Mew Consulting
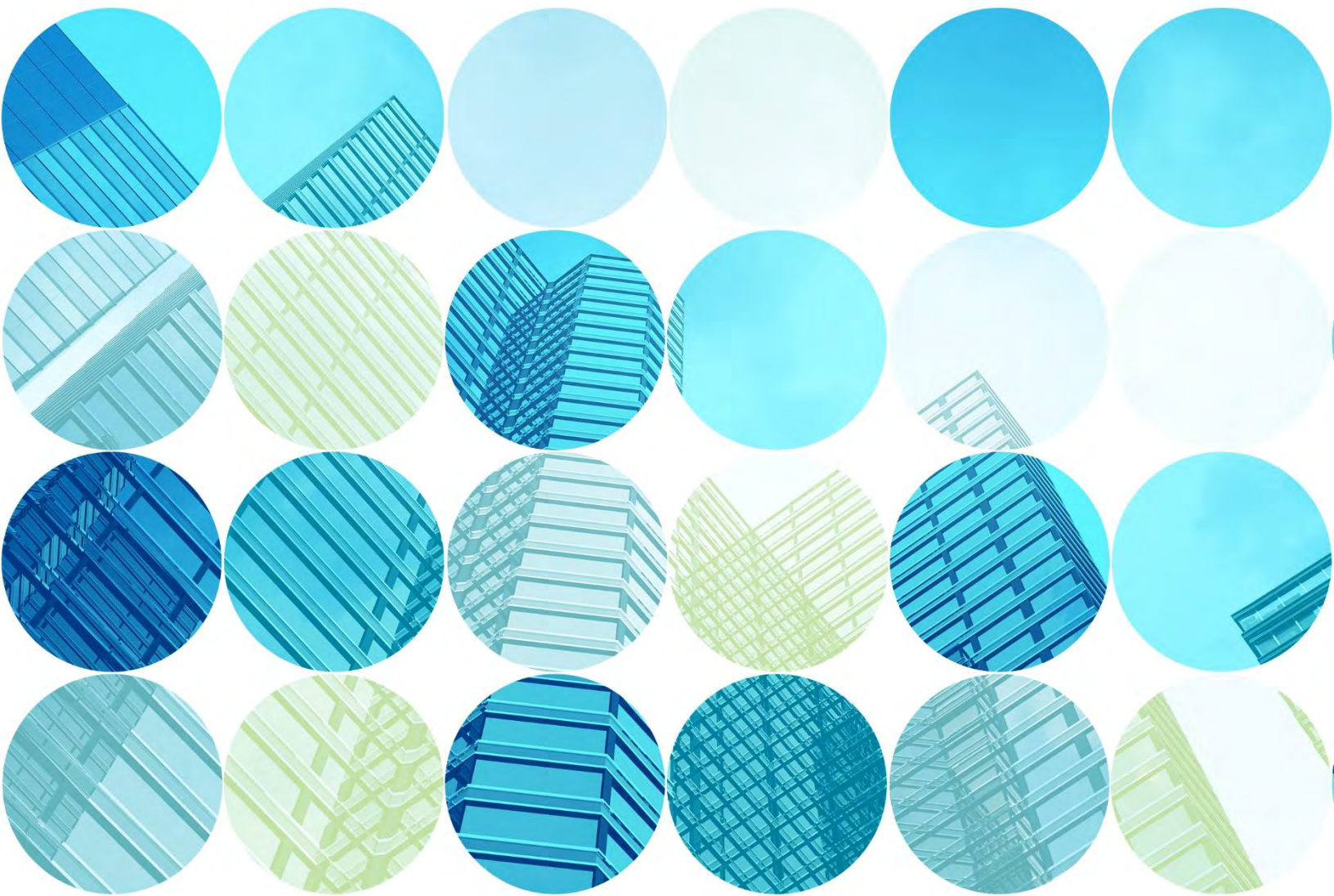# SUPERLIFE WELLNESS

SOA Student Research Case Study Challenge 2024

Cameron Cash | Emily Shaeffer
Lauren Specht | Carly Pfaff
Advisor: Dr. Jiacheng Cai

Salisbury
UNIVERSITY

OUTLINE

1. <u>OBJECTIVES</u>

1.1 EXECUTIVE SUMMARY

In today's information age, the insurance industry is constantly changing as new products are continually developed. Among many shifts, "one of the most promising developments in innovation involves coupling life insurance with health and wellbeing programs"[1], as research "demonstrate[s] the value and potential of continuing to incorporate wellness into insurance offerings."[2] In response to growing interest in this field, Mew Consulting has been contracted by SuperLife to develop a health-incentive program bundled with the company's long-term products. We have thus designed **SuperLife Wellness**, a holistic and effective wellness program which advances the interests of SuperLife and all Lumarians.

1.2 REDUCE POLICYHOLDER MORTALITY

SuperLife Wellness's programs target the most widespread causes of death among policyholders, leading to a significantly increased expected lifespan for all who participate. Mortality is expected to decline by up to 24% for some policyholders, with an average reduction for enrollees nearing 15%[3]. A new member aged 35 who joins SuperLife Wellness and continues with the program has an expected lifespan nearly two years greater than their nonparticipating peers, amounting to an increase in expected age at death from 79 to 81.

1.3 INCREASE POLICY ATTRACTIVENESS

SuperLife policyholders will become eligible for a wide range of free or discounted health-positive interventions. Additionally, a yearly cash bonus of Č 50 uplifts policy value for most of those who participate in the wellness program. The program's benefits will be extolled to people all across Lumaria, all of whom are invited to participate with a qualifying SuperLife policy to share a longer and more fulfilling life.

1.4 COST SAVINGS FOR SUPERLIFE

Our financial analysis demonstrates large and enduring cost savings for SuperLife under the program. Had SuperLife Wellness been in effect for the past twenty years, the company would have saved Č 1,919,496,526, and projected net savings for the next twenty years equal Č 3,432,073,561. A robust risk mitigation and scheduled reassessment plan ensures long-term program profitability.

---

[1] https://www.scor.com/en/expert-views/health-wellness-pathway-ecosystem-strategy
[2] https://www.rgare.com/knowledge-center/article/the-case-for-wellness-programs-in-life-and-health-insurance
[3] See Appendix I.

2. PROGRAM OVERVIEW

2.1 PROGRAM FEATURES AND ELIGIBILITY

No two policyholders have identical health risks and considerations, so to better reflect the varying circumstances of our customers we have designed four separate intervention programs to match the needs of separate groups.

Firstly, we demarcate our policyholders by smoking status, as those who smoke have a starkly different mortality composition from nonsmokers[4]. Smoking policyholders will be offered enrollment in smoking cessation programs designed to help wean them off the deadly habit[5]. These programs are costly, but the high mortality reduction observed amongst successful quitters (up to 50%, per the intervention data provided) justifies the outlays for most policyholders. Furthermore, most overweight members are eligible for unintrusive interventions to decrease the risk posed by elevated BMI[6].

Participating policyholders are eligible for free participation in hiking and outdoors activity groups and incentives for preventive screenings, while those with fewer risk factors may participate in driver safety courses and receive incentives for vaccination. Preventive programs were prioritized for the wide breadth of screening, while hiking groups and community garden plots were selected for their cost-effectiveness. Driver safety courses were notable for their disproportionate effect on younger policyholders. A more in-depth analysis as to why specific interventions were chosen is included in Appendix A.

	PROGRAM 1	PROGRAM 2	PROGRAM 3	PROGRAM 4
ELIGIBILITY	Overweight Smokers (3.32%)	Smokers of Normal Weight (2.99%)	Overweight Nonsmokers (49.22%)	Nonsmokers of Normal Weight (44.47%)
ACTIVITY 1	Smoking Cessation*[7]	Smoking Cessation*	Community Gardens*	Vaccination Incentives*
ACTIVITY 2	Community Gardens*	Vaccination Incentives*	Healthy Eating Campaigns*	Driver Safety Courses*
ACTIVITY 3	Healthy Eating Campaigns*	Driver Safety Courses*	Driver Safety Courses*	Hiking Groups
ACTIVITY 4	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings
ACTIVITY 5	Hiking Groups	Hiking Groups	Hiking Groups	N/A

Figure 2.1: Intervention Programs (See Appendix B for detail)

[4] See Appendix K
[5] https://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/effects_cig_smoking/index.htm
[6] https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(16)30175-1/fulltext
[7] Asterisks denote interventions with reduced benefits for some policyholders: See Appendix L

SuperLife Wellness was designed to enable every Lumarian to live a healthier, longer and more fulfilling life. Greater coverage of individual programs is included within Appendix B.

2.2 PROGRAM BENEFITS

To fulfill its role as an attractive and effective program without adjusting the current premium calculation, SuperLife Wellness has been designed to provide a variety of benefits to encourage enrollment:

- **Free or reduced cost activities:** Hiking and outdoors groups, community gardens and driver safety courses are provided free of charge or discounted for most policyholders.
- **Incentives for preventive care:** Low-cost preventive screenings are subsidized, and incentives are provided for staying up to date on vaccinations.
- **Yearly cash bonus:** At the beginning of each calendar year, a Č 50 cash bonus is transferred to most participating members by mail to encourage reenrollment.

A reduced benefit offering was necessary for some policyholders with smaller death benefit amounts, as the intervention cost would otherwise exceed premium amounts. This qualifier chiefly affects smoking cessation programs, which are available to all policyholders with death benefits of at least Č 1,000,000 and at a 50% discount to those with a death benefit of Č 500,000. More information on eligibility limits is left within Appendix L.

2.3 ENROLLMENT AND IMPLEMENTATION

Initial program recruitment will be powered by a nationwide broadcast and billboard campaign titled "Be Your Own Super Luminova", drawing upon the jubilant energy of Lumaria's celebratory summer holiday to introduce SuperLife Wellness to existing policyholders and expose new audiences to SuperLife's products.

SuperLife Wellness offers a flexible participation structure with yearly enrollment, enabling customers to easily join and exit the program from year to year. At the start of each calendar year, all members will receive a mailed document detailing the program's benefits and directing them to enroll either online or by mail. This letter will also enclose the Č 50 cash bonus for those eligible, to encourage reenrollment.

According to our models, 38.28% of people eligible for a program with Č 50 yearly bonus, 9.36% of people eligible for a program which includes smoking cessation, and 20% of people with neither feature are expected to sign up annually. This amounts to a total expected participation rate of 32.70% amongst SuperLife policyholders for any given year. Further details are given in Appendix D.

3. COST SAVINGS, PAST AND FUTURE

3.1   THEORETICAL PAST COST SAVINGS

Single Plan Savings					
Policy	Benefit	P1	P2	P3	P4
SPWL	100000	-353.78	-437.37	-514.77	-607.16
	250000	-249.58	-992.22	-1302.07	-1599.90
	500000	-1576.19	-1959.04	-574.90	-1037.15
	1000000	-2738.99	-3191.98	2198.44	1443.27
	2000000	-563.85	-973.19	7745.13	6404.11
T20	50000	-47.04	-78.44	-206.54	-226.45
	100000	280.27	127.43	-127.36	-226.81
	250000	2351.02	1472.49	144.17	-268.33
	500000	838.68	407.49	1525.53	755.01
	1000000	1962.95	1304.69	5092.41	3610.93
	2000000	7320.86	6258.67	12226.16	9322.75

Figure 3.1: Single Plan Savings, by Policy Type and Program

Figure 3.1 shows average per-policy savings for policyholders of age 26-65 given independent yearly participation rates[8]. Each value (in 2023 Č) represents individual annual savings. Past and future savings calculations begin with this framework, extrapolating the policy-specific savings to the number of policies of each type. The graphic also serves as a guide for which policies should be marketed most by SuperLife (with lighter-tinted policies being preferred); special emphasis on the increased value of higher benefit policies may be warranted. Further information about theoretical past savings calculations is in Appendix J.

POLICY TYPE	BENEFIT	P1	P2	P3	P4
SINGLE PREMIUM WHOLE LIFE	100000	-864117	-964989	-19311002	-20671895
	250000	-681977	-2413076	-53842249	-60043549
	500000	-4251948	-4773798	-23819765	-39000525
	1000000	-7394795	-7784620	91162508	54316792
	2000000	-1434806	-2237151	302725260	227176006
20-YEAR TERM	50000	-146419	-220564	-9874412	-9825510
	100000	862689	354294	-6020798	-9731634
	250000	10230373	5787976	9636094	-16275862
	500000	3653361	1603331	102061223	45843521
	1000000	6664134	4000908	265523501	170876178
	2000000	20335122	15703369	521589867	360965477
TOTAL		26,971,617	9,055,681	1,179,830,227	703,629,000

Figure 3.2: Theoretical Past Savings (2023 Č), by Policy Type and Program

---

[8] See Appendix D, Figure 7.4.3: Forecast Yearly Participation Rate by Death Benefit Amount and Program

Figure 3.2 displays the theoretical aggregate savings over the past twenty years by policy type, benefit amount and program[9]. The chart's total sum of **Č 1,919,496,526** (2023 Č) indicates the total savings that SuperLife Wellness would have generated had the program been implemented for the past two decades.

3.2 PROJECTED FUTURE COST SAVINGS

POLICY TYPE	BENEFIT	P1	P2	P3	P4
SINGLE PREMIUM WHOLE LIFE	100000	-2264862	-2529269	-5061491	-54182009
	250000	-1770917	-6359752	-141903585	-158247043
	500000	-11171214	-12542201	-62582156	-102466424
	1000000	-19479588	-20506323	240141836	143081575
	2000000	-3756291	-5856350	792472258	594699529
20-YEAR TERM	50000	-230424	-347109	-15539770	-15462767
	100000	1364579	560422	-9523634	-15393190
	250000	16369245	9261125	15417525	-26042402
	500000	5799375	2545286	162020355	72776070
	1000000	10617659	6374774	423064851	272261678
	2000000	31636313	24431116	811479332	561584728
TOTAL		**27,111,874**	**-4,968,281**	**2,164,432,097**	**1,272,609,744**

Figure 3.3: Future Cost Savings (2044 Č), by Policy Type and Program
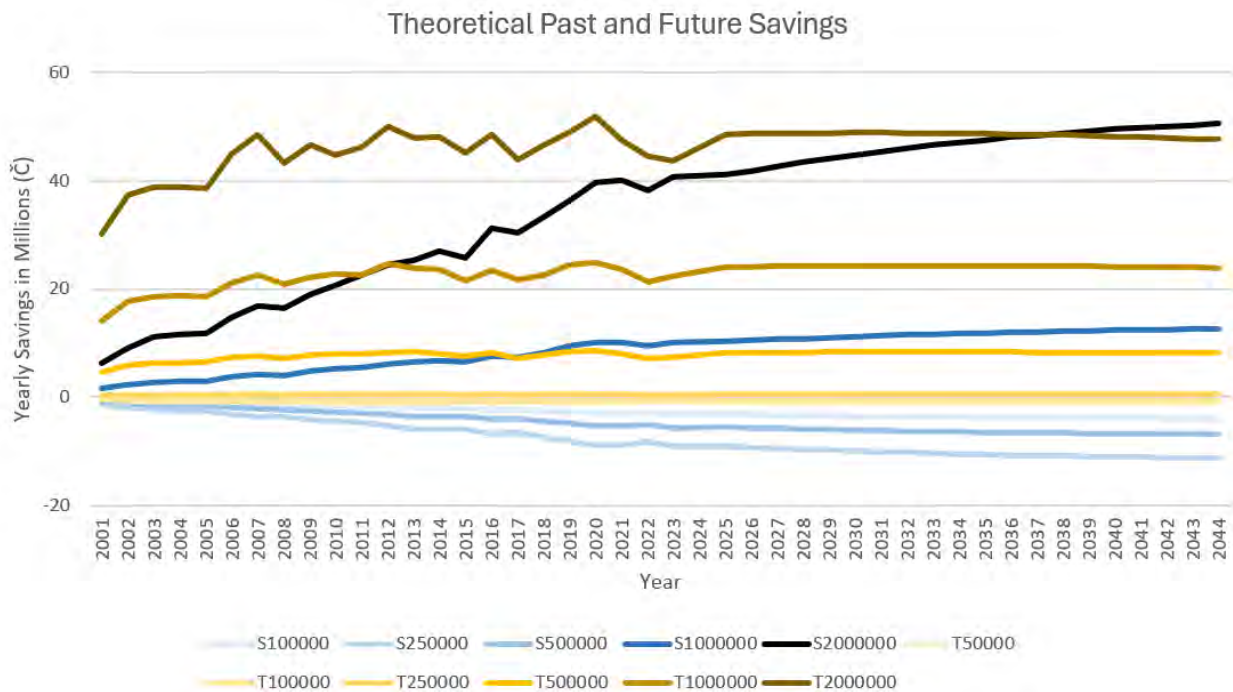

Figure 3.4: Yearly Savings by Policy and Program Type: Past and Future (2023 Č)

---

[9] Note: Positive values denote savings

Our projections predict a future cost saving of up to **Č 3,432,073,561** over the next twenty years attributable to SuperLife Wellness[10]. This is evidence for the program's efficacy, and we urge the product development team to actualize these savings by approving it. See Appendix M for more elaboration on the process of future savings calculation.

3.3 TARGETS AND METRICS

Despite the various risk mitigation techniques employed in the design of SuperLife Wellness[11], there is still potential for benefits to fall below expectations or costs to outrun forecasts. As such, we recommend a series of objective metrics and benchmarks to evaluate the program's effectiveness at clearly defined intervals.

First, SuperLife will need to continuously monitor the enrollment of eligible policyholders. A simple yes/no enrollment entry into the Inforce dataset for each person yearly will allow for useful measurements without burdensome data collection. We define three metrics for program success in Figure 3.5 below.

MEASURE	DEFINITION
ENROLLMENT RATE	The percentage of all policyholders enrolled in the program each year averaged over the prior five years.
PROGRAM COST	Total program cost, excluding benefit and incentive costs, divided by the total number of participants and averaged over the prior five years.
MORTALITY RATIO	The ratio of the mortality rate amongst policyholders enrolled in the program for at least two of the past five years to the mortality rate amongst other policyholders.

Figure 3.5: Success Metrics

Upon the conclusion of each five-year interval, the benchmarks in Figure 3.6 should be compared with known data, and program adjustments made if necessary. Five years is a sufficient reevaluation period to have reliable data insight without a loss of responsiveness.

MEASURE	ON TARGET	BELOW TARGET	VERY BELOW TARGET
ENROLLMENT RATE	≥ 30% enrollment	< 30% enrollment	< 20% enrollment
PROGRAM COST (YEARLY)	≤ Č 400/person	> Č 400/person	> Č 700/person
MORTALITY RATIO	≤ 0.85 enrolled deaths per unenrolled death	> 0.85 enrolled deaths per unenrolled death	> 0.95 enrolled deaths per unenrolled death

Figure 3.6: Objective Benchmarks

---

[10] This value is in 2044 Crowns, not 2023 Crowns. The equivalent value in 2023 Crowns is Č 2,330,662,986.
[11] See Section 5.1: Risk Mitigation and Section 5.2: Sensitivity Analysis

4. ASSUMPTIONS AND DATA

4.1 DATA LIMITATIONS AND KEY ASSUMPTIONS

Although we utilized a varied and thorough mass of data in program development, many limitations affected our precision and level of confidence. To address these issues, we made a series of assumptions and inferences throughout the design process, detailed below in Figure 4.1.

DATASET	LIMITATION	RESPONSE (ASSUMPTION)
INFORCE DATASET	Low Death Cause Specificity	Individual direct causes of death were estimated for each age from the broad categories provided using WHO estimates for similar countries[12]. Standardized distances from Lumaria on health and economic characteristics (sourced from the World Bank[13]) were used to derive the three most similar countries.[14]
	Limited Demographic Data for Policyholders	Only smoking status and age were used for program design. While data on sex was provided, regulatory issues could be a hurdle, as it is unknown whether Lumaria permits sex-based wellness program differentiation[15].
INTERVENTION DATA	Imprecise Mortality Reduction Estimates	For most calculations, we used the median of the range given for mortality reduction rate. We created Sankey diagrams to compare the effectiveness of each program and isolate programs whose effects may be inflated by targeting only a few specific causes of death[16]. Intervention efficacies under maximum mortality reduction scenarios were also used to consider the potential of each program under a wide range of situations.

[12] See Appendices E, F, G, H and I
[13] https://data.worldbank.org/country
[14] See Appendix E
[15] https://www.hhs.gov/civil-rights/for-individuals/section-1557/fs-sex-discrimination/index.html
[16] See Appendix A

	Imprecise Cost Estimates	The median of the cost range provided was used for calculations.
	Vague Intervention Descriptions	Best judgement was used when evaluating intervention scope when ambiguity remained. See Appendices A and G.
WORLD BANK DATA[17]	Missing or Outdated Data for Some Countries	Countries with inadequate data were removed from consideration[18]. Small differences in years (ex. 2022 data instead of 2023) were assumed to have minimal impact.
WORLD HEALTH ORGANIZATION DEATH CAUSE DATA[19]	Low Data Quality for Some Countries	Countries with low data quality (as identified by the WHO) were excluded from our analysis[20].

Figure 4.1: Data Limitations and Assumptions

We also made a series of assumptions during the modeling process. Firstly, we assumed that participation in the program was independent from year to year, with one's prior enrollment in the program having no significant effect on future reenrollment probability. Furthermore, we assumed that savings from SuperLife Wellness are accumulated linearly throughout program duration, relative to a basis of someone who is enrolled in the program throughout the entirety of their life after becoming a policyholder. See Appendix D for more details as to participation modeling.

Additionally, we used the effective annual interest rate from 2004 to 2023 as the basis for premium calculation. To simplify calculation, we assumed no additional inflation. The rate derived using the period of 2004 to 2023 was 1.86%. The process for deriving this value and for forecasting future interest rates is detailed in Appendix N. Calculations with inflation and other interest rates are discussed in Section 5.2: Sensitivity Analysis.

---

[17] data.worldbank.org/country

[18] See Appendix E

[19] https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death

[20] See Appendix E

5. RISK MITIGATION

5.1 RISK MITIGATION TECHNIQUES

If SuperLife Wellness had been implemented twenty years ago, much of the essential information we are privy to now could not have been predicted. As such, the product was designed with caution in mind and safeguards were established for risk mitigation. Figure 5.1 below summarizes the most significant risks to program success and our corresponding mitigation techniques.

RISK	DESCRIPTION	PROBABILITY	SEVERITY	MITIGATION TECHNIQUES
Elevated Intervention Costs	Intervention costs outpace inflation.	Medium	Medium	The five-year measures of program success include program cost (see Section 3.3). Forecast benefits far exceed costs, so even a large uptick in costs will not alone cause program failure.
Lower Mortality Reduction	SuperLife Wellness reduces mortality by less than predicted among enrollees.	Medium	Medium	The five-year program success metrics include mortality reduction (see Section 3.3). We recommend reevaluating benefit selection for programs which fall considerably below our prediction intervals.
Lower Participation Rates	Fewer people than expected enroll in SuperLife Wellness.	Medium	Low	Program costs scale with enrollment, so low participation entails cost decreases of roughly equal proportion to lost savings. If participation fails to meet standards, we recommend considering alternate incentive techniques.
Pandemic/Health Shock	Mortality rises suddenly for all policyholders.	Low	High	General insurance risk mitigation techniques apply. No additional risk is assumed with SuperLife Wellness.
Higher Inflation	Price and interest rate changes affect premiums.	High	Medium	See Section 5.2: Sensitivity Analysis.

Figure 5.1: Potential Risks and Mitigation Techniques

Due to the dispersed nature of benefits derived from SuperLife Wellness's interventions, we can be virtually 100% confident that the program will lower overall mortality, though the degree to which this occurs may vary significantly. A failure to lower mortality to any degree would require many individual points of failure. The unit scalability of costs with enrollment limits risk to relatively few variables, as participation rates do not directly affect per-enrollee profit or loss. From this, it follows that the value of premiums received under the proposed program will almost certainly exceed those received in the counterfactual scenario. Overall program unprofitability is highly possible with very low interest rates (as shown below), but unlikely otherwise.

5.2 SENSITIVITY ANALYSIS

Inflation is highly likely to occur, and depending on how high the rates are compared to the interest rate, savings can shift dramatically. Testing our results with hypothetical inflation (0-5%) and interest rates (1-5%) offers insight into the potential cost changes and cost mitigation methods. Figure 5.2 below displays the estimated per-policy savings in 2023 Č under different interest and inflation environments. Even large inflation rate changes have little effect relative to interest rate fluctuations.

		Interest Rate					
		0.01	**0.0186**	0.02	0.03	0.04	0.05
Inflation Rate	0.00	-17612.03	1807.91	4358.00	18990.58	28963.60	35912.26
	0.01	-17995.25	1499.76	4060.08	18753.72	28771.51	35753.73
	0.02	-18494.90	1105.63	3680.18	18457.70	28535.72	35562.22
	0.03	-19160.19	591.44	3186.13	18081.05	28241.59	35327.50
	0.04	-20065.27	-93.42	2530.29	17592.48	27868.13	35035.22
	0.05	-21323.33	-1025.12	1641.14	16945.84	27384.92	34664.91

Figure 5.2: Average Cost Savings Per Policy, by Changes in Inflation & Interest Rate

See Appendix P for information on the deriving of Figure 5.2. At an annual interest rate of 1.86% (the twenty-year average)[21], the program returns a profit at inflation rates below 4.00%; inflation rates in excess of this amount may require premium reevaluation. In such circumstances, government involvement may also be solicited. The average inflation rate in the data period was 2.54%. Under most macroeconomic environments, SuperLife Wellness is likely to return a profit overall.

---

[21] See Appendix N

6. <u>REFERENCES</u>

(OCR), Office for Civil Rights. "Section 1557: Protecting Individuals Against Sex Discrimination." HHS.Gov, 6 Jan. 2023, www.hhs.gov/civil-rights/for-individuals/section-1557/fs-sex-discrimination/index.html.

"13 Preventative Screenings: Why They're Important and Who Needs Them Most." Nebraska Medicine, 2 July 2020, www.nebraskamed.com/primary-care/13-preventive-screenings-why-theyre-important-and-who-needs-them-most.

Borland, Ron, et al. "Cessation assistance reported by smokers in 15 countries participating in the International Tobacco Control (ITC) policy evaluation surveys." Addiction, vol. 107, no. 1, 12 Dec. 2011, pp. 197–205, https://doi.org/10.1111/j.1360-0443.2011.03636.x.

Callaway, Julianne. "The Case for Wellness Programs in Life and Health Insurance." RGA, June 2022, www.rgare.com/knowledge-center/article/the-case-for-wellness-programs-in-life-and-health-insurance.

Cheung, Yee Tak, et al. "Effectiveness of a small cash incentive on abstinence and use of cessation aids for adult smokers: A randomized controlled trial." Addictive Behaviors, vol. 66, Mar. 2017, pp. 17–25, https://doi.org/10.1016/j.addbeh.2016.11.006.

"Consequences of Obesity." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 15 July 2022, www.cdc.gov/obesity/basics/consequences.html.

"Countries and Economies." World Bank Open Data, data.worldbank.org/country. Accessed 19 Mar. 2024.

Di Angelantonio, Emanuele, et al. "Body-mass index and all-cause mortality: Individual-participant-data meta-analysis of 239 prospective studies in Four Continents." The Lancet, vol. 388, no. 10046, Aug. 2016, pp. 776–786, https://doi.org/10.1016/s0140-6736(16)30175-1.

"Global Health Estimates: Leading Causes of Death." World Health Organization, World Health Organization, 2020, www.who.int/data/gho/data/themes/mortality-and-

global-health-estimates/ghe-leading-causes-of-death.

"Global Health Estimates: Leading Causes of Death." World Health Organization, World Health Organization, Dec. 2020, www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death.

Grassini, Simone. "A systematic review and meta-analysis of Nature walk as an intervention for anxiety and depression." Journal of Clinical Medicine, vol. 11, no. 6, 21 Mar. 2022, p. 1731, https://doi.org/10.3390/jcm11061731.

"Health & Wellness: A Pathway to an Ecosystem Strategy?" SCOR, 1 Aug. 2019, www.scor.com/en/expert-views/health-wellness-pathway-ecosystem-strategy.

"Health Effects of Cigarette Smoking." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 29 Oct. 2021, www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/effects_cig_smoking/index.htm.

"Health Effects of Cigarette Smoking." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 29 Oct. 2021, www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/effects_cig_smoking/index.htm.

"HPV Vaccination: What Everyone Should Know." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 16 Nov. 2021, www.cdc.gov/vaccines/vpd/hpv/public/index.html.

Kokkinos, Peter. "Physical activity, health benefits, and mortality risk." ISRN Cardiology, vol. 2012, 30 Oct. 2012, pp. 1–14, https://doi.org/10.5402/2012/718789.

Lab. "55 Amazing Cover Page Templates (Word, Powerpoint + PSD)." TemplateLab, 18 Feb. 2024, templatelab.com/cover-page-templates/.

Lee, Dong Hoon, et al. "Long-term leisure-time physical activity intensity and all-cause and cause-specific mortality: A prospective cohort of US adults." Circulation, vol. 146, no. 7, 16 Aug. 2022, pp. 523–534, https://doi.org/10.1161/circulationaha.121.058162.

"Let's Learn Together." Desmos, 2024,

www.desmos.com/.

"List of Vaccines Used in United States." Centers for Disease Control and Prevention, Centers for Disease Control and Prevention, 13 Apr. 2018, www.cdc.gov/vaccines/vpd/vaccines-list.html.

"Logistic Function." Wikipedia, Wikimedia Foundation, 16 Mar. 2024, en.wikipedia.org/wiki/Logistic_function.

Mattke, Soeren et al. "Workplace Wellness Programs: Services Offered, Participation, and Incentives." Rand health quarterly vol. 5,2 7. 30 Nov. 2015

Notley, Caitlin, et al. "Incentives for smoking cessation." Cochrane Database of Systematic Reviews, vol. 2019, no. 7, 17 July 2019, https://doi.org/10.1002/14651858.cd004307.pub6.

"Sankeymatic: A Sankey Diagram Builder for Everyone." Make Beautiful Flow Diagrams, 2024, www.sankeymatic.com/.

"Share of Adults Who Are Overweight or Obese." Our World in Data, ourworldindata.org/grapher/share-of-adults-who-are-overweight. Accessed 19 Mar. 2024.

Thornton, Rebecca L. "The demand for, and impact of, learning HIV status." American Economic Review, vol. 98, no. 5, 1 Nov. 2008, pp. 1829–1863, https://doi.org/10.1257/aer.98.5.1829.

Thun, Michael J., et al. "50-year trends in smoking-related mortality in the United States." New England Journal of Medicine, vol. 368, no. 4, 24 Jan. 2013, pp. 351–364, https://doi.org/10.1056/nejmsa1211127.

7. APPENDICES

APPENDIX A

INTERVENTION SELECTION CHOICES

From the weighted subcategories of death (see Appendix E), it was necessary to link the primary causes of death to the available intervention programs to determine which were the most desirable. Sankey diagrams were of interest to draw visual connections between the causes of death (center nodes), categories of death (right side) and the interventions (left side). The numbers shown indicate the number of deaths and their connections between the three groupings. Three diagrams were constructed to measure cost effectiveness, maximum mortality reduction, and potential outliers. Bayes rule was used to calculate the percentage each intervention contributes to the cause of death (typically those causes over 1000 deaths), and then we multiplied by the total deaths to approximate how many deaths each intervention would reduce or prevent. Some causes of death with smaller numbers were combined in "Other" categories.

The first diagram measures the best-case scenario ratios association with each cause of death by dividing the maximum mortality reduction by the minimum cost. This indicates which interventions greatly reduce mortality for a low cost.
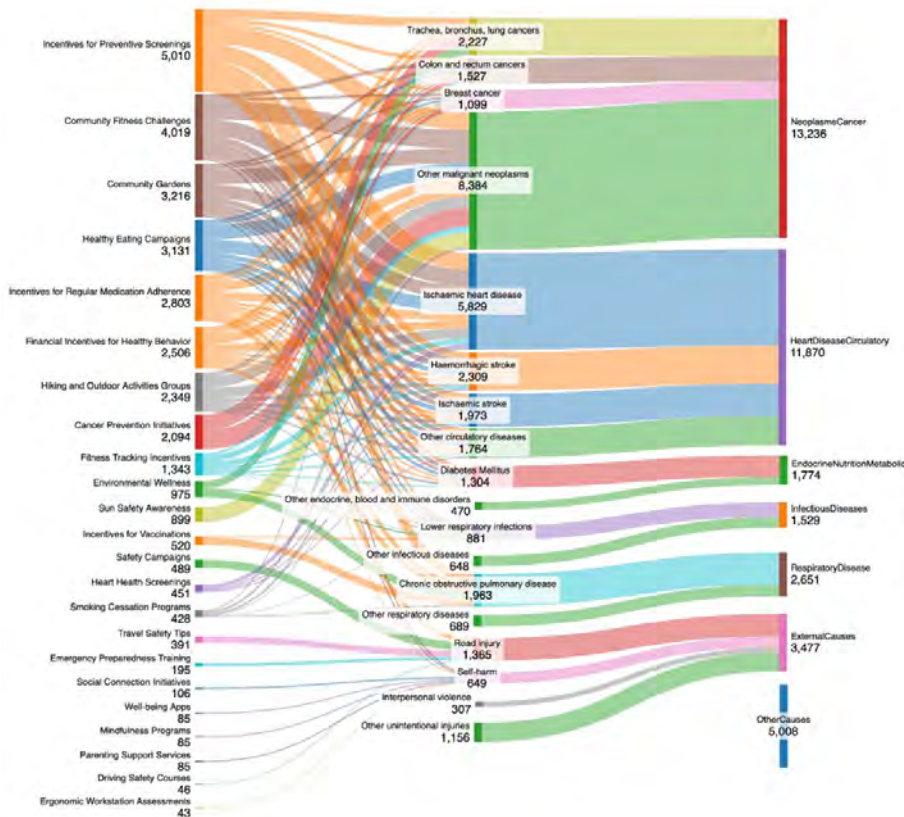
Figure 7.1.1: Intervention Programs by Cost Effectiveness Ratio

The second measures the maximum potential mortality reduction each intervention can achieve so expensive interventions with exceptionally high mortality reduction will stand out. Otherwise, the best-case scenario ratios may overrepresent low-cost interventions with low mortality reduction. The third and final diagram uses a uniform distribution to divide the interventions evenly. The latter is meant to highlight interventions that may be inflated.

Best-case scenarios were produced by calculating the ratio between optimal mortality reduction and lowest cost to judge the potential of each intervention (see Figure 7.1.4). Interventions with an optimal mortality reduction to lowest cost ratio below a certain threshold were removed. Half of the available programs were removed from consideration primarily by judgment-based decision-making (due to high costs, low mortality reduction, perceived issues with implementation or other factors). A variety of these programs whose ratios were cost-neutral and served similar purposes to interventions with preferred best-case scenarios were also removed. This process limited the choices for consideration to twenty-three programs included in the Sankey diagrams. For each diagram, causes of death are matched with the interventions that affect them, with the size of the connection-links equaling the estimated association each intervention has with key causes of death.
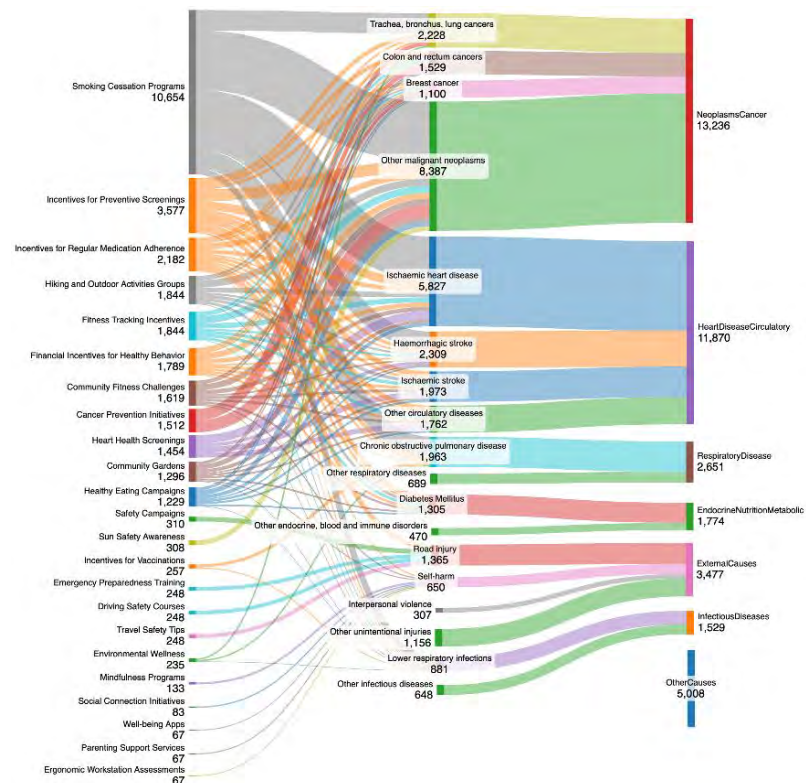
Figure 7.1.2: Intervention Programs by Maximum Mortality Reduction
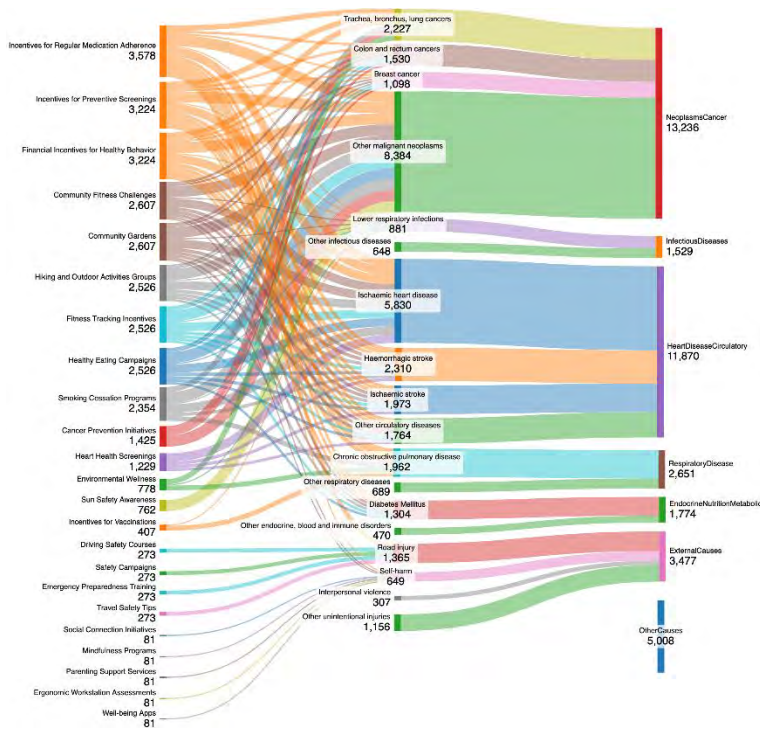
Figure 7.1.3: Inflated Intervention Programs by Uniform Distribution

The above Sankey diagrams were produced using SankeyMatic[22]. Of the three diagrams, Figure 7.1.1 measures interventions by a cost effectiveness ratio, Figure 7.1.2 measures maximum mortality reduction, and Figure 7.1.3 follows a uniform distribution of mortality reduction. The latter tracks which programs may have an inflated effectiveness. Some interventions are vague in their descriptions and may cover an ample collection of death subcategories, so they would naturally appear larger than many other programs. This does not necessarily rule them out of consideration but rather highlights which top programs to reconsider.

- **Smoking Cessation Programs**
Since 18% of Lumarian adults smoke, and smoking-related deaths account for a substantial number of deaths, we offer a program to directly target this risk factor. Our primary concerns regarding this program are the low mortality reduction to cost ratio (see Figure 7.1.1) and low participation rates. The latter results in a small impact overall, and the mortality reduction to cost ratio is the second smallest of all fifty interventions. The program does, however, have the highest possible reduction in mortality of all fifty listed programs, but it is also the most expensive. When deciding on complete program financing, smoking

---

[22] sankeymatic.com/build/

cessation is by far the costliest. Nevertheless, smoking cessation programs will have the greatest impact on combating lung cancer and other associated causes of death (i.e., lower respiratory illness, COPD).

- **Incentives for Preventive Screenings**

While this program is potentially inflated in the above Sankey diagrams, its mortality reduction to cost ratio and overall mortality reduction are high (5-10%) (See Figure 7.1.4). Owing to the program description's vagueness, we assume the programs will cover any necessary heart screenings in addition to various other cancers and illnesses. We assume that "per incentive" means a Č 20-85 participation cost.

One primary goal for selecting this intervention is to find an overlap between interventions. If one policyholder does not wish to participate in a single intervention, another intervention they are willing to participate in may serve some fraction of the original intervention's purpose in combating a cause of death. This is true for Hiking & Outdoor Activity Groups as well.

- **Hiking and Outdoors Activity Groups**

Cancer and heart disease are the two leading causes of death in Lumaria. According to the CDC[23], inactivity and poor eating habits are the two main contributors to obesity, which is not only related to a multitude of heart/circulatory issues, but also has an impact on diabetes, lung issues and several types of cancers. To combat obesity, we sought interventions that promote physical activity and healthy eating. When looking for physical activity interventions, we considered hiking and outdoor activity groups, community fitness challenges and fitness tracking incentives.

The optimal cost effectiveness ratio for hiking activities was lower than one of the other two (See Figure 7.1.4), and while the cost for the other two were estimated to be Č 10-35 per person and Č 35-175 per tracker, respectively, hiking groups cost Č 20-85 per group. Even if a group consists of only two people, the cost is highly reduced. While it is still more expensive than the community fitness challenges, it has an estimated one percent greater reduction in mortality (3-6% over 2-5%). The fitness tracking incentives entail a 3-6% reduction in mortality, so hiking and outdoors groups cost less for an equivalent decrease in mortality.

Additionally, one article from the National Library of Medicine mentioned that in Thailand, a major influence to quit smoking was an institutional incentive[24], while another article listed the third main reason people quit smoking was social pressure from family and friends[25]. In addition to physical activity, participating in community/social activities reduces isolation and stress, and the new relationships one makes by interacting with others may

---

[23] www.cdc.gov/healthreport/publications/compendium.pdf

[24] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3237953/

[25] www.ncbi.nlm.nih.gov/pmc/articles/PMC3237953/.

offer opportunities for new friends to encourage each other to quit smoking; this will allow for overlap with Smoking Cessation Programs.

- **Community Gardens**

    The second cause of obesity is poor eating habits, so a program that encourages policyholders to eat more fresh fruits and vegetables is beneficial. As such, we also included healthy eating campaigns. In the former case, the intervention cost is cited as Č 10-35 per plot, and a plot may be shared among multiple policyholders. Both programs share an equal reduction in mortality and cheap cost, so the potential for community gardens and healthy eating campaigns to jointly encourage healthy habits led to their pairing in our proposal.

- **Driving Safety Course**

    Road injuries are the top external cause of death, so driving safety courses would contribute to reducing accidental deaths across Lumaria. Other external causes such as self-harm and interpersonal violence should be reduced by previously described community interventions. Moreover, external deaths disproportionately affect younger policyholders, so driver safety may have an especially outsized effect in cost savings for SuperLife. The cost is quite high, however, so this intervention is not available to some low-benefit policyholders (See Appendix L).

- **Incentives for Vaccinations**

    To complement our emphasis on preventive screenings, we supplement SuperLife Wellness with vaccination incentives for some policyholders. Incentivizing annual vaccines for existing viruses and providing accompanying information to the public regarding the importance of social distancing and sanitary etiquette in reducing viral transmission would serve to combat other currently existing infections and potential future viruses in Lumaria. Vaccination incentives provide an opportunity for proactive intervention to prevent large future hazards to our customers and SuperLife.

INTERVENTION	MINIMUM COST	MAXIMUM MORTALITY REDUCTION	MAXIMUM MORTALITY REDUCTION PER Č 100
Safety Campaigns	Č 10	5.0%	50.00% per Č 100
Community Fitness Challenges	Č 10	5.0%	50.00% per Č 100
Social Connection Initiatives	Č 10	5.0%	50.00% per Č 100

Preventive Screenings[26]	Č 20	10.0%	50.00% per Č 100
Cancer Prevention Initiatives	Č 20	10.0%	50.00% per Č 100
Healthy Eating Campaigns	Č 10	4.0%	40.00% per Č 100
Incentives for Vaccinations	Č 20	8.0%	40.00% per Č 100
Online Health Resources	Č 10	4.0%	40.00% per Č 100
Well-being Apps	Č 10	4.0%	40.00% per Č 100
Sun Safety Awareness	Č 10	4.0%	40.00% per Č 100
Stress Reduction	Č 20	8.0%	40.00% per Č 100
Environmental Wellness	Č 10	4.0%	40.00% per Č 100
Community Gardens	Č 10	4.0%	40.00% per Č 100
Mindfulness Programs	Č 20	8.0%	40.00% per Č 100
Parenting Support Services	Č 10	4.0%	40.00% per Č 100
Travel Safety Tips	Č 10	4.0%	40.00% per Č 100
Art and Creativity Classes	Č 10	4.0%	40.00% per Č 100
Hydration Campaigns	Č 10	3.0%	30.00% per Č 100
Active Aging	Č 20	6.0%	30.00% per Č 100
Hiking and Outdoors Activities	Č 20	6.0%	30.00% per Č 100
Cognitive Health	Č 20	6.0%	30.00% per Č 100
Sleep Hygiene	Č 20	5.0%	25.00% per Č 100
Financial Incentives for Healthy Behavior	Č 20	5.0%	25.00% per Č 100
Home Safety Inspections	Č 20	5.0%	25.00% per Č 100

---

[26] Highlighted interventions were included in one or more of SuperLife Wellness's programs.

Incentives for Regular Medication Adherence	Č 20	5.0%	25.00% per Č 100
Educational Workshops	Č 20	4.0%	20.00% per Č 100
Emergency Preparedness Training	Č 20	4.0%	20.00% per Č 100
Nutrition Education	Č 20	4.0%	20.00% per Č 100
Financial Literacy Workshops	Č 20	4.0%	20.00% per Č 100
Ergonomic Workstation Assessments	Č 20	4.0%	20.00% per Č 100
Heart Health Screenings	Č 90	10.0%	11.11% per Č 100
Telemedicine Services	Č 50	5.0%	10.00% per Č 100
Mental Health Support	Č 90	8.0%	8.89% per Č 100
Personalized Health Plans	Č 90	6.0%	6.67% per Č 100
Alcohol Moderation Programs	Č 90	6.0%	6.67% per Č 100
Holistic Health Assessments	Č 90	6.0%	6.67% per Č 100
Mind-Body Wellness Retreats	Č 90	6.0%	6.67% per Č 100
Smoking Cessation Programs	Č 870	50.0%	5.75% per Č 100
Annual Health Check-ups	Č 175	10.0%	5.71% per Č 100
Weight Management Programs	Č 175	10.0%	5.71% per Č 100
Chronic Disease Management	Č 175	10.0%	5.71% per Č 100
Wellness Programs	Č 90	5.0%	5.56% per Č 100
Employee Assistance Programs	Č 90	5.0%	5.56% per Č 100
Driving Safety Courses	Č 85	4.0%	4.71% per Č 100
Financial Planning Assistance	Č 90	4.0%	4.44% per Č 100

Intervention			
Regular Dental Check-ups	Č 90	4.0%	4.44% per Č 100
Genetic Testing	Č 90	4.0%	4.44% per Č 100
Fitness Tracking Incentives	Č 175	6.0%	3.43% per Č 100
Discounted Gym Memberships	Č 175	6.0%	3.43% per Č 100
Vision Care Programs	Č 90	3.0%	3.33% per Č 100

Figure 7.1.4: Optimal Cost Effectiveness of Interventions

INTERVENTION	MEDIAN COST	MEDIAN MORTALITY REDUCTION	MORTALITY REDUCTION PER Č 100
Safety Campaigns	Č 22.5	4.0%	17.78% per Č 100
Social Connection Initiatives	Č 22.5	4.0%	17.78% per Č 100
Community Fitness Challenges	Č 22.5	3.5%	15.56% per Č 100
Healthy Eating Campaigns	Č 22.5	3.0%	13.33% per Č 100
Online Health Resources	Č 22.5	3.0%	13.33% per Č 100
Well-being Apps	Č 22.5	3.0%	13.33% per Č 100
Sun Safety Awareness	Č 22.5	3.0%	13.33% per Č 100
Environmental Wellness	Č 22.5	3.0%	13.33% per Č 100
Community Gardens	Č 22.5	3.0%	13.33% per Č 100
Parenting Support Services	Č 22.5	3.0%	13.33% per Č 100
Travel Safety Tips	Č 22.5	3.0%	13.33% per Č 100
Art and Creativity Classes	Č 22.5	3.0%	13.33% per Č 100
Preventive Screenings	Č 57.5	7.5%	13.04% per Č 100
Cancer Prevention Initiatives	Č 57.5	7.5%	13.04% per Č 100
Hydration Campaigns	Č 22.5	2.5%	11.11% per Č 100
Stress Reduction	Č 57.5	5.5%	9.57% per Č 100
Mindfulness Programs	Č 57.5	5.5%	9.57% per Č 100
Vaccination Incentives	Č 57.5	5.0%	8.70% per Č 100

Active Aging	Č 57.5	4.5%	7.83% per Č 100
Hiking & Outdoors	Č 57.5	4.5%	7.83% per Č 100
Cognitive Health	Č 57.5	4.5%	7.83% per Č 100
Sleep Hygiene	Č 57.5	4.0%	6.96% per Č 100
Home Safety Inspections	Č 57.5	4.0%	6.96% per Č 100
Financial Incentives for Healthy Behavior	Č 57.5	3.5%	6.09% per Č 100
Regular Medication Adherence	Č 57.5	3.5%	6.09% per Č 100
Educational Workshops	Č 57.5	3.0%	5.22% per Č 100
Emergency Preparedness Training	Č 57.5	3.0%	5.22% per Č 100
Nutrition Education	Č 57.5	3.0%	5.22% per Č 100
Financial Literacy Workshops	Č 57.5	3.0%	5.22% per Č 100
Ergonomic Workstation Assessments	Č 57.5	3.0%	5.22% per Č 100
Fitness Tracking	Č 105	4.5%	4.29% per Č 100
Telemedicine Services	Č 112.5	4.0%	3.56% per Č 100
Heart Health Screenings	Č 217.5	7.5%	3.45% per Č 100
Mental Health Support	Č 217.5	5.5%	2.53% per Č 100
Driving Safety Courses	Č 130	3.0%	2.31% per Č 100
Personalized Health Plans	Č 217.5	4.5%	2.07% per Č 100
Alcohol Moderation Programs	Č 217.5	4.5%	2.07% per Č 100
Health Assessments	Č 217.5	4.5%	2.07% per Č 100
Wellness Retreats	Č 217.5	4.5%	2.07% per Č 100
Employee Assistance Programs	Č 217.5	4.0%	1.84% per Č 100
Wellness Programs	Č 217.5	3.5%	1.61% per Č 100
Annual Health Check-ups	Č 522.5	7.5%	1.44% per Č 100
Weight Management Programs	Č 522.5	7.5%	1.44% per Č 100
Chronic Disease Management	Č 522.5	7.5%	1.44% per Č 100

Financial Planning Assistance	Č 217.5	3.0%	1.38% per Č 100
Regular Dental Check-ups	Č 217.5	3.0%	1.38% per Č 100
Genetic Testing	Č 217.5	3.0%	1.38% per Č 100
Vision Care Programs	Č 217.5	2.5%	1.15% per Č 100
Smoking Cessation Programs	Č 2177.5	25.0%	1.15% per Č 100
Discounted Gym Memberships	Č 522.5	4.5%	0.86% per Č 100

Figure 7.1.5: Median Cost Effectiveness of Interventions

APPENDIX B

PROGRAM CHARACTERISTICS

To determine the estimated proportion of policyholders eligible for each of the four programs, we first derived the expected proportion of smoking policyholders and the estimated proportion of overweight policyholders.

From the SuperLife Inforce Dataset, 61740 of 916842 entries (or 6.31%) listed smoker status. While this value may change over time, we assume a constant rate.

For estimating the rate of overweight policyholders, we utilize the similar country heuristic described in APPENDIX E. We average the share of adults who are overweight or obese[27] for the top five countries by similarity to Lumaria, those being Thailand, Uruguay, Malaysia, Argentina, and Sri Lanka. The result of 52.54% is again assumed to be constant throughout the duration of the program. When combining these two factors, we assume independence of smoking and overweight status.
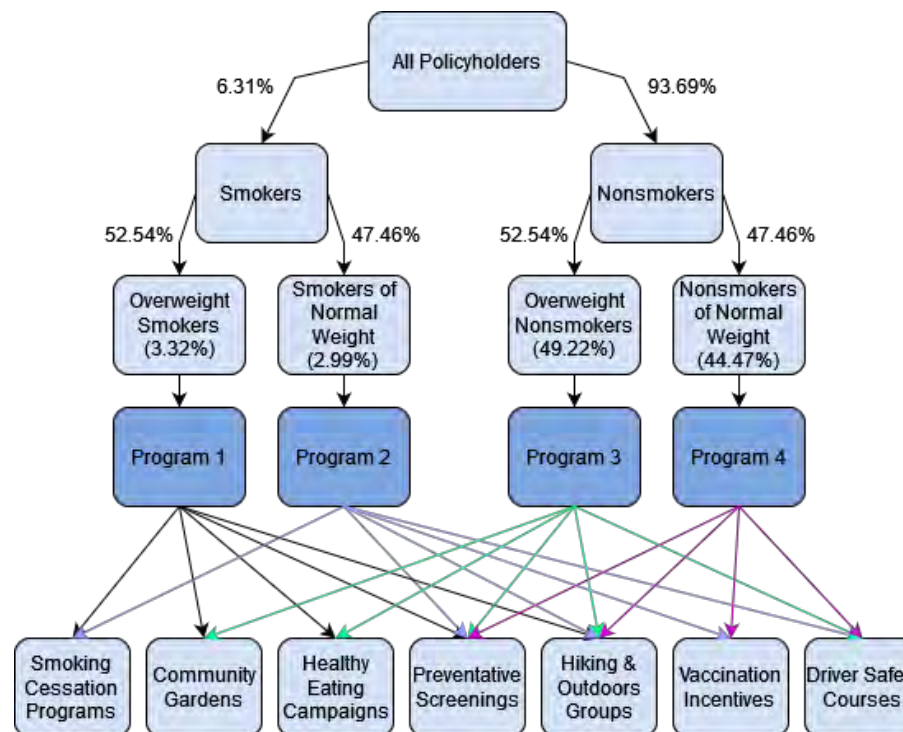
Figure 7.2.1: Program Eligibility Rates and Composition

We limited each program to a maximum of five interventions, as we did not wish to overwhelm policyholders with an endless set of programs and activities. Our customers value their own time, and we are hesitant to impose a large additional role in their lives.

Some interventions may be excluded or offered at modified rates for 20-year term policyholders with low death benefit amounts. For more information, see Appendix L.

---

[27] https://ourworldindata.org/grapher/share-of-adults-who-are-overweight

Program 1: Eligible for overweight smokers

INTERVENTION	INTERVENTION NAME	DESCRIPTION	BASE COST	MORTALITY REDUCTION
1	Smoking Cessation Programs*[28]	Resources and support for policyholders looking to quit smoking.	Č 870-Č 3,485	Up to 50%
2	Community Gardens*	Support community gardens to promote access to fresh and healthy foods.	Č 10-Č 35	2-4%
3	Healthy Eating Campaigns*	Promote healthy eating habits through educational campaigns and incentives.	Č 10-Č 35	2-4%
4	Hiking & Outdoors Activity Groups	Facilitate outdoor activities groups to promote physical activity.	Č 20-Č 85	3-6%
5	Incentives for Preventive Screenings	Offer rewards for policyholders who undergo preventive health screenings.	Č 20-Č 85	5-10%
TOTAL			Č 930-Č 3725	12-74%, unadjusted: See Appendix H

Program 2: Eligible for smokers of normal weight

INTERVENTION	INTERVENTION NAME	DESCRIPTION	BASE COST	MORTALITY REDUCTION
1	Smoking Cessation Programs*	Resources and support for policyholders looking to quit smoking.	Č 870-Č 3,485	Up to 50%
2	Vaccination Incentives*	Encourage policyholders to stay up to date with vaccinations by offering incentives.	Č 20-Č 85	2-8%
3	Driver Safety Courses*	Offer discounts for policyholders who complete defensive driving courses.	Č 85-Č 175	2-4%
4	Hiking & Outdoors Activity Groups	Facilitate outdoor activities groups to promote physical activity.	Č 20-Č 85	3-6%
5	Incentives for Preventive Screenings	Offer rewards for policyholders who undergo preventive health screenings.	Č 20-Č 85	5-10%
TOTAL			Č 1015-Č 3915	12-78%, unadjusted: See Appendix H

---

[28] Asterisks Denote Reduced Benefit Availability for Some Low Premium Policyholders: See Appendix L

Program 3: Eligible for overweight nonsmokers

INTERVENTION	INTERVENTION NAME	DESCRIPTION	BASE COST	MORTALITY REDUCTION
1	Driver Safety Courses*	Offer discounts for policyholders who complete defensive driving courses.	Č 85-Č 175	2-4%
2	Community Gardens*	Support community gardens to promote access to fresh and healthy foods.	Č 10-Č 35	2-4%
3	Healthy Eating Campaigns*	Promote healthy eating habits through educational campaigns and incentives.	Č 10-Č 35	2-4%
4	Hiking & Outdoors Activity Groups	Facilitate outdoor activities groups to promote physical activity.	Č 20-Č 85	3-6%
5	Incentives for Preventive Screenings	Offer rewards for policyholders who undergo preventive health screenings.	Č 20-Č 85	5-10%
TOTAL			Č 145-Č 415	14-28%, unadjusted: See Appendix H

Program 4: Eligible for nonsmokers of normal weight

INTERVENTION	INTERVENTION NAME	DESCRIPTION	BASE COST	MORTALITY REDUCTION
1	Vaccination Incentives*	Encourage policyholders to stay up to date with vaccinations by offering incentives.	Č 20-Č 85	2-8%
2	Driver Safety Courses*	Offer discounts for policyholders who complete defensive driving courses.	Č 85-Č 175	2-4%
3	Hiking & Outdoors Activity Groups	Facilitate outdoor activities groups to promote physical activity.	Č 20-Č 85	3-6%
4	Incentives for Preventive Screenings	Offer rewards for policyholders who undergo preventive health screenings.	Č 20-Č 85	5-10%
TOTAL			Č 145-Č 430	12-28%, unadjusted: See Appendix H

Figure 7.2.2: Program Descriptions; See Interventions Database

APPENDIX C

GROUP MORTALITY DISPOSITION

Not all Lumarians have equal demographic and health characteristics, so we cannot assume an equal rate of mortality between groups with different key characteristics. As our pitch design demarcates four programs depending upon BMI and smoking status, we saw it necessary to simulate a different base rate of mortality for each group.

Firstly, we saw that the "population-attributable fractions for all-cause mortality due to overweight or obesity for 19% in North America"[29], and we thus applied this estimate to overweight policyholders (as our program includes both those who are overweight and obese without distinction).

Next, we referenced research estimating that "current smokers also had similar relative risks for death from ... all causes combined (2.80 men and 2.76 for women)"[30] and used the average risk factor of 2.78 in our model.

For those who are both overweight and current smokers, we assumed multiplicative severity for a cumulative total risk ratio of 3.31.

We then solved for the requisite base value for an overall fraction of 1.00 to determine final risk ratios by group.

GROUP	DESCRIPTION	RELATIVE RISK RATIO	ABSOLUTE RISK RATIO
1	Overweight smokers	3.31	2.72
2	Smokers of normal weight	2.78	2.28
3	Overweight nonsmokers	1.19	0.98
4	Nonsmokers of normal weight	1.00 (base rate)	0.82

Figure 7.3.1: Mortality Risk Ratios by Program Group

[29] https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(16)30175-1/fulltext
[30] https://www.nejm.org/doi/full/10.1056/NEJMsa1211127

APPENDIX D

PARTICIPATION RATE MODELING

While the development of a robust program offering is the premier role of SuperLife Wellness, it was also necessary for the purpose of simulation to model the participation of policyholders with the program each year. To do so, we relied upon various research sources to estimate general willingness to enroll in such programs, as a function of variable incentive bonus provided to participants.

For the purpose of participation modeling, we found it necessary and prudent to create two separate models to represent programs with and without smoking cessation programs. The reasons for this are manifold: smoking cessation programs generally have low uptake due to the unique factors behind addiction, smoking cessation support is especially costly and a wealth of supporting research allows for adequate granularity in separation.

Both model types were fit to a logistic curve, as logistic models are especially suited for population modeling.[31] In construction of the general participation model, we cite an article published in the National Library of Medicine relating to wellness programs in the workplace[32]. The median participation rate for wellness programs without incentives was 20%, whereas the median rate for employers with monetary incentives amounted to 40%. Assuming the employers exhausted close to all of the potential participation, we thus begin with a logistic function with a minimum value of 20% at no incentive amount, and a maximum of 40%. A separate article researching the effect of cash incentives on Malawi adults choosing to learn about HIV status[33] provides a basis for the rate of increase in participation with respect to monetary amounts provided. In this study, a benefit of \$0.30-0.50 resulted in about 67% of the maximum observed rate of enrollment, along a logistic curve. Using the Malawi GDP in 2005 as a reference for conversion, the \$0.3-0.5 range corresponds to approximately Č 26. We calibrated a logistic function to meet the above parameters, leading to the function of $p = \left(1 + e^{-0.062(x)}\right)^{-1} * 0.4$ being chosen to represent the overall participation rate p as a function of direct monetary incentive x.

An image of the function is provided in Figure 7.4.1 below.

---

[31] https://en.wikipedia.org/wiki/Logistic_function
[32] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5158287/
[33] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3115776/
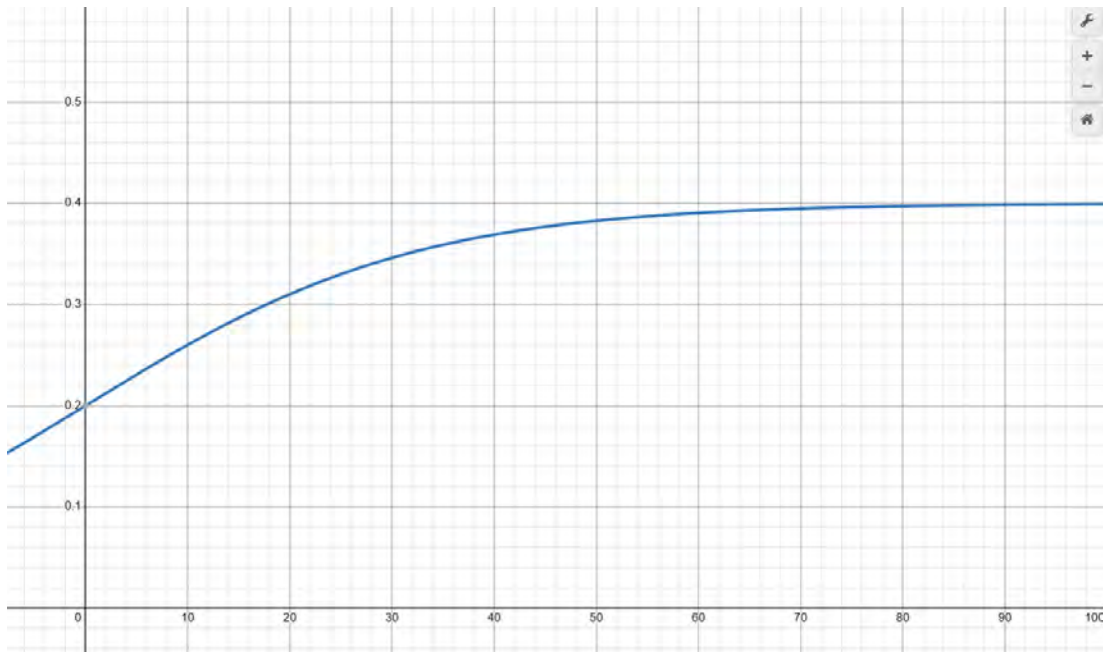
Figure 7.4.1: Participation Rate by Cash Bonus Amount, General Model via Desmos[34]

A similar method was used to construct a model to represent program uptake for smoking cessation programs. A study testing the effect of incentives on smoking cessation[35] found a success rate of 7.1% without incentive and 10.6% with incentive; we thus use these values as the y-intercept and horizontal asymptote, respectively. Furthermore, a separate study[36] claimed that $64 (equivalent to Č 37) was insufficient to produce significant results. From this we derive the function $p = \left(1 + e^{-0.2(x-47)}\right)^{-1} * 0.035 + 0.071$ to match the datapoints of interest.

[34] https://www.desmos.com/calculator
[35] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6635501/table/CD004307-tbl-0001/
[36] https://pubmed.ncbi.nlm.nih.gov/27863323/
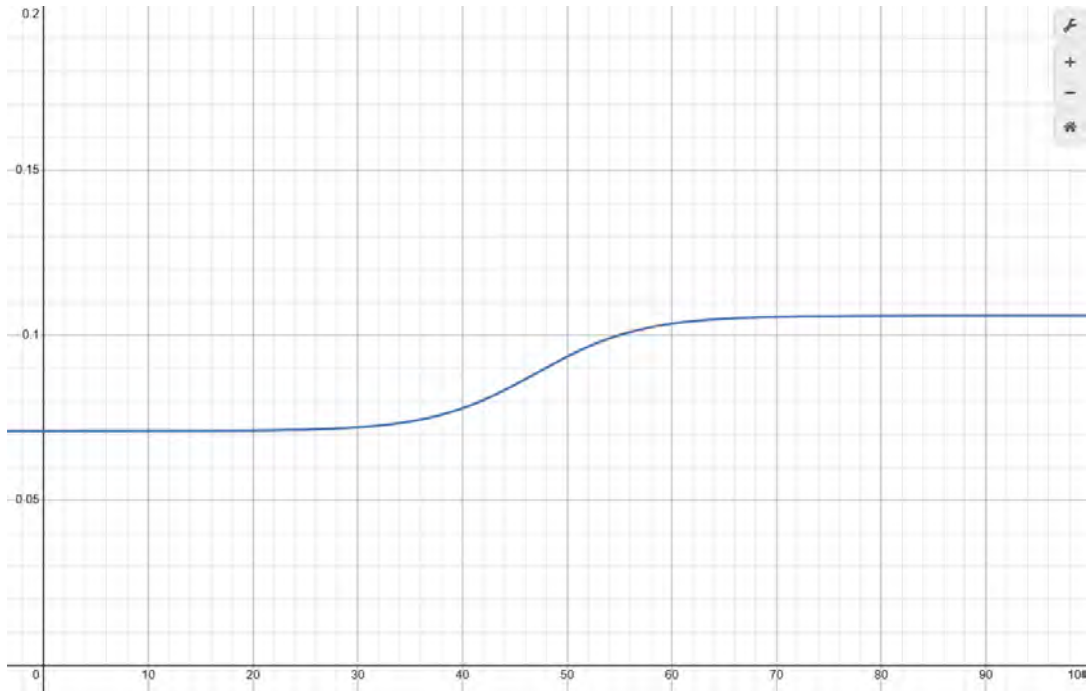
Figure 7.4.2: Participation Rate by Cash Bonus Amount, Smoking Model via Desmos

For both varieties of program, we chose an amount Č 50 yearly as our preferred bonus amount, as the number is round (easy to advertise) and achieves most of the maximum participation for each program without wasting money on quickly diminishing returns. The functions modeling participation as a function of cash incentive amount were applied to derive expected participation rates of 38.28% for the general program type and 9.39% for programs inclusive of smoking cessation programs. Programs without cash incentives are expected to have a yearly participation rate of 20.00%. A table of expected participation rates by program and benefit amount is displayed below.

BENEFIT AMOUNT	PROGRAM 1	PROGRAM 2	PROGRAM 3	PROGRAM 4
Č 50000	20.00%	20.00%	20.00%	20.00%
Č 100000	20.00%	20.00%	20.00%	20.00%
Č 250000	38.28%	38.28%	38.28%	38.28%
Č 500000	9.39%	9.39%	38.28%	38.28%
Č 1000000	9.39%	9.39%	38.28%	38.28%
Č 2000000	9.39%	9.39%	38.28%	38.28%

Figure 7.4.3: Forecast Yearly Participation Rate by Death Benefit Amount and Program

We assume independent participation from year-to-year for the purpose of estimation.

APPENDIX E

SIMILAR COUNTRY ESTIMATION

Data compiled by the World Bank[37] was utilized to compare Lumaria to other nations for the purpose of extrapolation from limited data. A file was assembled including worldwide country-specific information for comparison with data provided by Lumaria's encyclopedia. We chose to include the metrics of population, GDP per capita (PPP) in USD, life expectancy, infant mortality, and smoking rate. By focusing on these key characteristics, we approximate countries with similar causes of death based on the size of the population and their wealth. Life expectancy and infant mortality were additionally incorporated to better measure health characteristics. Smoking/tobacco use was a key focus as well, as it was one of the few health factors present in the Inforce data besides age and sex, and because smokers have a vastly different death cause composition from nonsmokers (See Appendix K). Countries not associated with the World Bank or who failed to provide relevant data were excluded from calculation.

The means and standard deviations were computed from the five variables for standardization. The standardized values for each variable from each country were compared to Lumaria's to derive five standardized distance values, $z_1, \ldots, z_5$. We then applied the distance formula of $d = \sqrt{z_1^2 + z_2^2 + z_3^2 + z_4^2 + z_5^2}$ to provide a function of quantitative distance from Lumaria on these key metrics. The top five nations by distance are given in Figure 7.5.1.

COUNTRY	DISTANCE	RANK
Thailand	0.48611	1
Uruguay	0.75876	2
Malaysia	0.76994	3
Argentina	0.78060	4
Sri Lanka	0.78516	5

Figure 7.5.1: Country Similarity to Lumaria

The three closest nations were the primary focus when calculating the weighted causes of death as gathered from the 2019 data by the World Health Organization (See Appendix F), so for estimation we used Thailand, Uruguay, and Malaysia as nations of reference.

---

[37] data.worldbank.org/country

APPENDIX F

DEATH CAUSE EXTRAPOLATION

The Inforce dataset maintained by SuperLife does not explicitly state the precise cause of death for each recorded loss of life, instead listing a broad category of death from the International Classification of Disease Tenth Revision (ICD-10). We found this to be an insufficiently detailed classifier for useful modeling, as many contributors to mortality of wildly different causes are often lumped into the same category. For instance, within the Inforce dataset there is no distinction made between Diabetes and malnutrition, or between car accidents and suicide (see Figure 7.6.1).
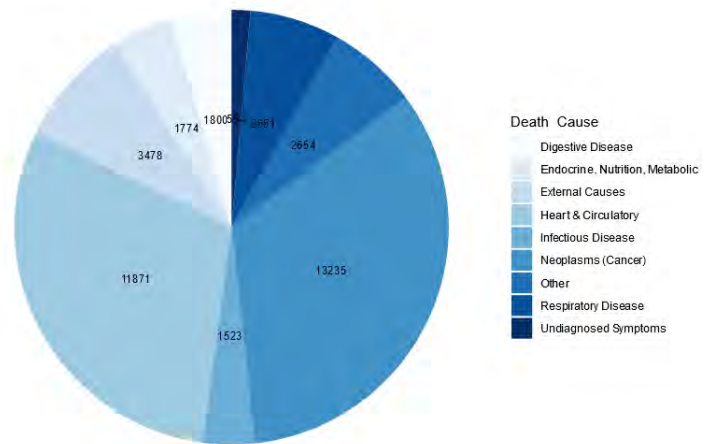
Figure 7.6.1: Leading Causes of Death by Category among SuperLife Policyholders

We chose to rectify this issue by estimating the proportion of total deaths for many individual causes of death, from which point we then reconstructed larger categories more useful in mortality modeling. We chose to use the World Health Organization's 2020 publication of cause-specific mortality estimates by country for 2019 as our basis for estimation[38]. Then, we used our estimates of the most similar countries to Lumaria (see Appendix E) to average the proportion of each ICD-10 category owed to the smaller causes. Of the top five countries, the final estimation relies upon data from the top three: Thailand, Uruguay, and Malaysia. This analysis results in a series of 164 causes of death by proportion of all deaths in Lumaria (we winnow the total amount to a more usable basis in Appendix G).

---

[38] https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death

APPENDIX G

INTERVENTION EFFECT FORECASTING

After assembling programs of interventions and a detailed list of death causes onto which to project results, the next step was to link the two components.

First, we reduced the number of individual causes of deaths to a more manageable amount. After consolidation, the list was condensed to 38 distinct causes, down from 164 prior to merging. This amount was selected for its ability to retain meaningful information more detailed than the Inforce dataset provided (for instance, by separating out different types of cancer) while allowing for a separate consideration of each cause.

After this step, we linked each intervention included within SuperLife Wellness's programs to the causes of death they may reasonably affect using a variety of medical sources as shown in Figures 7.7.1 and 7.7.2 below.

INTERVENTION NAME	ID FOR FIGURE 8.7.2	SOURCE FOR LINKAGE
Smoking Cessation Programs	I1	CDC: Health Effects of Cigarette Smoking[39]
Community Gardens	I2	CDC: Consequences of Obesity[40]
Healthy Eating Campaigns	I3	CDC: Consequences of Obesity
Driver Safety Courses	I4	Only Road Injuries Included
Incentives for Preventive Screenings	I5	Nebraska Medicine[41]
Incentives for Vaccination	I6	CDC Vaccination Resources[42],[43]
Hiking & Outdoors Activity Groups	I7	National Library of Medicine: Physical Activity, Health Benefits, Mortality Risk[44] and Nature Walks as an Intervention for Anxiety and Depression[45]

Figure 7.7.1: Sources and Key for Figure 7.7.2

---

[39] https://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/effects_cig_smoking/index.htm
[40] https://www.cdc.gov/obesity/basics/consequences.html
[41] https://www.nebraskamed.com/primary-care/13-preventive-screenings-why-theyre-important-and-who-needs-them-most
[42] https://www.cdc.gov/vaccines/vpd/vaccines-list.html
[43] https://www.cdc.gov/vaccines/vpd/hpv/public/index.html
[44] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3501820/
[45] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8953618/

CAUSE OF DEATH	I1	I2	I3	I4	I5	I6	I7	% OF DEATHS
RESPIRATORY INFECTIONS	N	N	N	N	N	Y	N	2.23
HIV/AIDS	N	N	N	N	Y	N	N	0.63
TUBERCULOSIS	N	N	N	N	N	Y	N	0.29
OTHER INFECTIOUS DISEASES	N	N	N	N	Y	Y	N	0.70
DIABETES MELLITUS	Y	Y	Y	N	Y	N	N	3.30
OTHER ENDOCRINE, BLOOD, NUTRITION AND IMMUNE ISSUES	N	N	N	N	Y	N	N	1.62
CANCER: LIPS, ORAL CAVITY, ESOPHAGUS, LARYNX, LUNG, TRACHEA	Y	Y	Y	N	Y	N	N	8.17
CANCER: STOMACH, COLON, RECTUM	Y	Y	Y	N	Y	N	N	5.37
CANCER: LIVER	Y	Y	Y	N	Y	N	N	3.17
CANCER: SKIN	N	N	N	N	Y	N	N	0.37
CANCER: OTHER	Y	Y	Y	N	Y	Y	N	1.64
ALCOHOL AND DRUG ABUSE	N	N	N	N	N		N	1.34
MENTAL ISSUES	N	Y	Y	N	N	N	N	0.08
NERVOUS SYSTEM ISSUES	Y	N	N	N	Y	N	N	2.39
HEART DISEASE	Y	Y	Y	N	Y	N	Y	15.77
STROKE	Y	Y	Y	N	Y	N	Y	10.83
OTHER CIRCULATORY	Y	N	N	N	Y	N	Y	3.43
CHRONIC OBSTRUCTIVE PULMONARY DISEASE	Y	N	N	N	N	N	Y	4.96
OTHER RESPIRATORY DISEASES	Y	Y	Y	N	Y	N	Y	1.74
LIVER CIRRHOSIS	N	N	N	N	Y	N	N	1.86
DIGESTIVE DISEASES	N	N	N	N	Y	N	N	2.69
GENITOURINARY DISEASES	N	Y	Y	N	Y	N	N	1.58
MUSCULOSKELETAL DISEASES	N	Y	Y	N	Y	N	N	0.48
PREGNANCY	N	N	N	N	N	N	N	0.01
CONGENITAL ANOMALIES	N	N	N	N	N	N	N	0.30
ROAD INJURY	N	N	N	Y	N	N	N	3.45
POISONINGS	N	N	N	N	N	N	N	0.06

FALLS	N	N	N	N	N	N	N	0.71
FIRES, HEAT AND HOT SUBSTANCES	N	N	N	N	N	N	N	0.16
DROWNING	N	N	N	N	N	N	N	0.50
SELF-HARM	N	N	N	N	N	N	Y	1.64
OTHER ACCIDENTAL	N	N	N	N	N	N	N	0.93
UNDIAGNOSED SYMPTOMS	N	N	N	N	Y	N	N	1.40
OTHER	N	N	N	N	N	N	N	1.46
PERCENT MORTALITY REDUCTION	25.0	3.0	3.0	3.0	7.5	5.0	4.5	--
PERCENT OF DEATHS AFFECTED	75.5	66.9	66.9	3.5	81.9	19.6	38.4	100.0

Figure 7.7.2: Linkage Between Interventions and Causes of Death

The middle of the mortality reduction range forecasted for each intervention was used for mortality modeling. For instance, the mortality reduction range provided for healthy eating campaigns was 2-4%, so 3% was chosen for the approximate value. We discuss methods used to mitigate the risk from the wide range of intervention effects in Section 5.1: Risk Mitigation. Mortality reduction was split amongst the causes affected for each intervention as a constant multiplier. For instance, because healthy eating campaigns may affect causes totaling 66.9% of all deaths, a reduction of $\frac{3.0\%}{0.669} = 4.49\%$ was applied to each cause of death affected by the campaigns to total a 3.0% reduction across all causes.

To calculate the effect of each program, the sum of the mortality reduction effects for each cause of death was used as the unadjusted mortality reduction for that cause, owing to the program. The adjustment of these results to reflect diminishing marginal decrease in mortality is detailed in Appendix H.

APPENDIX H

MORTALITY REDUCTION ADJUSTMENT

It is impossible to achieve 100% mortality reduction under any circumstance, so there is clearly some degree of diminishing marginal benefit to the summation of multiple mortality reduction factors. To adjust for this impossibility, we performed an adjustment to mortality reduction for each cause of death to model the decreasing benefits of additional interventions.

Several factors were considered when seeking and constructing a function to model the relationship between unadjusted mortality reduction (denoted p^*) and adjusted mortality reduction (denoted p).

- Adjusted mortality reduction should be at or below the unadjusted mortality reduction for all positive values of p.
- A study on the effects of long-term physical activity on mortality showed that participants experienced "nearly the maximum mortality reduction" of "≈35%–42%"[46]; we use the lower bound of this range (of 35%) as the theoretical maximum mortality reduction in the interest of caution.
- Within the same study, the main cohort of participants experienced a 19% decrease in mortality, whereas those who committed to twice the regular amount of physical activity experienced 21-23% lower mortality. We thus derive and $f(2p^*) = 0.19$ for some.
- Finally, (0.05,0.05) was a point of interest as well, as unadjusted rates of mortality reduction below 5% should be expected to carry over to the final value without undue diminishment.

From these points, the function $p = \frac{7\tan^{-1}4.5p^*}{10\pi}$ was derived to best fit the requirements.

---

[46] https://www.ahajournals.org/doi/full/10.1161/CIRCULATIONAHA.121.058162
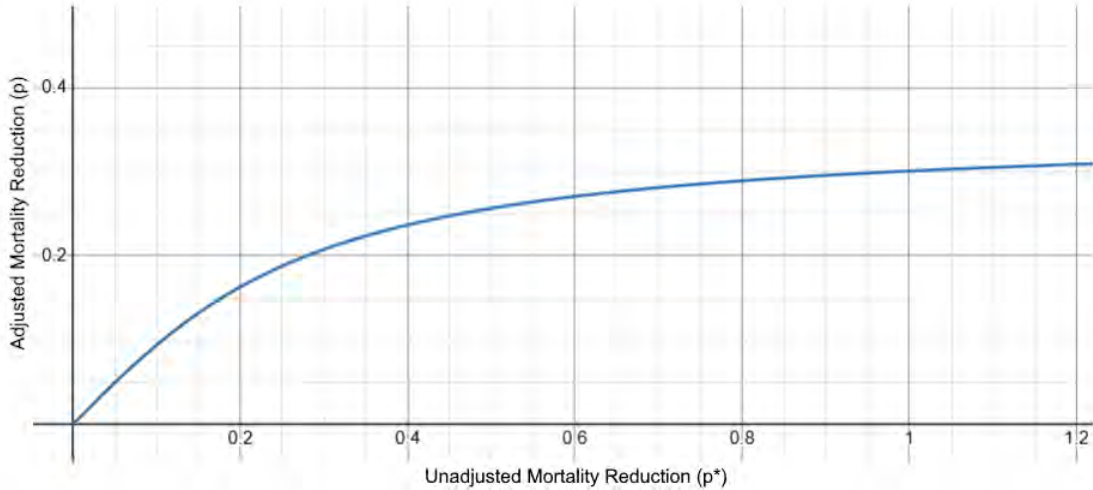
Figure 7.8.1: Mortality Reduction Adjustment Function via Desmos[47]

Mortality reduction was applied separately for each cause of death, so the decrease in program effect from mortality adjustment for entire programs is greater than a simple adjustment on total mortality reduction would imply. A table of unadjusted versus adjusted mortality reduction by program Is displayed in Figure 7.8.2, and more detail into the use of this data is provided in Appendix I.

PROGRAM	UNADJUSTED MORTALITY REDUCTION	ADJUSTED MORTALITY REDUCTION
Program 1[48]	43.00%[49]	11.19 - 24.84% by age group[50]
Program 2	45.00%	13.01 - 24.74% by age group
Program 3	21.00%	12.65 - 16.26% by age group
Program 4	20.00%	13.12 – 14.33% by age group

Figure 7.8.2: Mortality Reduction Adjustment, by Program

[47] https://www.desmos.com/calculator
[48] Typical program intervention offerings included here; reduced offerings for some policyholders were considered in our model but not shown in Figure 7.8.2.
[49] The middle of the range of mortality reduction for each intervention was assumed; See Appendix G.
[50] See Appendix I for age groupings and greater detail.

APPENDIX I

PROGRAM EFFECT ON POLICYHOLDER MORTALITY

Under the methods described in prior appendices, a table of forecast mortality reduction for each of 38 causes of death was created for SuperLife Wellness's four intervention programs. We found a simple weighting of per-cause mortality reduction by proportion of deaths to be insufficiently precise when applying these values to the groups as a whole, as the death cause composition among policyholders varies by many factors, including age.

To account for the effect of age on mortality reduction magnitude, we first used the Inforce dataset to create a table containing the proportion of each major death type within deaths at each age. For instance, road injuries account for 10% of deaths amongst 40-year-olds but only 0.6% amongst 75-year-olds. We then applied the methods in Appendix F to each age to create an estimate of individual death cause proportion by age, then combined to Appendix G's 38-cause set. Next, to reduce yearly noise, we consolidated the ages into five buckets. Finally, we used the per-cause mortality reduction output described in Appendix H to create an estimate overall reduction in mortality for each program, separated by age group. Final reduction in mortality rate by program and age group is shown below.

PROGRAM[51]	AGE GROUP	MORTALITY REDUCTION
PROGRAM 1	≤ 35 years	11.19%
	36-50 years	16.92%
	51-65 years	22.00%
	66-80 years	23.64%
	≥ 81 years	23.84%
PROGRAM 2	≤ 35 years	17.01%
	36-50 years	19.97%
	51-65 years	22.75%
	66-80 years	23.74%
	≥ 81 years	23.55%
PROGRAM 3	≤ 35 years	12.65%
	36-50 years	13.76%
	51-65 years	15.26%
	66-80 years	15.84%
	≥ 81 years	16.26%
PROGRAM 4	≤ 35 years	13.12%
	36-50 years	13.82%
	51-65 years	14.31%
	66-80 years	14.49%
	≥ 81 years	14.33%

Figure 7.9.1: Mortality Reduction by Program, by Age Group

---

[51] Only complete program intervention sets are shown here, but reduced mortality reduction for those eligible for fewer benefits was considered in final modeling (See Appendix L).

APPENDIX J

PAST IMPLEMENTATION SIMULATION

The primary goal of much of the prior appendices was to create the basis for a robust simulation of the savings which would have been realized had SuperLife Wellness been in effect for the past twenty years, based upon the data available to us. From this standpoint, we endeavor to demonstrate the financial feasibility of the program and the breadth of savings available to SuperLife, should you choose to go forward with the plan.

1. First, we calculated the average rate of interest over the past twenty years to be 1.86% (see Appendix N).
2. Next, we divided all SuperLife policyholders by their policy type and accompanying program type. Summary tables for policyholder apportionment are provided in Appendix L. For this process, we relied upon participation weighting by the methods of Appendix D. When separating policyholders into their respective programs, we used the estimate of overweight proportion in Appendix B and assumed equivalent overweight proportion between groups. Figure 7.10.1 below shows the proportion of policyholders belonging to each policy and program type, with forecast participation rate highlighted.

POLICY TYPE	BENEFIT, Č	COUNT	PROGRAM 1	PROGRAM 2	PROGRAM 3	PROGRAM 4
SPWL	100000	69287	0.2269%	0.2050%	3.4853%	3.1632%
	250000	76424	0.2503%	0.2261%	3.8443%	3.4890%
	500000	76581	0.2508%	0.2266%	3.8522%	3.4962%
	1000000	76747	0.2514%	0.2271%	3.8605%	3.5037%
	2000000	72262	0.2367%	0.2138%	3.6249%	3.2990%
20-YEAR TERM	50000	89631	0.2935%	0.2652%	4.5086%	4.0919%
	100000	88767	0.2907%	0.2626%	4.4652%	4.0525%
	250000	125383	0.4106%	0.3709%	6.3070%	5.7241%
	500000	125376	0.4106%	0.3709%	6.3070%	5.7238%
	1000000	97918	0.3207%	0.2897%	4.9255%	4.4703%
	2000000	80206	0.2627%	0.2373%	4.0345%	3.6617%
TOTAL		978582	3.2049%	2.8951%	49.2247%	44.6753%

Figure 7.10.1: Policyholders by Policy and Program Type

HIGHLIGHTED COLOR	PARTICIPATION CLASS
CYAN	20.00%[52]
YELLOW	38.28%
LIME	9.39%

Figure 7.10.2: Legend for Figure 7.10.1

3. Then, we applied the estimated adjusted mortality rate by age to each policyholder according to their program and demographic status, first assuming full participation from initially joining SuperLife until death. The mortality adjustments described in Appendices C and I were applied to each group as necessary. From this we derived a final mortality table for each class of individual policyholder. The expected present value of savings was calculated using the following formulas based on the two different plan types.
   a. SPWL: $EPV = P - E \cdot \ddot{a}_x^* - B \cdot A_x^*$
   b. T20: $EPV = P \cdot \ddot{a}_{x:\overline{20|}}^* - E \cdot \ddot{a}_{x:\overline{20|}}^* - B \cdot A_{x:\overline{20|}}^{1*}$

Where B is the death benefit amount, P is the premium calculated without the programs, and E is the cost of the programs. Additionally, the asterisk indicates that the expected present value was computed using the adjusted mortality table that resulted from the implementation of the given program.

4. We then averaged the present value of savings realized by policyholders of all relevant ages (26-65).
5. Following this, we multiplied the above savings by forecast participation rate to derive final estimated savings for each type of individual. Figure 7.10.3 details the one-person savings by program and policy type. Individual losses for some policyholders are more than canceled out by large gains among preferred groups. A system which ensures complete gains for all groups by eliminating further interventions and benefits for low-premium policyholders risks losing the attractiveness of SuperLife Wellness as a program, so we maintained benefits to every degree possible.

POLICY TYPE	BENEFIT, Č	PROGRAM 1	PROGRAM 2	PROGRAM 3	PROGRAM 4
SPWL	100000	Č -353.79	Č -437.37	Č -514.76	Č -607.16
	250000	Č -249.59	Č -992.22	Č -1302.07	Č -1599.90
	500000	Č -1576.18	Č -1959.04	Č -574.90	Č -1037.15
	1000000	Č -2738.97	Č -3191.99	Č 2198.44	Č 1443.27
	2000000	Č -563.82	Č -973.20	Č 7745.14	Č 6404.11
20-YEAR TERM	50000	Č -47.04	Č -78.44	Č -206.54	Č -226.45

[52] See Appendix D for Participation Rate Explanations

100000	Č 280.27	Č 127.42	Č -127.36	Č -226.81
250000	Č 2351.02	Č 1472.49	Č 144.18	Č -268.33
500000	Č 838.72	Č 407.49	Č 1525.54	Č 755.02
1000000	Č 1963.04	Č 1304.69	Č 5092.43	Č 3610.94
2000000	Č 7321.05	Č 6258.67	Č 12226.22	Č 9322.77

Figure 7.10.3: Per-Person Savings by Program and Policy Type

6. Then, we used the Inforce dataset of policyholders over the past twenty years to determine estimated savings for each actual individual policyholder, had the program been in effect. Figure 7.10.4 charts the number of holders for each policy type by year, while Figures 7.10.5 and 7.10.6 display the savings (and losses) by each program, by year (yearly and accumulated).

7. Finally, we estimate the final savings to be **Č 1,919,496,526**, had SuperLife been in effect for the past twenty years.
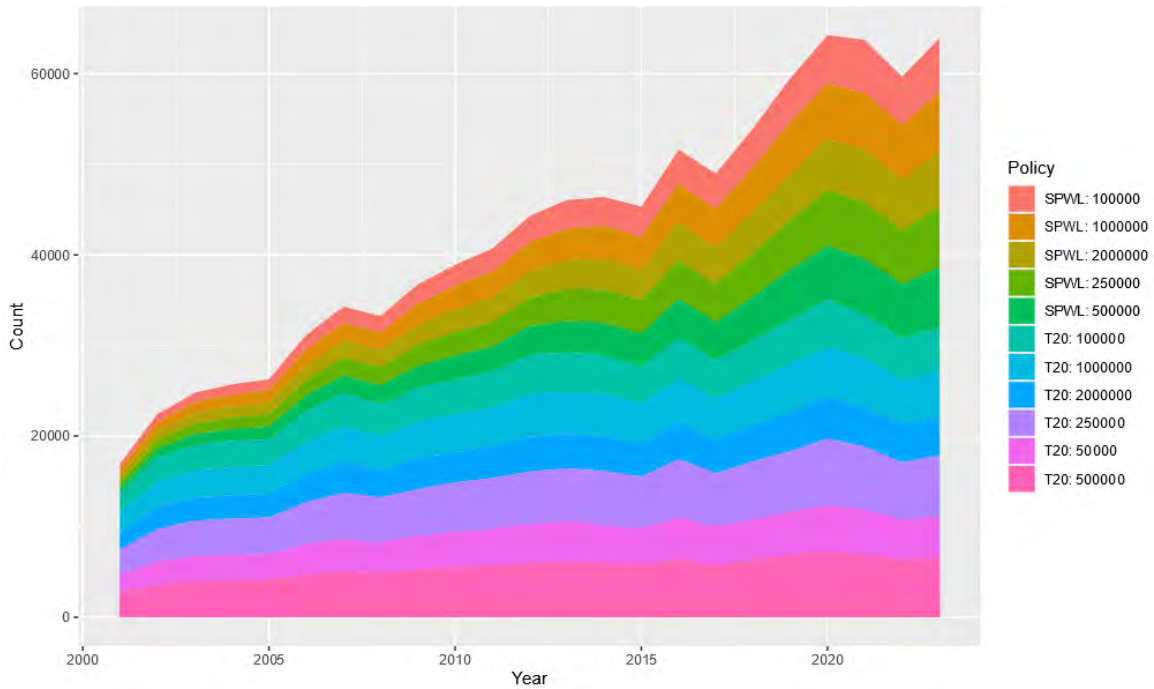
Figure 7.10.4: Policy Count by Type, Benefit Amount and Year
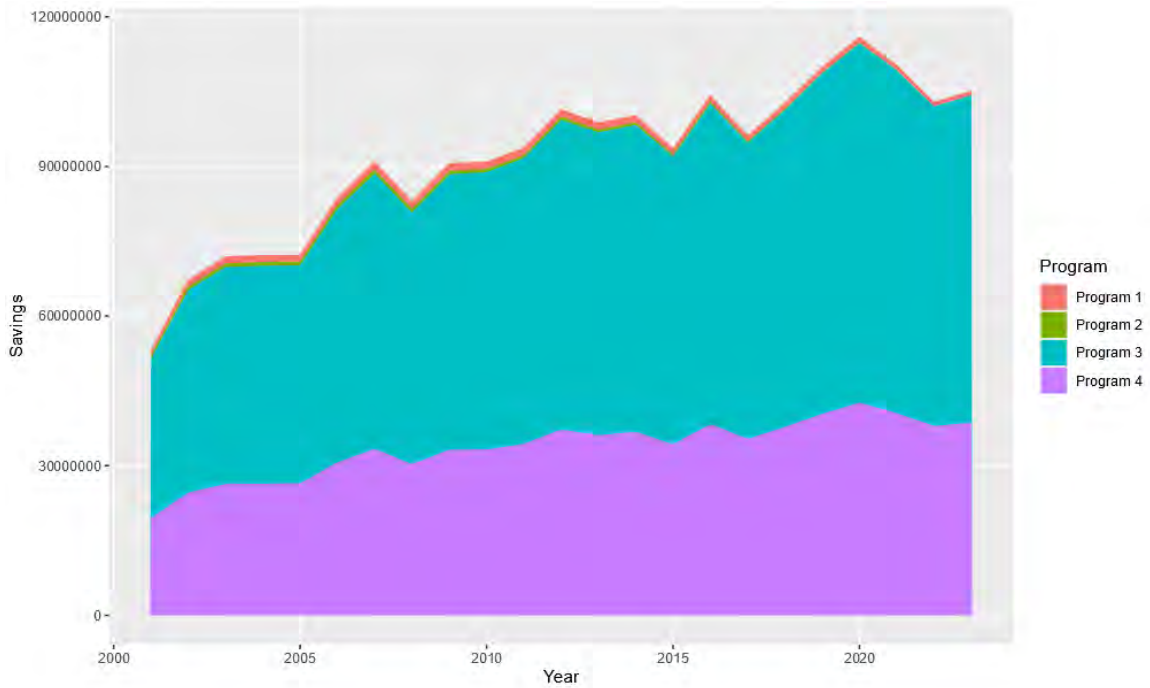
Figure 7.10.5: Yearly Savings by Policy Type
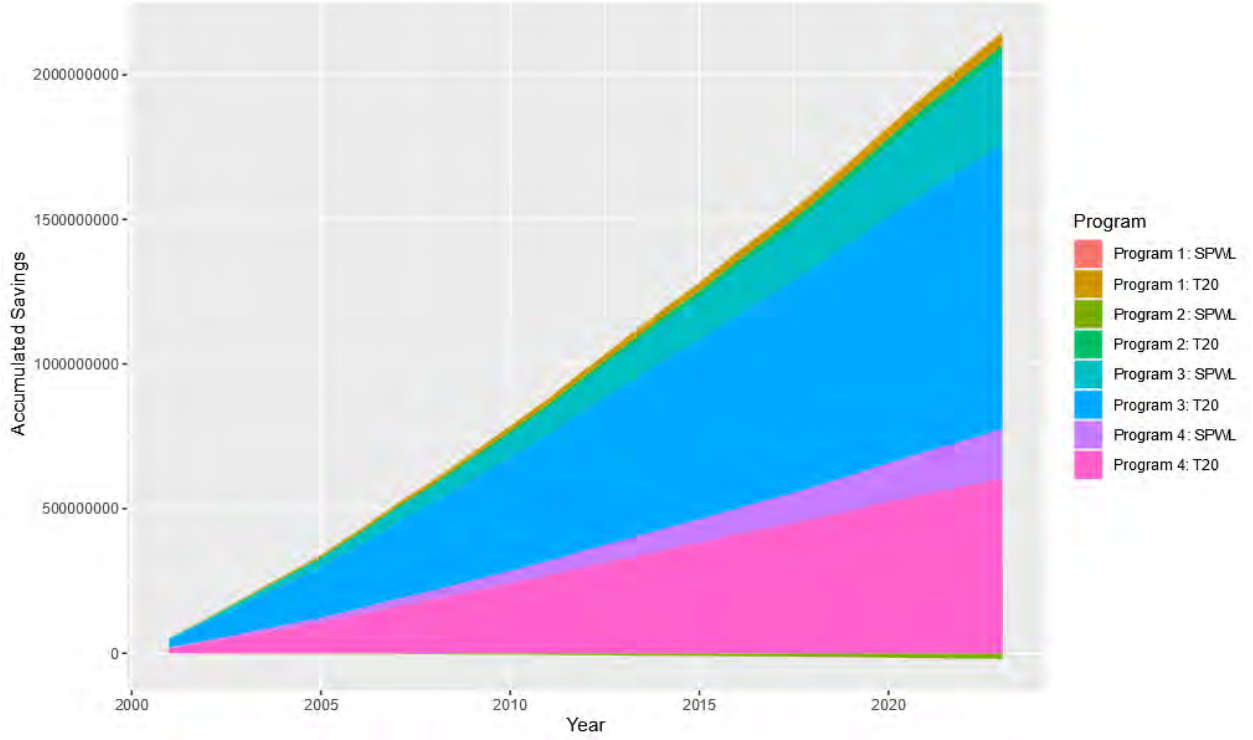
Figure 7.10.6: Accumulated Savings by Policy and Program Type, by Year

APPENDIX K

POLICYHOLDER DEATHS BY DEMOGRAPHICS

Not all policyholders die of different causes at equal rates, and the clearest divides are in the causes of death befalling people of differing smoking statuses and ages.

Smokers have a much higher all-cause mortality rate, and most of this increase is spread amongst various circulatory and respiratory ailments. Strokes and heart disease befall smokers at greater rates than their nonsmoking counterparts, and chronic obstructive pulmonary disease (COPD) is a leading killer amongst almost exclusively smokers.
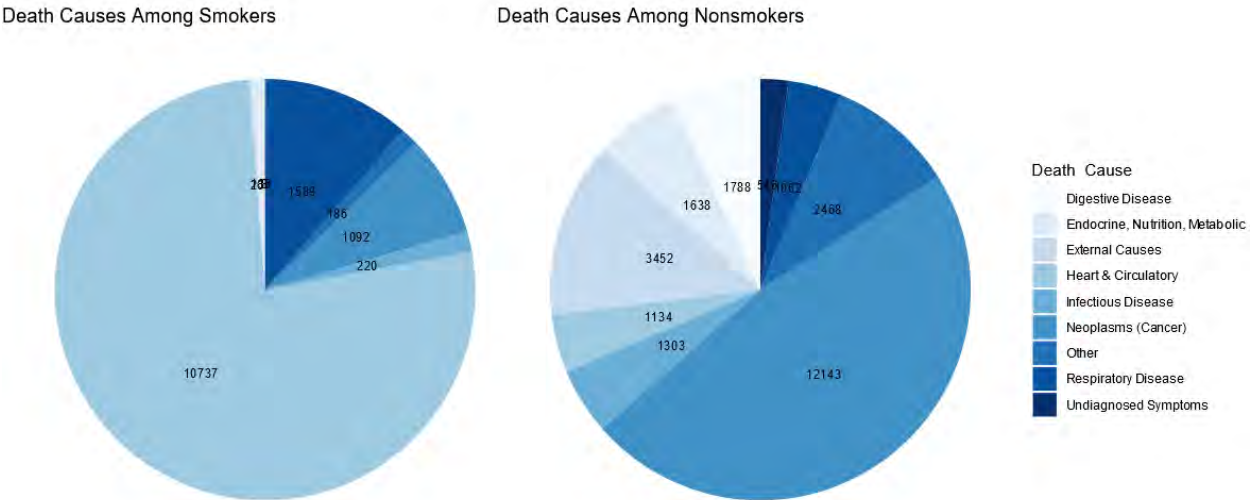
Figure 7.11.1: Leading Causes of Death by Smoking Status, among SuperLife Policyholders

The death cause gulf when separated by age at death is quite large as well, though not quite as stark in its manifestation. Figure 7.11.2, shown below, illustrates the outsized role of external causes of death for the youngest SuperLife policyholders. While close to half of the younger deceased died of external causes, far less than 10% of older groups befell in such a way. This informed our decision making in program design, as while driver safety courses may not have an extraordinarily high ratio of mortality reduction to cost, they address the largest single cause of external deaths head on, and thus has the potential for large savings.
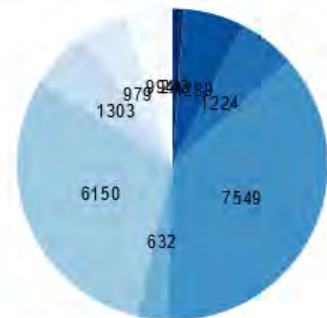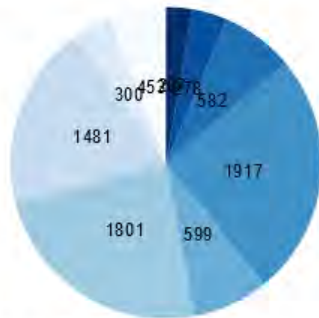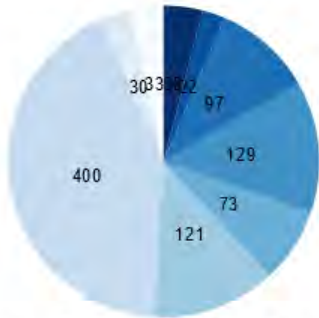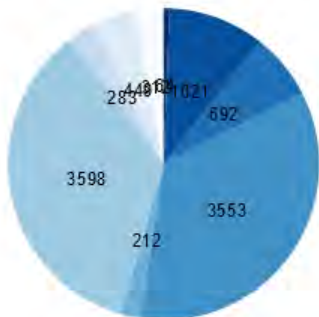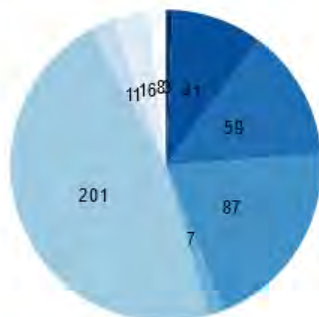
Figure 7.11.2: Leading Causes of Death by Age at Death, among SuperLife Policyholders

APPENDIX L

REDUCED BENEFIT ELIGIBILITY TABLES AND PRICES

Although SuperLife Wellness would ideally serve as a complete and comprehensive program for all SuperLife policyholders, the low premium amounts for some policyholders make the cost of interventions prohibitively expensive. While single premium whole life policyholders and 20-year term policyholders with benefit amounts of at least Č 1000000 often have premium amounts in the tens of thousands, the yearly premiums for those who possess Č 50000 or Č 100000 benefit policies may be as low as a few dozen Crowns. To ensure that program costs do not outpace benefits, we have implemented a more limited set of interventions within each program for the 47.19% of current policyholders with low-premium plans.

We sought to preserve the core benefits of preventive screening incentives and hiking and outdoors groups for all policyholders, choosing to primarily limit the high-cost interventions of smoking cessation programs and driver safety courses. Figure 7.12.1 includes a table of benefit offerings within each program for each category of policy along with a summary of premium prices (P) by policy type.

Program 1: Eligible for overweight smokers

DEATH BENEFIT	Č 50000	Č 100000	Č 250000	Č 500000	Č 1000000	Č 2000000
I1	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors
I2	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings
I3			Community Gardens	Community Gardens	Community Gardens	Community Gardens	Community Gardens
I4		Healthy Eating Campaigns	Healthy Eating Campaigns	Healthy Eating Campaigns	Healthy Eating Campaigns	Healthy Eating Campaigns
I5				Smoking Cessation (50% discount)	Smoking Cessation	Smoking Cessation
BONUS RATE			Č 50/year	Č 50/year	Č 50/year	Č 50/year
COST	Č 105	Č 150	Č 200	Č 1288.75	Č 2377.5	Č 2377.5
20-YEAR TERM LIFE INSURANCE POLICYHOLDERS[53]						
AVG P[54]	Č 1032.47	Č 2064.94	Č 5162.35	Č 10324.70	Č 20649.41	Č 41298.81
MEDIAN P	Č 651.98	Č 1303.96	Č 3259.90	Č 6519.80	Č 13039.61	Č 26079.22
MIN P	Č 125.77	Č 251.53	Č 628.84	Č 1257.67	Č 2515.35	Č 5030.70
MAX P	Č 3487.19	Č 6974.39	Č 17435.97	Č 34871.95	Č 69743.89	Č 139487.79
PROPORTION[55]	0.2935%	0.2907%	0.4106%	0.4106%	0.3207%	0.2627%
SINGLE PREMIUM WHOLE LIFE INSURANCE POLICYHOLDERS						
AVG P	N/A	Č 62115.46	Č 155288.64	Č 310577.29	Č 621154.58	Č 1242309.15
MEDIAN P	N/A	Č 61776.49	Č 154441.23	Č 308882.46	Č 617764.92	Č 1235529.85
MIN P	N/A	Č 44968.06	Č 112420.16	Č 224840.31	Č 449680.62	Č 899361.25
MAX P	N/A	Č 80342.32	Č 200855.81	Č 401711.61	Č 803423.23	Č 1606846.46
PROPORTION	N/A	0.2269%	0.2503%	0.2508%	0.2514%	0.2367%

---

[53] Both single-premium whole life and 20-year term policyholders face the same tiers by death benefit amount.

[54] Average forecasted yearly premium (See Appendix M)

[55] Proportion of all policyholders holding 20-year term plans with the given death benefit; see Appendix B for program eligibility flowchart.

Program 2: Eligible for smokers of normal weight

DEATH BENEFIT	Č 50000	Č 100000	Č 250000	Č 500000	Č 1000000	Č 2000000
I1	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors
I2	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings
I3		Vaccination Incentives	Vaccination Incentives	Vaccination Incentives	Vaccination Incentives	Vaccination Incentives
I4			Driver Safety Courses (50% discount)	Driver Safety Courses	Driver Safety Courses	Driver Safety Courses
I5				Smoking Cessation (50% discount)	Smoking Cessation	Smoking Cessation
BONUS RATE			Č 50/year	Č 50/year	Č 50/year	Č 50/year
COST	Č 105	Č 157.5	Č 272.5	Č 1426.25	Č 2515	Č 2515
20-YEAR TERM LIFE INSURANCE POLICYHOLDERS						
AVG P	Č 887.34	Č 1774.67	Č 4436.69	Č 8873.37	Č 17746.74	Č 35493.49
MEDIAN P	Č 551.51	Č 1103.01	Č 2757.54	Č 5515.07	Č 11030.15	Č 22060.29
MIN P	Č 105.78	Č 211.57	Č 528.92	Č 1057.83	Č 2115.67	Č 4231.33
MAX P	Č 3065.03	Č 6130.07	Č 15325.17	Č 30650.35	Č 61300.69	Č 122601.38
PROPORTION	0.2652%	0.2626%	0.3709%	0.3709%	0.2897%	0.2373%
SINGLE PREMIUM WHOLE LIFE INSURANCE POLICYHOLDERS						
AVG P	N/A	Č 60518.97	Č 151297.43	Č 302594.86	Č 605189.72	Č 1210379.44
MEDIAN P	N/A	Č 60107.6	Č 150268.99	Č 300537.98	Č 601075.95	Č 1202151.90
MIN P	N/A	Č 43562.63	Č 108906.57	Č 217813.14	Č 435626.27	Č 871252.54
MAX P	N/A	Č 78827.15	Č 197067.89	Č 394135.77	Č 788271.54	Č 1576543.09
PROPORTION	N/A	0.2050%	0.2261%	0.2266%	0.2271%	0.2138%

Program 3: Eligible for overweight nonsmokers

DEATH BENEFIT	Č 50000	Č 100000	Č 250000	Č 500000	Č 1000000	Č 2000000
I1	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors
I2	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings
I3		Community Gardens	Community Gardens	Community Gardens	Community Gardens	Community Gardens
I4		Healthy Eating Campaigns	Healthy Eating Campaigns	Healthy Eating Campaigns	Healthy Eating Campaigns	Healthy Eating Campaigns
I5			Driver Safety Courses (50% discount)	Driver Safety Courses	Driver Safety Courses	Driver Safety Courses
BONUS RATE			Č 50/year	Č 50/year	Č 50/year	Č 50/year
COST	Č 105	Č 150	Č 265	Č 330	Č 330	Č 330
20-YEAR TERM LIFE INSURANCE POLICYHOLDERS						
AVG P	Č 408.38	Č 816.76	Č 2041.90	Č 4083.79	Č 8167.58	Č 16335.16
MEDIAN P	Č 240.82	Č 481.65	Č 1204.11	Č 2408.23	Č 4816.46	Č 9632.91
MIN P	Č 45.41	Č 90.81	Č 227.03	Č 454.06	Č 908.13	Č 1816.25
MAX P	Č 1521.64	Č 3043.27	Č 7608.19	Č 15216.37	Č 30432.75	Č 60865.49
PROPORTION	4.5086%	4.4652%	6.3070%	6.3067%	4.9255%	4.0345%
SINGLE PREMIUM WHOLE LIFE INSURANCE POLICYHOLDERS						
AVG P	N/A	Č 53042.01	Č 132605.03	Č 265210.06	Č 530420.11	Č 1060840.22
MEDIAN P	N/A	Č 52385.21	Č 130963.02	Č 261926.03	Č 523852.06	Č 1047704.12
MIN P	N/A	Č 37359.36	Č 93398.40	Č 186796.79	Č 373593.58	Č 747187.16
MAX P	N/A	Č 71029.82	Č 177574.54	Č 355149.08	Č 710298.15	Č 1420596.31
PROPORTION	N/A	3.4853%	3.8443%	3.8522%	3.8605%	3.6349%

Program 4: Eligible for nonsmokers of normal weight

DEATH BENEFIT	Č 50000	Č 100000	Č 250000	Č 500000	Č 1000000	Č 2000000
I1	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors	Hiking & Outdoors
I2	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings	Preventive Screenings
I3		Vaccination Incentives	Vaccination Incentives	Vaccination Incentives	Vaccination Incentives	Vaccination Incentives
I4			Driver Safety Courses (50% discount)	Driver Safety Courses	Driver Safety Courses	Driver Safety Courses
I5						
BONUS RATE			Č 50/year	Č 50/year	Č 50/year	Č 50/year
COST	Č 105	Č 157.5	Č 272.5	Č 337.5	Č 337.5	Č 337.5
20-YEAR TERM LIFE INSURANCE POLICYHOLDERS						
AVG P	Č 346.31	Č 692.61	Č 1731.53	Č 3463.05	Č 6926.11	Č 13852.22
MEDIAN P	Č 202.85	Č 405.71	Č 1014.27	Č 2028.54	Č 4057.07	Č 8114.14
MIN P	Č 38.17	Č 76.34	Č 190.84	Č 381.69	Č 763.38	Č 1526.76
MAX P	Č 1302.85	Č 2605.71	Č 6514.26	Č 13028.53	Č 26057.06	Č 52114.12
PROPORTION	4.0919%	4.0525%	5.7241%	5.7238%	4.4703%	3.6617%
SINGLE PREMIUM WHOLE LIFE INSURANCE POLICYHOLDERS						
AVG P	N/A	Č 51571.10	Č 128927.74	Č 257855.48	Č 515710.96	Č 1031421.92
MEDIAN P	N/A	Č 50884.61	Č 127211.52	Č 254423.05	Č 508846.10	Č 1017692.19
MIN P	N/A	Č 36202.28	Č 90505.70	Č 181011.41	Č 362022.82	Č 724045.64
MAX P	N/A	Č 69366.10	Č 173415.26	Č 346830.51	Č 693661.03	Č 1387322.05
PROPORTION	N/A	3.1632%	3.4890%	3.4962%	3.5037%	3.2990%

Figure 7.12.1: Reduced Benefit Eligibility by Policy Type, by Program with Premium Pricing

APPENDIX M

FUTURE COST SAVINGS ESTIMATION

The process of future cost savings estimation was analogous to that of past savings estimation in many respects. The per-policy average savings calculation was handled in the same manner, belied on the same participation rate basis.

The key difference between the two models was in the count of policies for future years. Over the prior twenty years, SuperLife's portfolio expanded massively, and this expansion was not uniform across all plan offerings. In general term life insurance expanded more surely, whereas single premium whole life insurance expanded much more rapidly. To account for this disparity, we ran a separate linear regression for the count of each policy type over the prior twenty years, extrapolating the resulting linear approximation to 2044. Figure 7.13.1 below shows the growth of policy types from 2001 to 2044.
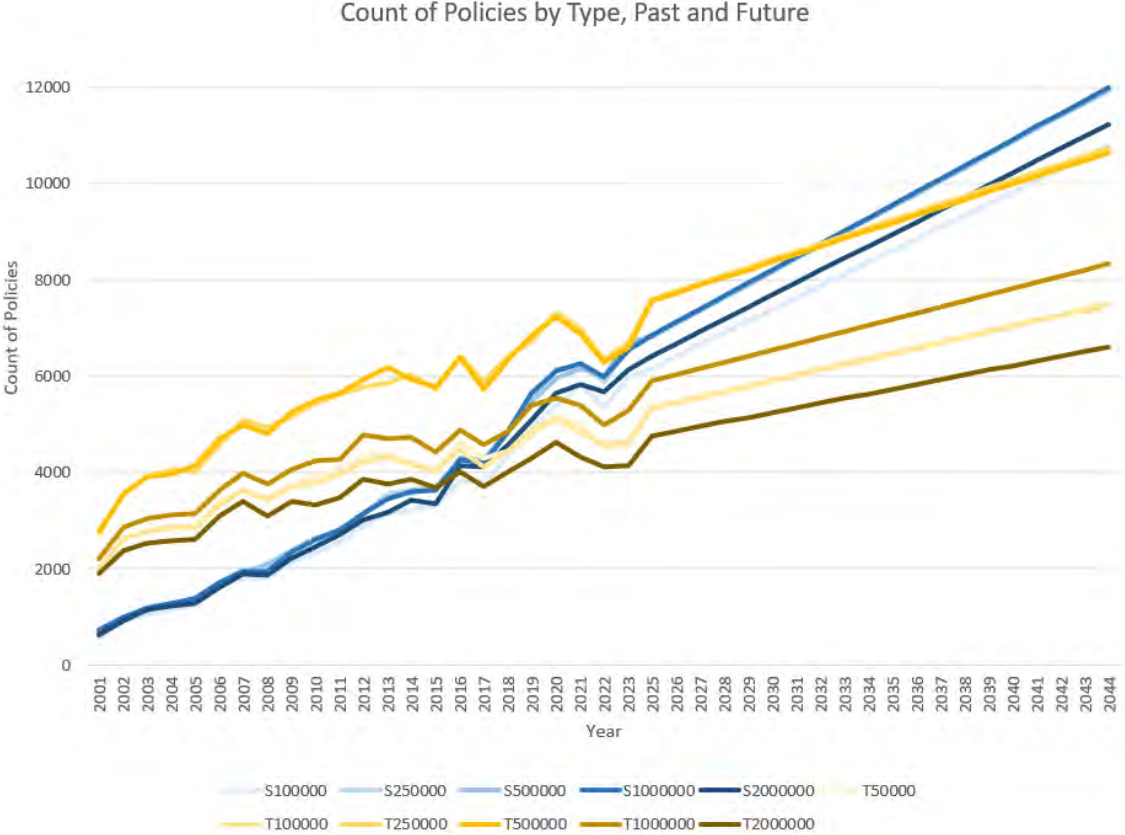
Figure 7.13.1: Count of Policies by Type, by Year, Past and Future

Figure 7.13.2 below shows the accumulated savings associated with SuperLife wellness, both past and future.
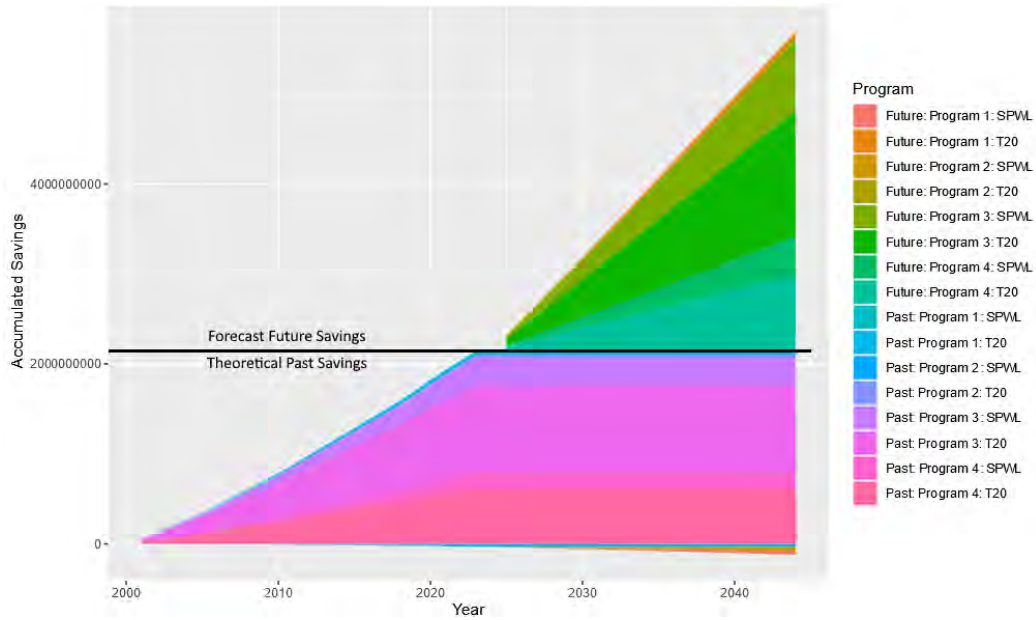
Figure 7.13.2: Accumulated Savings by Policy and Program Type, by Year: Past and Future

APPENDIX N

INTEREST RATE FORECASTING

For interest rate forecasting, we used the past twenty years of data for the 1-yr Risk Free Annual Spot Rate, as provided by the economic data for Lumaria. The average rate (geometrically calculated) for the period of 2004-2023 was found to be 1.860%, and this rate extrapolated to the future in our models. There is a considerable amount of risk contained within potential interest rate fluctuations, which we explore in Section 5.2: Sensitivity Analysis. Generally, we assume that insurance adjustments with respect to changing interest rates will be handled by the existing SuperLife team and decision structure, and the addition of SuperLife Wellness to the portfolio adds little additional risk[56].
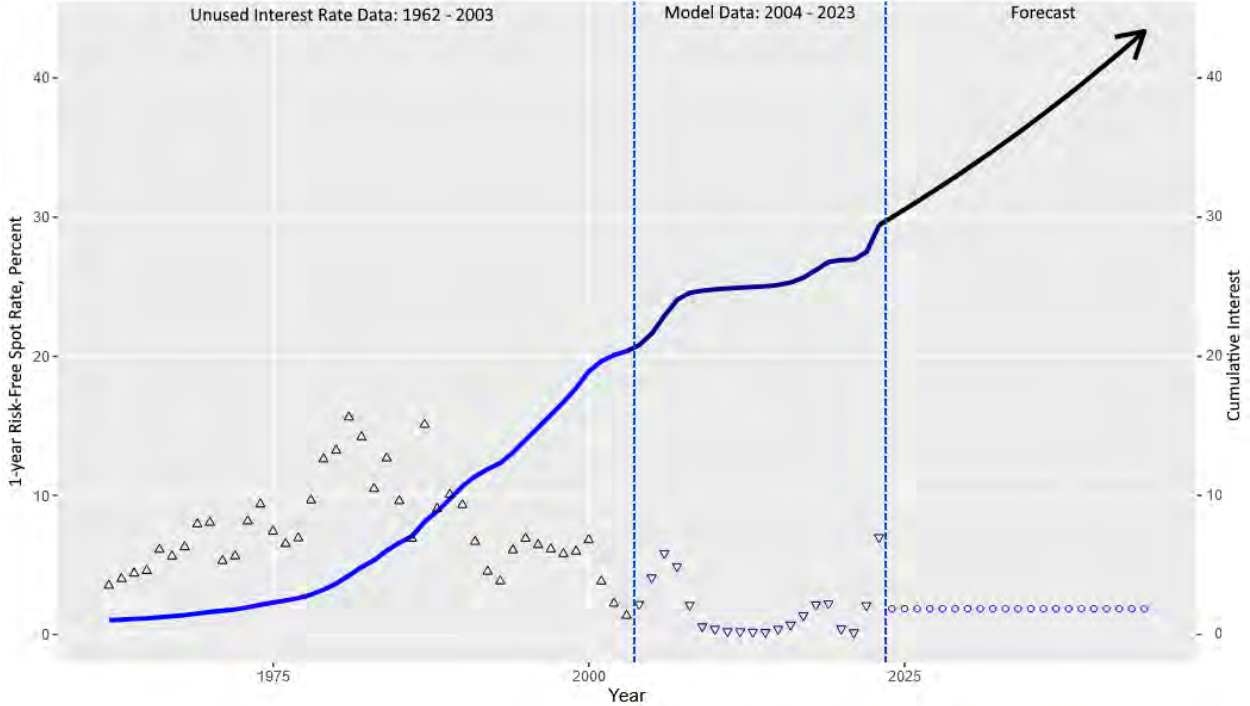
Figure 7.14.1: Yearly and Cumulative Interest, Past and Forecasted

---

[56] See Section 5.1: Risk Mitigation.

APPENDIX O

EXPECTED REMAINING LIFESPANS

SuperLife Wellness achieves savings for SuperLife by expanding the lifespans of those who participate in the program. The results are demonstrated below in Figure 7.15.1, which shows that the programs are forecast to extend life by an average of between 1-4 years for all policyholders.

GROUP	DESCRIPTION	% OF POLICYHOLDERS	EXPECTED REMAINING LIFESPAN AT AGE 35
G1_1	Participating overweight smokers	0.30	36.96 years
G1_0	Nonparticipating overweight smokers	2.91	34.61 years
G2_1	Participating smokers of normal weight	0.27	38.71 years
G2_0	Nonparticipating smokers of normal weight	2.62	35.33 years
G3_1	Participating overweight nonsmokers	18.84	45.93 years
G3_0	Nonparticipating overweight nonsmokers	30.38	44.29 years
G4_1	Participating nonsmokers of normal weight	17.02	47.45 years
G4_0	Nonparticipating nonsmokers of normal weight	27.45	45.95 years
G_1	All participating members, weighted for equal participation rate by demographic group	36.64	46.01 years
G_0	All nonparticipating members, weighted for equal participation rate by demographic group	63.36	44.37 years

Figure 7.15.1: Expected Remaining Lifespan at Age 35, by Group Status

APPENDIX P

EFFECTS OF INFLATION AND INTEREST RATE CHANGES

PROPORTIONS IN SPWL	P1	P2	P3	P4
100000	0.002269	0.00205	0.034853	0.031632
250000	0.002503	0.002261	0.038443	0.03489
500000	0.002508	0.002266	0.038522	0.034962
1000000	0.002514	0.002271	0.038605	0.035037
2000000	0.002367	0.002138	0.036349	0.03299

PROPORTIONS IN T20	P1	P2	P3	P4
50000	0.002935	0.002652	0.045086	0.040919
100000	0.002907	0.002626	0.044652	0.040525
250000	0.004106	0.003709	0.06307	0.057241
500000	0.004106	0.003709	0.063067	0.057238
1000000	0.003207	0.002897	0.049255	0.044703
2000000	0.002627	0.002373	0.040345	0.036617

Figure 7.16.1: Proportions of Policyholders by Insurance Type, Program, and Benefit

Once the expected present values for each program and benefit were calculated (assuming 1.86% interest rate and 0% inflation), we experimented with different interest and inflation rates to test the effect on the present values. Policyholder data was split into program type eligibility, either Whole Life or 20-year Term, and benefit to calculate proportions from the total policyholder number. Figure 7.16.1 are the resulting proportions, and the estimated present values were weighted and summed all together to calculate an average present value. Testing different interest rates and inflation rates produced the results in Section 5.2: Sensitivity Analysis. Figure 7.16.2 provides examples of the age-averaged expected present values of per-policy savings, for interest rates at 0.01, 0.02, 0.03, and 0.05, with inflation rates set at 0, 0.01, 0.02, and 0.03.

Inflation Rate 0% — Interest Rate 1%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	-3453.72	-3639.29	-4180.98	-4357.31
	250000	-14882.13	-16186.68	-18668.81	-19335.16
	500000	-9143.65	-9835.95	-34960.55	-36125.87
	1000000	-17815.24	-18838.72	-65998.91	-68113.18
	2000000	-30018.74	-31468.69	-128075.63	-132087.79
20T	50000	-144.50	-168.17	-265.91	-281.37
	100000	117.75	-27.83	-220.85	-317.33
	250000	1648.72	796.18	-243.50	-636.76
	500000	494.47	78.20	846.23	118.79
	1000000	1295.95	683.18	3892.30	2502.16
	2000000	6241.58	5291.90	9984.44	7268.91

Inflation Rate 1% — Interest Rate 1%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	-3587.08	-3790.66	-4392.08	-4593.53
	250000	-15222.47	-16689.58	-19384.18	-20118.99
	500000	-9707.23	-10515.43	-35851.38	-37096.66
	1000000	-18854.92	-20036.88	-66889.74	-69083.97
	2000000	-31058.43	-32666.86	-128966.46	-133058.59
20T	50000	-175.36	-199.87	-300.52	-316.37
	100000	73.35	-75.60	-270.44	-369.93
	250000	1535.41	637.79	-411.27	-811.02
	500000	312.83	-128.00	637.31	-97.04
	1000000	960.87	319.58	3683.38	2286.34
	2000000	5906.50	4928.30	9775.52	7053.09

Inflation Rate 0% — Interest Rate 2%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	70.52	-1.67	-32.28	-116.68
	250000	1752.00	1073.89	981.39	717.33
	500000	-543.07	-890.45	3943.38	3544.12
	1000000	-681.12	-1070.03	11154.76	10519.30
	2000000	3452.29	3157.25	25577.52	24469.65
20T	50000	-32.75	-65.28	-197.79	-218.34
	100000	303.95	150.08	-113.66	-213.51
	250000	2452.85	1570.79	200.64	-214.49
	500000	888.69	455.45	1623.87	847.40
	1000000	2059.72	1394.99	5265.01	3770.83
	2000000	7475.66	6397.26	12547.30	9617.70

Inflation Rate 1% — Interest Rate 2%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	-33.34	-118.72	-189.12	-290.85
	250000	1486.96	685.09	450.02	139.50
	500000	-980.06	-1413.16	3281.68	2828.46
	1000000	-1487.29	-1991.76	10493.06	9803.64
	2000000	2646.13	2235.51	24915.82	23753.99
20T	50000	-60.08	-93.34	-228.35	-249.24
	100000	264.64	107.82	-157.45	-259.94
	250000	2352.54	1430.64	52.48	-368.34
	500000	727.94	273.07	1439.37	656.85
	1000000	1763.17	1073.37	5080.52	3580.28
	2000000	7179.11	6075.65	12362.81	9427.15

Inflation Rate 2%

Interest Rate 1%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	-3759.46	-3987.83	-4679.56	-4917.96
	250000	-15662.38	-17344.83	-20358.61	-21195.77
	500000	-10439.18	-11405.62	-37064.82	-38430.29
	1000000	-20205.24	-21606.63	-68103.18	-70417.60
	2000000	-32408.75	-34236.60	-130179.90	-134392.22
20T	50000	-209.97	-235.44	-339.42	-355.73
	100000	23.55	-129.20	-326.19	-429.08
	250000	1408.34	460.05	-599.90	-1006.98
	500000	109.07	-359.45	402.41	-339.75
	1000000	584.97	-88.55	3448.48	2043.63
	2000000	5530.60	4520.17	9540.62	6810.38

Inflation Rate 3%

Interest Rate 1%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	-3985.20	-4248.18	-5077.93	-5371.73
	250000	-16238.47	-18210.30	-21709.24	-22702.16
	500000	-11402.66	-12588.41	-38746.74	-40296.01
	1000000	-21982.68	-23692.30	-69785.10	-72283.32
	2000000	-34186.18	-36322.28	-131861.82	-136257.93
20T	50000	-248.82	-275.39	-383.20	-400.02
	100000	-32.34	-189.40	-388.92	-495.65
	250000	1265.69	260.43	-812.16	-1227.55
	500000	-119.73	-619.49	138.09	-612.93
	1000000	162.87	-547.09	3184.16	1770.44
	2000000	5108.50	4061.63	9276.30	6537.19

Inflation Rate 2%

Interest Rate 2%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	-165.54	-268.78	-398.44	-525.09
	250000	1149.57	186.53	-259.31	-637.74
	500000	-1538.77	-2086.80	2398.36	1865.82
	1000000	-2518.00	-3179.63	9609.74	8841.00
	2000000	1615.42	1047.64	24032.50	22791.35
20T	50000	-90.66	-124.75	-262.64	-283.91
	100000	220.66	60.49	-206.58	-312.06
	250000	2240.28	1273.72	-113.74	-540.99
	500000	547.99	68.78	1232.38	443.02
	1000000	1431.19	713.14	4873.53	3366.45
	2000000	6847.14	5715.41	12155.82	9213.32

Inflation Rate 3%

Interest Rate 2%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	-336.00	-463.75	-682.63	-845.80
	250000	714.55	-461.39	-1222.59	-1702.15
	500000	-2262.54	-2967.01	1198.80	547.51
	1000000	-3853.23	-4731.76	8410.18	7522.69
	2000000	280.18	-504.48	22832.94	21473.04
20T	50000	-124.91	-159.95	-301.14	-322.86
	100000	171.38	7.45	-261.75	-370.59
	250000	2114.52	1097.83	-300.40	-734.92
	500000	346.35	-160.27	999.93	202.83
	1000000	1059.19	309.24	4641.07	3126.26
	2000000	6475.14	5311.52	11923.36	8973.13

Inflation Rate 0%

Interest Rate 3%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	2608.46	2589.10	2742.47	2686.90
	250000	13716.36	13350.15	14100.97	13948.05
	500000	5620.96	5444.87	29884.81	29681.07
	1000000	11594.60	11505.83	62546.35	62265.43
	2000000	27381.61	27602.75	127869.41	127434.16
20T	50000	58.59	18.84	-141.47	-166.03
	100000	454.07	294.02	-26.28	-128.28
	250000	3094.83	2192.20	558.58	128.07
	500000	1204.78	759.53	2242.74	1430.89
	1000000	2670.20	1965.62	6342.68	4772.54
	2000000	8438.75	7259.03	14542.56	11455.82

Inflation Rate 1%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	2526.20	2496.98	2623.36	2555.49
	250000	13506.44	13044.23	13697.49	13512.20
	500000	5276.20	5035.39	29382.36	29141.26
	1000000	10958.57	10783.77	62043.89	61725.62
	2000000	26745.58	26880.69	127366.96	126894.34
20T	50000	34.31	-6.06	-168.55	-193.41
	100000	419.16	256.50	-65.07	-169.41
	250000	3005.73	2067.78	427.32	-8.21
	500000	1062.04	597.67	2079.28	1262.11
	1000000	2406.87	1680.21	6179.22	4603.75
	2000000	8175.42	6973.61	14379.10	11287.04

Interest Rate 5%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	5865.44	5865.28	5971.61	5900.57
	250000	29042.42	28842.40	29327.74	29066.81
	500000	13484.26	13400.55	59931.55	59478.87
	1000000	27246.24	27282.65	121968.63	121145.77
	2000000	57793.72	58153.74	246042.79	244479.58
20T	50000	194.04	143.73	-56.24	-86.40
	100000	671.43	503.77	102.89	-0.82
	250000	4007.94	3084.13	1077.08	630.10
	500000	1657.97	1199.75	3119.03	2266.67
	1000000	3540.53	2783.79	7830.10	6170.40
	2000000	9750.84	8431.23	17252.23	13977.85

Type	Benefit	P1	P2	P3	P4
SPWL	100000	5811.40	5805.40	5898.65	5820.96
	250000	28904.50	28643.63	29080.67	28802.82
	500000	13259.23	13136.48	59623.88	59151.91
	1000000	26831.09	26816.99	121660.96	120818.81
	2000000	57378.57	57688.08	245735.12	244152.63
20T	50000	174.69	123.90	-77.71	-108.09
	100000	643.61	473.91	72.13	-33.41
	250000	3936.94	2985.12	973.03	522.12
	500000	1544.32	1071.02	2989.45	2132.94
	1000000	3330.87	2556.80	7700.52	6036.67
	2000000	9541.18	8204.23	17122.66	13844.12

Interest Rate 3%

Inflation Rate 2%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	2423.01	2380.66	2467.42	2382.30
	250000	13243.09	12657.86	13169.17	12937.62
	500000	4841.96	4515.92	28724.45	28429.63
	1000000	10157.49	9867.76	61385.99	61013.99
	2000000	25944.50	25964.67	126709.06	126182.71
20T	50000	7.20	-33.89	-198.87	-224.06
	100000	380.17	214.58	-108.51	-215.48
	250000	2906.23	1928.77	280.36	-160.82
	500000	902.59	416.76	1896.27	1073.10
	1000000	2112.72	1361.19	5996.22	4414.75
	2000000	7881.28	6654.60	14196.10	11098.03

Inflation Rate 3%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	2291.93	2231.88	2259.85	2150.01
	250000	12908.59	12163.56	12465.77	12166.85
	500000	4288.03	3848.02	27848.52	27475.00
	1000000	9135.60	8690.01	60510.05	60059.36
	2000000	24922.61	24786.92	125833.12	125228.08
20T	50000	-23.10	-65.01	-232.84	-258.42
	100000	336.58	167.68	-157.19	-267.11
	250000	2795.00	1773.29	115.66	-331.88
	500000	724.30	214.34	1691.18	861.23
	1000000	1783.80	1004.26	5791.12	4202.87
	2000000	7552.35	6297.67	13991.01	10886.16

Interest Rate 5%

Inflation Rate 2%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	5745.39	5731.88	5806.45	5719.82
	250000	28736.05	28399.52	28768.39	28467.40
	500000	12983.49	12811.00	59235.01	58736.48
	1000000	26322.41	26243.05	121272.09	120403.38
	2000000	56869.89	57114.14	245346.25	243737.19
20T	50000	153.18	101.84	-101.64	-132.28
	100000	612.68	440.69	37.85	-69.75
	250000	3858.01	2874.97	857.03	401.73
	500000	1417.92	927.77	2845.01	1983.83
	1000000	3097.68	2304.18	7556.08	5887.56
	2000000	9307.99	7951.61	16978.22	13695.01

Inflation Rate 3%

Type	Benefit	P1	P2	P3	P4
SPWL	100000	5663.86	5640.54	5688.16	5589.28
	250000	28527.97	28096.19	28367.69	28034.42
	500000	12641.69	12404.91	58736.02	58200.21
	1000000	25691.84	25526.97	120773.10	119867.12
	2000000	56239.32	56398.06	244847.26	243200.93
20T	50000	129.24	77.28	-128.35	-159.27
	100000	578.26	403.68	-0.41	-110.31
	250000	3770.15	2752.28	727.58	267.33
	500000	1277.17	768.15	2683.81	1817.38
	1000000	2838.02	2022.72	7394.88	5721.10
	2000000	9048.33	7670.15	16817.01	13528.55

Figure 7.16.2: Examples of Expected Savings at Different Inflation/Interest Rates