



Carolina Blue Sky Analytics

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Executive Summary

In response to the growing interest in enhancing policyholder life expectancy, the team at Carolina Blue Sky Analytics has developed several health incentive programs aimed at this objective. Our exploratory data analysis (EDA) reveals a significant association between smoking habits and increased mortality due to circulatory diseases. While this correlation does not establish causation, it underscores the need for a deeper investigation into the underlying data to identify effective strategies for mortality reduction related to circulatory diseases. Building on the premise that lifestyle choices play a pivotal role in health outcomes, our second initiative delves into the impact of physical activities, such as walking and exercise, on reducing the incidence of adverse health events within the Lumaria population. This approach is predicated on the basis that encouraging healthier lifestyles can contribute to a decrease in health-related risks and improve overall longevity. Furthermore, our research extends to examining the high mortality rates attributed to neoplasms. Given the complex and often intractable nature of these conditions, our focus shifts towards the exploration of preventative measures. By emphasizing early detection and adopting proactive health strategies, we aim to mitigate the prevalence and severity of these conditions among SuperLife's policyholders. Together, these initiatives represent a holistic approach to extending life expectancy through the modification of lifestyle factors and the implementation of preventative health measures.

The findings from our analysis not only highlight critical areas warranting immediate attention and intervention, setting the stage for the implementation of bespoke health initiatives tailored to address these concerns. The deployment of our recommended strategies promises a multitude of benefits across the spectrum of stakeholders. For SuperLife policyholders and the broader Lumarian community, these initiatives herald the advent of healthier lifestyles, characterized by increased vitality and longevity, alongside a significant reduction in long-term healthcare expenditures. Concurrently, SuperLife stands to reap substantial benefits from these health incentive programs. Anticipated outcomes include the enhancement of its market competitiveness through the offering of more attractive insurance plans and a notable decrease in expected total payout amounts, owing to the improved health and longevity of its policyholder base.

In summary, Carolina Blue Sky Analytics presents a comprehensive and forward-thinking approach to extending life expectancy. Through the strategic alignment of lifestyle modifications and preventative health measures, we aim to catalyze a paradigm shift towards a healthier, more vibrant future for the Lumarian population and beyond. Our initiatives not only aim to mitigate prevailing health risks but also endeavor to engender a culture of proactive health management, promising substantial benefits for individuals and institutions alike. As we move forward, our commitment to leveraging data-driven insights to inform our strategies remains unwavering, with the ultimate goal of achieving a lasting impact on public health outcomes.

Smoking

Introduction

The history of smoking spans centuries, evolving through cultural, social, and economic contexts to become one of the leading global public health concerns of modern times. Historically viewed as a symbol of sophistication or a leisurely pastime, the per-

ception of smoking has dramatically shifted as scientific research has unveiled its detrimental health effects [Cornfield et al., 1959]. Among these, the impact on the cardiovascular system is particularly alarming, with evidence strongly linking smoking to a range of circulatory diseases, including hypertension, coronary heart disease, and peripheral vascular disease [Ambrose and Barua, 2004, Okorare et al., 2023]. Recent studies underscore the heightened risk smokers face regarding circulatory health. For instance, the incidence of myocardial infarction and stroke is significantly higher among smokers than in non-smokers, a disparity that underscores the urgency of addressing this modifiable risk factor [Ambrose and Barua, 2004]. Our analysis, building on these established relationships, seeks to quantitatively demonstrate the link between smoking and increased mortality due to circulatory diseases. Utilizing comprehensive data from the SuperLife policyholder data set, we can see that these problems arise in Lumaria as well as demonstrated by Figure 7. The forthcoming section will delve into the specifics of our methodology, culminating in a graphical representation that highlights the stark realities faced by smokers and also reinforces the critical need for intervention strategies aimed at reducing smoking rates.

After running a Fisher's Exact Test on the counts of alive and deceased smoker versus non-smoker policyholders as shown in Figure 9, the p-value is below our alpha of 0.05, so we reject the null hypothesis that the proportions are equal. When determining the actual mortality rates of each group, we calculate policyholders who smoke to have a 23 percent mortality rate while policyholders who do not smoke have a 3 percent mortality rate. This notable difference is the reason why our recommendations aim to assist policyholders in smoking cessation.

Planned Design

Despite widespread knowledge of its risks since the 1960s, smoking persists, largely due to nicotine's addictive properties. "Nicotine is the key chemical compound that causes and sustains the powerful addicting effects of commercial tobacco products" [Centers for Disease Control and Prevention (US), 2010]. Although Nicotine has not been proven to cause detrimental health benefits on its own—at least when compared to tobacco. When paired with other substances, as it often is, nicotine can have the effect of generating a physical addiction within an individual who may have already or will begin to develop a psychological attachment to the substance. To mitigate these risks, I propose a planned design for disseminating free nicotine products to SuperLife policyholders who smoke. This will lead to an overall benefit in SuperLife policyholder's health since the "use of nicotine or other medications to facilitate smoking cessation in people with known cardiovascular disease produces far less risk than the risk of continued smoking" [Centers for Disease Control and Prevention, 2023]. Further, we will call this technique Nicotine Replacement Therapy (NRT) as it is commonly referred to in scientific literature. NRT has been widely researched and is known to be a significant technique for increasing smoking cessation in populations of individuals possessing a substance use disorder. In our proposal, we will focus on a few forms of NRT inhalators, lozenges, gum, and quickmist spray (all offered by Nicorette, the brand name of several products for nicotine replacement therapy that contain nicotine polacrilex). NRT was developed in the late 1970s in Sweden by AB Leo in the form of chewing gum such that Nicorette was the first nicotine replacement product on the market. Although less and more expensive options exist on the market, we have chosen Nicorette due to its widespread availability and relatively average pricing in comparison to other products.

When seeking to optimize costs, it is certainly possible for SuperLife to use alternative NRT brands in their aims to reduce costs with similar outcomes on policyholders. Notably, there is an opportunity for identical effects on policyholders regardless of which form of NRT is chosen, so each person can subscribe to their favorite of those available without expecting worsened results compared to other NRT options. This was researched further in [Stead et al., 2012] which found, “The chances of stopping smoking [when using NRT] were increased by 50 to 70%. The evidence suggests no overall difference in effectiveness between different forms of NRT, nor a benefit for using patches beyond eight weeks. NRT works with or without additional counseling and does not need to be prescribed by a doctor. Heavier smokers may need higher doses of NRT. People who use NRT during a quit attempt are likely to further increase their chance of success by using a combination of the nicotine patch and a faster-acting form or by combining the patch with the antidepressant bupropion. Data suggest that starting to use NRT patches shortly before the planned quit date may increase the chance of success. Adverse effects from using NRT are related to the type of product and include skin irritation from patches and irritation to the inside of the mouth from gum and tablets. There is no evidence that NRT increases the risk of heart attacks.” So, it would be most beneficial to smoking cessation if SuperLife allowed policyholders to choose their favorite of the NRT options offered and to pair this was regular patches for up to 8 weeks, at which point SuperLife can stop divvying out free patches to the individual since it will have a marginal impact. It may be presupposed by the reader that the drastic effect of NRT on smoking cessation noted above may have been impacted by the support offered to the individual due to their participation in the research study, a phenomenon commonly referred to as participant bias. However, this was also looked into and it was found that “NRTs increase the rate of quitting by 50 to 70%, regardless of setting. The effectiveness of NRT appears to be largely independent of the intensity of additional support provided to the individual. Provision of more intense levels of support, although beneficial in facilitating the likelihood of quitting, is not essential to the success of NRT” [Stead et al., 2012]. So, we propose a plan to divvy out NRT to policyholders to increase smoking cessation which will, in turn, lead to a lower outcome of diseases of the circulatory system-the second highest proportion of cause of deaths among policyholders.

Cost-Benefit Analysis

Product	Cost	Cigarette Equivalent
Inhalator	Č74.93	140
Lozenge	Č59.26	40
Gum	Č62.74	105
QuickMist Spray	Č60.99	150
Patches 7-Pack	Č38.35	70

Figure 1: Nicorette NRT Products

As evidenced by the above graph, we have three best values as an inhalator, gum, and quickmist spray with a cost per cigarette equivalent of Č0.54, Č0.60, and Č0.41 respectively. Notably, it was also found that pairing NRT with the use of patches over 8 weeks had a greater effect on smoking cessation so we should also consider patches for each individual with a cost per cigarette equivalent to Č0.55. We’ve chosen to highlight the three best values of NRT since as mentioned earlier each individual will have a preferred NRT and each will have an identical outcome on smoking cessation. Thus, we should opt to allow an

individual to choose their favorite amongst the three. To account for this, we will take the average of the three with a cost per cigarette equivalent of \$0.52. So, across 8 weeks we can expect a cost of Č306.80 for patches and Č582.40 for NRT given an individual on the higher end of the spectrum who regularly smoke 20 cigarettes a day, to offer a more conservative estimate. In our data there are 47,434 living smokers, meaning that if 100% of our smoking policy holders were to adopt the NRT we could have a maximum cost of Č27,625,561.60. However, the impact this would have on our rates of payout compared to the length of an individual holding their policy would be substantial. Diseases of the circulatory system were the second highest cause of death in SuperLife policyholders within Lumaria and contributed to the death of 11,871 individuals. Offering free NRT programming will lead to a 50 to 70% increase in smoking cessation within the population leading to a, conservative, reduction of smokers by 23,717 amongst currently living policyholders who smoke. Given that 75.05% of smokers die to diseases of the circulatory system, this could lead to a reduction in deaths of 17,800 individuals. If we take the average payout for smokers-which was significantly lower than for nonsmokers as evidenced by [Figure 14](#)-this results in an average inflation-adjusted savings of Č759,747.50. Overall this results in a savings of Č13,523,505,500. This can be subtracted from the maximum cost of Č27,625,561.60 to result in a total profit of Č13,495,879,938.40 for SuperLife to those who are paid out to diseases of the circulatory system.

Neoplasms

Introduction

Cancer has many unknown risk factors and research is still being done on treatments. As of right now, the most effective way to reduce the mortality rate starts with early detection. In Lumaria, a large portion of their mortality rate is linked to deaths due to cancer. As employees of Superlife, our goal is to minimize the mortality from cancer due to preventative measures. There is a 33.47 percent correlation between Neoplasms and cause of death and with the data provided, we know that there is a 5-10 percent reduction in mortality from cancer prevention incentives. The five-year survival rate for cancer is very low, however, for stage 1 cases, the five-year survival rate is much higher. Cancers detected earlier have a relatively good prognosis compared to those detected at a later point. Using age, sex, and family history, we can filter high-risk individuals specifically and incentivize them to get more frequently screened. Many cancers currently do not have cures, however, primary and secondary prevention are the most effective measures. Primary prevention includes high risk groups taking preventative measures, such as avoiding while secondary prevention [[Pinsky, 2015](#)]. Thus, we propose methods to incentivize people to get frequent screenings and take preventative measures.

Planned Design

Lumaria has an employment distribution consisting of 12 percent of the employed population working in agriculture and 15 percent in construction. Specifically in agriculture, farmers and farm workers face increased risks of skin cancer from exposure to solar ultra-violet radiation from working outdoors [[Kearney et al., 2014](#)]. Lumaria is also known for Super Luminova, a festival celebrated on the summer solstice with outdoor activities. Recent studies have shown that good sun habits prevent damage that can eventually lead to melanoma. [[Harvard Health, 2012](#)]. The general recommendation is to reapply sunscreen

every two to three hours as a preventative measure, ultimately helping with skin cancers like melanoma [Li et al., 2019]. As an incentive to apply sunscreen more frequently, we wanted to provide free sunscreen dispensers to employees of the agriculture and construction sectors who spend more time outside. Additionally, it would be beneficial to provide the attendees of Super Luminova with sunscreen since it is an event with a wide number of outdoor activities. A study done recently highlighted that public receptiveness to sunscreen dispensers was positive when they were implemented by a nonprofit combating melanoma [Eason et al., 2021]. Cervical cancer screening decreased mortality by more than 80 percent [Pinsky, 2015]. We know that there is a correlation between increased screenings and decreased mortality rates, so we want to incentivize people to get screenings by offering them at a discounted price. Barriers that keep women from getting mammograms include high cost [Clark, 1992]. Reducing the price of mammograms would increase the proportion of women who get mammograms. Additionally, we will implement a discount on genetic testing as 10 percent of patients diagnosed with cancer have a gene that increases their susceptibility to cancer. There are over 100 genes that have been linked to a higher susceptibility to cancer. If high-risk populations with this gene were aware of its presence, they would be able to take primary and secondary preventative measures more frequently to reduce the mortality from cancer [Stadler and Schrag, 2023]. Due to this, we plan to offer a free genetic counseling session with a preliminary analysis of any high-risk genes that should be monitored. As a result, people would be motivated to take advantage of this free service. If anything that should be monitored is found, people would be more likely to get screened frequently, knowing that there is something to be concerned about.

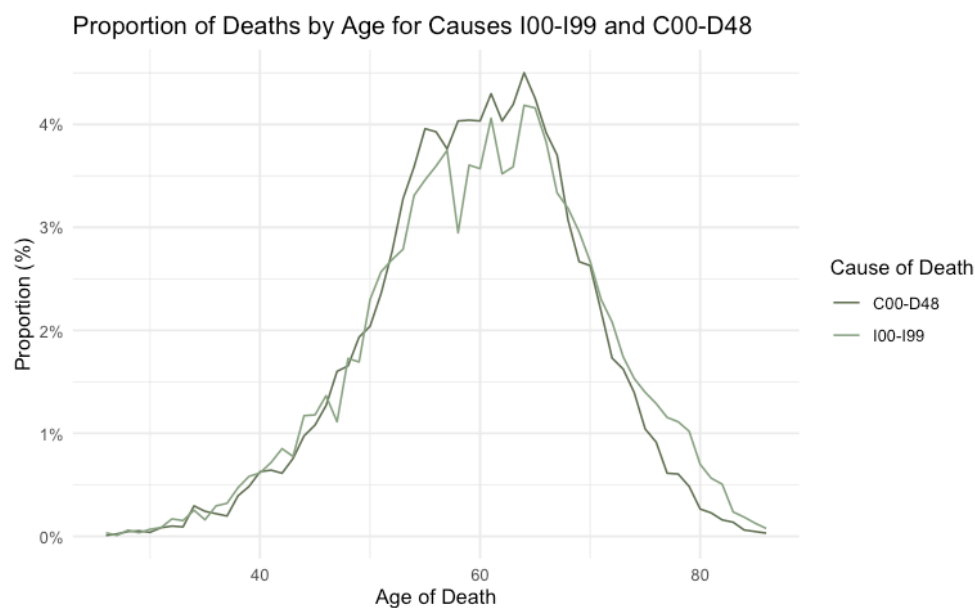


Figure 2: Line plot depicting the proportion of deaths by age for causes C00-D48 and I00-I99. Both causes are represented with a green line, illustrating their respective distribution over the age of death.

Cost-Benefit Analysis

As shown in Figure 2, we can see a similar trend in the proportion of deaths by age for both cancer and circulatory system deaths. There is a peak in the proportion of deaths around 55 to 65 years old which could be the time period in which we emphasize screenings for cancers, specifically for populations with a high-risk gene or frequent smokers. Overall, implement-

ing this design can be costly. We would have to offer a free session in genetic counseling where people could choose to continue if anything could possibly increase the risk of cancer in the future. The average cost of a genetic counseling session is about Č348.60 per session, however, comparing this cost to the benefit that Superlife will have if people continue to take preventative measures after finding out they are at high risk for cancer. Additionally, we plan on giving out free sunscreen to people who spend a lot of time outside for their jobs. In Lumeria, 17.25 percent of the population is employed in either the agriculture or construction sector, meaning that a significant portion of their day is spent outside in the sun. The average price of a sunscreen dispenser is Č148.55 per dispenser. We plan to install 1000 sunscreen dispensers in the most populated farms, construction sites, and cities for people to use so that they are more incentivized to reapply their sunscreen every few hours. Specifically on Super Luminova, we would make sure to have at least 100 additional sunscreen dispensers in the area for the citizens to use intermittently while taking part in the outdoor activities. Since using sunscreen has been shown to reduce the chances of melanoma, this will ultimately benefit Superlife by decreasing the proportion of the population with melanoma, ultimately decreasing the mortality rate. Finally, we will also offer a 15 percent discount on screenings as one of the barriers stopping people from getting screened consistently is the price point. Since people tend to opt for treatments when they are available at a discounted price, we think that this will ultimately motivate Lumerians to get screened regularly. The cost it takes to implement these treatments is paid back by the impact it will have on ultimately decreasing mortality rates.

Gamifying Healthy Behaviors

Introduction

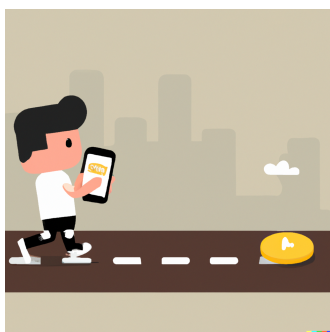
In an era where digital engagement is at its zenith, the intersection of technology and health promotion presents unprecedented opportunities for fostering healthier lifestyles. Among the myriad of digital innovations, gamification has emerged as a potent mechanism for encouraging active behaviors, leveraging the intrinsic human affinity for play and competition. The success story of *Pokemon Go*, a mobile game that achieved global acclaim in 2016 with over 1 billion downloads, exemplifies the profound impact that gamified apps can have on physical activity levels and overall health [Zach and Tusseyadiah, 2017]. However, the potential of gamification extends far beyond a single application; it encompasses a wide array of strategies designed to motivate and engage users in healthy behaviors through digital rewards, progress tracking, social interaction, and personalized challenges [Johnson et al., 2016].

The significance of such strategies is particularly acute in Lumaria, where a substantial segment of the population—53 percent of whom are employed in the service sector—leads predominantly sedentary lifestyles. The adverse health implications of physical inactivity are well-documented, ranging from increased risks of obesity and type 2 diabetes to heart disease and various forms of cancer [Centers for Disease Control and Prevention, 2023]. With cancer and heart disease already identified as major health concerns in Lumaria, there is a critical need for innovative interventions that can seamlessly integrate into the daily lives of the population, encouraging movement and healthy living without feeling burdensome.

This backdrop of technology's potential to effect positive health changes, coupled with Lumaria's specific health challenges, lays a compelling foundation for SuperLife to venture into the development of a health-centric mobile application. By capitalizing on the principles of gamification, SuperLife can pioneer a novel approach to health promotion, one that not

only addresses the immediate need for increased physical activity among its policyholders but also aligns with broader public health goals. The envisioned app will not only offer a game-based incentive mechanism to encourage walking and running but also serve as a multifaceted platform offering insights into policy details, company information, and premium management. Through this initiative, SuperLife aims to transcend the traditional boundaries of insurance services, venturing into the realm of preventive health care and wellness promotion, thereby contributing to a healthier, more vibrant Lumaria.

Planned Design



Example of App Design Developed by AI Image Generator Software DALL-E

For the aforementioned reasons, SuperLife should develop an app for their policyholders. This app should have multiple uses. The first one is the game aspect, which will encourage healthy behaviors. The app will reward players for walking and/or running by allowing them to pick up coins. These coins will spawn in the game after every 10 minutes of walking for up to 30 minutes a day for a total of up to 3 coins. These coins can then be used for monetary rewards such as €10 or €25 gift cards to Lumarian stores and restaurants for 200 coins or 500 coins respectively. In cases where policyholders have term insurance, they will also have the chance to lower their premium payments for one installment by €5 for 100 coins. Other aspects of the app will include general information about a policyholder's plan, information about SuperLife, and the ability to pay premiums if the user has a term insurance plan.

Cost-Benefit Analysis

Developing an advanced app can be pretty costly. Up-front costs can range anywhere from €60,000 to €105,000, while app maintenance will most likely cost about 25 percent of the initial development cost a year [Sebastian, 2023]. This means over a 10-year period the app will have a total cost anywhere from €210,000 to €367,500. This does not include the payouts through the reward system. With full utilization, we expect the cost to be €604,600,000. This is calculated by assuming that the number of future policyholders will follow a quadratic model following 2001 to 2023 policyholder data. After calculating the predicted number of policyholders over the next 10 years using Figure 11, it is multiplied by the maximum amount of reward earned over 10 years for 1 person. €604,967,500 is the predicted maximum cost of the app over 10 years, though this number is very unrealistic as less utilization would mean a lower cost than the previously mentioned number. The probability that 100 percent of policyholders utilize the app for 100 percent of the days in the 10 years is unrealistic. But even with the maximum cost, using a predictive model Figure 10 to estimate the total claims over the next 10 years at €35,076,871,079, it is only a small portion. This model is calculated using data from 2001 to 2023 excluding 2020 to 2022. Data from these years were excluded because of a sudden unexplained jump in total claims as shown in Figure 13 but eventually steadies out and returns to the previous rate. When assuming that the service sector will be the most affected group and estimating their proportion of the claims to be 53 percent of the total, the app would only need to decrease their claims by 3.3 percent to net gain. This is a very obtainable number seeing as the previously mentioned research has found that gamified apps with monetary rewards are wildly successful and have linked ties to healthy behaviors.

Influence of Celebrities on Health

Introduction

In today's society, celebrities are highly influential people whose words and actions greatly affect a large audience. This target audience not only tends to emulate similar behaviors but also promotes and persuades other around them to do the same. Many celebrities promote and publicize medicinal products and offer health-related advice that may or may not create a beneficial impact on individuals consuming the media [Hoffman et al., 2017]. However, among all celebrities, athletes are used most often by corporations for health-related campaigns. The athletes' image, reputation, and success are factors that have become popular to use for endorsement. Researchers Minh Ha and Cao conducted over 450 questionnaires with a 5-point Likert Scale to identify what makes an athlete endorsement effective [Minh Ha and Cao, 2019]. The questions asked were split into three main categories; athlete identification, athlete endorsement and finally purchase intention of the consumer. Based on the survey, the research concluded that the five main attributes of the athletes that increase their effectiveness include; athlete expertise, trustworthiness, attractiveness, and toughness. Taking in these factors, we can propose methods to improve the health of the citizens of Lumaria by providing incentives through influential figures such as athletes.

Table 1 Fourteen mechanisms explaining celebrity influence

Discipline	Mechanism	Description
Economics	1) Signals	Celebrity endorsements act as markers that differentiate endorsed items from competitors.
	2) Herd behavior	Celebrities activate people's natural tendency to make decisions based on how others have acted in similar situations.
Marketing	3) Meaning transfer	People consume items to acquire the endorsing celebrities' traits, which have become associated with the product.
	4) Source credibility	Celebrities share personal experiences and success stories associated with the endorsed item to be perceived as credible sources of health information.
	5) Halo effect	The specific success of celebrities is generalized to all their traits, biasing people to view them as credible medical advisors.
Neuroscience	6) Neural mechanisms of meaning transfer	Celebrity advertisements activate a brain region involved in forming positive associations, indicating the transfer of positive memories associated with the celebrity to the endorsed item.
	7) Neuropsychology of credibility	Endorsements from celebrities activate brain regions associated with trustful behavior and memory formation, thereby improving attitudes toward and recognition of the endorsed item.
Psychology	8) Classical conditioning	The positive responses people have toward celebrities come to be independently generated by endorsed items.
	9) Self-conception	People follow advice from celebrities who match how they perceive (or want to perceive) themselves.
	10) Cognitive dissonance	People unconsciously rationalize following celebrity medical advice to reduce the psychological discomfort that may otherwise result from holding incompatible views.
	11) Attachment	People, especially those with low self-esteem, form attachments to celebrities who make them feel independent in their actions, supported by others, and competent in their activities.
Sociology	12) Social networks	Celebrity advice reaches large masses by spreading through systems of people linked through personal connections.
	13) Commodification and social capital	People follow celebrity medical advice to gain social status and shape their social identities.
	14) Social constructivism	Celebrity medical advice may alter how people perceive health information and how it is produced in the first place.

Reproduced from Hoffman SJ, Tan C. Biological, psychological and social processes that explain celebrities' influence on patients' health-related behaviors. Archives of Public Health. 2015;73(3). doi:10.1186/2049-3258-73-3

Figure 3: Fourteen mechanisms explaining celebrity influence

Planned Design

Lumaria is known to have a remarkable array of celebrities including scientists, mathematicians, artists, musicians, and athletes. From the study discussed above, we can assume that using Lumaria's well-known athletes to advertise healthy habits in multiple forms including brand endorsements, media advertisements, television, social media, radio, and events in Lumaria can influence Lumerians to take on healthy habits due to the social stand-

ings of these celebrities. We plan to use one of Lumeria’s well-known athletes to advertise the benefits of using sunscreen on a regular basis and the importance of it in their routine. This will establish a sense of credibility since certain athletes usually are people who spend a significant amount of time outside in the sun, so sun protection is also an important part of their routine. Additionally, a celebrity’s characteristics are often transferred to the products that they endorse. If our app used to promote fitness is endorsed by an athlete, the app will be associated with the athlete’s existing fitness. Hearing celebrity endorsements create positive associations in the brain between the product and its function [Hoffman et al., 2017]. Utilizing a performer, specifically one that is going through nicotine withdrawal therapy, would contribute to a decrease in the number of smokers. Studies show that people are conditioned to follow their favorite celebrities and have a subconscious push to become more like them. This will incentivize more people to start nicotine withdrawal therapy.

Cost-Benefit Analysis

The cost-benefit of techniques dedicated towards smoking cessation, preventative measures for neoplasms, and gamifying healthy behaviors have already been discussed above. To further enhance, this we will now discuss the impact of celebrity endorsements on these techniques. The cost of celebrity endorsements ranges from thousands of dollars to millions of dollars. Taking into account that we want to use more influential celebrities, we are assuming that our compensation would be around the higher end, around five million dollars per endorsement deal. However, the benefits would outweigh the costs due to the halo effect as referenced in the table where people tend to look to celebrities for medical advice.

Implementation Plan

All 4 of these programs should be put into effect in a timely manner. The sooner they are implemented the sooner the benefits will be noticed. The effectiveness of the app, sunscreen stations, and mammogram discounts will be reviewed on a 5-year basis as they will have constant preventative benefits. They will be analyzed for cost and benefits attributed to these programs. The smoking cessation program will be reviewed on an annual basis on the assumption that the effective use of the program will decrease the proportion of policyholders who smoke and therefore render the program redundant. Celebrity endorsements require a more regular reviewal every 3 months as celebrity favor is often rapidly changing.

Data Limitations and Assumptions

The dataset provided to us was characterized by a significant presence of categorical or binned variables, which inherently constrained the scope of statistical tests and analytical techniques deployable in our study. The granularity required for complex hierarchical or predictive modeling was notably absent, thereby limiting our ability to extrapolate our findings to unobserved phenomena, such as predicting temporal trends as highlighted in Figure 13. This granularity deficit curtailed our capacity to employ advanced statistical models that could have provided more nuanced insights into the data, particularly in forecasting future trends based on past patterns. Additionally, the impact of recent global events, specifically the COVID-19 pandemic, on the study area could not be fully quantified due to a scarcity of contemporaneous news and updates from the region. However, a discernible deviation from expected trends in the years 2020 through 2022—marked in red in Figure 13—suggests a significant, albeit indirectly observed, impact of the pandemic on the area. The apparent

reversion to anticipated data patterns in 2023 posits a post-pandemic normalization, though the lack of direct data limits the robustness of this inference.

A fundamental assumption underlying our analysis was the applicability of research conducted in other regions—predominantly North America and Europe—to the population of Lumaria, despite the notable absence of detailed cartographic data for the area. To counter-balance this assumption, we employed a strategy of corroborating our findings through the aggregation of multiple, diverse sources. This methodological approach was predicated on the rationale that if similar outcomes could be consistently replicated across various populations, it would be reasonable to infer the potential for similar phenomena within Lumaria. This approach, however, introduces an element of extrapolative risk, as it presumes a level of universality in human and societal behaviors that may not account for unique cultural, environmental, or socio-political factors intrinsic to Lumaria.

Conclusion

Our investigations have laid bare the stark realities confronting Lumaria—high mortality rates stemming predominantly from smoking, neoplasms, and sedentary lifestyles. In response, our multifaceted strategy encompasses smoking cessation programs, cancer prevention efforts, the gamification of health-promoting activities, and leveraging celebrity endorsements to foster a culture of health consciousness.

The introduction of a smoking cessation initiative represents a pivotal step towards addressing the root cause of numerous circulatory diseases, with the potential to drastically reduce mortality rates and healthcare costs associated with smoking-related ailments. By utilizing Nicotine Replacement Therapy (NRT), we are poised to initiate a significant shift in public health dynamics, directly benefiting both the individual policyholders and the broader Lumarian community. Additionally, Neoplasms poses a formidable challenge to public health; our approach emphasizes early detection and preventative measures. By advocating for regular screenings and fostering awareness of lifestyle factors that can mitigate cancer risk, we aim to not only decrease the incidence of cancer but also alleviate the emotional and financial burdens it imposes on individuals and families. Finally, recognizing the power of engagement and motivation in promoting physical activity, our gamification strategy seeks to transform healthy behaviors into a rewarding and enjoyable pursuit. Inspired by the success of mobile applications like Pokemon Go, this innovative approach is designed to seamlessly integrate exercise into the daily routines of Lumarians, leveraging technology to combat the sedentary lifestyle endemic to modern service-oriented economies. Furthermore, celebrity endorsements serve as a potent tool for amplifying our health promotion efforts, leveraging the influence of public figures to inspire and motivate the population towards healthier lifestyle choices. This strategy not only enhances the visibility of our initiatives but also contributes to a cultural shift, wherein health consciousness becomes a valued and aspirational norm.

Collectively, these initiatives are not just health interventions; they represent a holistic approach toward fostering a resilient and vibrant Lumarian society. For SuperLife, the implementation of these measures transcends conventional corporate objectives, aligning long-term profitability with social responsibility. By investing in the health of Lumaria's citizens, SuperLife is poised to witness not only an expansion in its market competitiveness through innovative, health-oriented insurance plans but also a reduction in expected payout amounts due to improved policyholder longevity.

Appendix

Cause of Death	Description
A00-B99	Certain infectious and parasitic diseases
C00-D48	Neoplasms
D50-D89	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism
E00-E88	Endocrine, nutritional and metabolic diseases
F01-F99	Mental and behavioural disorders
G00-G98	Diseases of the nervous system
I00-I99	Diseases of the circulatory system
J00-J98	Diseases of the respiratory system
K00-K92	Diseases of the digestive system
L00-L98	Diseases of the skin and subcutaneous tissue
M00-M99	Diseases of the musculoskeletal system and connective tissue
N00-N98	Diseases of the genitourinary system
O00-O99	Pregnancy, childbirth and the puerperium
Q00-Q99	Congenital malformations, deformations and chromosomal abnormalities
R00-R99	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified
V01-Y89	External causes of morbidity and mortality

Figure 4: Classification of Causes of Death

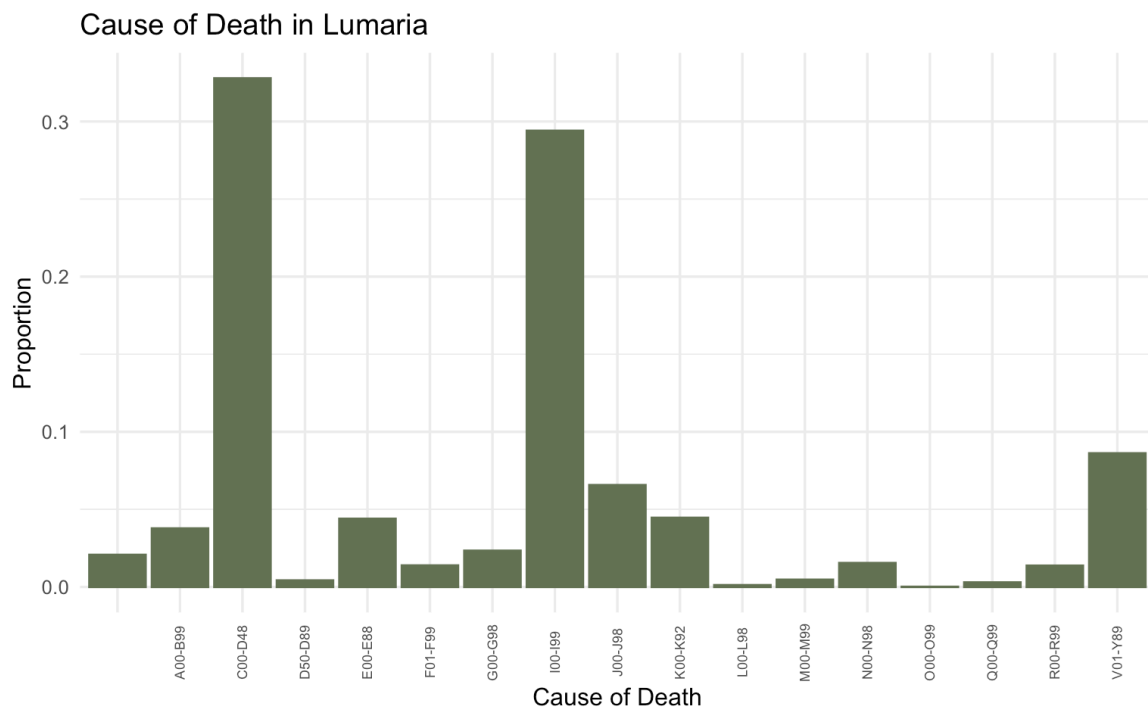


Figure 5: Proportion of population-wide causes of death in Lumaria

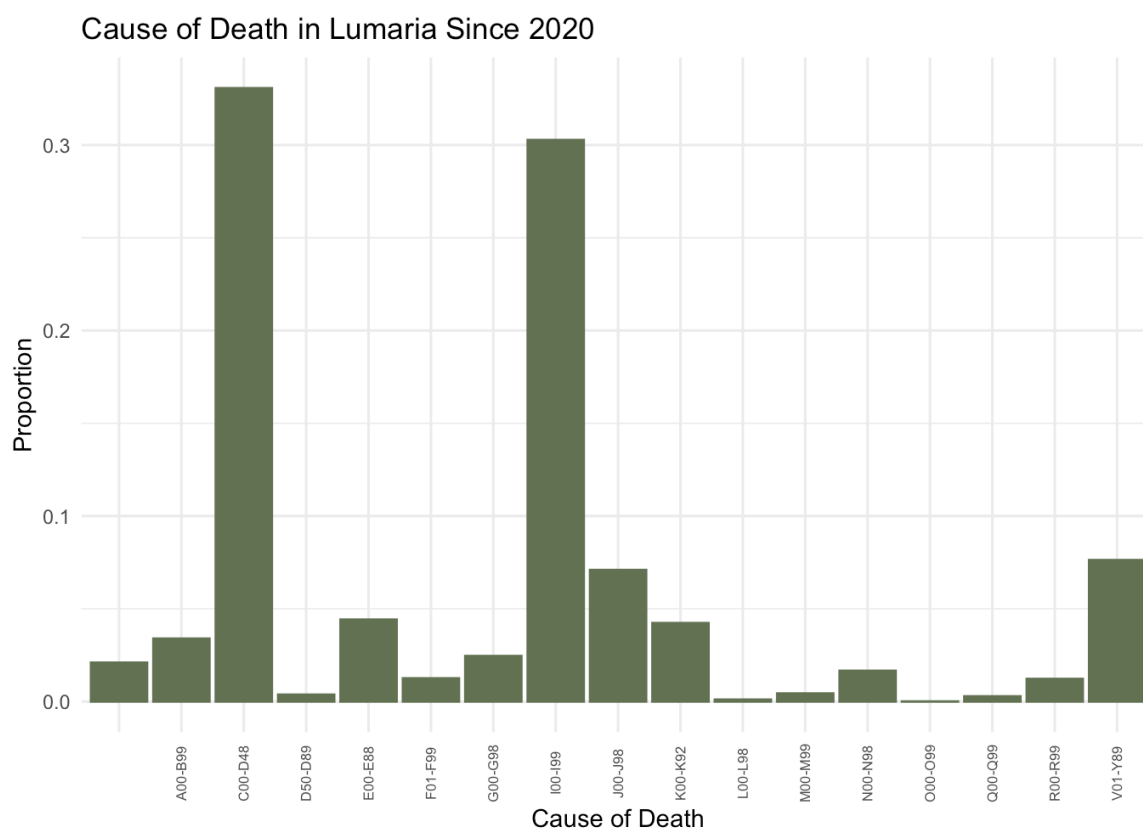


Figure 6: Proportion of population-wide causes of death in Lumaria Since 2020

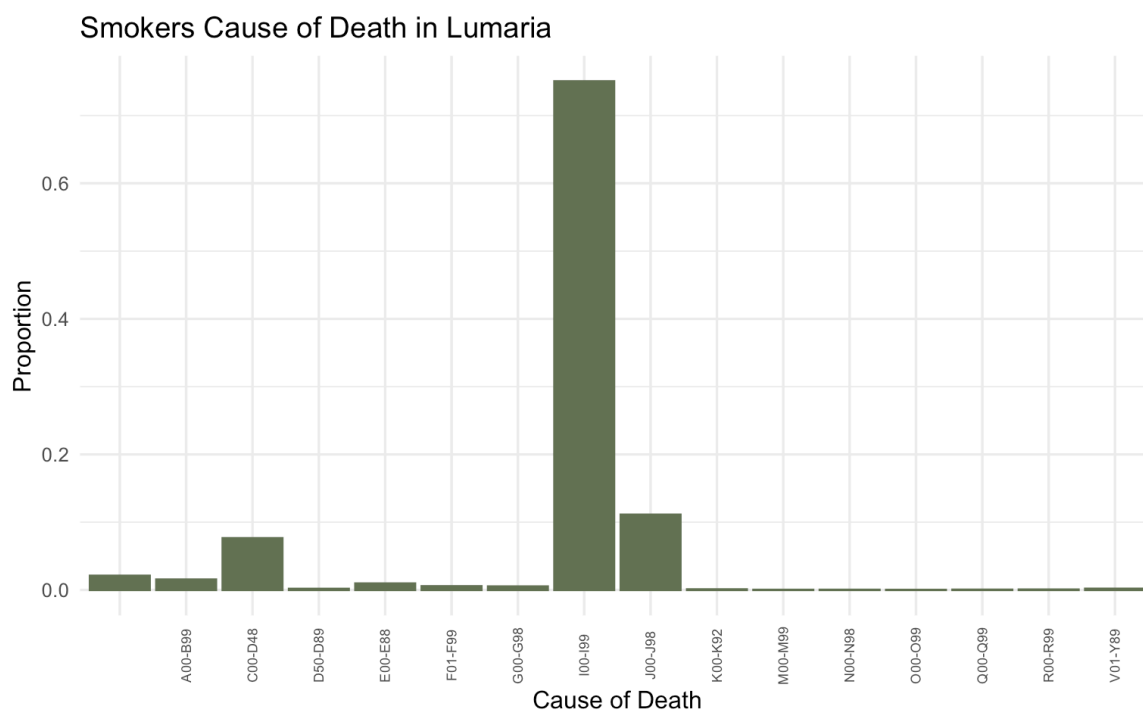


Figure 7: Proportion of smokers' causes of death in Lumaria

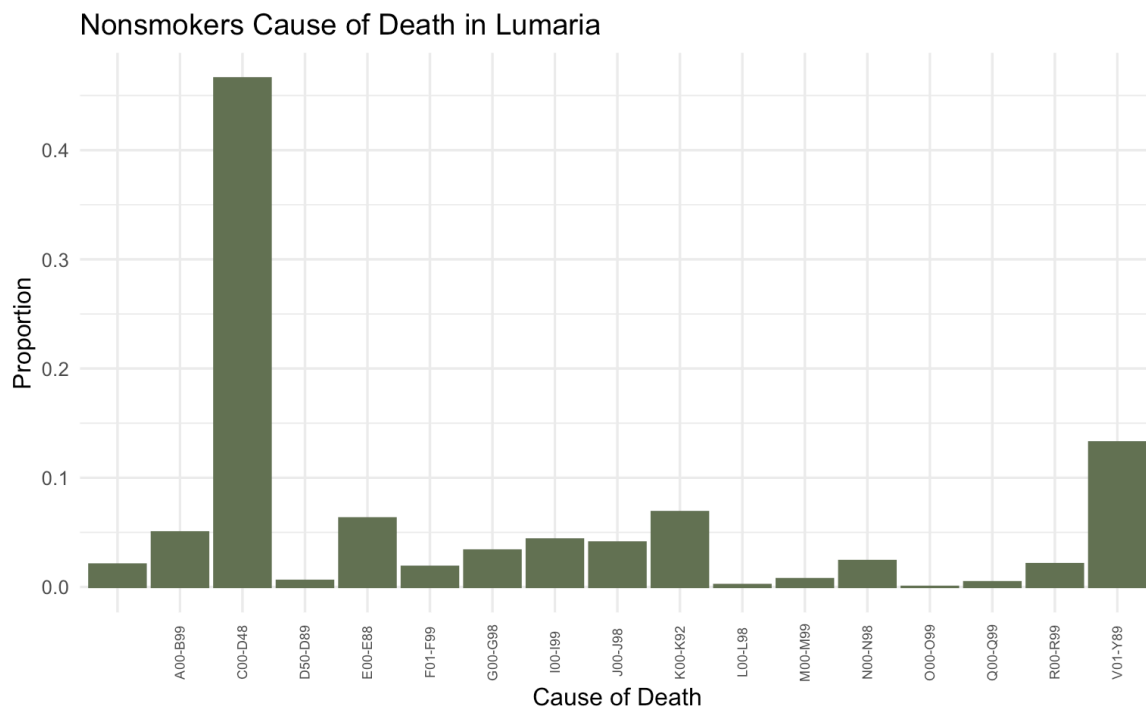


Figure 8: Proportion of nonsmokers' causes of death in Lumaria

Fisher's Exact Test for Count Data

```
data: matrix(c(14306, 26070, 47434, 890772), ncol = 2)
p-value < 2.2e-16
alternative hypothesis: true odds ratio is not equal to 1
95 percent confidence interval:
 10.07428 10.53824
sample estimates:
odds ratio
 10.30515
```

Figure 9: Fisher's Exact Test for Statistical Significance of Smoker vs Non-smoker Mortality Rate

Formula: yvalues ~ model(xvalues, a, b)

Parameters:

	Estimate	Std. Error	t value	Pr(> t)
a	3.418e+04	2.279e+03	15.00	1.29e-11 ***
b	-1.371e+11	9.214e+09	-14.88	1.47e-11 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 247800000 on 18 degrees of freedom

Number of iterations to convergence: 1

Achieved convergence tolerance: 2.142e-07

Figure 10: Predictive Model For Future Inflation Adjusted Claims in the Form $Ax^2 + b$ Where X is Year and Y is Inflation Adjusted Claims

Formula: y ~ model(x, a, b)

Parameters:

	Estimate	Std. Error	t value	Pr(> t)
a	1.046e+01	2.909e-01	35.95	<2e-16 ***
b	-4.192e+07	1.178e+06	-35.60	<2e-16 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 37240 on 21 degrees of freedom

Number of iterations to convergence: 1

Achieved convergence tolerance: 1.054e-07

Figure 11: Predictive Model For Future Policyholders in the Form $Ax^2 + b$ Where X is Year and Y is the Number of Policyholders

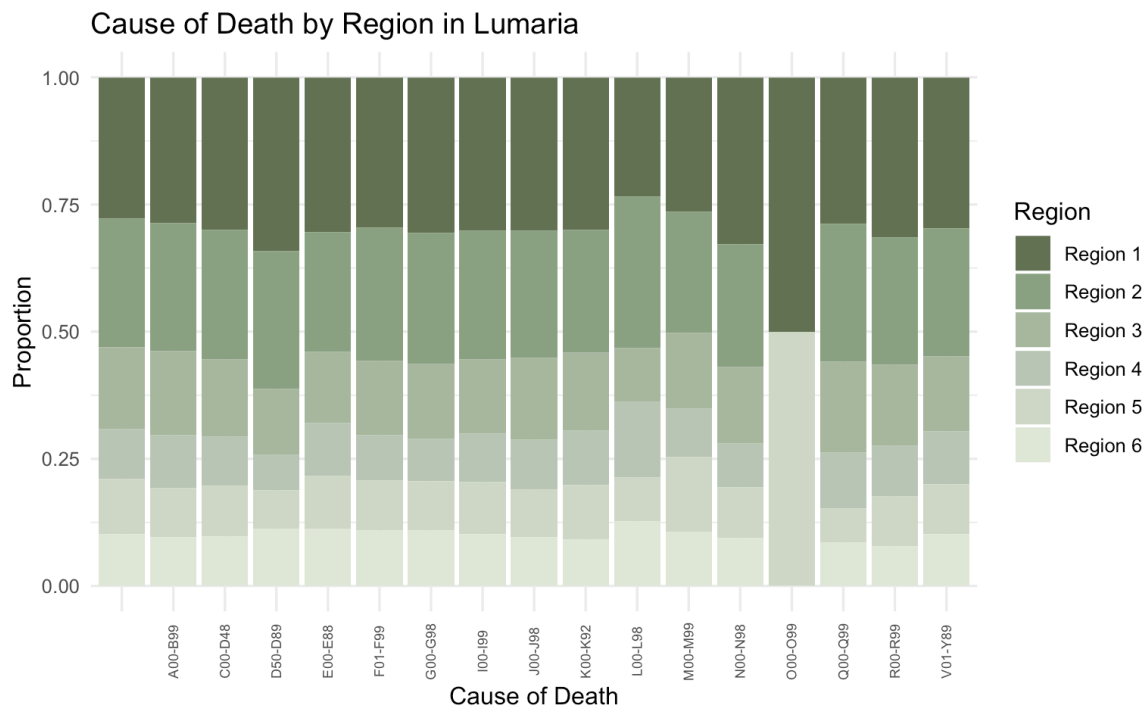


Figure 12: Proportion of death by region in Lumaria

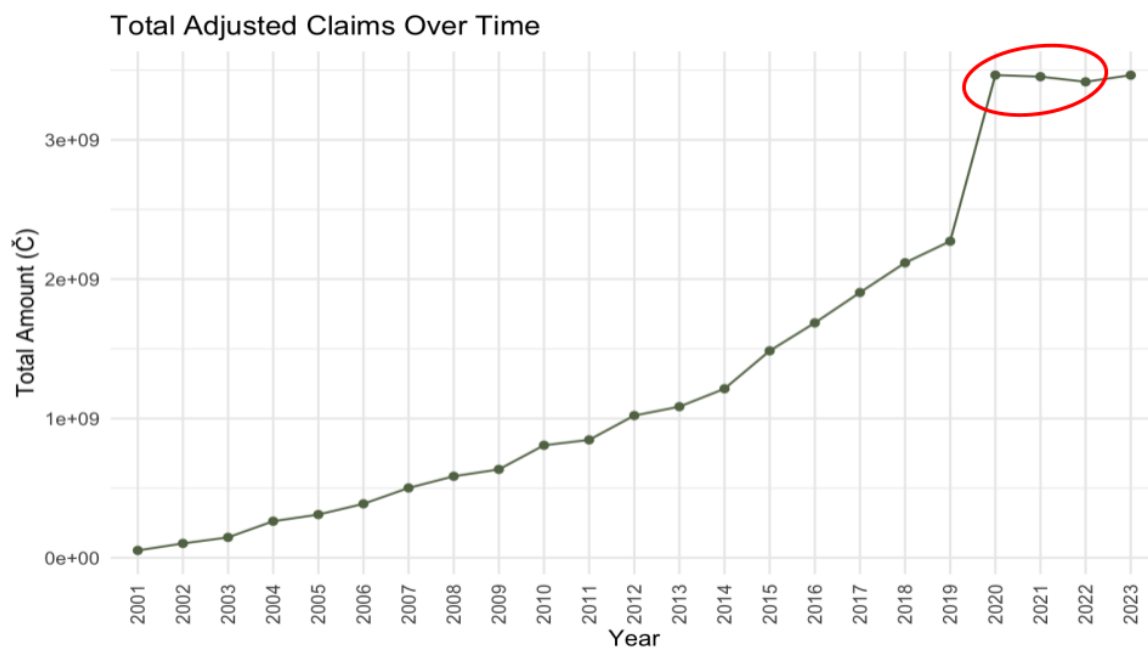


Figure 13: Total Inflation-Adjusted Claims in Lumaria

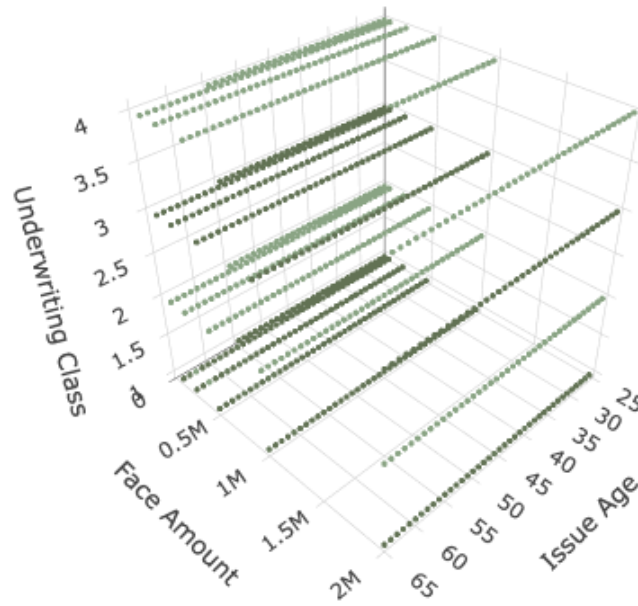


Figure 14: Three-Dimensional Visualization of Smoker Status such that the plot distinguishes between smokers and non-smokers, labeled in dark green and light green, respectively, illustrating their distribution across different underwriting classes, issue ages, and face amounts.

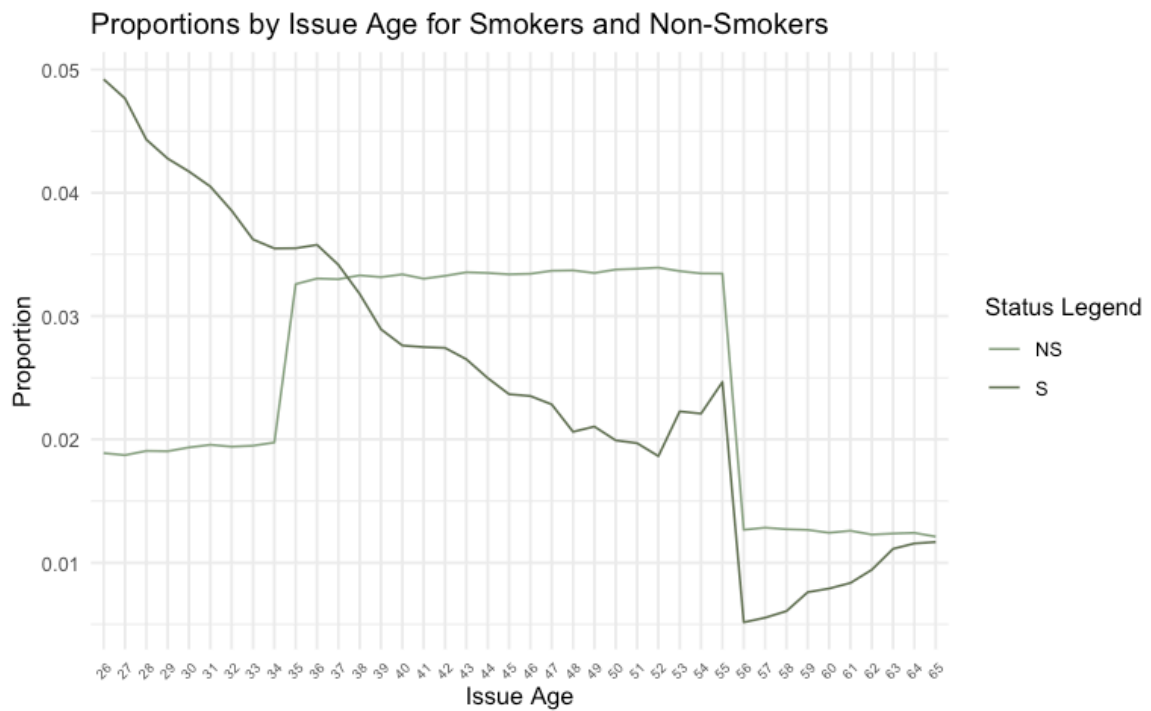


Figure 15: Line plot depicting the proportions by issue age for smokers and non-smokers. Smokers are represented by a dark green line, and non-smokers by a light green line, showcasing the proportional distribution across different issue ages.

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