormon teaches that newly baptized Latter-day Saint members promise to "come into the fold… and bear one another's burdens" (The Church of Jesus Christ of Latter-day Saints, 2013b, Mosiah 18:8).

Furthering these ideals, an 1834 revelation by church founder Joseph Smith establishes a divine approach to community to make sure all individuals are economically cared for. This revelation depicted an ideal social order where all capital is held in common, and decisions are made collectively (The Church of Jesus Christ of Latter-day Saints, 2013a; Section 104). These principals were experimented with at various times in the early church. This included extreme examples like Orderville, Utah. Here citizens wore clothes created from Orderville Industries, shared their economic goods, lived in equally apportioned apartments, and consumed their meals in the same dining hall (*Our History*, n.d.; Pendleton, 1939). Although the church gradually replaced its many communal economic orders of the 19th century with capitalist enterprises (Arrington, 1953, 2005), the core concept of church members supporting each other not only in times of trials, but as part of everyday life, remains a key principle of the Latter-day Saint faith. Thus, for those individuals who seek to follow beliefs and lifestyle of the Latter-day Saint faith, the community offers variety of means to support them in their pursuits.

Theologies of fertility: Two communal societies arising from of America's Second Great Awakening (Mathews, 1969) offer illustrations of how nuances in belief may inform demographics: The United Society of Believers in Christ's Second Appearing (the Shakers) and The Church of Jesus Christ of Latter-day Saints. These religion's contrasting approaches to the Original Sin produced vastly different populations (Bean et al. 1990; Bean et al. 1983; Foster, 1981). The Shakers, believing that Adam's sin was sexual in nature, require a life of celibacy from the believer. The Latter-day Saints, who view the same offense as the necessary genesis to the human family, focus upon the charge to "Be fruitful, and multiply..." The numbers bear the results: as of 2017 the Shaker Community consisted of two people and the Latter-day Saints had 16,118,169 (*2017 Statistical Report for 2018 April General Conference - Church News and Events*, n.d.; Blakemore, 2017).

The Latter-day Saint belief in a pre-earthly life offers another example of a pro-fertility tenet. The concept of a pre-earth life contends that each individual's mortal journey originated as a soul created in a pre-earth spirit world (*The Doctrine and Covenants of The Church of Jesus Christ of Latter-Day Saints.*, 1981, see section 76). Prior to birth, the individual soul chose to come to earth gain a body and then be tested by the life's experiences as part of the larger salvation process (*Where Did We Come From?*, n.d.). If gaining a physical existence through birth is the fundamental prequel to salvation, then fertility acts as a mechanism to this plan (Andersen, 2011). Consequently, Latter-day Saints not only believe in high fecundity, but offer a culture that welcomes and supports children and values large families (Anderson, 1937; Anderton et al., 1984; Givens & Barlow, 2015; Marks, 2004).

Fertility in historic Utah: Research within historic Utah suggests that Latter-day Saint women simultaneously display greater parity compared to non-Latter-day Saint women, yet follow similar patterns as fertility declined with the rise of industrialization and modernization (Anderton et al., 1984; Anderton & Bean, 1985; Bean et al., 1990; Bean et al., 1992; Hsueh & Anderton, 1990; Mineau et al., 1979; Skolnick et al., 1978; Smith & Mineau, 2021). Prior to post-industrial fertility declines, Utah fertility was first marked by earlier marriage age, shorter interbirth intervals, and greater parity compared to their originating populations (Skolnick et al., 1978). The post-1869 period, a time of increased secularism and industrialization, was marked by equal declines in fertility among all Utah religious groups (Mineau et al., 1979).

More specific findings concerning Utah's fertility patterns during this time focus upon parity, inter-birth interval, and mother's age at first and last birth. Anderton and Bean (1985) suggest that fertility spacing post-1869 depended upon parity. Those with less children assumed the birth schedule of smaller families in previous cohorts. Bean et al. (1990) find that the mother's age at last birth continually declines across Utah's 19th century birth cohorts. Extending these findings, Hsueh & Anderton (1990) explain that Utah's post-industrial fertility decline is characterized by both sustained decreases over time and age-specific use of contraceptive innovations that lead to birth interval truncation. In sum, Utah's fertility, while greater than the

U.S. at large, followed similar trajectories over time demonstrated by less parity, declining age at last birth and increased fertility spacing.

Fertility and religious networks: Previous literature suggests a strong relation between religious networks and conduct. These reports include associations between church communities and substance abuse (Bahr et al., 1993), adolescent sexual activities (Adamczyk & Felson, 2006), altruistic acts (Power, 2017b), adolescent delinquency (Regnerus, 2003), civic engagement (Lewis et al., 2013) and consumer behaviors (J. M. Bailey & Sood, 1993).

I hypothesize that religious community may act as a mechanism to increase fertility among its adherents in ways that mirror mechanisms in which religious communities influence health and other types of pro-social behavior (Barlow & Bergin, 1998; Lund et al., 1989; Power, 2017b). I assume a dose-response relation (Levin, 1994) between local religiosity and increased parity. This relation could arise if, for instance, fertility minded Latter-day Saints move to locations where larger families are supported and rewarded (i.e., non-random residential selection) (McBride, 2007, 2016), or families increase their offspring when introduced to a more like-minded community. In either case, I hypothesize that communities may reinforce religious pronatalism and thereby increase parity.

While researchers postulate that religious pronatalism spurred fertility in Utah (Stanford & Smith, 2013), little research explores how theology may have informed religious community to increase reproduction (McQuillan, 2004; Shaver, 2017). I address this gap in the literature by arguing that the Latter-day Saint faith responded to secular declines in fertility more broadly by embracing pronatalism, and that its communities likely responded in kind. Consequently, I offer analysis of religion, ecologies, and fertility in Utah utilizing the Utah Population Database

(UPDB) which consists of Latter-day Saint genealogies linked to census, vital records, and medical records (Smith & Mineau 2021). Not only does the UPDB include detailed individual census and genealogic information, but also notes if the individual participated in Latter-day Saint baptism and endowment ceremonies. Baptism, which occurs in late childhood (median age= 8.54 years, see Table 3.1), is the required step for all individuals to formally become members of the Church. The endowment, performed during early adulthood (median age= 25.12 years, see Table 3.1) within Latter-day Saint temples, consists of further promises to God, including fealty to the Church and its leaders (*About the Temple Endowment*, n.d.). Although my study question and hypothesis focus upon those who are most likely to find identity and belief with the Latter-day Saint faith, I do consider fertility among females of other religious participation levels. Similar to Maloney et al. (2014) I divide mothers into three categories: endowed before age 40 (Active Latter-day Saint), baptized only or not endowed before age 40 (Inactive Latter-day Saint), or not Latter-day Saint. With this information I advance the following hypothesis:

> ***Hypothesis:*** Active Latter-day Saint females within communities of greater religious density will display greater fertility (e.g., increased maternal parity, earlier maternal age at first birth, later maternal age at last birth, and diminished inter-birth intervals) compared to active Latter-day Saint females within communities of lower religious density.

Intriguingly, some anthropological research shows that religious people who live in less religious environments tend to exhibit greater orthodoxy in contrast to those living in highly religious ecologies (McElreath et al., 2003). A given individual may choose to assimilate with, or entrench against, their community's culture. In consideration of this argument, I propose the following competing hypothesis:

> ***Competing Hypothesis:*** Active Latter-day Saint females within communities of lower religious density will display greater fertility (e.g., increased maternal parity, a younger maternal age at first birth, a greater maternal age at last birth, and diminished inter-birth intervals) compared to active Latter-day Saint females within communities of increasing religious density.

Methods

Dataset

The Utah Population Database (UPDB), one of the world's most comprehensive computerized genealogies, serves as the primary data source for this analysis. While further details of the UPDB are offered in Chapter's 1 and 2, the UPDB's structure of linked data between genealogies, vital records and censuses allows this analysis to consider how religion might interact with fertility within geographic communities.

Population

My study population consists of 154,320 females who survived to at least age 50 and were recorded in at least one census in Utah between 1900 to 1940 during reproductive ages (15 to 50). These census years provide a historical backdrop as they constitute a period post-statehood when Utah was assimilating into the broader US culture, had largely shunned polygamy, and slowed religious immigration. As such, the importance of shared-identity and community support within a shrinking Latter-day Saint majority might play an important role during this period.

Mechanisms

The variables in this analysis derive from proposed mechanisms between religion and fertility. Based upon Durkheim's hypotheses (Durkheim, 1912) and previous literature (Cohen et al., 2009; M. Daniels, 2004; de Diego Cordero & Badanta Romero, 2017; Elkalmi et al., 2016; Johnstone et al., 2012; Regnerus, 2003), I identify three key mechanisms employed by religion to shape individual choices and behaviors, and thus population health outcomes: beliefs, rules, and community. Figure 3.1a illustrates the proposed relation between religion and population health outcomes. More specifically, Figure 3.1b illustrates this same relation with regards to fertility and community.

Variables

Fertility outcomes: This study employs the total children ever born to a female, maternal parity, as the primary endpoint. Secondary endpoints, associated with fertility (Skolnick et al., 1978), include birth interval spacing, and ages at first and last birth. Both within and without the UPDB, multiple studies establish these variables as important indicators of changing trajectories in Utah fertility from 1847 until the present day (Anderton & Bean, 1985, 1985; Bean et al., 1992; Eijkemans et al., 2014; Soest & Saha, 2018; Tomkinson, 2019). For maternal parity I consider the total number of children born to the mother, regardless of spouse. I measure birth interval spacing by calculating the difference between each sibling's birth, and then creating a variable that is an average across all birth intervals for the mother. I also employ the mother's age at first birth and last birth as additional dependent variables. Figures 3.2a through 3.2d illustrate how these measurements change across time in our study population according to birth cohort and Latter-day Saint religious participation.

Religious intensity (RI): I present a novel approach to measuring community religious intensity (RI). Ecological studies concerning health and religion tend to compare population levels of religiosity against population rates (Blanchard et al., 2008; Haron & Jensen, 2008; Kark et al., 1996; Merrill, 2004). While research concerning religious community and individual outcomes exist, it tends to employ sampling surveys (Deaton, 2009; VanderWeele, 2017c) or qualitative interviews (Badanta et al., 2020; Banerjee et al., 2014; Dengah et al., 2019a). No research, that I can find, examines population rates of both fertility and religiosity according to individual-level data. Therefore, the UPDB's ability to link individual religious information to census spatial information across an entire population presents a unique opportunity to consider how the density of individual religious participants in a given geographic locale might affect individual fertility.

I define the intensity of community religiosity—the key exposure variable—as the ratio of active Latter-day Saint individuals to the total population within a given enumeration district during a given census year. To define this variable across all ages, I counted those between the ages of 0 and 7 years as active at the time of census if both of their parents were endowed at time of census. For those ages 8 to 18, I selected only those baptized before 10 years of age. Lastly, those who were 18 years and older I considered active if they were endowed prior to the following census. I was more lenient with the time frame for endowment age due to historic differences compared to current endowment practices. I reasoned that endowment age for active Latter-day Saint members could have a wider time frame during this period than in 2024, given changing attitudes towards endowment age (Noyce, 2024), less-developed transportation systems

(Haymond, 1994; Knowlton, 1967; Schwantes, 2003), and fewer temples (MormonWiki, n.d.) within Utah than current Latter-day Saints enjoy. I then summed all active members from each group within a given district to create a numerator.

I employed IPUMS USA to create total population counts of each Utah census district (Ruggles et al., 2024). The resulting proportion of active Latter-day Saint members within the locality's total population was the enumeration district's RI for that census year. To obtain the individual female's mean RI, I matched specific RI scores to the individual females who were in that district at that time. Individuals could have one to five possible scores depending on the number of censuses between 1900 to 1940 in which they were alive and recorded. As such, I averaged all RI scores for each individual female to create the final mean community RI score.

Key variable: The RI of the female's enumeration district comprises the main variable of interest.

Covariates: The study covariates include mother's birth cohort (born after 1900 = 1, born before 1900 = 0), urban or rural census district, and whether the mother has a completed fertility history. As this dataset constitutes an historical dataset derived from multiple sources with missing data, the UPDB includes a binary variable stating if the fertility records are complete (Yes/No). I include the urbanicity of the census records as the Utah-based literature reveals delineation of health effects upon urban/rural lines post-industrialization which may affect fertility (Blackburn et al., 2019; Koric et al., 2023; Ou et al., 2018; Rogers et al., 2020). To operationalize urban status, I assign a 1 (urban) or a 0 (rural) for each census the female is recorded.

Excluded variables: Several variables were explored and rejected as possible covariates. These include paternal SES, total enumeration districts, and paternal religious participation. I excluded paternal SES variable due to both overall-size of missingness (24.99%) and between-group disparities (15.19% missing among those with 5+ children and 32.42% among those with less than 5 children). I then considered the justification of using two covariates concerning data quality: completed fertility history and census records. As the completeness of recorded fertility seemed more salient to the study question, I opted to test the validity of utilizing total census records as an additional covariate of record completeness. The resulting logistic regression analysis revealed a negative correlation ($\beta = -0.30$, $P < .0001$) between the total amount of enumeration districts and the risk of having a completed maternal fertility history. This result suggests a quality similar between those individuals with incomplete fertility records and lower census records. Further, I observed no concerning patterns in the number of census records across other covariates that might necessitate its inclusion as a covariate. Thus, in an effort to balance accuracy with simplicity I elected to use completed fertility history as the sole measurement of record accuracy.

I also excluded the use of paternal religiosity due to both its similar distributions with maternal religiosity across parity outcomes as well as questions concerning selection. Given Latter-day Saint pronatalist theology, the strength of the Church's influence on Utah life, and our focus on maternal fertility, it seems more likely that believing Latter-day Saint women chose equally religious partners to fulfill parity ideals rather than marrying husbands who lobbied for increasing fertility. While both my study question and hypothesis consider how a religion influences demographic dynamics among the faithful, I opted to consider how less active and non-Latter-day Saint women responded to religious environments. Accordingly, I considered its potential use as an interaction term with RI, as a separate covariate, or as a basis for stratification. I reasoned that stratification would better address the study hypotheses as a within-group analysis would offer better a better inference for the proposed hypotheses than a between-group interaction term. As such, I stratified mothers into three categories (i.e., active LDS, inactive LDS, and not LDS) and examined the role of RI for each stratum. For a more complete description of the Latter-day Saint endowment in religious measurement, see Chapter 1.

Analytic and Statistical Approach

Parity Progression: I first employ an analysis of Parity Progression Ratios (PPR). These ratios represent the proportion of women with N births who progress to N+1 births ((P(N+1|N), 0 <= N <=14) along with constructed odds ratios produced by logistic regression models that examine PPRs as the dichotomous dependent variables. This method of analysis, which considers the probability of a mother with a certain set of characteristics of having an additional birth given her current number of births, has previously been employed in the UPDB. Following the methods of Robson and Smith (2012), I created plot the resulting parity progression ratios (Figures 3.5a – 3.5d). While Robson and Smith divide their groups by time (1870, pre and post industrialization), I divide the population according to the individual's religious category (Not Latter-day Saint, baptized only or endowed after 40, and endowed before 40) and compare PPRs according to whether the female was below or above the median RI score of the study population (i.e., .5003). This decision to dichotomize RI according to the median RI score allows for a simplified manner to consider Parity Progression Ratios across multiple categories of religious participation. In sum, these PPRs were calculated through RI comparisons (i.e., < .50 to >.50 RI), according to religious participation groups, to illustrate the proportion of women with N births who progress to N+1 births ((P(N+1|N), 0 <= N <=14).

Linear regression: For analyses of total parity, inter-birth spacing, age at first birth, and age at last birth I utilize Ordinary Least Squares (OLS) regression models. I specified the mean religious intensity RI_i of the individual's enumeration district as the key variable of interest, along with a range of individual covariates X_i in the final model. For additional considerations concerning how these affects may have differed across levels of Church participation I stratified the sample according to the religious status of the mother as previously discussed.

These models take the form of:

1: $Y_i = \alpha + \beta_1 * RI_i + \varepsilon_i$

2: $Y_i = \alpha + \beta' * X_i + \beta_1 * RI_i + \varepsilon_i$

Results

Descriptive Tables and Figures

Tables 3.2 and 3.3 describe key variables for the study population. The total population consists of 154,320 females born between 1850 and 1925, who appeared in Utah in at least one US Census between 1900 to 1940 while of fertility age and survived to at least age 50. Of these females, 43.11% had five or more children. Females endowed by age forty are more likely to have 5 or more children (endowed < 40 y.o. = 51.43%, baptized-only/endowed > 40 y.o. = 34.68%, non-Latter-day Saint= 32.41%) compared to other religious groups (Figure 3.2). Likewise, women who have five or more children tend to be found in higher RI communities (55.93%). The reverse is true for women with less than 5 children, who tend to be more represented by lower RI environments (54.33%).

Figures 3.2a through 3.2d demonstrate the fertility differences between endowed Latter-day Saints women and those of other Church participation levels. While these charts echo findings of previous studies (Bean et al., 1990; Hsueh & Anderton, 1990) that demonstrate increased fertility among Latter-day Saints, they offer further granularity regarding endowed/baptized/non-Latter-day Saint status. Interestingly, inactive Latter-day Saint females (baptized only or endowed after age 40) have fertility levels and patterns more in concert with non-Latter-day Saint females than they do with active Latter-day Saint females. In general, all figures demonstrate similar patterns between religious groups, but Figures 3.2b and 3.2d show points of convergence between active female rates and those rates of inactive and non-Latter-day Saint females (3.2a around 1870, 3.2b around 1900).

Figures 3.3a through 3.3d illustrate the same fertility measures as 3.2a through 3.2d, but according to RI scores only without regard to individual level measure of Latter-day Saint participation. These figures demonstrate a consistently higher rates of fertility across cohorts among females in RI districts over .50 than those below .50. Yet in later cohorts, these differences either narrow (3.2b – 3.2d, secondary fertility endpoints) or, in the case of parity, change sign.

Figures 3.4a through 3.4d provide initial descriptive evidence in support of the first hypothesis. These charts plot the relation between parity and enumeration district's religious intensity according to religious status of the female. As the US census does not employ consistent enumeration district IDs across census years, each dot represents a single census enumeration district for a given census (i.e., 1900, 1910, 1920, 1930, or 1940). Thus, one chart includes all Utah districts from all census years (N= 2255). Figure 3.4a demonstrates a positive correlation between RI and parity. Yet, this association might be attributed to the fact that enumeration districts with more active Latter-day Saints will demonstrate higher parity as active Latter-day Saint females manifest higher fertility. Figures 3.4b through 3.4d dispel this notion. They show this same RI association holds within all religious groups, although a lesser correlation is found among low participators and non-Latter-day Saints.

Parity Progression Ratios

Using the same analytic approach of Robson and Smith (2012), I analyzed fertility according to RI and Church participation status through parity progression ratios (N=78,509). Figures 3.5a through 3.5c demonstrate higher ratios of progression through parity orders amongst those in religious intensity districts greater than .50. Table 3.4 and Figure 3.5c demonstrate the results of logistic regression tests considering the Odds Ratio (OR) of progression between high and low intensity environments within various levels of religiosity. These ORs generally depict decreased odds of progressing to the next order of parity among individuals in low religious intensity environments up until around the 9th child. Although the odds of progressing are higher among females in low RI districts after the 9th child, the small numbers of individuals in this category have imprecisely estimated coefficients (and wide confidence intervals) which leave me hesitant to offer a clear interpretation.

Linear Regressions

Tables 3.5 (results) and 3.7A/3.7B (scenario interpretations) represent the study's main findings. As both models, across all religions, show detectable increases of parity according to RI, these results support the main hypothesis. Model 2, which demonstrates better fit statistics than Model 1, provides the basis for the final analysis. This decision comes with the noted limitation that, unlike Model 1, the differences in parity between Active Latter-day Saints and non-Latter-day Saints in Model 2 found in the scenario interpretations appear less than findings of previous UPDB studies and current concepts of Utah fertility (Harris, 2022; Maloney et al., 2014; *Utah's Fertility Rate Continues to Drop, Now Fourth Highest in the Nation - Kem C. Gardner Policy Institute*, 2022).

Table 3.5, Model 2, reveal a positive association between religious intensity and parity among active Latter-day Saint females (β=0.027, P <.0001). Given the log transformation of the coefficients due to use of a general linearized model with a negative binomial distribution (see Table footnote) and that I scaled mean RI to .10, this coefficient to leads to a .44 (*see* Table 3.7b) increase in parity between a hypothetical enumeration district at the bottom 10% (RI = 0.27) compared to the top 10% (RI = 0.67). This positive relation is not limited to active Latter-day Saint, as the other two religious participation categories yield a positive association (Inactive Latter-day Saint, β=0.006, p = 0.002; Not Latter-day Saint, β=0.013, p = <.0001). While statistically detectable, comparisons of parity among the top and bottom 10% of mean RI's show smaller absolute differences, as inactive Latter-day Saint females demonstrate a 0.09 increase in parity for high RI (vs. low RI) and non-Latter-day Saints females manifest an increase of 0.19 (for high RI vs low RI).

In alignment with previous studies (G. P. Mineau et al., 1979; Skolnick et al., 1978), Table 3.7 shows that active Latter-day Saint women realized increased fertility through lower ages at first birth, increased age at last birth, and diminished birth interval spacing. Comparisons between the same hypothetical RI groups (i.e., high vs. low) would account for 0.62 years decreased age at first birth, 0.76 increased age at last birth, and 0.11 years decrease in birth interval spacing.

Insight from the selected covariates suggest a time and geography dimension to parity along religious lines. While later maternal birth cohorts of all religious participation groups saw statistically detectable declines in parity after 1900, active Latter-day Saints saw the smallest decrease (Active Latter-day Saint β= -0.038, Inactive Latter-day Saint, β=-0.396, Not Latter-day Saint, β=-0.275, all p values <.0001). A similar negative correlation was observed when comparing diminished parity owed to urban living environment (Active Latter-day Saint β= -0.044, Inactive Latter-day Saint, β=-0.86, Not Latter-day Saints, β=-0.117, all p values <.0001). Therefore, the totality of these results suggests that increased community religious intensity, through a variety of fertility mechanisms, corresponds positively with fertility in early 20th century Utah.

Discussion

Genealogies linked to census records in UPDB provide a unique opportunity to study how fertility and religious community indicators are associated. Accordingly, the data offer insights as to how an individual might respond to religious ecologies in a manner that would affect fertility. Through considerations of religion's interest in demographic expansion, by way of religious community, I offer an examination of how endowed Latter-day Saint females might increase their fertility depending upon the density of similar religious individuals within their census enumeration districts. I hypothesized that endowed Latter-day Saint females within higher RI enumeration districts will manifest greater religiosity than those who live in lower enumeration districts of RI. I also offered a competing hypothesis that posited higher fertility among endowed Latter-day Saint females in lower RI districts.

My findings support the main hypothesis through demonstrations of a positive correlation between parity and the intensity of one's religious community among active-Latter-day Saint females. Similar to Skolnick (1978), linear regression analyses of secondary endpoints reveal that increased parity among endowed females in high RI environments was accomplished through expanded duration of fertility activity and shorter interbirth intervals. Interestingly, other religious participation groups, though exhibiting this same correlation, did so to a lesser degree. Thus, the relation between community, religion, and fertility offers reasonable grounds to consider how religion may seek to advance social objectives.

Limitations and future directions

Limitations include the accuracy of the constructed ecological measure, Latter-day Saint participation measurement, selection into high RI ecologies, and generalizability to other religions or geographies. Using census enumeration districts as a proxy for religious community assumes that these geographic units constitute an accurate religious community proxy. This is a strong assumption that further research could investigate through other geographic measures such as contiguous enumeration districts or county level measurements. As of 2024, we do not have maps for enumeration districts prior to 1940 (*GIS Files | IPUMS NHGIS*, n.d.). If historic maps are created (IPUMS has expressed interest) this research can support further spatial analysis (*Enumeration District Shapefiles - NHGIS*, 2022).

Despite the individual's participation in the endowment offering a finite level of measurement of religious commitment that survey responses may lack, it only offers a single point in time of individual participation. It is possible some individuals fell away from the faith after endowment, or some were endowed but never fully committed to the faith. Moreover, lower

RI communities may increase the chance of inactivity. As such, a deeper analysis into the quality of the endowment as a tool of measurement may be warranted. While more detailed longitudinal measures such as records of weekly service attendance or tithing offerings may prove impossible to access or too personal for individuals to share, other possibilities might exist. Items such as the number of children baptized before age 10 or dates of children's baptism as additional points of religiosity may resolve this problem to some extent. Additionally, a familial network analysis might expand beyond the husband's faith and consider that of the parents, siblings, and cousins.

Although the descriptive results of this examination suggest a linear relation between RI and parity, future analysis may consider a categorical approach to RI. For instance, lower intensity areas might represent differing social scenarios outside of RI. Perhaps low RI's represent mostly mining camps or agriculture workers, rather than similar neighborhoods to high RI ED's but only with less Latter-day Saint people. As such, this type of analysis might support analysis between RI and occupation or consider the ED's geographic place within specific counties or cities. However, the previously mentioned lack of GIS maps of these districts may limit such analyses.

My decision regarding covariates points toward deeper analysis. For instance, all religious categories demonstrate a similar negative relation but dissimilar magnitude between parity and the included predictors of urban environment and birth cohort. Future research might consider why active Latter-day Saint females manifest less sensitivity to these changes. Likewise, fertility patterns that situate inactive Latter-day Saint females closer to non-Latter-day Saint mothers as opposed to the religiously active females of the same faith might point towards either (or both) weaknesses in the non-Latter-day Saint portions of UPDB data or further studies regarding sociology topics like identification and deviance.

One result that deserves mention concerns inactive Latter-day Saint females. Through descriptive charts, parity progression analysis, and comparisons of regression results, it appears inactive Latter-day Saint female fertility patterns and rates correspond more closely to those of non-Latter-day Saint instead of active Latter-day Saint females. Considering chapter 2, where inactive Latter-day Saint males' life expectancy contradicts national trends by reducing during the 1920's, this chapter's fertility results may point towards a unique social status for former and inactive religious people. While the loss of world-view and social support for those who leave the Church (Brooks, 2020; Joseph & Cranney, 2017; Ormsbee, 2020) provide possible explanations, this phenomenon may point towards non-random residential selection. Perhaps born-Latter-day Saint females assign themselves to religious activity or religious communities based upon fertility desires. Furthermore, it is possible inactive Latter-day Saint people signal their differences in faith through their lifestyles and community (Power, 2017a).

With these conjectures in mind, researchers may build upon the UPDB's unique abilities through derivative comparisons to this study. One possible study design might include comparisons of birth interval changes within individual females who migrate between high and low RI districts. Additionally, further examinations of selection may consider qualitative designs to better account for the individual's experience. This may include journal accounts, newspaper editorials, sermons by Latter-day Saint leaders, and other sources to gain a better concept of the social milieu (*for examples see* Anderson, 1930; Thomas & Znaniecki, 1918; Thrasher, 1927). Certainly, a variety of methods could shed further light upon these findings.

Lastly, the Latter-day Saint faith may constitute a singular type of religious community. I do not argue that these results would translate to all religions or that community religiosity would be equally meaningful to other faiths. As illustrated earlier, Latter-day Saints possess a unique emphasis on community compared to other faiths due to its doctrines, policies, and history. Yet, social theory maintains a strong role for communities across a broad range of health outcomes (Callaghan & Morrissey, 1993; Kaplan et al., 1977; Schwarzer & Leppin, 1991). Therefore, I would argue that importance of community exists for all groups, but further thought should be given to the singular circumstance found in the Latter-day Saint faith.

Conclusions

Any study of fertility must consider the social circumstances surrounding fertility decisions. The changing patterns in religiosity influence contemporary fertility offers one consideration (Pew Research Center, 2022; *The Future of World Religions: Population Growth Projections, 2010-2050.*, 2015). Thus, as research focuses upon social determinants of demographic change, historic analyses might offer new theoretic approaches. With this endeavor in mind, I focused upon testing a possible mechanism between religion and fertility. The results, consequently, supported the hypothesis that increased community religiosity positively influences parity. Likewise, these tests suggest that religion might serve the demographic aims of society, using its community to strengthen fertility outcomes. Yet further research may refine how community is approached both through new data availability in the form of enumeration district geography and other alternative methodologies. Therefore, I encourage additional research to consider how community might perform as a mediator between religion and fertility.

Tables and Figures

Table 3.1: Median age (in years) of Church ceremony participation among Utah births, 1880 to 1920, who either died or were last documented in Utah.

Median age at baptism (N=139,542)	8.54
Median age at endowment (N=105,747)	25.12

Table 3.2: Descriptive tables of independent variables according to the individual's maternal parity among Utah females. Females must have been born between 1850 and 1925, appeared in at least one Census in Utah between 1900 to 1940 during fertility age, and survived to at least age 50. (N=154,320).

		All		<5 Children		5+ Children	
		N= 154,320		N = 87,797		N = 66,523	
		N	%	N	%	N	%
Mean ED religious intensity							
	<.50	77018	49.91%	47702	54.33%	29316	44.07%
	>.50	77302	50.09%	40095	45.67%	37207	55.93%
Church participation							
	Endowed < 40 y.o.	80066	51.88%	38890	44.30%	41176	61.90%
	Baptized only or endowed > 40 y.o.	56378	36.53%	36824	41.94%	19554	29.39%
	Not LDS	17876	11.58%	12083	13.76%	5793	8.71%
Husband's Church participation							
	Not Endowed	55736	36.12%	41582	47.36%	14154	21.28%
	Endowed	98584	63.88%	46215	52.64%	52369	78.72%
Fertility history record							
	Not Complete	65543	42.47%	50205	57.18%	15338	23.06%
	Complete	88777	57.53%	37592	42.82%	51185	76.94%
Birth cohort							
	Born Before 1900	76568	49.62%	32293	36.78%	44275	66.56%
	Born After 1900	77752	50.38%	55504	63.22%	22248	33.44%
Urbanicity of enum. dist.							
	Rural	69076	44.76%	36206	41.24%	32870	49.41%
	Urban	85244	55.24%	51591	58.76%	33653	50.59%
Total censuses records (1900 to 1940)							
	1	23000	14.90%	15101	17.20%	7899	11.87%
	2	42830	27.75%	27998	31.89%	14832	22.30%
	3	39014	25.28%	22749	25.91%	16265	24.45%
	4	30484	19.75%	14666	16.70%	15818	23.78%
	5	18992	12.31%	7283	8.30%	11709	17.60%
Husband's median SES score							
	Missing	38565	24.99%	28460	32.42%	10105	15.19%
	0 to 126	28968	18.77%	11354	12.93%	17614	26.48%
	126 to 240	28605	18.54%	12759	14.53%	15846	23.82%
	240 to 409	29181	18.91%	16396	18.67%	12785	19.22%
	409 to 1000	29001	18.79%	18828	21.44%	10173	15.29%

Table 3.3: Descriptive tables of dependent variables among Utah females according to mean religious intensity (RI) of the individual's census enumeration district. Females must have been born between 1850 and 1925, appeared in at least one Census in Utah between 1900 to 1940 during fertility age, and survived to at least age 50. (N=154,320).

		All		Below .50 RI		Above .50 RI	
		N= 154,320		N = 77,018		N = 77,302	
		N	%	N	%	N	%
Parity							
	0	14822	9.60%	7477	9.71%	7345	9.50%
	1 to 3	51540	33.40%	29091	37.77%	22449	29.04%
	4	21435	13.89%	11134	14.46%	10301	13.33%
	5 to 7	41114	26.64%	19289	25.04%	21825	28.23%
	8 or more	25409	16.47%	10027	13.02%	15382	19.90%
Mothers age at first birth							
	Missing	14960	9.69%	7561	9.82%	7399	9.57%
	< 20	33530	21.73%	16101	20.91%	17429	22.55%
	20 to 22	32728	21.21%	15600	20.26%	17128	22.16%
	22 to 25	36933	23.93%	18432	23.93%	18501	23.93%
	25 or older	36169	23.44%	19324	25.09%	16845	21.79%
Mothers age at last birth							
	Missing	13961	9.05%	7075	9.19%	6886	8.91%
	15 to 30	32865	21.30%	18465	23.97%	1440	1.86%
	30 to 36	40015	25.93%	20813	27.02%	19202	24.84%
	36 to 40	32698	21.19%	15698	20.38%	1700	2.20%
	40 or older	34781	22.54%	14967	19.43%	19814	25.63%
Median birth spacing							
	Missing	25503	16.53%	13507	17.54%	17334	22.42%
	0 to 2.6 years	31392	20.34%	15135	19.65%	18126	23.45%
	2.6 to 3.4 years	33898	21.97%	15775	20.48%	18188	23.53%
	3.4 to 4.6 years	31735	20.56%	15730	20.42%	18041	23.34%
	4.6 or more years	31792	20.60%	16871	21.91%	17978	23.26%

Tables 3.4: Odds ratios (ORs; and 95% confidence intervals) of a mother having an additional child in a low religious intensity community relative to a mother from a community of higher religious intensity (27 compared to .67) by individual Church religious participation. An OR of <1.00 means females from .27 RI districts are of decreased parity progression risk compared to females in .67 RI districts. All mothers must have been born between 1850 and 1925, appeared in at least one Census in Utah between 1900 to 1940 during fertility age, and survived to at least age 50. These results are based upon logistic regression analysis. (N = 154,320)

	Not LDS			Inactive LDS			Active LDS		
	OR	Low 95%	High 95%	OR	Low 95%	High 95%	OR	Low 95%	High 95%
0 to 1	1.07	0.79	1.45	1.15	0.99	1.33	0.98	0.87	1.10
1 to 2	0.65	0.49	0.86	0.82	0.73	0.93	0.75	0.68	0.83
2 to 3	0.49	0.40	0.60	0.75	0.69	0.81	0.65	0.61	0.69
3 to 4	0.58	0.49	0.69	0.73	0.68	0.79	0.70	0.66	0.73
4 to 5	0.59	0.50	0.70	0.77	0.72	0.83	0.75	0.72	0.79
5 to 6	0.67	0.56	0.81	0.84	0.78	0.91	0.75	0.72	0.79
6 to 7	0.81	0.67	0.98	0.88	0.81	0.97	0.83	0.78	0.87
7 to 8	0.76	0.62	0.94	0.88	0.79	0.97	0.80	0.75	0.85
8 to 9	0.70	0.55	0.89	0.82	0.73	0.92	0.79	0.73	0.85
9 to 10	0.86	0.65	1.14	0.87	0.76	0.99	0.89	0.81	0.97
10 to 11	0.99	0.72	1.37	0.80	0.68	0.93	0.88	0.79	0.98
11 to 12	0.95	0.64	1.42	1.11	0.92	1.35	0.90	0.79	1.03
12 to 13	1.01	0.60	1.70	0.87	0.68	1.12	0.88	0.74	1.05
13 to 14	1.03	0.49	2.18	0.94	0.66	1.33	1.04	0.81	1.34

Table 3.5: Coefficients concerning the relation between maternal parity and local religious intensity (continuous variable). Utah females must have been born between 1850 and 1925, appeared in at least one census in Utah between 1900 to 1940 during fertility age, and survived to at least age 50. (N = 154,320)

	Active LDS		Inactive LDS		Not LDS	
	Model 1 Coefficient *(SE)*	Model 2 Coefficient *(SE)*	Model 1 Coefficient *(SE)*	Model 2 Coefficient *(SE)*	Model 1 Coefficient *(SE)*	Model 2 Coefficient *(SE)*
Intercept	1.352*	1.301*	1.259*	1.242*	1.125*	1.251*
	(0.050)	*(0.009)*	*(0.019)*	*(0.010)*	*(0.011)*	(0.015)
Main Effect						
Religious intensity (continuous)	0.050*	0.027*	0.019*	0.006**	0.043*	0.013*
	(0.001)	*(0.001)*	*(0.001)*	*(0.002)*	*(0.003)*	*(0.003)*
Covariates						
Born after 1900		-0.038*		-0.396*		-0.275*
		(0.003)		*(0.004)*		*(0.008)*
Urban enum. dist. (Average of all records)		-0.044*		-0.086*		-0.117*
		(0.004)		*(0.005)*		*(0.009)*
Completed fertility history of wife		0.466*		0.585*		0.523*
		(0.004)		*(0.005)*		*(0.008)*

All coefficients are log transformed for parity models. Religious intensity is scaled to .10. General linearized model, negative binomial distribution.
*= <.0001
**= <.01

Table 3.6: Coefficients concerning the relation between maternal age at first and last birth, and local religious intensity (continuous variable) among active Latter-day Saint females. Mothers must have been born between 1850 and 1925, appeared in at least one census in Utah between 1900 to 1940 during fertility age, and survived to at least age 50. (N = 154,320)

	Age at first birth	Age at last birth	Inter-birth interval
	Coefficient	Coefficient	Coefficient
	(SE)	*(SE)*	*(SE)*
Intercept	24.350*	34.565*	3.923*
	(0.080)	*(0.106)*	*(0.037)*
Main Effect			
(A) Religious intensity (continuous)	-0.154*	0.191*	-0.027*
	(0.012)	*(0.016)*	*(0.005)*
Covariates			
Born after 1900	0.231*	-2.955*	0.747*
	(0.031)	*(0.041)*	*(0.014)*
Urban enum. dist. (Average of all records)	0.468*	0.082	0.049**
	(0.034)	*(0.046)*	*(0.016)*
Completed fertility history of wife	-0.858*	2.537*	-0.450**
	(0.036)	*(0.048)*	*(0.017)*

Religious intensity is scaled to .10. General linearized model, negative binomial distribution.

** P < .05

Table 3.7a: Summated and exponentiated coefficients from Table 5, Model 1, reflecting different parity outcomes based upon two scenarios of religious intensity unadjusted for covariates. A median religious intensity (RI) score of .27 and .67 represent the bottom and upper 10% of the distribution of individuals. All coefficients from Table 5 are statistically detectable.

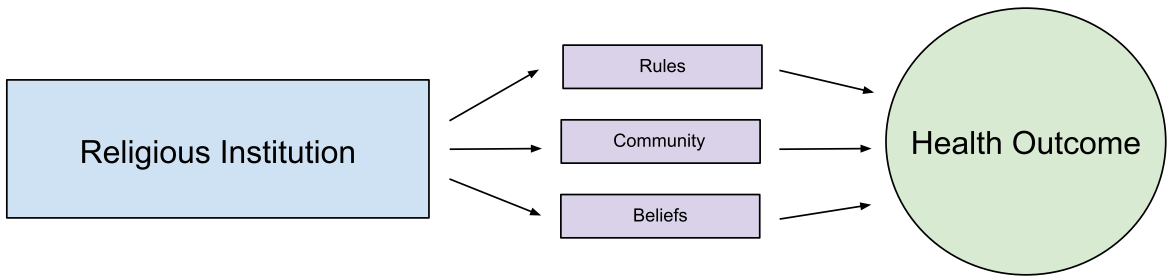
		Active LDS		Inactive LDS		Not LDS	
		RI=0.27	RI=0.67	RI=0.27	RI=0.67	RI=0.27	RI=0.67
	Coefficient						
Intercept							
Active LDS	1.352	1.352	1.352				
Inactive LDS	1.259			1.259	1.259		
Non-LDS	1.125					1.125	1.125
Religious Intensity of ED							
Active LDS	0.050	0.136	0.338				
Inactive LDS	0.019			0.0513	0.1273		
Non-LDS	0.043					0.116	0.289
	esum	1.488	1.690	1.310	1.386	1.241	1.414
	Total Children	4.43	5.42	3.71	4.00	3.46	4.11

Table 3.7b: Summated and exponentiated coefficients from Table 3.5, Model 2, reflecting different parity outcomes based upon two scenarios of religious intensity with covariate adjustments. A median religious intensity (RI) score of .27 and .67 represent the bottom and upper 10% of the distribution of individuals. All coefficients from Table 3.5 are statistically detectable.

		Active LDS		Inactive LDS		Not LDS	
.27 = 10%; .67 = 90%		RI=0.27	RI=0.67	RI=0.27	RI=0.67	RI=0.27	RI=0.67
	Coefficient						
Intercept							
Active LDS	1.301	1.301	1.301				
Inactive LDS	1.242			1.242	1.242		
Non-LDS	1.251					1.251	1.251
Religious Intensity of ED							
Active LDS	0.027	0.072	0.178				
Inactive LDS	0.006			0.0162	0.0402		
Non-LDS	0.013					0.035	0.087
	esum	1.373	1.479	1.259	1.283	1.286	1.338
	Total Children	3.95	4.39	3.52	3.61	3.62	3.81

Figure 3.1a – 3.1b: Conceptual models of mechanisms between religious institutions and health outcomes.

3.1a



3.1b

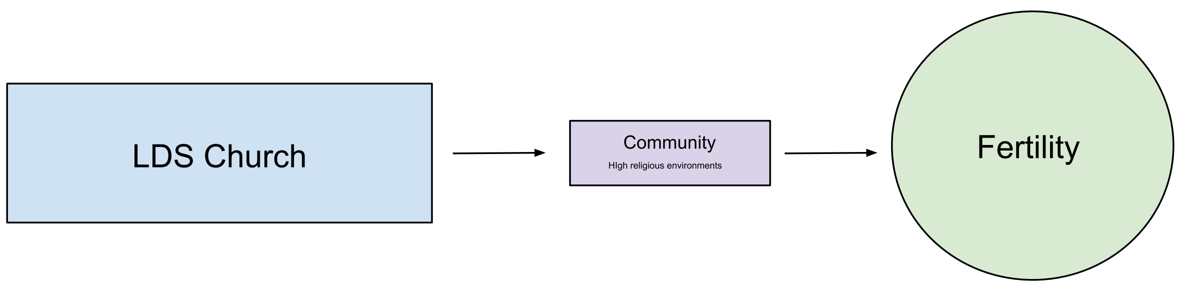
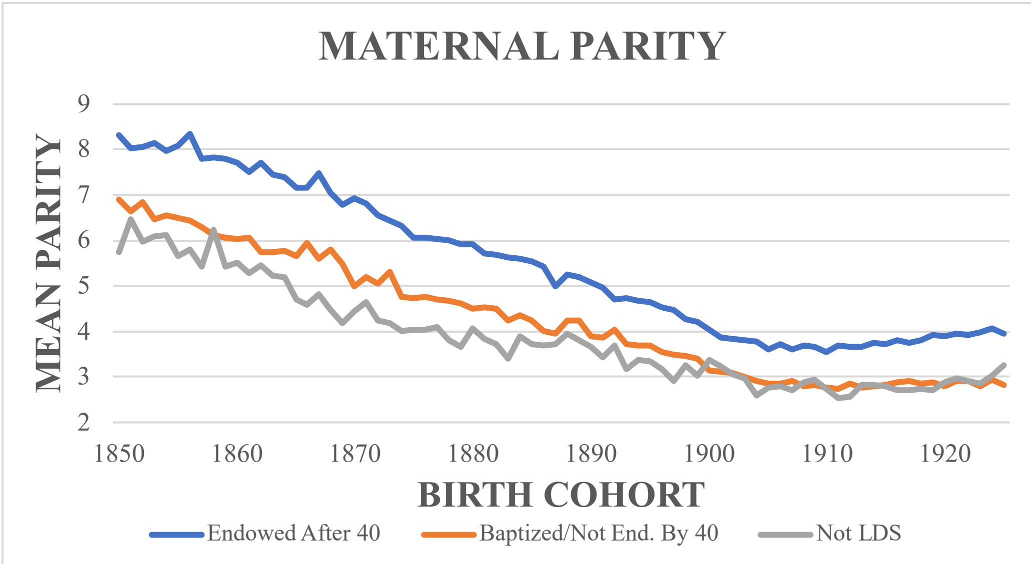
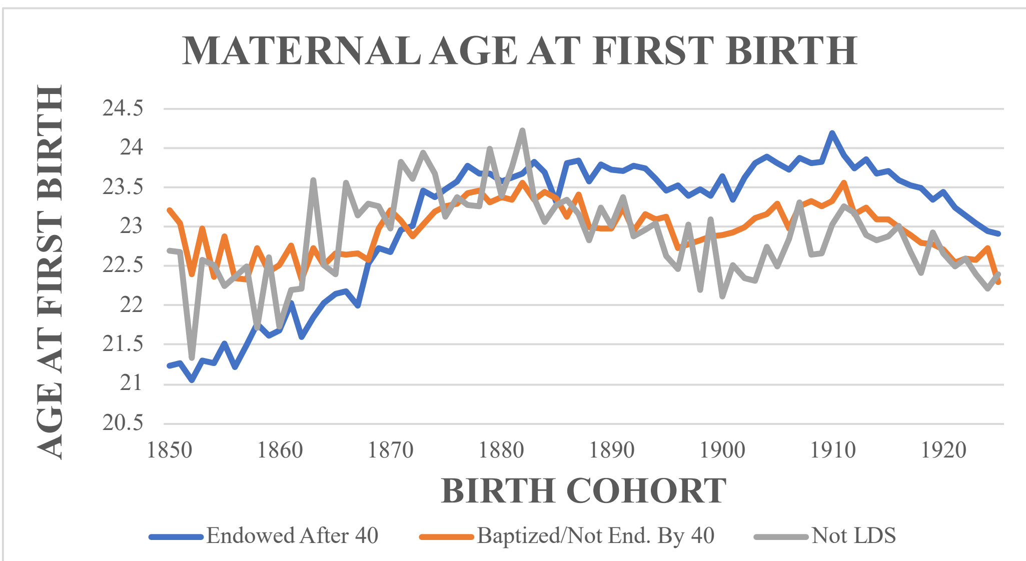


Figure 3.2a – 3.2d: Descriptive charts of birth cohort maternal parity, age at first birth, age at last birth, and birth interval spacing according to female's Church participation. Utah females, born between 1850 to 1925, recorded in at least one census between 1900 to 1940, and survived to age 50. (N = 154,320)

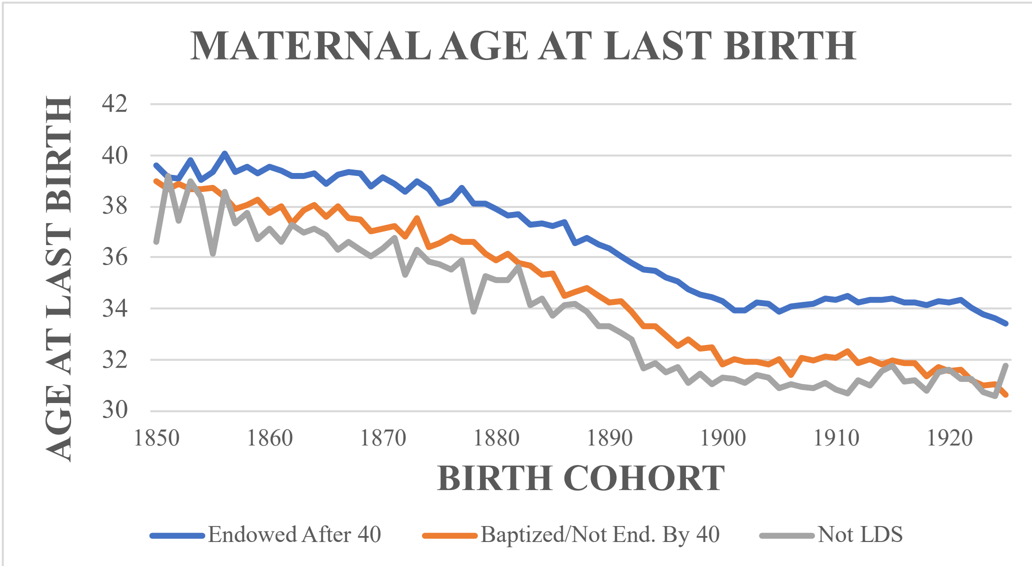
3.2a



3.2b



3.2c


MATERNAL AGE AT LAST BIRTH
AGE AT LAST BIRTH
42
40
38
36
34
32
30
1850
1860
1870
1880
1890
1900
1910
1920
BIRTH COHORT
Endowed After 40
Baptized/Not End. By 40
Not LDS

3.2d

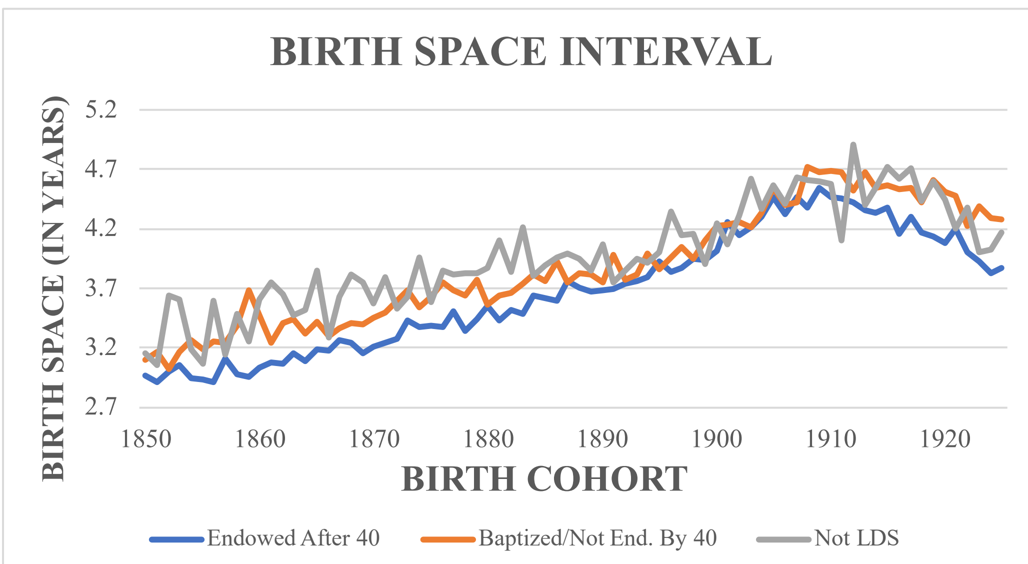
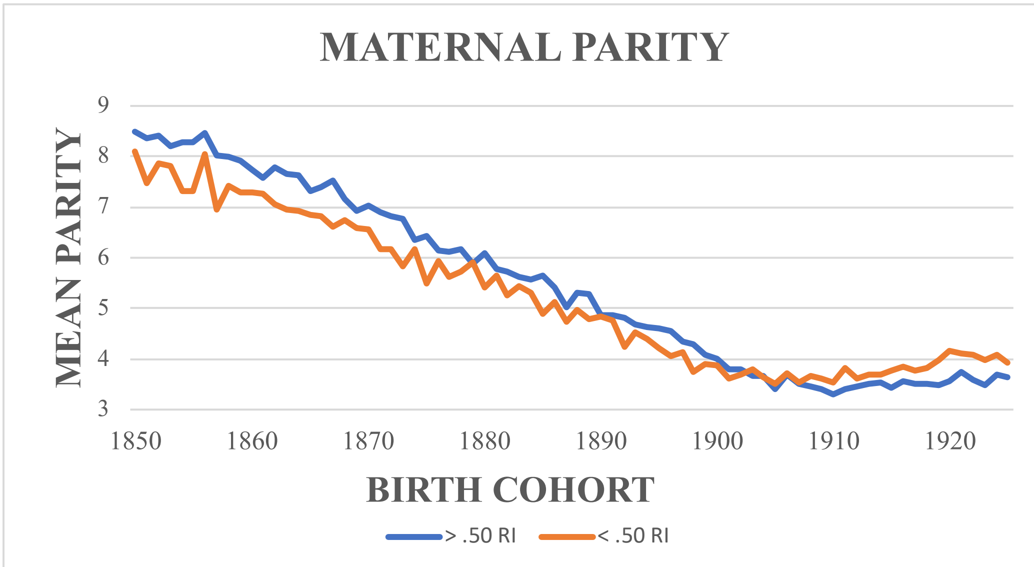
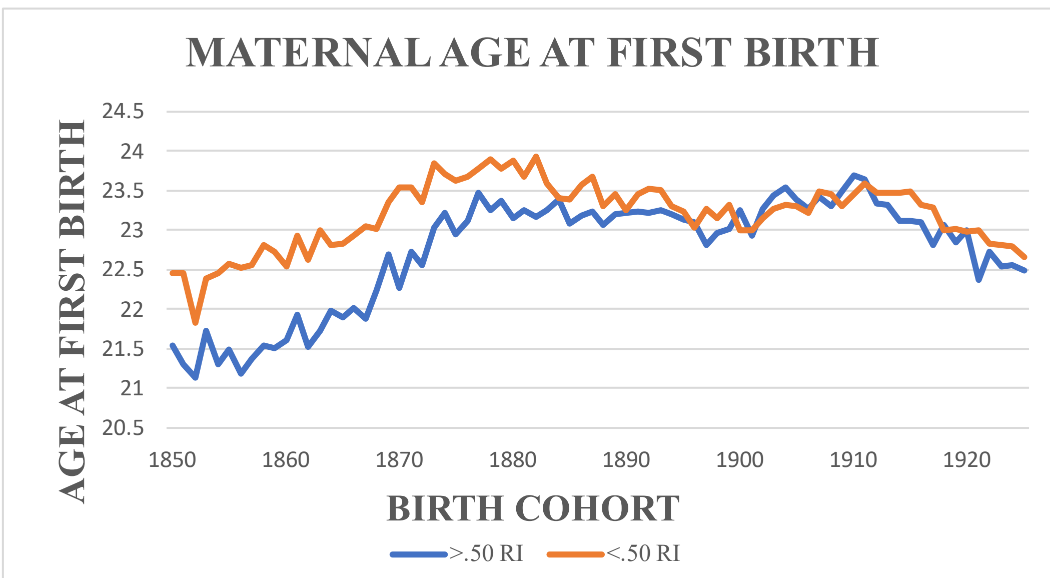

BIRTH SPACE INTERVAL
BIRTH SPACE (IN YEARS)
5.2
4.7
4.2
3.7
3.2
2.7
1850
1860
1870
1880
1890
1900
1910
1920
BIRTH COHORT
Endowed After 40
Baptized/Not End. By 40
Not LDS

Figure 3.3a – 3.3d: Descriptive charts of maternal parity, age at first birth, age at last birth, and birth interval spacing according to the mean religious intensity of the female's census enumeration district. Utah females, born between 1850 to 1925, recorded in at least one census between 1900 to 1940, and survived to age 50. (N = 154,320)

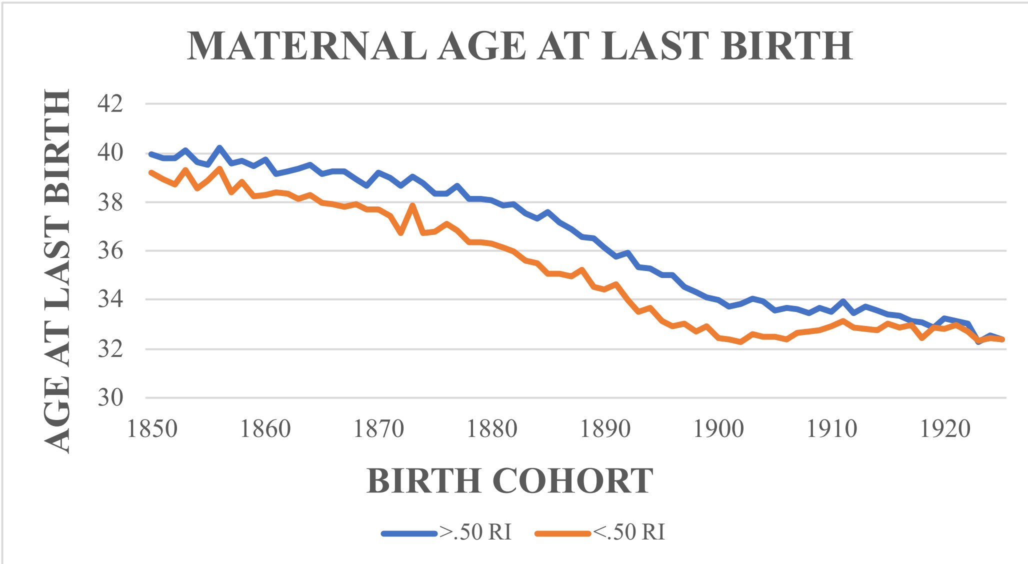
3.3a



3.3b

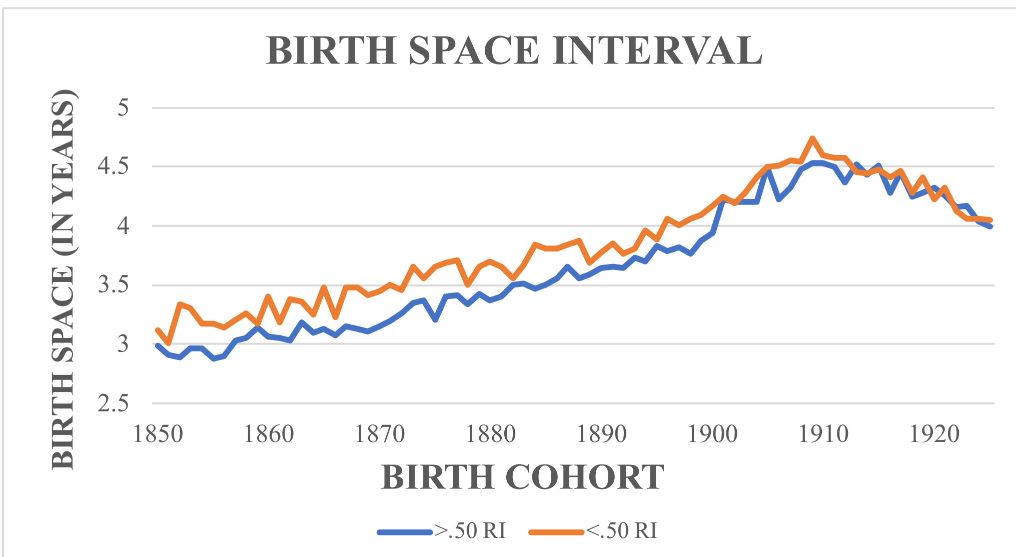


3.3c



MATERNAL AGE AT LAST BIRTH
AGE AT LAST BIRTH
42
40
38
36
34
32
30
1850
1860
1870
1880
1890
1900
1910
1920
BIRTH COHORT
>.50 RI
<.50 RI

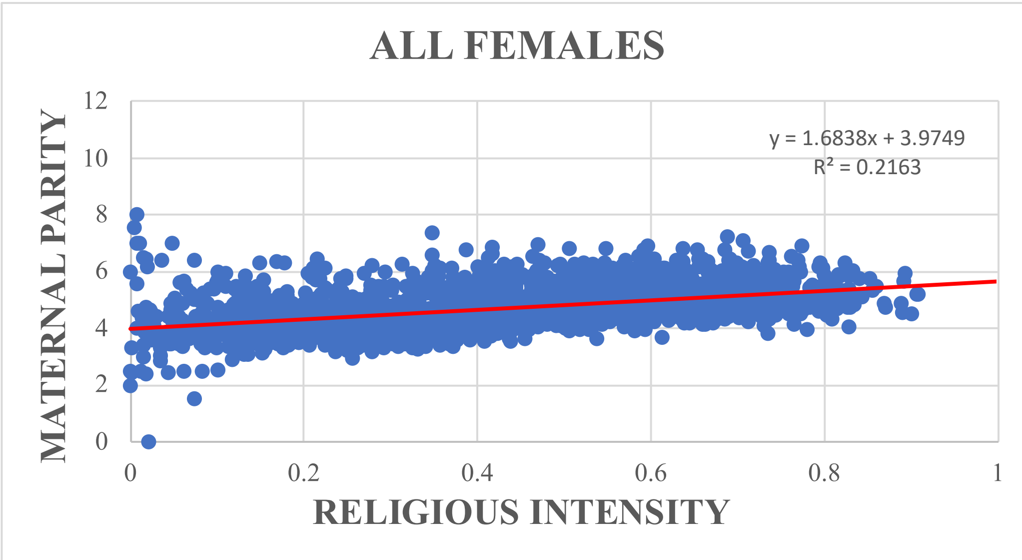
3.3d



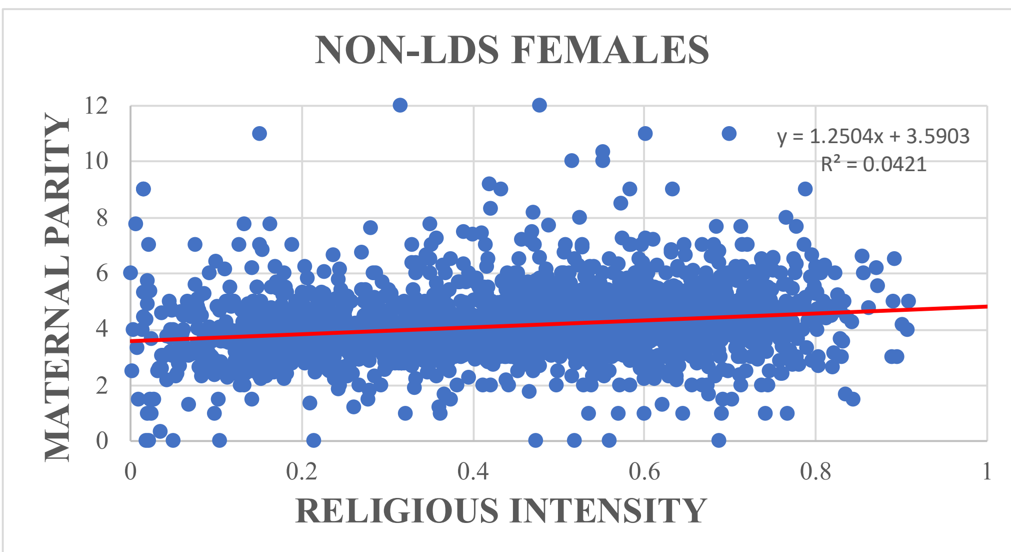
BIRTH SPACE INTERVAL
BIRTH SPACE (IN YEARS)
5
4.5
4
3.5
3
2.5
1850
1860
1870
1880
1890
1900
1910
1920
BIRTH COHORT
>.50 RI
<.50 RI

Figure 3.4a – 3.4d: Association between religious intensity and mean maternal parity of census enumeration district. Each dot represents one enumeration district (N= 2255). Parity measured among Utah females born between 1850 to 1925, recorded in at least one census between 1900 to 1940, and survived to age 50.

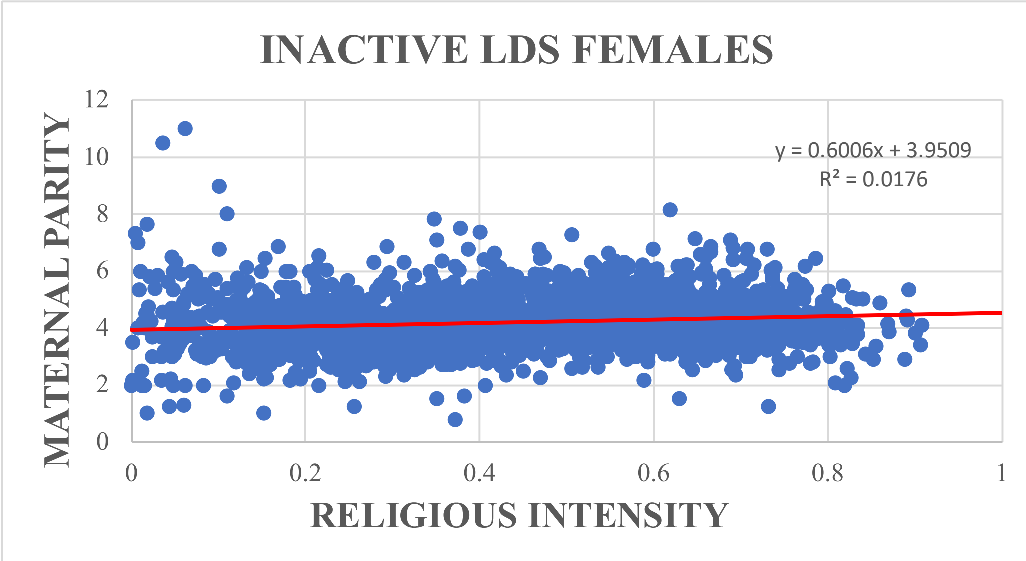
3.4a



3.4b



3.4c


INACTIVE LDS FEMALES
MATERNAL PARITY
RELIGIOUS INTENSITY
y = 0.6006x + 3.9509
R² = 0.0176
0
2
4
6
8
10
12
0
0.2
0.4
0.6
0.8
1

3.4d

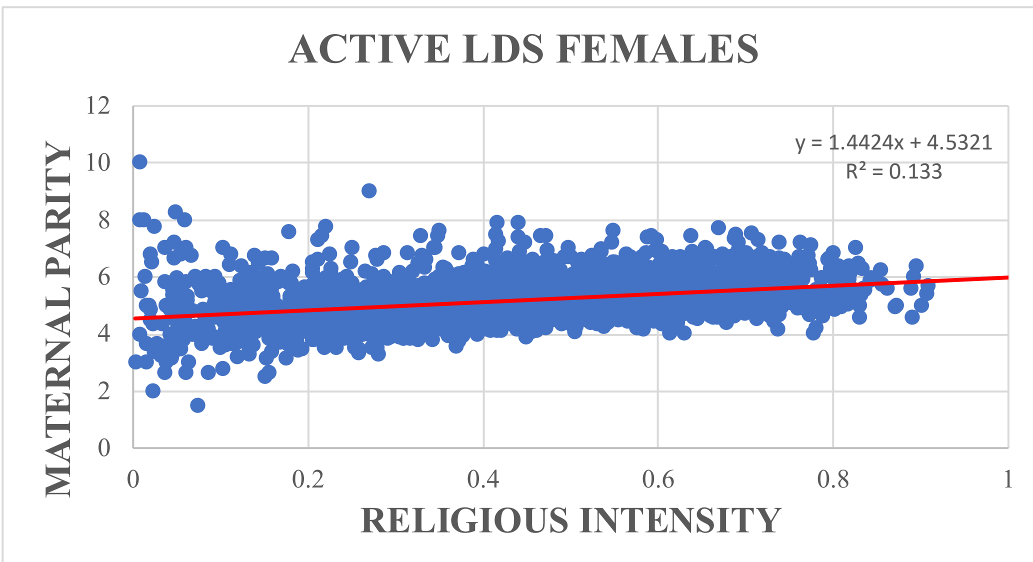
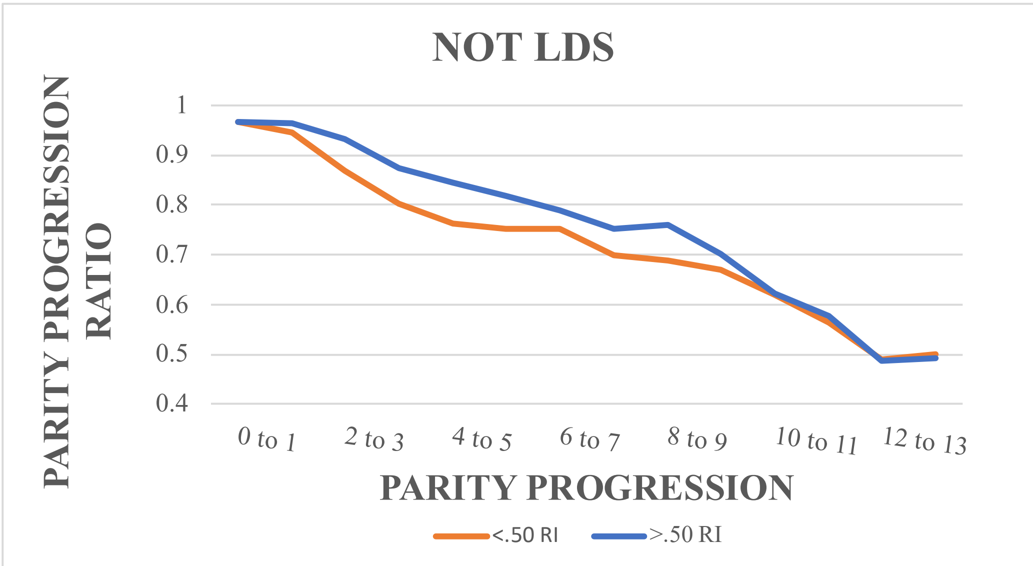
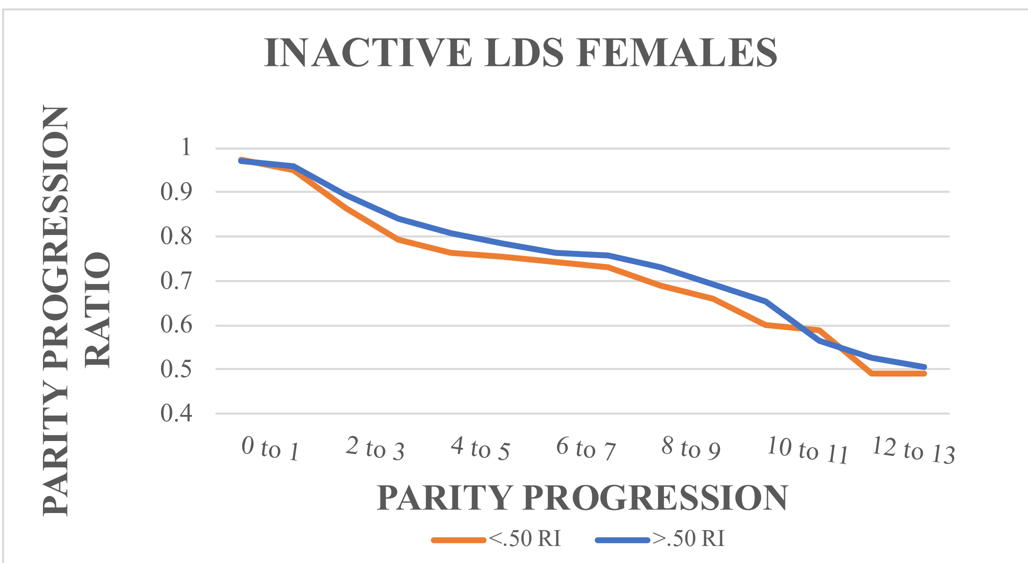

ACTIVE LDS FEMALES
MATERNAL PARITY
RELIGIOUS INTENSITY
y = 1.4424x + 4.5321
R² = 0.133
0
2
4
6
8
10
12
0
0.2
0.4
0.6
0.8
1

Figure 3.5a – 3.5d: Parity progression ratios and odds ratios of parity progression ratios according to female's Church participation and mean enumeration district religious intensity score. Females included if endowed by age 40, have a completed UPDB fertility history, born between 1850 and 1925, appeared in at least one Census in Utah between 1900 to 1940 during fertility age, and survived to at least age 50 (N=78,509). I categorize RI according to the median score (.5003).

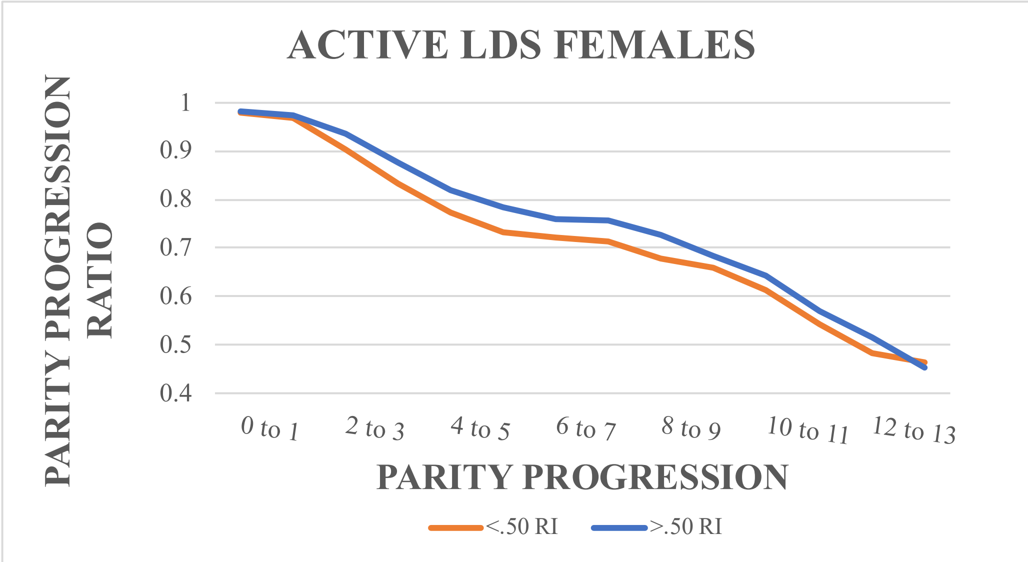
3.5a



3.5b

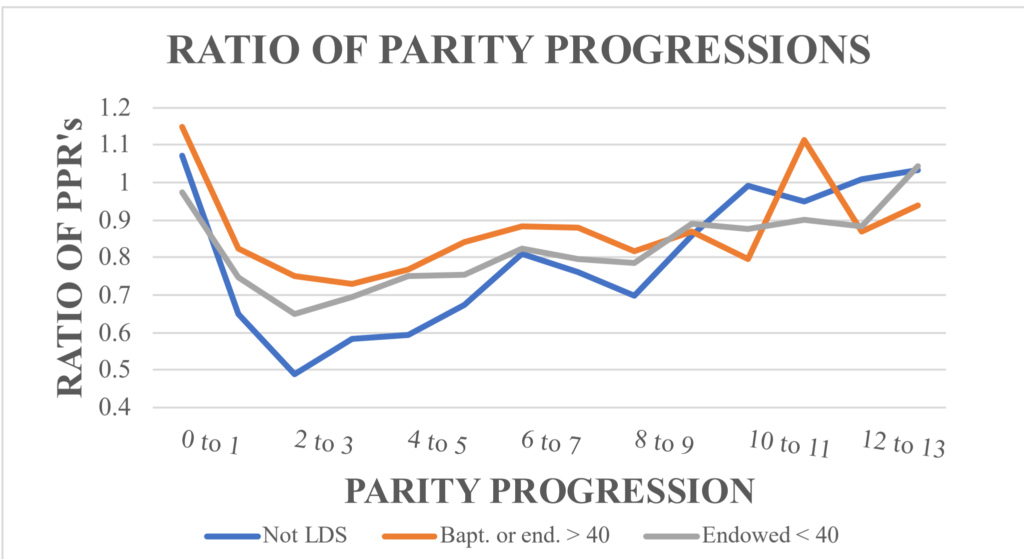


3.5c



ACTIVE LDS FEMALES
PARITY PROGRESSION RATIO
1
0.9
0.8
0.7
0.6
0.5
0.4
0 to 1
2 to 3
4 to 5
6 to 7
8 to 9
10 to 11
12 to 13
PARITY PROGRESSION
<.50 RI
>.50 RI

3.5d



RATIO OF PARITY PROGRESSIONS
RATIO OF PPR's
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0 to 1
2 to 3
4 to 5
6 to 7
8 to 9
10 to 11
12 to 13
PARITY PROGRESSION
Not LDS
Bapt. or end. > 40
Endowed < 40

CHAPTER 4

Beliefs: Polygamy and infant mortality

Introduction

Background

Historical demographers and anthropologists suggest that high fertility in pre-industrial societies served to compensate for the high levels of infant death (Canning, 2011; Conley et al., 2007; Dyson, 2010). Consequently, as industrialization and public health efforts in the late 19th century decreased mortality among infants while fertility remained relatively high, a post-industrial population boom ensued (Cole, 2019; Kirk, 1996). Researchers often point towards advances in clean water and sanitation systems (Cutler & Miller, 2005), pasteurization of milk (Currier & Widness, 2018), and maternal education (Bhatia et al., 2019) as common sources of the infant mortality decline.

Outside of these public health advances, scholars have identified other key factors associated with religion that influence infant health and mortality. These include reductions in mortality associated with lower maternal parity (Bean et al., 1992) and greater allo-parental support (Waynforth, 2020). Consequently, scholarship concerning how religion affects infant mortality pre- and post-industrialization might illuminate the understanding of religion's role in affecting population health. As such, I examine whether the Church of Jesus-Christ of Latter-day Saints' belief in polygamy (the marriage of one man to many women simultaneously[2]) offered additional parental support to high fertility couples in a manner that reduced infant mortality during the 19th and early 20th century.

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[2] As this analysis considers marriage to multiple wives as a social phenomenon of 19th century Utah stemming from a specific Latter-day Saint belief, rather than in the broader context of human marriage arrangements, it employs the term preferred by Latter-day Saints "Polygamy" as opposed to the more scientifically accurate term "polygyny." (*See* Low, 1988)

Framework

A functionalist approach holds that formal institutions emerge within societies to maintain order and assist with objectives (Durkheim, 1912; Stark & Bainbridge, 1997; Weber, 1930). Processual theory offers further insight to the relation between institution and community by asserting that organizations constantly evolve due to social catalysts rather than remaining fixed entities (Abbott, 2009; Trinitapoli, 2023). The agents to these transformations may include economics (Becker et al., 2021; Weber, 1930), politics (Greenberg, 2000), or health (Chatters, 2000; Zentner, 2015). Economic theory argues that despite change, institutions retain individual allegiance through a "club goods" approach that rewards activity and loyalty with increased access and hierarchical status (Carvalho, 2019; McBride, 2007). For institutional religion, individual demonstrations of loyalty are incentivized by the organizational claims of supernatural authority that legitimize both its requirements and its offered rewards (Azra et al. 2010; Durkheim 1912; Fitouchi & Singh, 2022; Singh et al. 2021). Within this framework, one might expect religious beliefs to emerge that support and reward increased fertility and reduced mortality when population expansion ranks as a key social objective.

A theology of polygamy

The tumultuous history (Phillips & Cragun, 2020) and the social taboos (Embry, 1992) surrounding polygamy often obscures the stated objective within Latter-day Saint scripture: to increase the offspring of faithful men (*The Doctrine and Covenants of The Church of Jesus Christ of Latter-Day Saints.*, 1981, *see* section 132:30-44). To further incentivize this marriage arrangement, 19th century Church leaders argued that polygamy constituted the highest order of marriage and a necessity for the institutional church to practice (Givens & Barlow, 2015;

Simmonds, 2020). Thus, the polygamist label, with its increased responsibilities and social stigma, provided a signal of both faithfulness and personal sacrifice for the common good (Power, 2017a; Sosis, 2003).

Historians estimate that the first Latter-day Saint polygamous marriage occurred between 1833-1835 when church founder Joseph Smith wed Fanny Alger as a second wife in Kirtland, Ohio (Compton, 1996). In 1843, Smith released a new revelation to a limited group of confidents that offered a theological justification to polygamy by citing the Old Testament's Abraham in which his relation with his wife's handmaiden resulted in a vast progeny (Anderson, 1937; Hales, 2012; Hardy & Daynes, 2009). Yet, both Smith and subsequent church president Brigham Young publicly denied the practice of polygamy until its official 1852 announcement in Utah. Smith's original 1843 revelation was not added to the Latter-day Saint cannon until 1876. Previous versions of Latter-day Saint scripture forbade the practice of plural wives (Bowman, n.d.).

Nineteenth century Utah constituted a time of transition from a secluded territory to a US state, beset by political turbulence (Arrington, 2005). During this time the Church of Jesus Christ of Latter-day Saints dominated both Utah culture and government (Firmage, 1990; Manning, 2017; Quinn, 1997). The church's ability to control economic and political life was facilitated by Millard Filmore's appointment of church president Brigham Young to the position of territorial governor (Hunter, 1937). Brigham Young, who had 55 wives (not all conjugal) and 56 children would work to keep polygamy protected from federal oversight (Johnson, 1987). Yet, these efforts did not insulate polygamy from an American public intent on ending its practice. Through a succession of congressional acts affirmed by the courts, the United States worked to end the practice of polygamy in Utah (Campbell, 2001; Gillett, 1999; Linford, 1964). These efforts culminated in the 1887 Edmunds Tucker Act which disincorporated the Church, confiscated its assets, and removed the right of Utah women from voting. Simultaneous to this national intervention, Utah had abandoned its past economic cooperatives founded upon its scriptural teachings concerning communalism (Arrington, 2005; Main, 2001) in favor of capitalistic enterprise (Kauffman & Kauffman, 1994). In turn, this economic development imported more non-Latter-day Saint owned business, and therefore external (i.e., non-Latter-day Saint) pressure, into Utah. Consequently, Utah's religious-oriented culture gradually transformed (Mauss, 1994b).

In an effort to relieve the church's legal status and provide a path for Utah's statehood (Quinn, 1997, pgs 322-329), Church president Wilford Woodruff issued a "manifesto" ending the practice of Polygamy in 1890 (*see* Manifesto 1, *The Doctrine and Covenants of The Church of Jesus Christ of Latter-Day Saints.*, 1981). In 1896 Utah became the 45th state to join the union. In 1903 the Church and Utah survived efforts to block Reed Smoot, a member of the Latter-day Saint faith's second highest governing body, from being seated as an elected U.S. senator (Heath, 2007; Paulos & Hansen, 2021). A second manifesto in 1904 by church president Joseph F. Smith (nephew to Church founder Joseph Smith) constituted a final expulsion of the practice of polygamy from the faith, leaving any practicing polygamous Latter-day Saint open to excommunication (*see* Manifesto 1, *The Doctrine and Covenants of The Church of Jesus Christ of Latter-Day Saints.*, 1981) . To this day, debate ensues over polygamy's place within Latter-day Saint theology, as the church forbids its practice but does has not formally renounced the theology (*Polygamy*, n.d.).

Latter-day Saint polygamy research tends to focus upon political (Cannon, 2013), legal (Campbell, 2001), or gender (Ulrich, 2017) issues, highlighting the social tensions surrounding polygamy. Conversely, a small body of research examines Latter-day Saint polygamy's role in health (Bean & Mineau, 1986; Hardy, 1992; Moorad et al. 2011; Barclay, 2020). Though a paucity of research exists concerning the effects of Latter-day Saint polygamy upon offspring, especially in a manner that considers the practices interaction with its history. Therefore, this study seeks to address differences of childhood mortality according to maternal polygamous status while accounting for the tensions that led to the practice's demise with the Church.

Polygamy and Child Mortality

Both its defined period of practice and its associations with higher social standing distinguishes Latter-day Saint 19th century polygamy from its counterparts in other geographies (Pearsall, 2022). Yet, Utah is similar to other settings as it manifested enhanced polygamous male fertility accompanied by lower polygamous maternal fertility (Bean & Mineau, 1986; Hardy, 1992; Millogo & Labite, 2022). Furthermore, polygamy in all cultures, including Utah, is frequently viewed as an imbalance of sexual power that favors a male hierarchy (Estes, 2015; Schnier & Hintmann, 2000; Ulrich, 2017). While it is true that many Latter-day Saint woman had difficult polygamous relations (Ulrich, 2017), many Latter-day Saint women of the period favored polygamy (Embry, 1984; Iversen, 1984). These participants argued that polygamy's effects upon women was more complex than anti-polygamy crusades portrayed. Specifically, some polygamist women maintained that the addition of extra wives provided further support and independence. This freedom in-turn allowed for ventures outside of the home (Arrington, 1988) including college education (McCloud, 1984), women's suffrage activism (Iversen, 1990), and more control over daily home life (Hulett, 1940). In fact, the first female doctor in Utah, Ellis Shipp who graduated in 1878 from Woman's Medical College in Pennsylvania while a polygamous wife, is often held up as an inspiring product of polygamy's social arrangement

(McCloud, 1984). Surprisingly, little health research investigates how this perceived parenting advantage may have affected infant health.

Alloparental care: Evolutionary theorists argue that parental helpers who engage in alloparenting, or offering further parental support beyond that of the biological parent, enhance offspring fitness (Koenig & Dickinson, 2004; Solomon & French, 1997). Quantitative research supports this framework with results demonstrating that alloparental care increases fertility (Guindre-Parker & Rubenstein, 2018; Hames, 1988; Schubert et al., 2009) and decreases mortality (Sear & Mace, 2008) in a variety of species. Yet, human polygamy research frequently demonstrates negative maternal and child health outcomes (Al-Sharfi et al., 2016; Berger-Polsky et al., 2020; Daoud et al., 2014; Smith-Greenaway & Trinitapoli, 2014). But a deeper reading of this literature demonstrates that other polygamy dynamics, such as increased intimate partner violence (Makayoto et al., 2013), depression (Daoud et al., 2014), and marital dissatisfaction (Al-Krenawi et al., 2011), may largely influence these findings. Thus, cultural and social milieu may serve to moderate (or negate) any hypothetical alloparental "advantage" for offspring health.

The 19th century Latter-day Saint social context provides a different lens to consider potential alloparental advantages for polygamous children. This historical context includes a belief that held polygamy as marriage's highest order that increased the posterity of the faithful (Hardy, 1994; *The Doctrine and Covenants of The Church of Jesus Christ of Latter-Day Saints.*, 1981, *Section 132)*, a Latter-day Saint feminist paradigm that viewed polygamy as a mechanism of maternal support and independence (Beecher, 1981; Olson, 2018), and increasing outside hostility towards the practice over time. Past health examinations find scientific support for the fertility enhancements and spousal support portions of polygamy.

Barclay and his colleagues (2020) demonstrate increased levels of familial support and shared empathetic load among 19th century Utah polygamous families. In a study of over 200,000 men and women born before 1900, the authors find that the loss of a polygamous wife has similar adverse mortality effects upon both the husband and the remaining sister wives. In demonstrating the increased support offered to men with multiple wives, the results illustrate that the mortality cost of widowhood on polygamous men is less than that of monogamous men.

Other literature demonstrates how polygamy provides advantages and disadvantages for fertility (Bean & Mineau, 1986; Matz, 2016; Moorad et al., 2011). Bean and Mineau (1986) find that 19th century Utah polygamist women display lower rates of fertility compared to non-polygamist women. Yet, both Matz (2016) and Moorad (2011) reveal that first polygamous wives displayed higher fertility compared to later wives. Matz argues that polygamous first wives were chosen due to perceptions concerning the likelihood of their reproductive success. Thus, higher fertility in first wives may reflect both selection, status, and the direction of help. Regarding mortality, a dissertation by Pesci (2019) demonstrates increased risk for infant mortality among offspring of polygamist mothers. Pesci's findings of non-statistically detectable risk differences concerning wife order do not attempt to compare wife order to polygamist wives, nor consider changing historical circumstances. Alternatively, Pesci's findings concerning birth order echo other findings from historical Utah and elsewhere (Barclay & Kolk, 2015; Dong et al., 2017; Horton, 1988; Modin, 2002).

Through this body of literature, the possibility emerges that first wives of Latter-day Saint plural marriages benefited in some respects through the introduction of additional wives. Consequently, this analysis extends Barclay and colleagues' (2020) and Matz and colleagues' (2016) scholarship through the investigation of the Latter-day Saint belief in polygamy as a mechanism of alloparental care offered to first wives. I intend to build on this body of research through tests based upon the combination of theoretical constructs and Latter-day Saint theology in a manner that explores the varying roles wife order may play within the context of historically increasing pressure against polygamy. As such, I will measure infant mortality according to the marriage status of the individual's mother, whether a monogamous or polygamous first wife, and time period.

In consideration of the reviewed body of research, I argue that the addition of plural wives may have increased parental oversight of the first wives' children, thus producing a protective effect prior to larger-scale public health interventions. 1st polygamous wives and monogamous wives offer a reasonable comparison group as 1st polygamous wives-initiated marriages as monogamist only to change later to polygamists. Therefore, I compare infant mortality among the children of polygamous first wives to that of children of monogamous wives. This test will consider changes in childhood mortality amongst polygamous mothers over different historical epochs: 1) 1847 until 1869 (pre-industrialization), 2) 1870 to 1879 (the Reynolds decision), 3) 1880 to 1889 (1890, 1st Manifesto banning polygamy) 4) 1890 to 1903, (1904, 2nd Manifesto banning polygamy) and 5) 1904 to 1920.

This study will test the following two hypotheses:

> H1: Offspring of polygamist mothers born between 1852 to 1920 will display lower levels of infant mortality compared to similar offspring of active Latter-day Saint monogamous mothers and other ordered polygamous wives. This mortality advantage will decrease over time according to increased social pressure against polygamy.

H2: Offspring of first polygamist wives will display lower levels of infant mortality compared to similar offspring of active Latter-day Saint monogamous mothers and other ordered polygamous wives. This mortality advantage will decrease over time according to increased social pressure against polygamy.

Methods

Population

The study population consists of all offspring found within the UPDB, born between 1852 and 1920, whose mother was either an endowed monogamous wife or a polygamous wife and survived to age 50 (N= 516,691, see Table 4.1). Similar to past UPDB studies and to allow sufficient time for mother's to participate in the endowment (*see* Chapter 2), I restrict the analysis to offspring of mothers who survived to age 50 (Bean et al., 1992; Gagnon et al., 2009; Hin et al., 2016; Robson & Smith, 2012). This population includes those born starting in 1852, the year that polygamy was first publicly acknowledged and openly practiced. Despite the Church's second manifesto in 1904, enough children were born to polygamous mothers to include births until 1920. The UPDB contains 460,300 offspring of monogamous endowed wives and 55,791 offspring of polygamous wives during the study period.

Mechanisms

The variables in this analysis derive from proposed mechanisms between religion and fertility. Based upon Durkheim's hypothesis (Durkheim, 1912) and previous literature (Cohen et al., 2009; Daniels, 2004; de Diego Cordero & Badanta Romero, 2017; Elkalmi et al., 2016; Johnstone et al., 2012; Regnerus, 2003), I identify three mechanisms employed by religion to shape individual choices and behaviors, and thus population health outcomes: beliefs, rules, and community. Figure 4.1a illustrates the proposed relation between religion and population health outcomes. More specifically, Figure 4.1b illustrates this same relation with regards to infant mortality and beliefs.

Variables

Dependent variable: Infant mortality, defined as death before the age of one (Galley & Woods, 1999) comprises the outcome for this study. Much research shows that the decline of infant mortality within the United States during the study period was a significant contributor to population growth (Cole, 2019; Kirk, 1996). Though accurate 19th century infant mortality rates are difficult to determine (Bean et al., 2002; Galley & Woods, 1999), Bean and colleagues (2002) found that infant mortality in Utah increased from 44.9 deaths per 1000 births in 1850 to 85.9 in 1890 and then receded to 59.8 by 1920.

Primary exposures: I first plot infant mortality over time, by marriage status of the mother (i.e., monogamous or polygamous 1st wife) to gain a descriptive understanding of mortality differences. Then, given the potential for confounding by individual-level factors, I conduct a series of regression-based approaches. Here, the interaction between the marriage status of the mother and historical epoch acts as the key independent variable. The initial models consider childhood mortality as a function of whether the child's mother was polygamous or not and how that interacted with the changing social milieu of polygamy. To gain a finer understanding of how experiences may have differed across polygamous households, I employ the same models but differentiate the mother's marriage type into 5 categories: monogamous, polygamous 1st wife, polygamous 2nd wife, polygamous 3rd wife, or polygamous 4th or higher ordered wife similar to Barclay, et al. (2020). All subjects are divided into 5 epochs that correspond to important historical events according to birth cohort.

Covariates: I consider important predictors of infant mortality: maternal parity (Kozuki et al., 2013), maternal age at birth (Finlay et al., 2011), sex of the child (Bruckner et al., 2015a), and urbanicity (Ely & Driscoll, 2021). Previous UPDB findings suggest differences in parity and maternal age between polygamous and monogamous wives (Moorad, 2011; see also Table 4.1). As such, I control for these variables when considering polygamy as a source of increased care and support from the point of view of the offspring. Likewise, I include offspring sex given research which demonstrates that males show increased mortality at nearly all ages, including in infancy (Bruckner et al., 2015b; Catalano & Bruckner, 2006; Lindahl-Jacobsen et al., 2013). I include whether the birth occurred in a designated Utah urban county as the Utah-based literature reveals delineation of health effects upon urban/rural lines post-industrialization (Blackburn et al., 2019; Koric et al., 2023; Ou et al., 2018; Rogers et al., 2020).

While polygamy likely reflects high social status bestowed by its theology and its greater prevalence among Church leadership (Mealey, 1985), I could not obtain a universal measure of socio-economic status (SES) for my population. Pre-19th century records of SES within the UPDB remain limited to the 1880 census. When considering the father's SES as a possible covariate, the UPDB has a high degree of missingness with only 79.5% of children of monogamous wives and 47.31% of polygamous wives possessing an 1880 census record. This disparity likely could have resulted from increasing pressure in 1880 for Latter-day Saint men to hide their polygamous families along with anti-federal government attitudes among Latter-day Saints concerning the execution of anti-polygamy laws.

Analytic and Statistical approach

Descriptively, I plot differences in mortality rates between monogamist and polygamist offspring by birth cohort according to the mother's polygamous status. By way of formal statistical modeling, I employ Cox Proportional Hazards models to estimate the hazard rate ratio of mortality λ_{1i} before age one between children of monogamist and polygamist mothers. The survival models include a vector of individual background characteristics X_i such as maternal parity, maternal age at birth, sex of the child, and the birth county's Utah urban status. I code both child's sex and urban status as binary variables. While all children in the population had a birth county listed, 17 children had no sex listed; I exclude these records from the analysis. I measure maternal parity as the number of maternal siblings of the offspring, categorized in a similar manner to Bean et al. (1992): 0, 1, 2, 3 to 7, 8 to 10, and more than 10 siblings. Finally, consistent with the age distribution of this population and past studies on maternal age and health outcomes, I categorize maternal age at birth as follows: 15 to 20, 20 to 30, 30 to 40, 40 to 45, and over 45 (Dildy et al., 1996; Salihu et al., 2003; Zaki et al., 2013).

In consideration of the changing nature of polygamy across epochs, I employ the offspring's mother's marriage status $POLY_i$ and epoch of the offspring's birth cohort EPC, as well as the interaction between these two factors $POLY_i$*EPC as key independent variables. For the initial tests, I categorize maternal marriage POLY into two categories, monogamous or polygamous. In the second and third tests I consider the role of maternal wife order as a predictor of infant mortality according to the second hypothesis. Here I expand the polygamous variable from its binary categorization to now include polygamous maternal wife order: monogamous or polygamous first, second, third, or fourth and later wife. The second model treats this categorization as continuous, while the third model treats maternal marriage status as categorical.

According to the time frames used in justifying the hypotheses, I bin offspring birth year into epochs EPC as follows: 1852 to 1869, 1870 to 1879, 1880 to 1889, 1890 to 1904, 1905 to 1920.

These models take the following form:

1: $\lambda_{1i}(a) = \lambda_{0i}(a)\exp(\beta_1 * POLY_i + \varepsilon_i)$

2: $\lambda_{1it}(a) = \lambda_{0it}(a)\exp(\beta_1 * POLY_i + \beta_2 * EPC_t + \varepsilon_{it})$

3: $\lambda_{1it}(a) = \lambda_{0itj}(a)\exp(\beta_1 * POLY_i + \beta_2 * EPC_t + \beta_3 * POLY_i * EPC_t + \varepsilon_{it})$

4: $\lambda_{1it}(a) = \lambda_{0itj}(a)\exp(\beta' * X_i + \beta_1 * POLY_i + \beta_2 * EPC_t + \beta_3 * POLY_i * EPC_t + \varepsilon_{it})$

Results

Table 4.1 provides descriptive statistics for this study's sample. The population of 516,091 offspring includes 460,300 children of monogamist mothers (48.90% female) and 55,791 children of polygamist mothers (48.80% female). The incidence of infant mortality is 13.61% higher among polygamist children (93.5 per 1000) compared to monogamist children (82.3 per 1000), with both groups possessing near equal amounts of censoring due to loss to follow up (4.70% monogamous, 4.46% polygamous). Reflecting the history of polygamy, the proportions of polygamist children born in the population decreases over time with majority being born in earlier cohorts. Polygamous children manifest greater likelihood of having more than 8 siblings, and their mothers tended to be older at the child's birth. Finally, both monogamous and polygamous children were more likely to be born in non-urban Utah counties, although this proportion is higher among monogamous offspring. This county makeup is similar to Pesci (2019) and likely reflects the inclusion of non-Utah births who would not have been counted as being born in an urban Utah county.

Figures 4.2a and 4.2b offer representations concerning the prevalence of polygamy within the UPDB. 1857 constitutes the high point of polygamist marriages within the UPDB manifesting a continual decline across the study period until the early 1900's. Figures 4.3a and 4.3b depict mean maternal parity across time according to the marriage status and wife order of the mother. Similar to Moorad (2011), this chart shows a decline in parity across wife order with first polygamist wives manifesting greater parity than monogamous and later order wives.

Table 4.2 and Figure 4.4 represents the population's infant mortality rates. In Table 4.2, polygamous children have higher unadjusted infant mortality compared to monogamist children. This relation remains consistent over time. The increasing swings in infant mortality over birth cohort (Figure 4.4) likely reflect the smaller numbers of polygamous children born in later years. This diminishing number of polygamous children offers partial endorsement to my grouping of individual births into epochs of historical significance in the survival analysis.

Tables 4.3 to 4.6 report the results from the Cox Proportional Hazards tests according to models listed above. Table 4.3, Model 1, which addresses the first hypothesis demonstrates polygamous children display a 9.3% increase in risk of infant mortality ($\beta = 0.089$, $p < .0001$) compared to monogamous children. When controlling for the number of offspring siblings, maternal age at first birth, sex of the child, and urban Utah place of birth, in Model 4, polygamous children display a 21% greater risk of infant mortality compared to monogamous children during the 1852 to 1869 birth cohorts ($\beta = 0.193$, $p < .0001$) though this difference appears to decrease over birth cohorts.

My second hypothesis is addressed in Table 4.4 to 4.6. The models in Table 4.4 employ wife order as a continuous variable across categories (1 for monogamous to 5 for 4th or higher ordered polygamous wife). All models demonstrate that the lowest risk for infant mortality is found among children of monogamous wives with increasing higher risk for offspring of polygamous wives positively correlated to the polygamous mother's wife order. For instance, Table 4.4 Model 1, which employs a continuous version of the wife-order variable, demonstrates a 2.1% increase in child infant mortality risk for each numbered increase in mother's wife order (β= 0.021, P = .001). When adding the interaction term of birth epoch in Model 4, and controlling for the model's covariates, the overall risk for polygamous children appears to increase greater according to wife order compared to Model 1 (β= 0.065, P = <.0001), but a similar decrease appears for polygamous offspring over epochs.

Tables 4.5 employs a categorical variable for polygamous wife order. While offspring of all polygamous wives demonstrate a decreased risk over time, the offspring of 3rd, 4th and higher order wives do not manifest statistically detectable results differentiating from their pre-1869 risk. Contrary to the second hypothesis, 1st polygamous wife's offspring possess a higher risk of infant mortality compared to monogamous offspring. The possible narrowing of infant mortality gaps over time may likely be due to the decreased practice of polygamy in later years leading to increased (i.e., "positive") wife selection.

Table 4.7 presents the results of the -2 Log Likelihood test and demonstrates that the full model in Table 4.5, has a better fit compared to the full model in Table 4.4 with which to address the second hypothesis. Using Model 4 of Table 4.5, I construct Table 4.6 as an exploratory analysis to compare infant mortality risk between marriage status birth groups of different epochs. Such results allow for the interpretation of how polygamy's changing status in the 19th century may have affected birth outcomes relative to those offspring of monogamous mothers. While the risk of infant death is lower in later cohorts among polygamous second and third wife’s offspring compared to other offspring of monogamous and polygamous mothers, these results are speculative at best due to the 95% confidence interval that consistently include the null result (1.0).

Several patterns emerge that support previous UPDB findings concerning the models’ covariates. Maternal parity, as measured by the total maternal siblings of the individual, positively correlates with increased risk of infant mortality (Bean et al., 1992). Likewise, this study’s findings that maternal age at birth correlates positively with infant mortality also supports Bean et al. (1992). Similar to Pesci (2019), male infants display a greater risk of mortality (Pesci, 2019), and birth within a designated Utah urban county (Davis, Salt Lake, Utah, or Weber counties) proved to predict lower risk of infant mortality. Although previous UPDB research demonstrates an urban disadvantage for pre-industrial (1869) cohorts, this finding seems plausible given that the majority proportion of the total study population was born after 1869.

Discussion

The Latter-day Saint faith’s theology concerning polygamy provides a unique setting to study how religious beliefs might interplay with an important population health outcome. Due to polygamy’s relation to enhanced social status (Mealey, 1985) and historical depictions of Latter-day Saint polygamy offering enhanced allo-parental help (Arrington, 1988), I tested maternal participation in polygamy as a predictor of infant mortality. The UPDB’s ability to link vital records across multiple generations combined with information on Church participation allowed for such a study. Using these features, I limited the population of interest to only those women who were either endowed or polygamous, with minimal censorship. The use of monogamous women as a comparison group to polygamous first wives ─those who began the marriage as monogamous and finished polygamous— allowed for a closer assimilation of the counterfactual. Contrary to both hypotheses, these tests reveal that maternal participation in polygamy increased the hazard of infant mortality among offspring. This increased risk was seen across wife order, and strongest in pre-industrial (1869) epochs, while later cohorts manifest a variety of results that were not statistically detectable.

Limitations and future directions

Key limitations include the lack of information concerning socio-economic status. While the UPDB contains information for the 1880 census, the high degree of missingness amongst polygamous families (polygamous 52.69% missing, monogamous 19.50%) renders this information unusable. The disparity of missingness surrounding the 1880 census data is understandable, given the time period. By 1880 Latter-day Saints practiced polygamy once again in secret. Polygamous fathers commonly hid evidence of their extra families from government officials. Therefore, without additional data from the Church in the form of leadership positions or priesthood rank (*see* chapter 2), this lack of social status measurement remains a notable omission.

The use of endowed monogamous women as a counterfactual to polygamous women also provides its own set of issues. A single timepoint of endowment participation does not ensure a life of continued church activity or fidelity to its theology in a manner similar than that of a long-term polygamous marriage arrangement. New research might glean additional timepoints of participation from linked offspring's baptism and endowment dates. Additionally, a network analysis of siblings, cousins, and parental temple participation might offer a clearer picture of family faith dynamics. A better counterfactual may include comparisons between offspring of polygamous wives and the offspring of the mother's monogamous female siblings. Another possibility would be to measure infant deaths among polygamous 1st wives, comparing rates before and after the introduction of a second wife.

My focus upon first polygamous wives presents its own limitations. I did not include any sort of variable to assess how many children were living, how long had the mother been married at time of birth, or the age of the mother upon addition of the second wife. Such work, both in terms of analysis and framework, as to how first polygamous wives are different from second wives, would substantially move this area forward. Finally, the theoretic framework with which I approached this study, namely that religious beliefs which positively influence health will emerge and remain, may benefit from integration of organizational and economic theories that might drive individual decision making in the "marriage market." Further researcher may consider the role of later ordered wives and total number of wives in polygamous marriages. Interesting analyses my arise from frameworks based upon frameworks such as mate selection economics (Grossbard, 1978), conspicuous consumption (Sundie et al., 2011; Veblen, 1899) or social signaling (Bliege-Bird & Smith, 2005).

Conclusions

The presence of infant mortality differences over time according to maternal monogamy / polygamy status, albeit in the direction I did not hypothesize, does indicate a role for religious theology on infant health. Previous findings, and the theology itself, demonstrate the chief purpose of polygamy as increased fertility of faithful Latter-day Saint men. From an evolutionary standpoint, it seems reasonable that a cost for this enhanced male fecundity may include increased infant mortality at a level that does not eclipse polygamy's fertility advantage. Future efforts might offer closer inspection to the differences between first and second monogamous wives. This future work might include tests of life expectancy, unexpected lengths of birth spacing that might point towards miscarriages, and maternal age mortality. On a theoretical level, research might consider other important theories in areas of economics, social psychology, or organizations to ascertain what might incentivize polygamy both individually and collectively, and how that might display in a health outcome such as infant mortality. In sum, I encourage future efforts that engage both historical datasets such as the UPDB and important theories within the social sciences to consider how religious theology might interact with demographic outcomes like infant mortality.

Tables and Figures

Table 4.1: Descriptive population characteristics of UPDB individuals, 1852 to 1920, born to either an endowed LDS woman or a polygamous woman, and survived to age 50. N= 516,091

	Monogamous mother *N= 460,300*		Polygamous mother *N= 55,791*	
	N	%	N	%
Sex				
Female	225099	48.90%	27224	48.80%
Male	235201	51.10%	28567	51.20%
Birth cohort		0.00%		0.00%
1852 to 1869	44490	9.67%	20222	36.25%
1870 to 1879	43019	9.35%	14402	25.81%
1880 to 1889	64518	14.02%	11491	20.60%
1890 to 1903	121147	26.32%	7686	13.78%
1904 to 1920	187126	40.65%	1990	3.57%
Child’s age at death				
0 to 1	37861	8.23%	5219	9.35%
1+	367869	79.92%	45901	82.27%
Missing death date	54570	11.86%	4671	8.37%
Age at censor				
0 to 1	21625	4.70%	2486	4.46%
1+	32879	7.14%	2169	3.89%
Number of maternal siblings				
0	4201	0.91%	252	0.45%
1	9758	2.12%	596	1.07%
2	18189	3.95%	1071	1.92%
3 to 7	213981	46.49%	20077	35.99%
8 to 10	103213	22.42%	14952	26.80%
10+	110958	24.11%	18843	33.77%
Total children per wife order of mother				
1st wife	460300	100.00%	20919	37.50%
2nd wife	0	0.00%	20016	35.88%
3rd wife	0	0.00%	8943	16.03%
4th or > wife	0	0.00%	5913	10.60%
Mother's age at birth				
15 to 20	23608	5.13%	3071	5.53%
20 to 30	209234	45.46%	20498	36.91%
30 to 40	166358	36.14%	23115	41.63%
40 to 45	34174	7.42%	5700	10.27%
over 45	4566	0.99%	771	1.39%
Missing	22360	4.86%	2636	4.75%
Urban Utah county birth				
No	316945	68.86%	32299	57.89%
Yes	143355	31.14%	23492	42.11%

Table 4.2: Unadjusted infant mortality rates (per 1,000 live births) of children found in the UPDB and born between 1852 and 1920. According to mother's polygamous status.

	1852 to 1920	1852 to 1869	1870 to 1879	1880 to 1889	1890 to 1904	1905 to 1920
Monogamous	93.32	87.31	90.42	96.00	98.21	91.03
Polygamous	102.09	98.78	101.49	103.13	110.16	103.88

Table 4.3: Estimated hazard rate ratios for infant mortality as a function of the individuals birth year's relation to the child's mother's marriage status, polygamous or monogamous. Mother's polygamous status is binary, yes or no.

	Model 1			Model 2			Model 3			Model 4		
	Coefficient	SE	P value	Coefficient	SE	P value	Coefficient	SE	P value	Coefficient	SE	P value
(A) Mother Polygamous (Y/N)	0.089	0.015	<.0001	0.114	0.016	<.0001	0.126	0.029	<.0001	0.193	0.030	<.0001
(B) Birth Cohort												
1852 to 1869				(ref)			(ref)			(ref)		
1870 to 1879				0.035	0.020	0.075	0.037	0.024	0.119	0.031	0.024	0.211
1880 to 1889				0.088	0.018	<.0001	0.100	0.021	<.0001	0.109	0.022	<.0001
1890 to 1903				0.111	0.017	<.0001	0.116	0.019	<.0001	0.144	0.020	<.0001
1904 to 1920				0.058	0.017	0.000	0.062	0.019	0.001	0.131	0.020	<.0001
(A*B)												
Polyg.*1852 to 1869							(ref)			(ref)		
Polyg.*1869 to 1879							-0.004	0.043	0.930	-0.063	0.045	0.160
Polyg.*1879 to 1889							-0.055	0.044	0.207	-0.146	0.046	0.002
Polyg.*1890 to 1904							-0.019	0.048	0.692	-0.174	0.050	0.001
Polyg.*1904 to 1920							0.091	0.078	0.242	-0.122	0.081	0.132
Covariates												
Total siblings from mother												
1										(ref)		
2										0.050	0.077	0.516
3										-0.002	0.072	0.974
4 to 8										0.205	0.065	0.002
9 to 11										0.333	0.066	<.0001
11+										0.562	0.065	<.0001
Mother's age at birth												
15 to 20										(ref)		
20 to 30										-0.272	0.021	<.0001
30 to 40										-0.186	0.022	<.0001
40 to 45										0.014	0.025	0.571
over 45										0.121	0.045	0.007
Sex												
Female										(ref)		

Male	0.183	0.010	<.0001
Urban Utah county birth			
No	(ref)		
Yes	-0.243	0.011	<.0001

Table 4.4: Estimated hazard rate ratios resulting from Cox Proportional Hazards test for infant mortality as a function of the individuals birth year's relation to the child's mother's marriage status, monogamous or polygamous by wife order*.

	Model 1			Model 2			Model 3			Model 4		
	Coefficient	SE	P value	Coefficient	SE	P value	Coefficient	SE	P value	Coefficient	SE	P value
(A) Mother polygamous	0.021	0.00 7	0.001	0.028	0.007	<.0001	0.035	0.013	0.006	0.065	0.013	<.0001
(B) Birth cohort												
1852 to 1869				(ref)			(ref)			(ref)		
1870 to 1879				0.031	0.020	0.117	0.051	0.037	0.165	0.053	0.037	0.147
1880 to 1889				0.078	0.018	<.0001	0.099	0.035	0.005	0.139	0.035	<.0001
1890 to 1903				0.095	0.017	<.0001	0.097	0.034	0.005	0.182	0.035	<.0001
1904 to 1920				0.039	0.016	0.016	-0.035	0.043	0.420	0.130	0.044	0.003
(A*B)												
Polyg.*1852 to 1869							(ref)			(ref)		
Polyg.*1869 to 1879							-0.012	0.019	0.525	-0.029	0.020	0.135
Polyg.*1879 to 1889							-0.015	0.020	0.472	-0.049	0.020	0.016
Polyg.*1890 to 1904							0.000	0.022	0.995	-0.059	0.023	0.010
Polyg.*1904 to 1920							0.067	0.035	0.056	-0.021	0.036	0.554
Covariates												
Total siblings from mother												
1										(ref)		
2										0.050	0.077	0.522
3										-0.003	0.072	0.966
4 to 8										0.205	0.065	0.002
9 to 11										0.334	0.066	<.0001
11+										0.565	0.065	<.0001
Mother's age at birth												
15 to 20										(ref)		
20 to 30										-0.272	0.021	<.0001
30 to 40										-0.185	0.022	<.0001
40 to 45										0.015	0.025	0.554
over 45										0.121	0.045	0.007
Sex												
Female										(ref)		

Male	0.183	0.010	<.0001
Urban Utah county birth			
No	(ref)		
Yes	-0.241	0.011	<.0001

*Mother's marriage status is treated as continuous, from 1 = monogamous to 5 = 4th+ ordered wife.

Table 4.5: Estimated hazard rate ratios resulting from Cox Proportional Hazards test for infant mortality as a function of the individuals birth year's relation to the child's mother's marriage status, monogamous or polygamous by wife order.

	Model 1			Model 2			Model 3			Model 4		
	Coefficient	SE	P value	Coefficient	SE	P value	Coefficient	SE	P value	Coefficient	SE	P value
A) Mother's marriage status												
Monogamous	(ref)			(ref)			(ref)			(ref)		
1st poly Wife	0.167	0.022	<.0001	0.196	0.023	<.0001	0.206	0.039	<.0001	0.216	0.040	<.0001
2nd Poly Wife	0.051	0.024	0.036	0.070	0.025	0.004	0.093	0.048	0.053	0.157	0.048	0.001
3rd Poly Wife	0.064	0.035	0.070	0.087	0.036	0.015	0.150	0.065	0.021	0.237	0.065	0.000
4+ Poly Wife	-0.043	0.046	0.345	-0.012	0.046	0.789	0.001	0.079	0.993	0.129	0.079	0.102
B) Birth cohort (Mon.)												
1852 to 1869				(ref)		(ref)		(ref)		(ref)		
1870 to 1879				0.037	0.020	0.063	0.043	0.024	0.081	0.031	0.024	0.209
1880 to 1889				0.091	0.019	<.0001	0.104	0.022	<.0001	0.109	0.022	<.0001
1890 to 1903				0.113	0.017	<.0001	0.119	0.020	<.0001	0.144	0.020	<.0001
1904 to 1920				0.060	0.017	0.000	0.057	0.019	0.003	0.131	0.020	<.0001
(A*B)												
1st poly. wife												
1852 to 1869							(ref)				(ref)	
1870 to 1879							0.010	0.061	0.874	-0.039	0.061	0.522
1880 to 1889							-0.067	0.066	0.314	-0.157	0.067	0.018
1890 to 1903							0.039	0.075	0.604	-0.142	0.076	0.060
1904 to 1920							0.137	0.143	0.338	-0.097	0.143	0.498
2nd poly. wife												
1852 to 1869							(ref)			(ref)		
1870 to 1879							0.015	0.070	0.827	-0.024	0.070	0.731
1880 to 1889							-0.070	0.072	0.332	-0.135	0.072	0.061
1890 to 1903							-0.075	0.079	0.340	-0.208	0.079	0.008
1904 to 1920							-0.004	0.125	0.974	-0.235	0.125	0.061
3rd poly. wife												
1852 to 1869							(ref)			(ref)		
1869 to 1879							-0.136	0.101	0.179	-0.184	0.101	0.069
1879 to 1889							0.011	0.101	0.914	-0.090	0.101	0.373

1890 to 1904	-0.070	0.117	0.551	-0.200	0.117	0.088
1904 to 1920	0.154	0.189	0.413	-0.048	0.189	0.798
4+ poly. wife						
1852 to 1869	(ref)			(ref)		
1870 to 1879	-0.058	0.125	0.645	-0.103	0.125	0.411
1880 to 1889	-0.127	0.143	0.375	-0.232	0.143	0.105
1890 to 1903	0.108	0.166	0.516	-0.029	0.166	0.862
1904 to 1920	0.524	0.242	0.030	0.321	0.243	0.186
Covariates						
Total siblings from mother						
1				(ref)		
2				0.050	0.077	0.514
3				-0.002	0.072	0.982
4 to 8				0.205	0.065	0.002
9 to 11				0.333	0.066	<.0001
11+				0.561	0.065	<.0001
Mother's age at birth						
15 to 20				(ref)		
20 to 30				-0.272	0.021	<.0001
30 to 40				-0.186	0.022	<.0001
40 to 45				0.015	0.025	0.564
over 45				0.120	0.045	0.007
Sex						
Female				(ref)		
Male				0.183	0.010	<.0001
Urban Utah county birth						
No				(ref)		
Yes				-0.243	0.011	<.0001

Table 4.6: Estimated hazard rate ratio (HRR) and 95% confidence intervals (L95%, U95%) of the risk of infant death among offspring of polygamous wives compared to monogamous wives by time period. Column 1 compares all polygamous offspring's risk of infant death to that of monogamous offspring. Columns 2 through 5 utilizes the same monogamous wive's comparison group, but now according to wife order of the polygamous wife.

	All Polygamous			1st wife			2nd wife			3rd wife			4th wife		
	HRR	L95%	U95%	HRR	L95%	U95%	HRR	L95%	U95%	HRR	L95%	U95%	HRR	L95%	U95%
1852 to 1869	1.21	1.14	1.29	1.25	1.15	1.35	1.17	1.06	1.28	1.26	1.11	1.44	1.12	0.96	1.31
1870 to 1879	1.12	1.05	1.20	1.19	1.08	1.30	1.13	1.02	1.25	1.04	0.89	1.21	0.99	0.82	1.20
1880 to 1889	1.05	0.98	1.13	1.06	0.95	1.18	1.02	0.92	1.13	1.17	1.00	1.36	0.90	0.71	1.14
1890 to 1904	1.03	0.95	1.11	1.09	0.96	1.24	0.96	0.85	1.08	1.05	0.87	1.27	1.12	0.84	1.49
1904 to 1920	1.05	0.90	1.22	1.09	0.83	1.43	0.90	0.72	1.13	1.20	0.85	1.70	1.54	0.98	2.41

Table 4.7: Results from comparisons of 2 proposed models

Comparison	Test Statistic	P Value
Continuous vs. Categorical	37.44	<.0001

Figure 4.1a: Conceptual model of mechanisms between religious institutions and health outcomes.

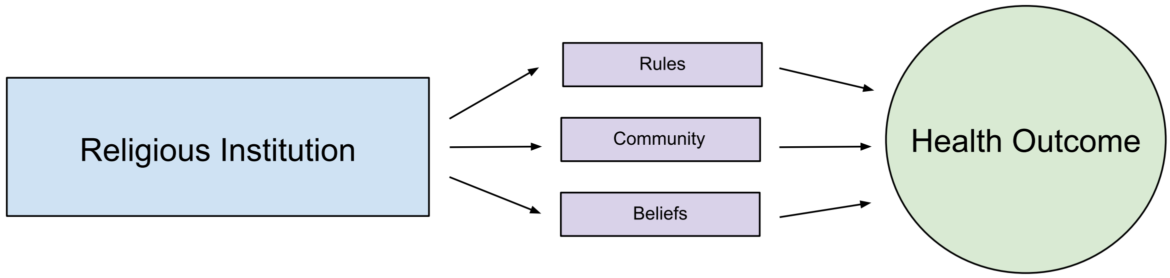
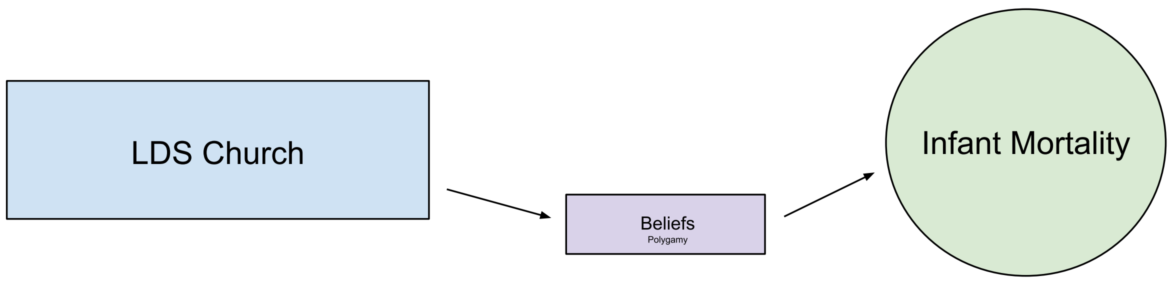
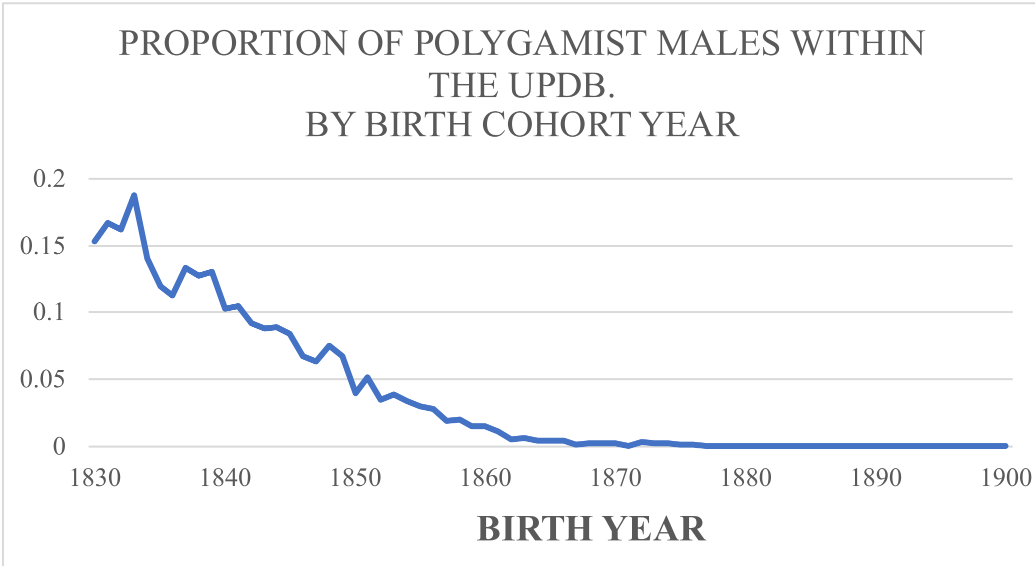


Figure 4.1b: Conceptual model of religious communities as a mechanism between religious the LDS church and fertility.

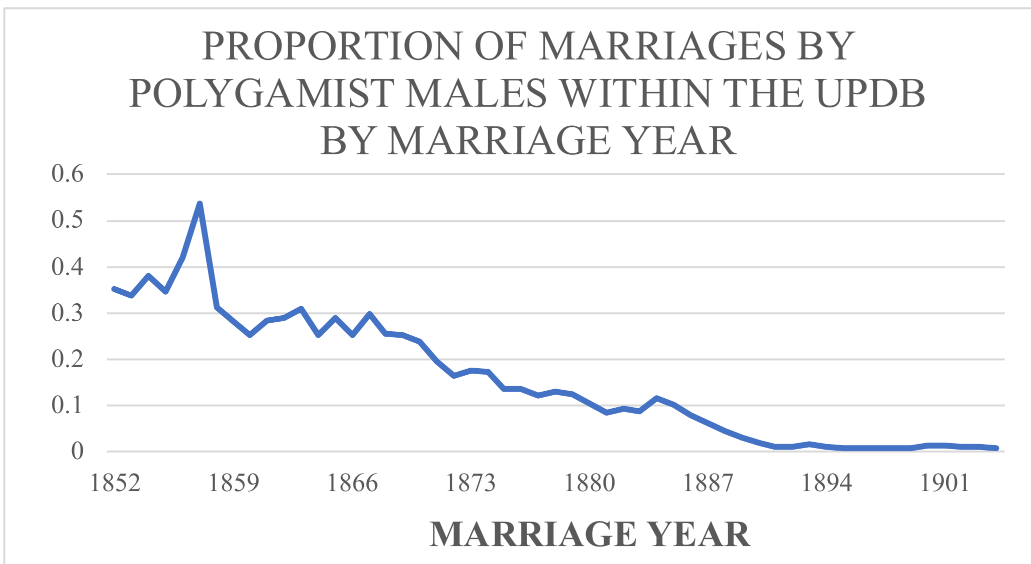


Figures 4.2a – 4.2b: Representations of the frequency of polygamy within the Utah Population Database.

4.2a

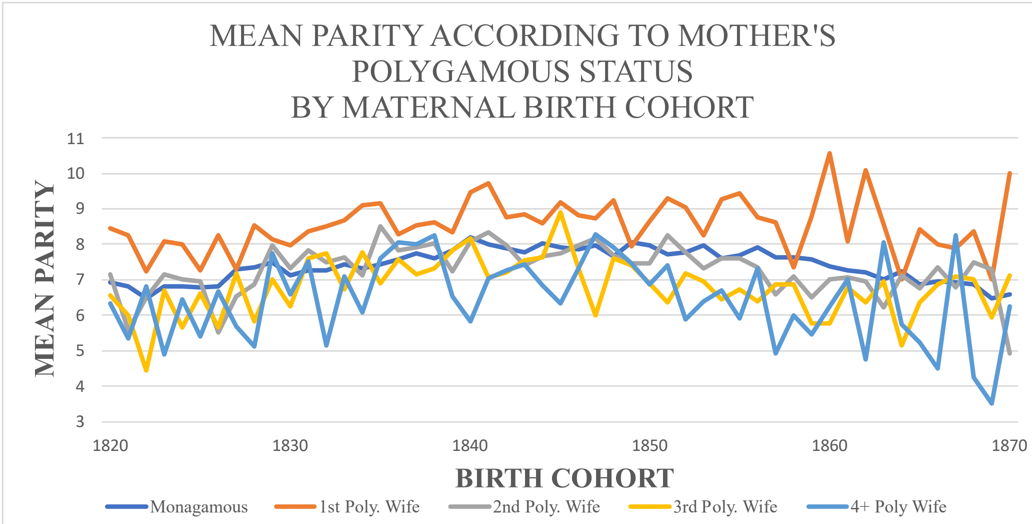


4.2b



Figures 4.3a – 4.3b. Mean maternal parity among LDS endowed or polygamous mothers.

4.3a



4.3a

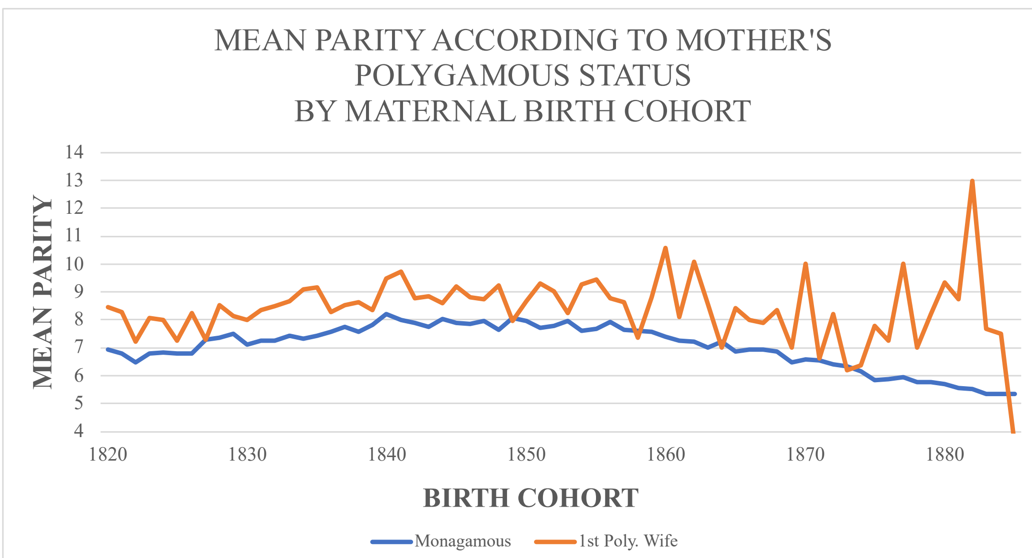
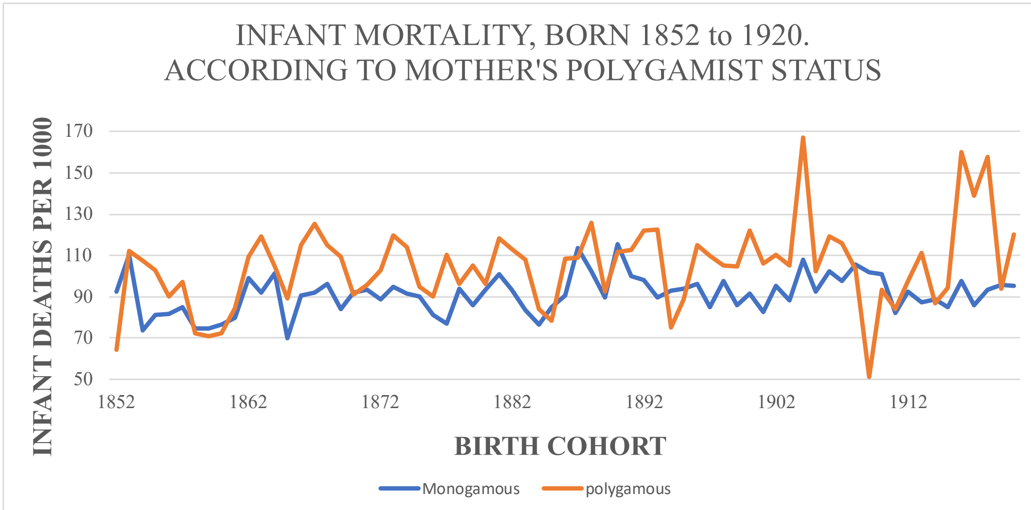


Figure 4.4. Infant mortality among study cohorts over time, found within UPDB, by monogamy/polygamy status of the mother.



CHAPTER 5

Conclusion

This study examined religion's role in fertility and mortality outcomes during a time of demographic expansion. In the introduction, I argued that religion, as an agent of society, often directs behavior on behalf of social objectives. Thus, I hypothesized that in response to the social need for population sustainment or growth, institutional religion may evolve in a manner that supports expansion. To test this statement, I devised three separate studies, each focusing upon one of three proposed mechanisms of institutional religion: beliefs, rules, or community. These studies required a population with detailed religious and health information over several generations. In response, I chose members of the Church of Jesus Christ of Latter-day Saints in 19th to early 20th century Utah, whose data are recorded in the Utah Population Database, as a suitable study population to test how religion shapes fertility and mortality.

The years 1850 to 1940 in Utah offered a particular advantage, relative to other historical settings, due to many factors. These include religion intertwined into nearly every facet of daily life, the ensuing historic interaction between social forces and institutional religion, and the contemporary availability of curated data. In this sense, 19th to mid-20th century Utah offers a large-scale social experiment. Further, extensive research confirms the proposed role of religion in Utah's society as historians and sociologists argue that 19th and early 20th century institutional Church developments were often responses to the social and physical environments of the time (Arrington, 2005; Arrington & Bitton, 1992; Mauss, 1994a, 1994b; O'Dea, 1954; Quinn, 1997).

Regarding data, my efforts benefited from the use of the Utah Population Database, one of the world's richest repositories of genealogic health data. This data set is partially an outcome of the theology within the Church that teaches record keeping as a sacred duty, but also results from the many previous health researchers who have explored and expanded its possibilities (Smith et al., 2022). Thus, the ability to quantitatively test and observe how changes in Utah's health occurred according to Church participation, due to the previous efforts of health researchers and religious-minded individuals, fuels this examination concerning the role of religion in demographic health outcomes.

Summary of main findings

Following an explanation of the proposed framework and a review of research into health and religion (Chapter 1), I offered an examination in Chapter 2 of the 1921 Church policy prohibiting tobacco use as a condition of participation in the endowment ceremony. These tests reveal that Latter-day Saint individuals who were endowed prior to age 50 enjoyed both a decreased risk of tobacco-related death and morbidity, and an increased life span compared to Latter-day Saint individuals who were not endowed. These associations were not found among health outcomes less associated with tobacco use such as breast and prostate cancers, which supports the specificity of results to the Latter-day Saint policy.

In Chapter 3, I investigated the role of community in fertility of active Latter-day Saint females. These results suggest that fertility among active Latter-day Saint females positively correlates with the religious intensity of their enumeration district. Specifically, the results demonstrate that an active Latter-day Saint female in an enumeration district with 67% fellow religiously active Latter-day Saints shows, on average, 0.44 more children than an endowed woman in a district with 27% active Latter-day Saints. Tests reveal this fertility increase was accomplished through expanded times of fertility activity and shorter birth intervals. Outside of within-group comparisons of fertility among endowed wives, this chapter's results showed that fertility patterns of inactive Latter-day Saint women more closely resemble those of non-Latter-day Saint females rather than active Latter-day Saint individuals.

The final analytic chapter considered polygamy as a source of maternal support. Although the logic leading to the hypotheses seemed well founded, the results from the analysis manifested non-confirming increased risk, rather than decreased risk, of infant death among polygamous children. While the overall relation between polygamy on infant mortality was negative, a non-statistically detectable timewise trend manifesting decreasing risk of infant mortality among polygamist children compared to monogamist children does appear over successive epochs. In retrospect these results do seem intuitive as polygamy would increase household size and thus lead to increased disease exposure. Further, increasing pressure towards polygamy in later cohorts might in fact lead to a more select group of practitioners, in turn increasing offspring robustness.

Taken together these results offer some support that in Utah, religion aided in reducing mortality and increasing fertility. While each test demonstrates groups that fare better in accordance with their religion, the third analysis stood alone in its contrary evidence to the study hypothesis. Indeed, the results from Chapter 4 might suggests that in the case of polygamy and infant death, a religious belief increased mortality risk among infants. These results outline several avenues of future work in the areas of theory, methodology, and hypothesis generation.

Limitations

Causal interpretations

Although inferential limitations exist, this study offers much in terms of disentangling potential relations between religion and population health. The methodology in study 3 contains key elements that may strengthen the case for causal inference. For instance, the discrete timing and the exogeneous nature of the 1921 tobacco policy (i.e., the policy unlikely led to conceptions of "healthier" birth cohorts), the ability to establish temporal order between exposure and outcome, the specificity of results to tobacco-related causes of death, and robustness of results after controlling for a wide range of covariates, all serve to strengthen internal validity. Yet questions remain regarding selection difference pre-and post-policy initiation. It is possible that the addition of a strict lifestyle rule led some to leave the faith who otherwise would have remained. Lastly, the assumption that having an endowment date in the UPDB means an individual is active in the Church does not hold true in all situations. It is likely that loyal Latter-day Saints existed who never were endowed, and equally true that some who were endowed later left the church.

The fertility analysis offered an important counterfactual as it compared similar Church participating women in different social contexts. Concerning the sample and restricting it to active Latter-day Saint females, unaccounted for variation remains among these women, thus introducing measurement error. Additionally, the hypothesis accounted for dose response, by maintain that increased dose (i.e., religious intensity) would increase response (i.e., fertility). Yet, both the appropriateness of the enumeration district as an accurate representation of one's religious community and concerns that increased RI in an enumeration district might result from increased local family persist as open questions. Thus, many concerns remain when attempting to show causation.

Problems with Mechanisms

The systematic employment of mechanisms stands as a key contribution of this dissertation. Nevertheless, this same utilization of mechanisms, where each chapter focuses upon one specific mechanism while not addressing the roles of its conceptual-model peers, restrains interpretation. For instance, although the role of religious rules in the Church's tobacco policy seems straight-forward, the studies do not consider community pressure or individual belief in the authority of the Church as driving health decisions. It is also clear that those who chose not to smoke likely did so based on a host of other factors outside of the proposed framework. These elements include family attitudes, role models, access to cigarettes, anxiety levels, and so forth. Thus, while my approach to these religious mechanisms presented in a manner similar to causal mediation (Pearl, 2012), the categorization and the quantification of these constructs as an attempt to disentangle their effects from the rest of Latter-day Saint life ignore the complexities of lived experience (Abbott, 1998, 1999; Daniels et al., 1999; Delacy, 1939; White, 1990). Therefore, the assumptions of the proposed conceptual model only offer a possible route to consider religion and society, not an exact description of how Latter-day Saints processed their relation to the Church.

Contributions

Despite the discussed limitations, this study offers much to public health, demography, and sociology. As mentioned throughout this dissertation, religious-health's research focus upon empirical analyses tends to limit inferences beyond the lifestyle choices of the surveyed individuals, assuming the results represent a greater population. I hoped to at least approach the question of the role of institutional religion in population health dynamics. While inferences beyond religion in Utah may not be possible, the manner of functionalist theory applied and the identification and testing of key mechanisms not only expand previous conceptual explorations, but also offers a practical means of future comparison between religions, time periods, and culture. Efforts such as these may allow better inferences regarding a more universal role of religion. Moreover, these mechanisms offer both a framework from which to build future data sets and models, as well as a point of organization to guide health interventions and policy.

Likewise, my creation of a community religiosity measure (RI) offers another such innovation. The constructed RI variable allows a practical extension to previous religious ecological analyses: to compare population-wide religious demographics, built upon individual-level data, to the health outcomes of the same individuals. This ecological approach directly arises from the UPDB's use of religious genealogies linked to census and vital records. While data availability may hamper applying similar methods to other contexts, perhaps the quality of findings will provoke better collection efforts for such research. In sum, this dissertation's application of functionalist theory, its proposal of religious mechanisms, and its employment of a novel religious ecology indicator variable to health demographic outcomes contributes much to science.

Future directions

Whereas this set of analyses advances research into religion and health by identifying key mechanisms and offering a plausible theoretic framework, future research may extend into several possible areas. Migration renders one such possibility. Regarding the Latter-day Saints, immigration has a doctrinal foundation: gathering the faithful to a singular geographic place (*The Doctrine and Covenants of The Church of Jesus Christ of Latter-Day Saints.*, 1981, see section 29). Throughout its early history, the Latter-day Saint church encouraged convert immigration to various geographic locations. Once in Utah, leaders oversaw a significant geographic expansion by assigning new immigrants to colonize the intermountain west (Quinn, 1997). This included settlements from Canada to Mexico. Leaders often made these assignments according to one's country of origin and occupation (Arrington, 2005). This backdrop affords multiple research opportunities concerning religious immigration-based population growth, including acculturation, regional health differences according to home country, and the health selection imposed on populations who undergo strenuous migrations.

Emigration out of Utah provides another possible research topic. During the 1920's and 1930's a "Mormon Diaspora" to California occurred resulting from a 1920's agriculture downturn and then the Great Depression (Bushman, 2008). My own exploratory data reveals that inactive Latter-day Saint males born between 1880 to 1940 who left Utah had an unexpected increase in life expectancy between the 1895 to 1915 birth cohorts, while inactive Latter-day Saint males of the same cohorts who remained in Utah exhibited a decrease in life expectancy. Thus, an in-depth study might yield insights regarding contemporary Utah religious patterns of longevity.

Regarding religiosity, further study of the endowment ceremony might contribute to better operationalization. One such possibility includes baptism dates of children as further evidence of long-term religiosity for endowed individuals. Sibling and parental religious participation provide additional avenues. For instance, the development of a variable that describes the proportion of the individual's immediate family who are endowed might provide new religiosity dimensions through health comparisons according to familial religious support.

Individual effects afford another opportunity to extend this study of religion and health outcomes. This might include a mixed-methods approach incorporating the UPDB and the vast collection of historic records found within various archives including those of the Church, the Library of Congress, the Huntington Library, and other locations. An effort such as this might allow better understanding of how institutional religion affects individual health experience- the foundation of subjects like human flourishing (VanderWeele, 2017b). As human flourishing considers important individual health outcomes such as mental health, longevity, and morbidity, applying these studies' religious mechanisms while utilizing mixed-methods methodologies might allow for additional insights relevant to how individuals viewed their faith, circumstance, and environment. These findings might offer expanded dimensions to relevant theory and health interventions.

The application of the proposed framework to other religions and other data sets offers perhaps the most obvious validity test of this dissertation's findings. This might include similar examinations within both western and non-western religions, as well as survey data designed specifically for this framework. One possible study might compare health outcomes among multiple religions that possess varying levels of emphasis on each of the proposed mechanisms. Another might examine tobacco related health outcomes among religions with and without rules concerning its use. Clearly, a multitude of possibilities exist to test belief, rules, and community as mechanisms of religion.

Conclusion

In the beginning of this dissertation, I framed the importance of religion to the public health discipline through Pew Research's (2022) findings concerning global religiosity. Religion will likely maintain prime cultural real estate for years to come. Accordingly, I maintain that religion as a key determinant to individual health choices will continue to shape global health. Therefore, I encourage further research to better understand how institutional religion might influence demographics and population health.

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