Sample of Recent Work/Publication

This document is the first analytic study of my dissertation. It is a slightly reworded draft for the purposes of submission to ***Demography*** *for publication. Dr. Tim Bruckner is my advisor and Dr. Ken Smith from the University of Utah provided suggestions as the former director of the Utah Population Database.*

Religion, Policy Change, and Older-Age Mortality in 19th and 20th Century Utah

Jason P. Bonham; University of California, Irvine

Ken R. Smith; University of Utah

Tim A. Bruckner; University of California, Irvine

This research was supported in part by the National Institute on Aging (R21 HD107508 PI TAB)

We thank the Pedigree and Population Resource of Huntsman Cancer Institute, University of Utah (funded in part by the Huntsman Cancer Foundation) for its role in the ongoing collection, maintenance and support of the Utah Population Database (UPDB). We also acknowledge partial support for the UPDB through grant P30 CA2014 from the National Cancer Institute, University of Utah and from the University of Utah's program in Personalized Health and Center for Clinical and Translational Science.

Abstract

Birth, reproduction, and death are of primary interest to both public health and religion. Both institutions maintain beliefs and practices surrounding these events meant to shape personal behavior that in turn influence demographic dynamics. We examine how mortality outcomes respond to a sudden change in religious policies related to tobacco use. Using the Utah Population Database, we compare life expectancy and tobacco-related health outcomes to the Church of Jesus Christ of Latter-day Saints' (LDS) smoking policy change in 1921 among Utah's 1880 to 1920 birth cohorts. Active LDS males and females who are born after 1900 exhibit an increase in life expectancy (Females = 3.644 years, Males = 5.177 years; $P < .0001$) compared to their inactive counterparts. Additionally, less-active LDS males and females born after 1900 (and exposed to the policy change before adulthood) manifest a dramatic increased Hazard Risk Ratio (HRR) in tobacco related death (Female HRR= 3.046, Male HRR= 3.865) compared to their LDS active peers. Similar differences do not exist in pre-1900 cohorts nor do the tobacco-related findings replicate in non-tobacco related cancers. These results suggest that in early 20th century Utah, abrupt changes in behavioral norms dictated by religious policy may have reduced mortality.

Keywords: religion, public health, morbidity, mortality, health behavior

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), beliefs and rules often emerge from religion to influence fertility and longevity (Baumard & Boyer, 2013; Radnitsky & Bartley, 1987). The Church of Jesus Christ of Latter-day Saints' (LDS) smoking-abstention policy of 1921 provides a modern example of the application of institutional rules to mortality-reducing behavior. As such, this early 20th century health code offers an opportunity to consider whether the interests of religion may indirectly precede 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; S. J. Lyon, 2013; Norton et al. 2010). Although research attributes multiple factors to this phenomenon (Lindahl-Jacobsen et al. 2013; Merrill, 2004), many credit an LDS culture that eschews tobacco and alcohol (Enstrom & Breslow, 2008; Merrill & Lyon, 2005; Merrill & Thygerson, 2001). Despite these associations, to postulate that religious policy invokes positive behavioral change requires one to address the counterargument that persons unwilling to conform to institutional codes are more likely leave the faith (Dengah et al., 2019; Francis & Katz, 2000; Jokela & Laakasuo, 2023; Scheitle & Adamczyk, 2010). Consequently, we set out to examine religion's employment of rules in shaping health behavior by leveraging the quasi-experimental setting provided by the nature of the early 20th century policy (Campbell & Stanley, 2011). To do so, we offer a formal test of the introduction of LDS tobacco abstention to changes in all-cause and cause-specific morbidity and mortality.

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, 2016; Fitouchi & Singh, 2022; Singh et al., 2021). If expansion ranks as a key objective of a religious body, leadership must consider the most efficient behaviors to meet this ambition. These behaviors would presumably need to support demographic fundamentals that conceive population change as a function of 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, we may find artifacts of religious beliefs surrounding fertility and mortality behavior within highly religious societies.

Health as LDS Identity

Both the LDS Church's history of assimilation with 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 in Utah their long-fought seclusion collided with the railroad's 19th century expansion, transforming the isolated Mormon colony into an inter-mountain crossroads (Farmer, 2015; Kucharski, 2017). The territory's industrialization left church leaders struggling to protect the unique LDS identity against cosmopolitism. Scholarship now argues this cultural struggle created vacillations between national assimilation and institutional orthodoxy, out of which a 20th century Latter-day Saint identity emerged (Bowman, 2012; Mauss, 1994a, 1994b). Polygamy and external conflict, casualties of national pressure and the bid for statehood, ceded to teetotaling and patriotism.

The theology of LDS health is found in "The Word of Wisdom" (WoW), introduced by Joseph Smith as a revelation in 1833. The initial teaching stood as advice on healthy living that promised physical stamina and greater spirituality (Hoskisson, 2012; *The Doctrine and Covenants*, Section 89). Yet, until the 20th century authoritative WoW interpretations varied, leaving tobacco and alcohol both taboo and ubiquitous within the church (Alexander, 1981; Eddington, 2023; Peterson, 1972). By the early 1900s, emerging social forces such as the evangelic temperance movement, a post-polygamy desire for acceptance within the American mainstream, and the exponential rise in cigarette uptake among the faith's youth produced the circumstances to solidify the Word of Wisdom (Alexander, 1996). In 1921, the church settled upon complete abstention from tobacco, alcohol, coffee, and tea as a prerequisite to temple ceremony participation, rituals at the heart of its theology, 30 years prior to the epidemiologic evidence concerning cigarettes (Cornfield et al., 1959; Doll & Hill, 1950; Khuder, 2001). For the next two decades church leaders solidified this new paradigm through speeches and printed media aimed at LDS youth. By 1940 obeying the WoW was a matter of orthodox identity.

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; Q. L. 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 network (Andres-Sanchez et al. 2021; Bailey et al. 2015) display inverse associations with tobacco consumption. Latter-day Saints display similar findings. LDS members 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-LDS populations, even when controlling for church attendance.

Despite the enormity of evidence that indicates LDS membership and activity is associated with reduced tobacco use, the work is limited in two ways. First, none of this research rules out the plausible rival that persons inclined to smoke tobacco exit LDS membership rather than conform. This non-random selection of persons into and out of the LDS faith limits causal inference. In addition, we know of no work that examines the relation between the enactment of 1921 WoW policy and the ***change*** in health of Latter-day Saint cohorts. Given the recent and abrupt nature of the policy, this circumstance provides a unique opportunity to examine whether a change in religious norms could affect health behavior and mortality.

Two empirical considerations require careful attention when investigating the WoW as health policy: defining LDS religiosity and establishing temporal order. Regarding religiosity, research often employs 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 LDS 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 LDS 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 LDS church determines membership by baptism status, which occurs at age 8 (median age= 8.54). As such, measurement of religiosity by LDS membership

would precede early-life behavioral decisions for many. The alternative, advancement in the male lay priesthood, 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 a church-wide policy.

As prior literature concerns LDS lifestyle characteristics rather 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 efforts illuminate religious experience as a determinant of health, they do not offer a mechanism that explains institutional function. For example, Merrill (2004) investigates how much of LDS 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 found amongst LDS males compared to non-LDS males. Although this study offers strong evidence regarding the health quality of LDS culture during the mid-1990s, it does not establish a clear link between how institution objectives cause individual behavior changes. As such, the need exists for a study that isolates whether, and to what extent, specific church rules precede improvements in health outcomes.

Therefore, we extend previous LDS research by investigating the WoW as precursor to health behavior among LDS members. We consider how cohort rates of smoking-related disease and death respond to the 1921 LDS anti-tobacco policy according to church activity. We extend past efforts within 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.

Predicted Outcomes

We anticipate that active church members born between 1900 to 1920 will experience greater life expectancy past age 50, and a lesser hazard of tobacco related cancer and death compared to inactive LDS members of the same birth cohorts. For individuals from the 1880 to 1899 birth cohorts, we expect no difference in these outcomes according to religious practice. We employ the year 1900 as a nexus point given that authorities in 1921 were most concerned with changing tobacco patterns in LDS youth, rather than older adults for whom they made allowances (Peterson, 1972). Psychology 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). We further test our hypotheses through a falsification test that employs prostate and breast cancers as health outcomes. For these tests, we expect to see no difference in non-tobacco related cancer diagnoses rates based upon religious activity.

Methods

Data

The Utah Population Database (UPDB), one of the world's most comprehensive computerized genealogies, serves as the primary data source. The UPDB links population information of over 11 million individuals from the late 1700s until today using LDS genealogical data matched to census, vital records, hospital records, and more (Smith & Mineau, 2021). For a given individual, UPDB lists all known residential, occupational, marriage, children, baptism, and endowment records. Thus, the ability to match social and health information over many generations stands as a key strength of the UPDB. We 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

Our population consists of 138,739 baptized members of the LDS church, born in Utah between 1880 to 1920, who have a place of death in Utah, and survived to at least age 50. These cohorts enjoy advantages in the UPDB as 1907 marks the initial use of death certificates in Utah, and 1975 is the last year of religious participation recorded in the UPDB. Further, the 1880 to 1920 cohorts would have been 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 ensure accuracy of records and similarity of exposure to church culture, we include only baptized LDS individuals and those whose birth and death states were Utah.

We considered four factors based upon exploratory data and literature to justify our 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 last year of recorded endowments in the UPDB, an individual born in 1920 and then endowed at age 50 sits five years prior to this threshold. Second, 97% of all tobacco-related deaths occur after age 50 among this UPDB cohort. Third, the requirement of survival to age 50 accounts for the high prevalence of unintentional injuries among younger ages that may dilute life expectancy differences between active and inactive LDS 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). Our age inclusion requirement allows sufficient time for one to be endowed and forsake

or cease smoking, renders persons less likely to suffer accidental death, and yet still captures nearly all tobacco-related deaths.

Variables

Our dependent variables are life expectancy in years past age 50, risk of smoking related death and risk of lung and bronchus cancer. We focus upon 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 this time exponentially grew. Without an intervention, we would expect tobacco related disease and mortality to climb in tandem among all groups (Gershon, 2022). We define tobacco-related deaths as deaths whose primary cause is either Chronic Obstructive Pulmonary Disease (COPD) or smoking specific cancers of the lung, bronchial, trachea, or esophagus (*appendix:* Table A2). When measuring morbidity, we use the individual classification provided by the UPDB "lung or bronchus" cancer diagnosis, as our primary endpoint. As a test of falsification, we consider diagnosis of colorectal, prostate and breast cancers.

We deviate from previous LDS tobacco studies by considering religious activity as a modifying factor between policy timing and health outcomes. Consequently, our 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). We reason that an LDS individual born on or after 1900 fell within the policy's target age in 1921 at or before age 20. Furthermore, by confining our exposure to a pre-adult age, our measurement of religiosity through recorded participation in the endowment allows for a clear means to identify

those who likely conformed to the new policy. Consistent with past UPDB studies, we defined our modifying covariate, "active LDS," as those with an endowment participation date recorded within the UPDB and "inactive LDS" as those with only a baptism date (Lindahl-Jacobsen et al. 2013; Mineau et al. 2004; K. R. Smith et al. 2002). The endowment ceremony constitutes a temple ritual generally performed in one's 20s (median age = 25.12) involving promises of loyalty to church teachings and leaders (*About the Temple Endowment*, n.d.). For simplicity of interpretation, we stratify our models by sex.

We also employ 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 old age longevity and disease susceptibility. Prior literature demonstrates 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 may produce weaker males that in-turn display increased hazard of disease and mortality. We also include urban or rural born as much 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). 29 counties in Utah were categorized as "urban" or "rural" based upon both past UPDB precedent and SEER*Stat definitions (Park et al., 2018; Rogers et al., 2020; *Rural-Urban Continuum Code - SEER Datasets*, 2014).

Models

For tests of life expectancy, we applied Ordinary Least-Squares Regression techniques to examine life expectancy Y_{itj} from age 50 years until death. We include a vector of individual background characteristics X_i that may predict the outcome but are not caused by the Word of

Wisdom policy, including birth cohort sex ratio and urban or rural status. We code sex ratio as a continuous variable. Urban or rural status is coded being born in an urban county (1) or born in a rural county (0).

Whether one was born between 1880 to 1899 (0) or 1900 to 1920 (1) is our key independent variable $WoWc_t$; β_1 is our coefficient of interest. In in our second model, we add background characteristics X_i, and religious participation $ActiveLDS_j$. We code religious participation as a binary variable that measures whether the LDS member was endowed (1) or not endowed (0). In our third model we add an interaction term between $WoWc_t$ and $ActiveLDS_j$. These models take the following form:

1: $Y_t = \alpha + \beta_1'*WoWc_t + \varepsilon_t$

2: $Y_{itj} = \alpha + \beta'*X_i + \beta_1*WoWc_t + \beta_2*ActiveLDS_j + \varepsilon_{itj}$

3: $Y_{itj} = \alpha + \beta'*X_i + \beta_1*WoWc_t + \beta_2*ActiveLDS_j + \beta_3*WoWc_t \times ActiveLDS_j + \varepsilon_{itj}$

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

4: $\lambda_{1t}(a) = \lambda_{0t}(a)\exp(\beta_1*WoWc_t + \varepsilon_t)$

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

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

The test for lung and bronchus cancer diagnosis and our falsification tests using colorectal, breast, and prostate cancer use the same models save for the fact that the outcome variables differ.

Results

Tables 1 and 2 present our descriptive results. Our population of 138,739 includes 33,569 inactive LDS individuals who were 49.19% female and 105,170 active individuals of which 52.11% were females. The 74.58% of inactive LDS individuals compared to 48.84% of active LDS individuals were born after 1900. Active LDS were slightly more represented in urban births.

[Table 1 Here]

[Table 2 Here]

Figure 1 provides visual evidence in support of health effect modification due to LDS church activity. There is striking difference between active and inactive LDS individuals' rates of tobacco related death and lung cancer. These same trends do not appear in breast and prostate cancers. Additionally, these charts support 1900 as an inflection point to a limited degree. Overall and male-only life expectancy, female tobacco related death, female lung cancer, and male prostate cancer appear to show clear effect modification occurring near 1900. Other outcomes, such as male tobacco related death and female life expectancy, appear to differentiate between 1890 and 1895 birth cohorts.

[Figure 1 here]

Table 3 offers the results from our OLS regression analysis. Active LDS males born after 1900 possessed 5.177 extra years of life past age 50 compared to inactive males. For females,

the difference was only 3.644 years. For those born prior to 1900, active LDS members demonstrated less life expectancy 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 we employ differences among LDS sub-groups rather than comparisons between members and non-members.

[Table 3 here]

Tables 4 and 5 displays the results from our Cox Proportional Hazard models. These finding demonstrate significant differences cohort and religious effects 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 significant increase in hazard of tobacco related death (Female HRR= 2.367, Male= 1.660) and lung cancer (Female HRR= 3.048, Male= 2.414). Yet when accounting for religiosity, its inactive LDS individuals who see the greatest increase of risk post 1900 with inactive females and males reporting increased risk in tobacco related death (Female HRR= 3.046, Male HRR 3.865) and lung cancer (Female HRR= 2.427, Male= 3.773). 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). Our covariates, birth cohort sex ratio and urban birth status, show some statistical significance but do not provide a substantial change in risk.

When testing for breast and prostate cancers, differences upon LDS activity lines either disappear or reverse. Our models for breast cancer show no significant difference according to LDS activity no matter the birth cohort. A difference in prostate cancer risk appears after 1900 with active LDS males demonstrating a 12% increase in risk of diagnosis, though not statistically significant. This small difference in prostate cancer risk, seen both in our exploratory charts and

statistical analysis, is likely an artifact of lengthened exposure time due to the increased longevity among active LDS males (*appendix*: Table A1 and Figure A1).

[Table 4 here]

[Table 5 here]

Figure 2 displays relevant survival ratios by sex, according to church activity and birth year relation to 1900. These charts echo the same between group differences found in exploratory charts concerning tobacco related death.

[Figure 2 here]

Discussion

The WoW provides a unique religious policy that tied cigarette abstention to higher level LDS ceremony participation, 30 years prior to epidemiological evidence of the risk of tobacco. As such, we tested the 1921 policy's relation to changes in all-cause and cause-specific morbidity and mortality as modified through participation in the LDS endowment. This test was strengthened by our choice in data. The UPDB allowed a population comparison of morbidity and mortality according to endowment status due to its composition of LDS genealogical data matched to census, vital records, hospital records. Our tests of reveal that LDS individuals who were endowed prior to age 50, enjoyed both decreased tobacco related death and lung/ bronchus cancer life expectancy, and increased life expectancy compared to LDS individuals who were not endowed. These results did not carry over into non-tobacco related health outcomes such as breast and prostate cancers. Therefore, our findings support the inference that religion may act in ways that support mortality reduction in populations.

Despite religious differences in our 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, religious disillusionment post-endowment, and/or selective uptake of church teachings (Mumford et al., 1987; Öberg et al., 2011; Scheitle & Adamczyk, 2010).

The results from our 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 LDS women compared non-LDS women (Daniels, 2004), we 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 a 12% greater risk of prostate cancer compared to inactive Latter-day Saint men-- a difference not found in pre-1900 birth cohorts. The age-dependent nature of prostate cancer diagnosis helps explains these results and offers confirmation to the hypotheses. As lower risk of tobacco related deaths among active LDS males contributed to higher life expectancy compared to inactive males, the exposure time for prostate cancer increased in tandem (*appendix:* Table A3, Figure A1). In sum, the total evidence suggests that those who obeyed tobacco prohibitions of the LDS church lived long enough to be diagnosed with prostate cancer late in life.

Limitations and Future Directions

Limitations include the questionable external validity of our results to other religions. We do not argue that religion in every circumstance improves mortality, nor specifically does the LDS faith. As such, further examinations within the UPDB considering LDS policies of fertility, marriage, sexual morality, and economics may yield positive and negative health outcomes. Previous studies reporting negative health aspects among LDS people support this approach (Bodson et al., 2017; Merrill & Thygerson, 2001) Replication studies to health outcomes among groups outside of the LDS faith may show differing relations between religion and health.

We also note measurement error in LDS activity given that a single timepoint of endowment participation does not ensure a lifetime of LDS 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, cousins, and parental temple participation might offer a clearer picture of family faith dynamics.

Our focus upon tobacco allows for similar investigations of alcohol concerning life expectancy and digestive tract diseases. We also did not consider socioeconomic status as smoking uptake during the time of the policy was sign of modernism and spreading to all levels of society (Brandt, 2007: pg. 61; Gardner, 2013; Gershon, 2022). But economic circumstance may have application in survival given a cancer diagnosis. As such, further research analyzing hazard rate ratio 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 our highly consistent results, we cannot claim with certainty that the 1921 policy caused believing Latter-day Saints to forgo tobacco. While our results provide clear support for the hypothesis that the 1921 policy initiated a behavioral boundary followed by the faithful, the possibility remains that the WoW drove smoking inclined youth away from the church who may have remained in absence of the ban. The extent to which this rival explanation seems plausible would require additional work on rates of change in LDS membership over time. We, however, note descriptively that LDS membership only increases post-WoW policy (Bennion & Young, 1996).

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 LDS members. 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). We 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.

References

About the temple endowment. (n.d.). The Church of Jesus Christ of Latter-Day Saints. Retrieved December 31, 2023, from https://www.churchofjesuschrist.org/temples/what-is-temple-endowment?lang=eng

Alexander, T. G. (1981). The Word of Wisdom: From Principle to Requirement. *Dialogue: A Journal of Mormon Thought*, *14*(3), 78–88.

Alexander, T. G. (1996). *Mormonism in transition: A History of the Latter-day Saints, 1890-1930.* University of Illionois Press.

Alzyoud, S., Kheirallah, K. A., Ward, K. D., Al-Shdayfat, N. M., & Alzyoud, A. A. (2015). Association of Religious Commitment and Tobacco Use Among Muslim Adolescents. *Journal of Religion and Health*, *54*(6), 2111–2121. https://doi.org/10.1007/s10943-014-9921-4

Amos, A., & Bostock, Y. (2007). Young people, smoking and gender—A qualitative exploration. *Health Education Research*, *22*(6), 770–781. https://doi.org/10.1093/her/cyl075

Andres-Sanchez, J. de, Belzunegui-Eraso, A., & Fernández-Aliseda, S. (2021). Religion as a Protective Factor Against Adolescent Smoking Habits: Evidence from Spain. *Christian Journal for Global Health*, *8*(2), Article 2. https://doi.org/10.15566/cjgh.v8i2.579

Arnett, J. J. (1997). Young People's Conceptions of the Transition to Adulthood. *Youth & Society*, *29*(1), 3–23. https://doi.org/10.1177/0044118X97029001001

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*, *55*(5), 469–480. https://doi.org/10.1037/0003-066X.55.5.469

Arrington, L. J. (2005). *Great Basin Kingdom: An Economic History of the Latter-day Saints, 1830-1900*. University of Illinois Press.

Azra, A., Dijk, K. van, & Kaptein, N. J. G. (2010). *Varieties of Religious Authority: Changes and Challenges in 20th Century Indonesian Islam*. Institute of Southeast Asian Studies.

Badanta, B., Lucchetti, G., & de Diego-Cordero, R. (2020). "A Temple of God": A Qualitative Analysis of the connection Between Spiritual/Religious Beliefs and Health Among Mormons. *Journal of Religion and Health*, *59*(3), 1580–1595. https://doi.org/10.1007/s10943-019-00922-7

Bailey, Z. D., Slopen, N., Albert, M., & Williams, D. R. (2015). Multidimensional religious involvement and tobacco smoking patterns over 9–10 years: A prospective study of middle-aged adults in the United States. *Social Science & Medicine*, *138*, 128–135. https://doi.org/10.1016/j.socscimed.2015.06.006

Bartz, J. D., Richards, P. S., Smith, T. B., & Fischer, L. (2010). A 17-year longitudinal study of religion and mental health in a Mormon sample. *Mental Health, Religion & Culture*, *13*(7–8), 683–695. https://doi.org/10.1080/13674670801944966

Baumard, N., & Boyer, P. (2013). Explaining moral religions. *Trends in Cognitive Sciences*, *17*(6), 272–280. https://doi.org/10.1016/j.tics.2013.04.003

Bennion, L. C., & Young, L. A. (1996). The Uncertain Dynamics of LDS Expansion, 1950-2020. *Dialogue: A Journal of Mormon Thought*, *29*(1), 8–32. https://doi.org/10.2307/45226165

Blackburn, B. E., Soisson, S., Rowe, K., Snyder, J., Fraser, A., Deshmukh, V., Newman, M., Smith, K., Herget, K., Kirchhoff, A. C., Kepka, D., Werner, T. L., Gaffney, D., Mooney, K., & Hashibe, M. (2019). Prognostic factors for rural endometrial cancer patients in a

population-based cohort. *BMC Public Health*, *19*(1), 921. https://doi.org/10.1186/s12889-019-7262-7

Bodson, J., Wilson, A., Warner, E. L., & Kepka, D. (2017). Religion and HPV vaccine-related awareness, knowledge, and receipt among insured women aged 18-26 in Utah. *PLOS ONE*, *12*(8), e0183725. https://doi.org/10.1371/journal.pone.0183725

Bowie, J. V., Parker, L. J., Beadle-Holder, M., Ezema, A., Bruce, M. A., & Thorpe Jr., R. J. (2017). The Influence of Religious Attendance on Smoking Among Black Men. *Substance Use & Misuse*, *52*(5), 581–586. https://doi.org/10.1080/10826084.2016.1245342

Bowman, M. (2012). *The Mormon People: The Making of an American Faith*. Random House Publishing Group.

Brandt, A. M. (2007). *The Cigarette Century: The Rise, Fall, and Deadly Persistence of the Product that Defined America*. Basic Books.

Brown, J. E. (1980). *The Mormon Trek West*. Double Day & Company, Inc.

Brown, Q. L., Linton, S. L., Harrell, P. T., Mancha, B. E., Alexandre, P. K., Chen, K.-F., & Eaton, W. W. (2014). The Influence of Religious Attendance on Smoking. *Substance Use & Misuse*, *49*(11), 1392–1399. https://doi.org/10.3109/10826084.2014.912224

Bruckner, T. A. (2018). Selection in utero and population health_ Theory and typology of research. *Population Health*, 16.

Bush, L. E. (2022). *MORMON "PHYSIOLOGY," 1850-1875*. 21.

Byrnes, J. P., Miller, D. C., & Schafer, W. D. (1999). Gender differences in risk taking: A meta-analysis. *Psychological Bulletin*, *125*(3), 367–383. https://doi.org/10.1037/0033-2909.125.3.367

Campbell, D. T., & Stanley, J. C. (2011). *Experimental and quasi-experimental designs for research*. Wadsworth.

Catalano, R., & Bruckner, T. (2006). Male lifespan and the secondary sex ratio. *American Journal of Human Biology*, *18*(6), 783–790. https://doi.org/10.1002/ajhb.20551

Chatters, L. M. (2000). Religion and Health: Public Health Research and Practice. *Annual Review of Public Health*, *21*, 335–367.

Coale, A. J. (1989). Demographic Transition. In J. Eatwell, M. Milgate, & P. Newman (Eds.), *Social Economics* (pp. 16–23). Palgrave Macmillan UK. https://doi.org/10.1007/978-1-349-19806-1_4

Coale, A. J., & trussle, J. (1996). *The Development and Use of Demographic Models: Population Studies: Vol 50, No 3*. *50*(3), 469–484.

Cornfield, J., Haenszel, W., Hammond, E. C., Lilienfeld, A. M., Shimkin, M. B., & Wynder, E. L. (1959). Smoking and Lung Cancer: Recent Evidence and a Discussion of Some Questions. *JNCI: Journal of the National Cancer Institute*, *22*(1), 173–203. https://doi.org/10.1093/jnci/22.1.173

Currie, C., Roberts, C., Settertobulte, W., Morgan, A., Smith, R., Samdal, O., Barnekow Rasmussen, V., & Europe, W. H. O. R. O. for. (2004). *Young people's health in context: Health Behaviour in School-aged Children (HBSC) study : international report from the 2001/2002 survey*. World Health Organization. Regional Office for Europe. https://iris.who.int/handle/10665/107560

Daniels, M. (2004). Associations between breast cancer risk factors and religious practices in Utah. *Preventive Medicine*, *38*(1), 28–38. https://doi.org/10.1016/j.ypmed.2003.09.025

de Diego Cordero, R., & Badanta Romero, B. (2017). Health Impacts of Religious Practices and Beliefs Associated with The Church of Jesus Christ of Latter-Day Saints. *Journal of Religion and Health, 56*(4), 1371–1380. https://doi.org/10.1007/s10943-016-0348-y

Dengah, H. J. F., Bingham Thomas, E., Hawvermale, E., & Temple, E. (2019). "Find that Balance:" The Impact of Cultural Consonance and Dissonance on Mental Health among Utah and Mormon Women. *Medical Anthropology Quarterly, 33*(3), 439–458. https://doi.org/10.1111/maq.12527

Doll, R., & Hill, A. B. (1950). Smoking and Carcinoma of the Lung. *Br Med J, 2*(4682), 739–748. https://doi.org/10.1136/bmj.2.4682.739

Durkheim, E. (2016). The Elementary Forms of Religious Life. In *Social Theory Re-Wired* (2nd ed.). Routledge.

Eddington, M. (2023, September 25). Brigham Young's southern Utah wine mission fueled LDS profits, prophecy and alcoholism. *The Salt Lake Tribune*. https://www.sltrib.com/religion/2023/09/25/brigham-youngs-southern-utah-wine/

Elkalmi, R. M., Alkoudmani, R. M., Elsayed, T. M., Ahmad, A., & Khan, M. U. (2016). Effect of Religious Beliefs on the Smoking Behaviour of University Students: Quantitative Findings From Malaysia. *Journal of Religion and Health, 55*(6), 1869–1875. https://doi.org/10.1007/s10943-015-0136-0

Enstrom, J. E. (1975). Cancer mortality among Mormons. *Cancer*, *36*(3), 825–841. https://doi.org/10.1002/1097-0142(197509)36:3<825::AID-CNCR2820360302>3.0.CO;2-Q

Enstrom, J. E. (1978). Cancer and total mortality among active mormons. *Cancer*, *42*(4), 1943–1951. https://doi.org/10.1002/1097-0142(197810)42:4<1943::AID-CNCR2820420437>3.0.CO;2-L

Enstrom, J. E. (1980). Cancer mortality among Mormons in California during 1968–75. *Journal of the National Cancer Institute65*, *65*(5), 1073–1082.

Enstrom, J. E., & Breslow, L. (2008). Lifestyle and reduced mortality among active California Mormons, 1980–2004. *Preventive Medicine*, *46*(2), 133–136. https://doi.org/10.1016/j.ypmed.2007.07.030

Farmer, J. (2015). Crossroads of the West. *Journal of Mormon History*, *41*(1), 156–173.

Fitouchi, L., & Singh, M. (2022). Supernatural punishment beliefs as cognitively compelling tools of social control. *Current Opinion in Psychology*, *44*, 252–257. https://doi.org/10.1016/j.copsyc.2021.09.022

Francis, L. J., & Katz, Y. J. (2000). *Joining and Leaving Religion: Research Perspectives*. Gracewing Publishing.

Friedl, A., Pondorfer, A., & Schmidt, U. (2020). Gender differences in social risk taking. *Journal of Economic Psychology*, *77*, 102182. https://doi.org/10.1016/j.joep.2019.06.005

GARDNER, J. W., & LYON, J. L. (1982). CANCER IN UTAH MORMON MEN BY LAY PRIESTHOOD LEVEL. *American Journal of Epidemiology*, *116*(2), 243–257. https://doi.org/10.1093/oxfordjournals.aje.a113409

Gardner, M. N. (2013). Risk, Pleasure, and Change: Using the Cigarette to Teach U. S. Cultural History. *The History Teacher*, *47*(1), 9–24.

Gershon, L. (2022, December 12). *A Cigarette-Eye View of US History*. JSTOR Daily. https://daily.jstor.org/a-cigarette-eye-view-of-us-history/

Gillum, R. F. (2005). Frequency of attendance at religious services and cigarette smoking in American women and men: The Third National Health and Nutrition Examination Survey. *Preventive Medicine*, *41*(2), 607–613. https://doi.org/10.1016/j.ypmed.2004.12.006

Gmel, G., Mohler-Kuo, M., Dermota, P., Gaume, J., Bertholet, N., Daeppen, J.-B., & Studer, J. (2013). Religion Is Good, Belief Is Better: Religion, Religiosity, and Substance Use Among Young Swiss Men. *Substance Use & Misuse*, *48*(12), 1085–1098. https://doi.org/10.3109/10826084.2013.799017

Hall, D. E., Meador, K. G., & Koenig, H. G. (2008). Measuring Religiousness in Health Research: Review and Critique. *Journal of Religion and Health*, *47*, 134–163.

Halpern, M. T., Gillespie, B. W., & Warner, K. E. (1993). Patterns of Absolute Risk of Lung Cancer Mortality in Former Smokers. *JNCI: Journal of the National Cancer Institute*, *85*(6), 457–464. https://doi.org/10.1093/jnci/85.6.457

Hawkes, C. H., Ramkumar, N., Baker, R., & Lyon, J. L. (2007). Multiple sclerosis in Latter Day Saints (Mormons). *Acta Neurologica Scandinavica*, *115*(4), 260–264. https://doi.org/10.1111/j.1600-0404.2006.00770.x

Hofstetter, C. R., Ayers, J. W., Irvin, V. L., Kang Sim, D. E., Hughes, S. C., Reighard, F., & Hovell, M. F. (2010). Does Church Participation Facilitate Tobacco Control? A Report on Korean Immigrants. *Journal of Immigrant and Minority Health*, *12*(2), 187–197. https://doi.org/10.1007/s10903-009-9228-9

Hoskisson, P. Y. (2012). The Word of Wisdom in Its First Decade. *Journal of Mormon History*, *38*(1), 131–200.

Jackson, E. L. (1950). Trends in the Consumption of Tobacco Products, United States, 1900-1950. *Journal of Farm Economics*, *32*(4), 881–893. https://doi.org/10.2307/1233840

Jokela, M., & Laakasuo, M. (2023). Health trajectories of individuals who quit active religious attendance: Analysis of four prospective cohort studies in the United States. *Social Psychiatry and Psychiatric Epidemiology*. https://doi.org/10.1007/s00127-023-02497-x

Kass, N. E. (2001). An Ethics Framework for Public Health. *American Journal of Public Health*, *91*(11), 1776–1782. https://doi.org/10.2105/AJPH.91.11.1776

Khuder, S. A. (2001). Effect of cigarette smoking on major histological types of lung cancer: A meta-analysis. *Lung Cancer*, *31*(2), 139–148. https://doi.org/10.1016/S0169-5002(00)00181-1

Kim, E. S., & VanderWeele, T. J. (2019). Mediators of the Association Between Religious Service Attendance and Mortality. *American Journal of Epidemiology*, *188*(1), 96–101. https://doi.org/10.1093/aje/kwy211

Koenig, H. G., George, L. K., Cohen, H. J., Hays, J. C., Larson, D. B., & Blazer, D. G. (1998). The Relationship Between Religious Activities and Cigarette Smoking in Older Adults. *The Journals of Gerontology: Series A*, *53A*(6), M426–M434. https://doi.org/10.1093/gerona/53A.6.M426

Koric, A., Mark, B., Chang, C.-P., Lloyd, S., Dodson, M., Deshmukh, V. G., Newman, M., Date, A., Gren, L. H., Porucznik, C. A., Haaland, B., Henry, N. L., & Hashibe, M. (2023). Adverse Health Outcomes among Rural and Urban Breast Cancer Survivors: A Population-Based Cohort Study. *Cancer Epidemiology, Biomarkers & Prevention*, *32*(10), 1302–1311. https://doi.org/10.1158/1055-9965.EPI-23-0421

Kucharski, J. (2017). Mexican Exoduses: The Mormon Struggle for Freedom, Identity, and Community In the United States and Mexico, 1823-1917. *IUSB Undergraduate Research Journal of History, 7*, 5–16.

Kuper, H., Boffetta, P., & Adami, H.-O. (2002). Tobacco use and cancer causation: Association by tumour type. *Journal of Internal Medicine*, *252*(3), 206–224. https://doi.org/10.1046/j.1365-2796.2002.01022.x

Lindahl-Jacobsen, R., Hanson, H. A., Oksuzyan, A., Mineau, G. P., Christensen, K., & Smith, K. R. (2013). The male–female health-survival paradox and sex differences in cohort life expectancy in Utah, Denmark, and Sweden 1850–1910. *Annals of Epidemiology*, *23*(4), 161–166. https://doi.org/10.1016/j.annepidem.2013.02.001

Lyon, J. L., Gardner, K., & Gress, R. E. (1994). Cancer incidence among Mormons and non-Mormons in Utah (United States) 1971-85. *Cancer Causes and Control*, *5*, 149–156.

Lyon, S. J. (2013). Psychotherapy and the Mormon faith. *Journal of Religion and Health*, *52*(2), 622–630. https://doi.org/10.1007/s10943-013-9677-2

Mauss, A. L. (1994a). Refuge and retrenchement: The Mormon quest for Identity. *Contemporary Mormonism: Social Science Perspectives*.

Mauss, A. L. (1994b). *The Angel and the Beehive: The Mormon Struggle with Assimilation*. University of Illinois Press.

McFadden, D., Croghan, I. T., Piderman, K. M., Lundstrom, C., Schroeder, D. R., & Hays, J. T. (2011). Spirituality in Tobacco Dependence: A Mayo Clinic Survey. *EXPLORE*, *7*(3), 162–167. https://doi.org/10.1016/j.explore.2011.02.003

Merrill, R. M. (2004). Life expectancy among LDS and Non-LDS in Utah. *Demographic Research*, *10*, 61–82. https://doi.org/10.4054/DemRes.2004.10.3

Merrill, R. M., & Lyon, J. L. (2005). Cancer incidence among Mormons and non-Mormons in Utah (United States) 1995–1999. *Preventive Medicine*, *40*(5), 535–541. https://doi.org/10.1016/j.ypmed.2004.10.011

Merrill, R. M., & Salazar, R. D. (2002). Relationship between church attendance and mental health among Mormons and non-Mormons in Utah. *Mental Health, Religion & Culture*, *5*(1), 17–33. https://doi.org/10.1080/13674670110059569

Merrill, R. M., & Thygerson, A. L. (2001). Religious Preference, Church Activity, and Physical Exercise. *Preventive Medicine*, *33*(1), 38–45. https://doi.org/10.1006/pmed.2001.0851

Mineau, G., Smith, K., & Bean, L. (2004). Adult mortality risks and religious affiliation: The role of social milieu in biodemographic studies. *Annales de Démographie Historique*, *108*(2), 85. https://doi.org/10.3917/adh.108.0085

Mumford, J. L., He, X. Z., Chapman, R. S., Cao, S. R., Harris, D. B., Li, X. M., Xian, Y. L., Jiang, W. Z., Xu, C. W., & Chuang, J. C. (1987). Lung cancer and indoor air pollution in Xuan Wei, China. *Science (New York, N.Y.)*, *235*(4785), 217–220. https://doi.org/10.1126/science.3798109

Norton, M. C., Smith, K. R., Østbye, T., Tschanz, J. T., Corcoran, C., Schwartz, S., Piercy, K. W., Rabins, P. V., Steffens, D. C., Skoog, I., Breitner, J. C. S., Welsh-Bohmer, K. A., & for the Cache County Investigators. (2010). Greater Risk of Dementia When Spouse Has Dementia? The Cache County Study: [See editorial comments by Dr. Peter P. Vitaliano, pp 976-978]. *Journal of the American Geriatrics Society*, *58*(5), 895–900. https://doi.org/10.1111/j.1532-5415.2010.02806.x

Öberg, M., Jaakkola, M. S., Woodward, A., Peruga, A., & Prüss-Ustün, A. (2011). Worldwide burden of disease from exposure to second-hand smoke: A retrospective analysis of data

from 192 countries. *The Lancet*, *377*(9760), 139–146. https://doi.org/10.1016/S0140-6736(10)61388-8

Ou, J. Y., Smits-Seemann, R. R., Wu, Y. P., Wright, J., & Kirchhoff, A. C. (2018). An investigation of survivorship clinic attendance among childhood cancer survivors living in a five-state rural region. *Journal of Cancer Survivorship*, *12*(2), 196–205. https://doi.org/10.1007/s11764-017-0658-4

Park, J., Blackburn, B. E., Rowe, K., Snyder, J., Wan, Y., Deshmukh, V., Newman, M., Fraser, A., Smith, K., Herget, K., Burt, L., Werner, T., Gaffney, D. K., Lopez, A. M., Mooney, K., & Hashibe, M. (2018). Rural-metropolitan disparities in ovarian cancer survival: A statewide population-based study. *Annals of Epidemiology*, *28*(6), 377–384. https://doi.org/10.1016/j.annepidem.2018.03.019

Peterson, P. H. (1972). An Historical Analysis of the Word of Wisdom [Masters Thesis, Brigham Young University]. *Maters Thesis, Brigham Young University*, 123.

Peto, R., Darby, S., Deo, H., Silcocks, P., Whitley, E., & Doll, R. (2000). Smoking, smoking cessation, and lung cancer in the UK since 1950: Combination of national statistics with two case-control studies. *BMJ*, *321*(7257), 323–329. https://doi.org/10.1136/bmj.321.7257.323

Radnitsky, G., & Bartley, W. W. (Eds.). (1987). *Evolutionary epistemology. Evolutionary epistemology, rationality, and the sociology of knowledge*. Open court.

Robbins, C. A., & Martin, S. S. (1993). Gender, Styles of Deviance, and Drinking Problems. *Journal of Health and Social Behavior*, *34*(4), 302–321. https://doi.org/10.2307/2137369

Rogers, C. R., Blackburn, B. E., Huntington, M., Curtin, K., Thorpe, R. J., Rowe, K., Snyder, J., Deshmukh, V., Newman, M., Fraser, A., Smith, K., & Hashibe, M. (2020). Rural–urban

disparities in colorectal cancer survival and risk among men in Utah: A statewide population-based study. *Cancer Causes & Control*, *31*(3), 241–253. https://doi.org/10.1007/s10552-020-01268-2

Rural-Urban Continuum Code—SEER Datasets. (2014, April 15). National Cancer Institute. https://seer.cancer.gov/seerstat/variables/countyattribs/ruralurban.html

Saito, E., Inoue, M., Tsugane, S., Ito, H., Matsuo, K., Wakai, K., Wada, K., Nagata, C., Tamakoshi, A., Sugawara, Y., Tsuji, I., Mizoue, T., Tanaka, K., & Sasazuki, S. (2017). Smoking cessation and subsequent risk of cancer: A pooled analysis of eight population-based cohort studies in Japan. *Cancer Epidemiology*, *51*, 98–108. https://doi.org/10.1016/j.canep.2017.10.013

Sanchez, Z. M., Opaleye, E. S., Chaves, T. V., Noto, A. R., & Nappo, S. A. (2011). God Forbids or Mom Disapproves? Religious Beliefs That Prevent Drug Use Among Youth. *Journal of Adolescent Research*, *26*(5), 591–616. https://doi.org/10.1177/0743558411402337

Schacht, R., Hollingshaus, M., Hanson, H., Macfarlan, S. J., Tharp, D., Bruckner, T., & Smith, K. R. (2021). Frail Males on the American Frontier: The Role of Environmental Harshness on Sex Ratios at Birth across a Period of Rapid Industrialization. *Social Sciences*, *10*(9), Article 9. https://doi.org/10.3390/socsci10090319

Scheitle, C. P., & Adamczyk, A. (2010). High-cost Religion, Religious Switching, and Health. *Journal of Health and Social Behavior*, *51*(3), 325–342. https://doi.org/10.1177/0022146510378236

Singh, M., Kaptchuk, T. J., & Henrich, J. (2021). Small gods, rituals, and cooperation: The Mentawai water spirit Sikameinan. *Evolution and Human Behavior*, *42*(1), 61–72. https://doi.org/10.1016/j.evolhumbehav.2020.07.008

Smith, A. H., Pool, D. I., Pearce, N. E., Lyon, J. L., Lilley, B. M., Davis, P. B., & Prior, I. A. M. (1985). Mortality among New Zealand Maori and Non-Maori Mormons. *International Journal of Epidemiology*, *14*(2), 265–271. https://doi.org/10.1093/ije/14.2.265

Smith, K. R., Mineau, G. P., & Bean, L. L. (2002). Fertility and post-reproductive longevity. *Social Biology*, *49*(3–4), 185–205. https://doi.org/10.1080/19485565.2002.9989058

Smith, Ken. R., & Mineau, G. P. (2021). The Utah Population Database. The Legacy of Four Decades of Demographic Research. *Historical Life Course Studies*, *11*, 48–73. https://doi.org/10.51964/hlcs10916

Smith, T. W. (1998). A Review of Church Attendance Measures. *American Sociological Review*, *63*(1), 131–136. https://doi.org/10.2307/2657485

Snow, S. E. (2019, April). *The Sacred Duty of Record Keeping*. Churchofjesuschrist.Org. https://www.churchofjesuschrist.org/study/eng/ensign/2019/04/the-sacred-duty-of-record-keeping

Sowden, A. J., & Stead, L. F. (2003). Community interventions for preventing smoking in young people. *Cochrane Database of Systematic Reviews*, *1*. https://doi.org/10.1002/14651858.CD001291

The Doctrine and Covenants of The Church of Jesus Christ of Latter-day Saints. (1981). The Church of Jesus Christ of Latter-day Saints.

United States Office on Smoking and Health. (1979). *Smoking and Health: A Report of the Surgeon General*. U.S. Department of Health, Education, and Welfare, Public Health Service, Office of the Assistant Secretary for Health, Office on Smoking and Health.

VanderWeele, T. J. (2017). Causal effects of religious service attendance? *Social Psychiatry and Psychiatric Epidemiology*, *52*, 1331–1336.

VanderWeele, T. J., & Chen, Y. (2020). VanderWeele and Chen Respond to "Religion as a Social Determinant of Health." *American Journal of Epidemiology*, *189*(12), 1464–1466. https://doi.org/10.1093/aje/kwz206

Williams, roger, Lyon, J. L., Brockert, J. E., & Maness, A. T. (1979). Decline in coronary mortality rates: Utah vs United States. *Proceedings of the Conference on the Decline in CHD Mortality. Washington, DC: US Department of Health and Human Services*, 48–57.

WISQARS Leading Causes of Death Visualization Tool. (n.d.). Centers for Disease Control and Prevention. Retrieved December 28, 2023, from https://wisqars.cdc.gov/lcd/

Zhou, W., Liu, G., Hung, R. J., Haycock, P. C., Aldrich, M. C., Andrew, A. S., Arnold, S. M., Bickeböller, H., Bojesen, S. E., Brennan, P., Brunnström, H., Melander, O., Caporaso, N. E., Landi, M. T., Chen, C., Goodman, G. E., Christiani, D. C., Cox, A., Field, J. K., … Amos, C. I. (2021). Causal relationships between body mass index, smoking and lung cancer: Univariable and multivariable Mendelian randomization. *International Journal of Cancer*, *148*(5), 1077–1086. https://doi.org/10.1002/ijc.33292

Table 1. Descriptive population characteristics of Utah births, 1880 to 1920, who also died in Utah, according to LDS church activity.

		All (n = 138739)		Inactive LDS (n = 33569)		Active LDS (n = 105170)	
		N	%	N	%	N	%
Sex							
	Female	70317	50.68%	16513	49.19%	54804	52.11%
	Male	68422	49.32%	17056	50.81%	51366	48.84%
Birth cohort							
	1880 to 1899	53931	38.87%	8532	25.42%	45399	43.17%
	1900 to 1920	84808	61.13%	25037	74.58%	59771	56.83%
Birth Cohort Sex Ratio							
	Below 1.02	19197	13.84%	4403	13.12%	14794	14.07%
	1.02 to 1.03	37764	27.22%	9549	28.45%	28215	26.83%
	1.04 to 1.05	27675	19.95%	7917	23.58%	19758	18.79%

	1.06	18520	13.35%	3734	11.12%	14786	14.06%
	1.07 and above	35583	25.65%	7966	23.73%	17617	16.75%
Urban or rural county born							
	Urban	76633	55.24%	18147	54.06%	58486	55.61%
	Rural	62106	44.76%	15422	45.94%	46684	44.39%

Table 2. Descriptive population characteristics of Utah births, 1880 to 1920, who also died in Utah, according to LDS church activity and status of tobacco related death or lung/bronchus cancer diagnosis.

		All (n = 138739)		Inactive LDS (n = 33569)		Active LDS (n = 105170)	
		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	509	26.28%	212	22.06%	297	28.81%
	Male	1483	76.56%	749	77.94%	724	70.22%
Birth cohort							
	1880 to 1899	357	17.92%	99	10.30%	258	25.02%
	1900 to 1920	1635	82.08%	862	89.70%	773	74.98%
Those without a lung or bronchus cancer diagnosis							
N		136747		32608		104139	
Sex							
	Female	69808	51.05%	16301	49.99%	53507	51.38%
	Male	66939	48.95%	16307	50.01%	50632	48.62%
Birth cohort							
	1880 to 1899	53574	39.18%	8433	25.86%	45141	43.35%
	1900 to 1920	83173	60.82%	24175	74.14%	58998	56.65%

Table 2. Estimated regression coefficients for life expectancy after age 50 as a function of birth cohort sex ratio (SSR), individual participation in the LDS Church, and the interaction between LDS membership and cohort indicator of exposure to LDS tobacco policy.

	Female (n=70317)		
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[1]		0.001 (.016)	0.004 (0.015)
Urban born		-0.308** (0.084)	-0.328*** (0.084)
Active LDS member (b)		0.598*** (0.010)	-2.038*** (0.190)
Interaction between a and b			3.644*** (0.223)

	Male (n = 68422)		
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[1]		-0.029 (0.016)	-0.040* (0.016)
Urban born		-0.301** (0.088)	-0.328** (0.088)
Active LDS member (b)		2.870*** (0.102)	-0.749*** (0.185)
Interaction between a and b			5.177*** (0.222)

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

[1] Birth sex ratios scaled to .01

Table 4. Estimated hazard rate coefficients for tobacco related death as a function of the individuals birth year's relation to the LDS tobacco policy changes, and individual participation in the LDS Church.

	Female (n = 70,317)					
	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[1]			-.001 (.013)	0.999 (0.974 - 1.025)	-.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 LDS member (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 = 68,422)					
	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[1]			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 LDS member (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)

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

[1] Birth sex ratios scaled to .01

Table 5. 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.

	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)	1.114** (0.124)	3.048 (2.388 - 3.890)	1.033** (0.127)	2.810 (2.192 - 3.603)	2.246*** (0.387)	9.450 (4.426– 20.177)
Birth cohort sex ratio[1]			0.017 (.017)	1.017 (0.983 – 1.052)	0.018 (0.018)	1.018 (0.983 – 1.055)
Urban born			0.106 (0.089)	1.112 (0.935 - 1.324)	0.111 (0.089)	1.118 (0.939 - 1.331)
Active LDS member (b)			-0.749** (0.091)	0.473 (0.396 - 0.565)	0.629 (0.397)	1.875 (0.861 – 4.084)
Interaction between a and b					-1.516** (0.408)	0.219 (0.098- 0.489)
	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)	0.897** (0.039)	2.453 (2.274 - 2.646)	0.913** (0.039)	2.492 (2.308 - 2.692)	0.929** (0.095)	2.547 (2.110 - 3.075)
Birth cohort sex ratio[1]			0.011 (0.006)	1.011 (0.999 – 1.023)	0.011 (0.006)	1.011 (0.999 – 1.023)
Urban born			0.078* (0.030)	1.081 (1.019 - 1.147)	0.078* (0.030)	1.081 (1.019 - 1.147)
Active LDS member (b)			0.027 (0.035)	1.028 (0.960 - 1.101)	0.044 (0.097)	1.045 (0.864 - 1.264)
Interaction between a and b					-0.019 (0.104)	0.981 (0.800 - 1.203)

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

[1] Birth sex ratios scaled to .01

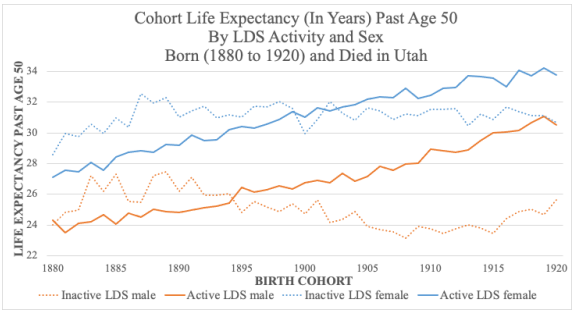
Table 6. Estimated hazard rate coefficients for male lung/bronchus and prostate cancer diagnoses as a function of the individuals birth year's relation to the LDS tobacco policy changes, and individual participation in the LDS Church.

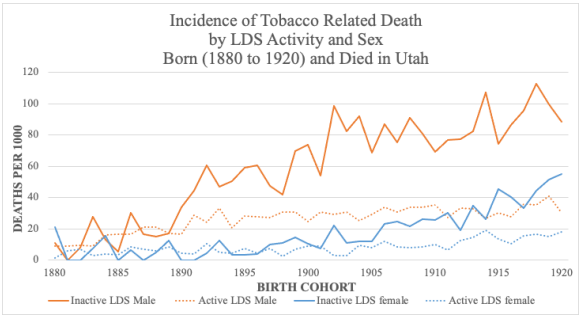
	Lung/Bronchus Cancer Diagnoses					
	Model 1		Model 2		Model 3	
Variable	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)	Coefficient (SE)	Hazard Ratio (95% CI)
Born between 1900 to 1920 (a)	0.881*** (0.066)	2.414 (2.120 - 2.749)	0.819*** (0.067)	2.268 (1.986 - 2.590)	1.110*** (0.112)	3.034 (2.866 - 3.213)
Birth cohort sex ratio[1]			.050*** (.010)	1.051 (1.031 – 1.072)	.051*** (.010)	1.052 (1.031 – 1.073)
Urban born			-0.025 (0.052)	0.976 (0.881 - 1.081)	-0.022 (0.052)	0.979 (0.883 - 1.084)
Active LDS member (b)			-1.240*** (0.052)	0.289 (0.261 - 0.321)	-0.844*** (0.127)	0.430 (0.335 - 0.552)
Interaction between a and b					-0.484** (0.140)	0.616 (0.468 - 0.811)
	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)	0.791*** (0.029)	2.205 (2.081 - 2.335)	0.802*** (0.030)	2.104 (2.104- 2.365)	0.700*** (0.070)	2.014 (1.756 - 2.310)
Birth cohort sex ratio[1]			.004 (.005)	1.005 (0.995 – 1.015)	.004 (.005)	1.005 (0.995 – 1.015)
Urban born			-0.012 (0.024)	0.989 (0.943 - 1.036)	-0.012 (0.024)	0.988 (0.942 - 1.035)
Active LDS member (b)			0.104** (0.030)	1.110 (1.047 - 1.176)	0.002 (0.070)	1.002 (0.874 - 1.149)
Interaction between a and b					0.123 (0.077)	1.130 (0.972 - 1.315)

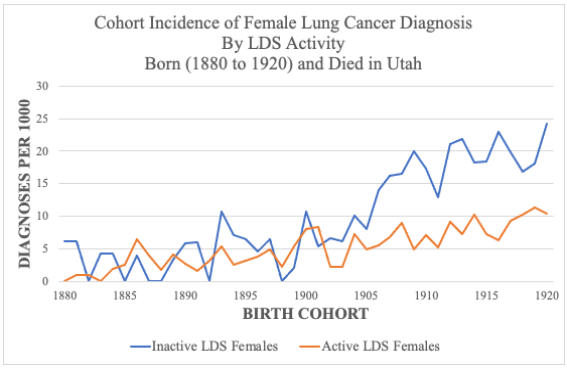
* P <.05, ** P <.001, ***P < .0001

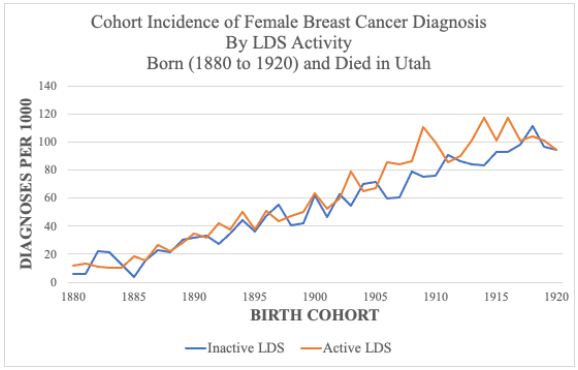
[1] Birth sex ratios scaled to .01

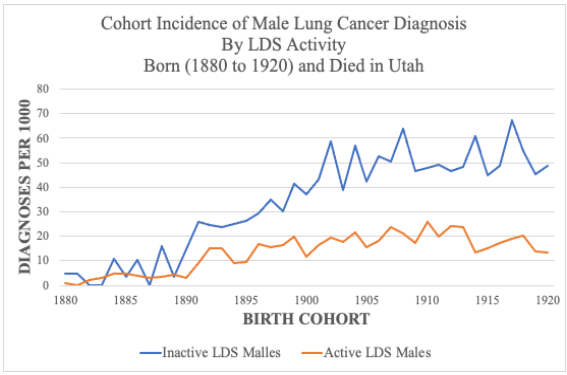
Figure 1. Descriptive charts of Lung and Bronchus, Colorectal, Breast, and Prostate cancers.











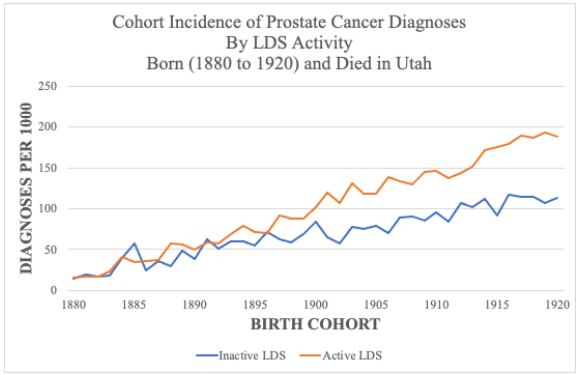
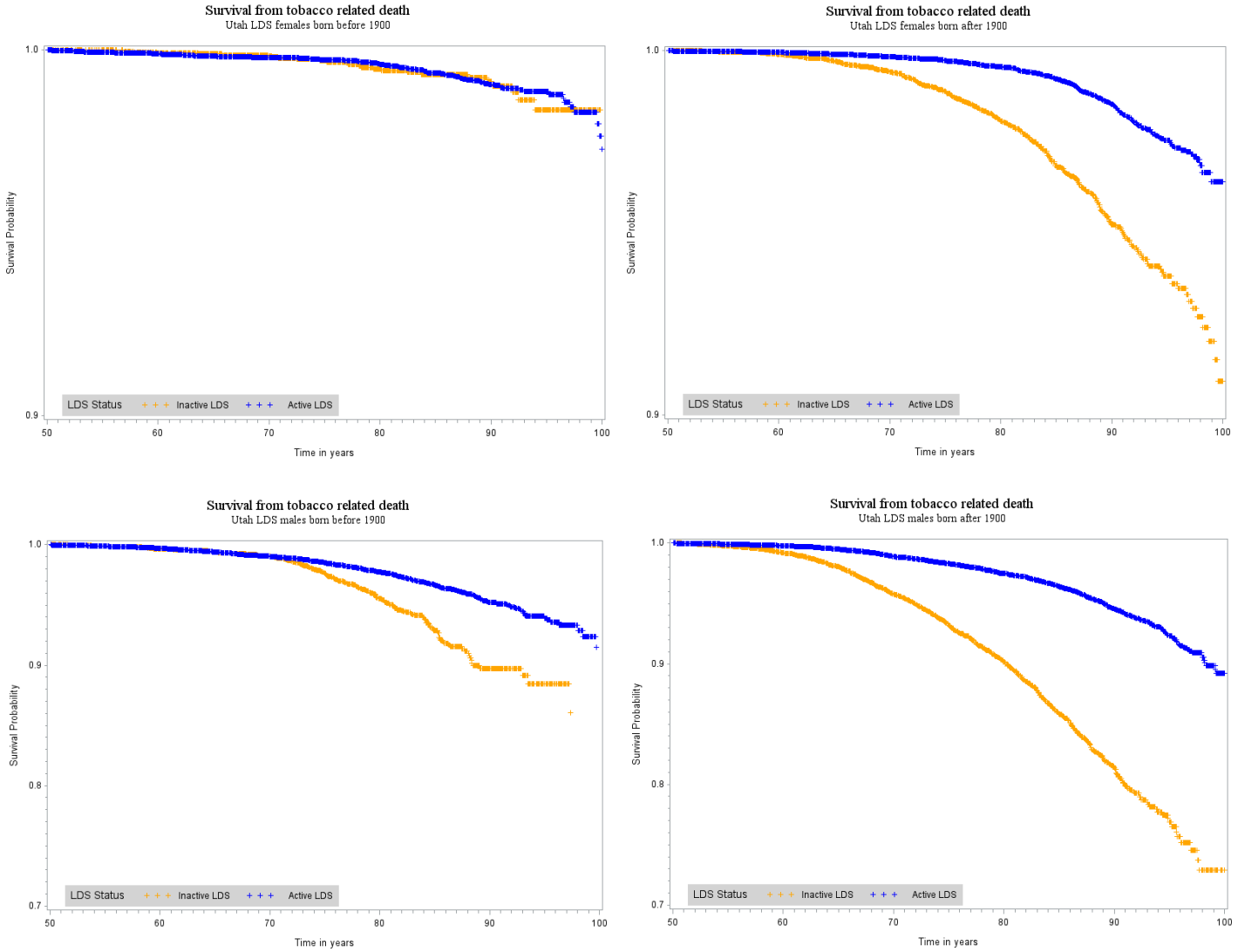


Figure 3. Survival plots, risk of tobacco related death, by sex and LDS activity status. Females appear in the top row, and males appear in the bottom row.



Online Appendix

Demographic Expansion in Utah: Religion, Policy, and Mortality

Jason P. Bonham, Ken R. Smith, Tim A. Bruckner

Supplementary Tables and Figures.

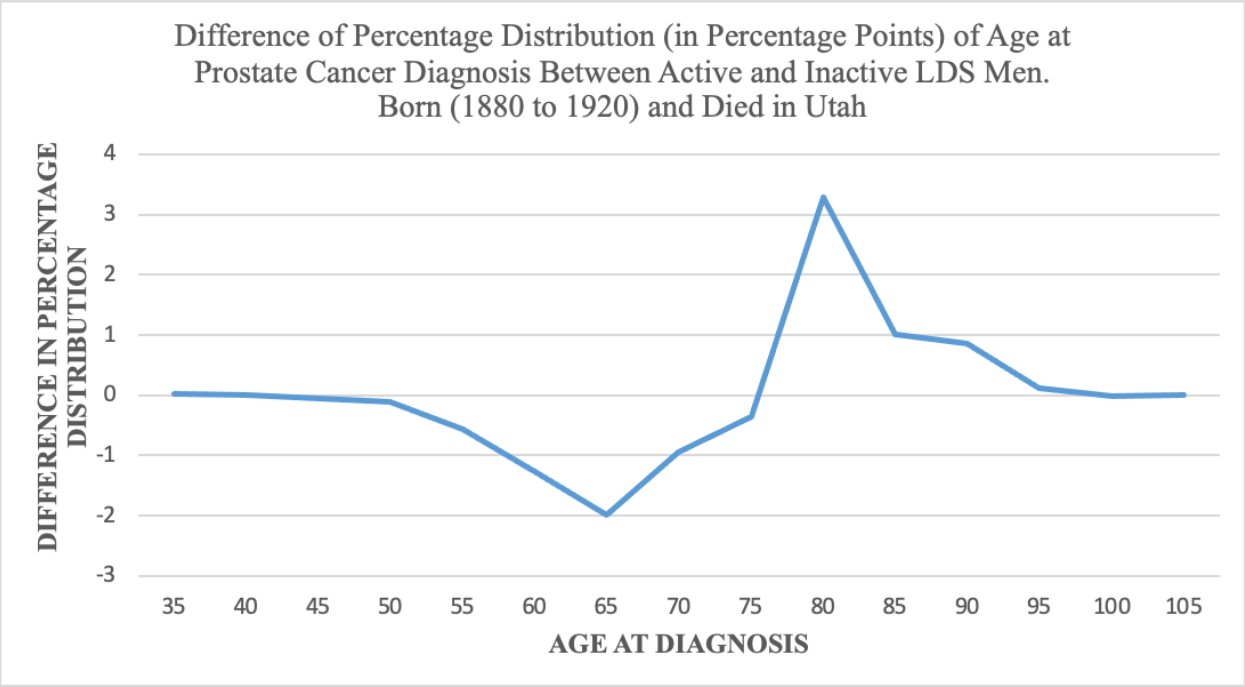
Table A1. Distribution of age at prostate cancer diagnosis by LDS activity level

	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 A2. ICD Codes by disease group and 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

Figure A1.


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