

Predict Likelihood of Completion for Future Lifestyle Medicine Program

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Abstract – Lifestyle Medicine is needed to be implemented to reduce the prevalence and incidence of chronic diseases, reduce the medical claim costs for employers, and improve life expectancy from improved well-being. The goal for this project was to create a list of psycho-demographic variables that are known to play in the likelihood for self-selection into comparable lifestyle medicine programs, as well as the likelihood for completion of the program in its entirety. This included research through literature reviews and discussion with experts in the field, performing data analysis, and creating a prediction model. Through this project's limitations, it was found that gender does not play a role in self-selection and BMI can be used to predict the likelihood of self-selection. Additionally, the health coaching that was used shows a lack of improvement in the health of the individuals. Thus the evidence does not support a health risk appraisal, despite evidence from literature reviews supporting health risk appraisals.

Keywords: Lifestyle, Medicine, Health Coaching, Health Risk

I. INTRODUCTION

A. U.S. Lifestyle Medicine

The United States healthcare system is battling the increase in patients and diseases by switching the focus of treatment from reversal to prevention. Due to the fact, the United States is leading in avoidable deaths and has the highest number of adults with chronic diseases. 90% of United States health care dollars are spent in treating chronic diseases and their complications (1). There is a need to prevent non-communicable diseases before they cause complications. The American College of Lifestyle Medicine focuses on 6 lifestyle factors that are correlated to preventing non-communicable and chronic diseases. These factors include implementing whole-plant-based nutrition, increasing exercise, improving sleep, avoiding risky substances, managing stress, and maintaining healthy relationships (1). All of these factors have evidence that supports the prevention of certain forms of cancers, diabetes, heart diseases, stroke, and many other diseases.

B. Objective

The need for Lifestyle Medicine (LM) is prevalent; however, there is a need for evidence that Lifestyle Medicine is an effective business tool for hospitals and businesses. Previous work has been done to investigate the Lifestyle Medicine program's effectiveness on diseases and how each pillar affects a disease. As well as work that includes the employer's benefits for implementing a program. The goal for this project is to create a list of psycho-demographic variables that are known to play in the likelihood for self-selection into comparable lifestyle medicine programs, as well as the likelihood for completion of the program in its entirety. This

included research through literature reviews and discussion with experts in the field, performing data analysis, and creating a prediction model.

RELATED WORK

A. Lifestyle Medicine Program Effectiveness

Lifestyle Medicine programs are starting to be implemented across the United States, and many trials have been conducted to see if it is effective in preventing or reversing a particular disease. Programs have been effective with hypertensive patients. Evidence has shown that “of the adult hypertensive population that received counseling, 88% reported adhering to those recommendations,” (2). Equally important, there are programs that have been effective with Diabetes. After a 12 week study, 86.2% of the adults were still using the app that helped with glycemic control with type 2 diabetes (3). Also, adults with diabetes have shown effective results using electronic health apps for interventions on weight loss (4). Furthermore, across the spectrum, intervention groups have seen fewer inpatient admissions (5). This information provides evidence that shows the foundation of how effective Lifestyle Medicine interventions and programs are.

B. Psycho-Demographics

One of the goals of the project is to create a list of psycho-demographic variables that are known to play in the likelihood of self-selection into comparable lifestyle medicine programs. Because a dataset for research was not established until later in the project’s timeline, a list of psycho-demographics based on other programs’ research was made. This was to establish what are the possible psycho-demographics that could be screened for. Possible common demographics to screen for are age, gender, health status, and body mass index (BMI). Additional survey demographics included income level, educational level, occupation, marital status, received health professionals advice, motivation, and willingness (6-9). Based on this research the psycho-demographics that affect the pillars of lifestyle medicine directly, such as stress level and amount of sleep, should have stronger correlations with health risk results. From this, it was concluded that BMI would be a good category to see the effects of nutrition and exercise intervention.

C. Machine Learning

The use of machine learning to analyze health care, specifically lifestyle data, was an important factor. Since lifestyle medicine is seen as advice or suggestion rather than a prescription, it is not always written down like a traditional prescription would be. To counteract this issue a study was done using natural language processing to identify patterns in electronic patient records to extract what suggestions or advice was given (6). Likewise, work has been done to simulate long-term health care costs after the lifestyle intervention, as well as machine-learning analysis on a weight loss intervention for reducing cardiovascular complications for type 2 diabetes (10, 11).

D. Treatment of Conditions

Under the circumstances that a dataset was not confirmed for a majority of the project, research was done on the treatment of specific conditions due to the possibility of a data set being specific to one non-communicable disease. The first analysis was on how lifestyle medicine can help in the prevention and use of opioids. Thus, pain mitigation was analyzed, and research showed that nutrition and exercise are the primary factors of pain mitigation (12, 13). Next was research on how lifestyle medicine can help in the prevention and management of cancer. First, it was concluded that the LM pillar avoiding risky substances is a major prevention factor for many forms of cancer. Smoking is the top preventable risk, for it can lead to many different forms of cancer. Exercise and nutrition are additional important factors that affect BMI which can lead to an increased risk of many forms of cancer (14). The last noncommunicable disease researched was post-traumatic stress disorder (PTSD). Every pillar of lifestyle medicine can help in the prevention and reversal of PTSD. Nutrition and exercise have shown promising intervention in veterans struggling with PTSD (15). PTSD is directly associated with sleep quality, increased severity of PTSD is correlated with decreased social relationship scores, and risky substances are related to coping methods of PTSD and both PTSD and alcohol dependency can trigger each other (16-18).

E. Business Benefits

One of the targets of this project is for Lifestyle Medicine to show how it is an effective business tool for hospitals and businesses. Thus it was important to research the cost benefits of lifestyle medicine to effectively target the correct audience. Through simulated data, it was shown that there are both short and long-term cost-saving benefits to implementing a lifestyle medicine program (10). In addition, intervention groups have fewer inpatient admissions, so there is a significant reduction in health care costs (5). It was also found that those with a chronic condition, specifically obesity, can significantly increase spending in health care plans (19). Lastly, intervention groups focusing on plant-based nutrition showed increases in not only mental health and quality of life but there were also improvements in productivity at work (9).

II. METHODS

A. Literature Review

In summary of the related work section, a literature review was a vital part of the research. Lifestyle medicine affects many different chronic diseases and already has a large amount of information out there. The overall census is that lifestyle medicine programs are effective across many diseases. Through research, psycho-demographics are strongest with those associated with the 6 pillars of lifestyle medicine. Simulation of data, natural language processing, and other machine learning techniques have been used to better access lifestyle medicine-focused datasets. Lifestyle Medicine's 6 pillars are effective in opioid use disorder, pain mitigation, cancer, and PTSD prevention and reversal. Lastly, lifestyle medicine programs provide a reduction in medical claim costs for employers.

B. Discussion with Experts

Health coaches and lifestyle medicine specialists were essential in understanding the results of literature reviews and data analysis. First, an interview with a Lifestyle Medicine certified urologist Dr. Jacobsohn was conducted. During this interview, it was brought to attention that current treatment of PTSD, cancer, and many disorders start with the typical treatment of medicine, surgery, or other means. Then lifestyle medicine is considered to help with symptoms, reversal of the condition, or reversal of conditions correlated with the condition. After a chronic disease is developed it can be a difficult process to reverse the condition by changing the lifestyle. That shows why focusing on lifestyle as preventative health is important. Additionally, lifestyle medicine is tailored to a patient and should be treated as a prescription. Those goals are set for the individual patients and steps are put in place to attain such goals. It was also suggested that with the data constraints the outcomes may not be as effective as the original goal if the program does not specifically target one chronic condition.

Following a discussion with Dr. Jacobsohn, a discussion with health coach Robin Cook was conducted to better understand what lifestyle coaching looked like as a part of a self-selected program. Most patients self-select themselves into a program for reasons such as wanting to feel healthier, wanting to prevent a disease from occurring, and wanting to reverse a disease holistically. She suggested that looking at psycho-demographics such as age and income level may show good predictions while marital status and hobbies may have inconsistent results.

C. Data Source

The de-identified data set is from a large Midwest health system. It is a database of de-identified individuals who participated in a health risk appraisal (HRA) program through their employers in year 1 and year 2. The outcome of the HRA measure is the personal health risk score (PHRS). Which ranges from 100 at best to a negative integer. Factors include total cholesterol, HDL, LDL, triglycerides, blood glucose, blood pressure, waist circumference, body mass index (BMI), and nicotine use. Based on the test results within a factor you can either score positive or negative numbers that are then summed with all the additional factors to create the individual's PHRS (figure 1). There was an optional intervention between year 1 and year 2 which was participation in health coaching sessions that vary in length and amount.

D. Data Analysis

The dataset included 9,366 deidentified individuals that had been taken apart in the PHRS. The data was pre-cleaned and given in an excel format. Additions to the spreadsheet were made to make analysis easier such as difference in PHRS and difference in BMI which were found by year 2 score – year 1 score. Lastly, the coaching sessions lengths varied thus an additional column was made to find the total coaching session length in minutes. The file was then examined in R studio using regression and descriptive statistics techniques.

The first question analyzed was how does health coaching deliver results by improving the health of employees? This was done plotting x, coaching in minutes by y, the difference in PHRS then using linear regression to plot the best fit line. Additionally, a plot was done plotting x, coaching in minutes by y, the difference in BMI then using linear regression to plot the best fit line. The second question analyzed was how does gender play a role in self-selection health coaching?

This included using the package “ggplot2” which gave the ability to look at what the patterns were between the qualitative variables on the graph. Continuing, the percentage of men and women that enrolled in health coaching who fall into a BMI category was found. As well as the percentage of men and women that attended an amount of health coaching sessions was found. The final question was what psycho-demographics aid in self-selection? Since the data set had a lack of demographics available, gender and BMI category were analyzed through descriptive statistics.

III. RESULTS

A. Background

The dataset included 9,366 deidentified individuals that participated in two years of PHA. Where 13.99% of all individuals (6.27% men and 7.72% women) enrolled in at least one session of health coaching. Their PHRS scores categories vary in weight of points. In figure 1 it can be seen how BMI has a range of 15 with 5 categories and nicotine use has a range of 25 with only two categories. The percent of individuals that fall into each category are: 19.44% for category 1 (BMI 18.5-24.9 - healthy), 32.86% for category 2 (BMI <18.5 or 25-29.9 - unhealthy and almost overweight), 25.05% for category 3 (BMI 30-34.9 - overweight), 12.86% for category 4 (BMI 35-39.9 - obese), and 9.80% for category 5 (BMI ≥ 40 - chronically obese). Also, boxplots were made to check for outliers within the difference in BMI scores and difference in PHRS scores. For both plots, the mean was around 0 and there were a lot of outliers. Due to the number of outliers a health expert was contacted and Dr. Kenneth Jacobsohn, a lifestyle medicine certified urologist explains how these outliers are not absurd. Within a year someone could change by losing a limb, becoming pregnant, being put on medication... etc. He went on to explain that there is no healthy or unhealthy amount of change for both BMI and PHRS that could be said for everyone. That healthy and unhealthy amount of change is case by case.

Total Cholesterol				
	< 200	200 - 239	240 - 259	≥ 260
Score	5	3	0	-3
HDL Cholesterol				
Male	> 40	35 - 40	30 - 34	25 - 29
Female	> 50	45 - 50	40 - 44	35 - 39
Score	5	3	1	-3
Triglycerides				
	< 150	150 - 174	175 - 199	200 - 499
Score	10	7	5	-5
Blood Glucose				
Fasting	< 100	100 - 110	111 - 125	126 - 139
Non-Fasting	< 140		140 - 199	≥ 200
Score	10	7	5	-5
LDL Cholesterol (Total Cholesterol - HDL Cholesterol - (Triglycerides/5) = LDL Cholesterol)				
	< 100	100 - 129	130 - 159	160 - 189
Score	5	3	1	-3
Non HDL Cholesterol (Total Cholesterol - HDL Cholesterol = Non HDL Cholesterol)				
	< 130	130 - 159	160 - 189	≥ 190
Score	5	3	1	-3
Blood Pressure				
Systolic	≤ 119		120 - 139	140 - 159
Diastolic	≤ 79		80 - 89	90 - 99
Score	15		10	-5
Waist Circumference				
Male	≤ 40 inches	40.1 - 42	42.1 - 44	44.1 - 46
Female	≤ 35 inches	35.1 - 37	37.1 - 39	39.1 - 41
Score	10	5	3	-3
Body Mass Index (BMI)				
	18.5 - 24.9	<18.5 or 25 - 29.9	30 - 34.9	35 - 39.9
Score	10	5	3	-5
Nicotine Use				
	Negative			Positive
Score	25			0
Total Points				
	100 - 85	84 - 75	74 - 60	59 - 40
				< 40

Figure 1: This shows how the Personal Health Risk Score (PHRS) was found and the categories that are used throughout the project.

B. Does health coaching deliver results by improving the health of employees?

This was done plotting x, coaching in minutes by y, the difference in PHRS then using linear regression to plot the best fit line. The inference was that the PHRS difference should increase while the length of coaching increases. The Pearson correlation test showed a t value of 4.17 and a p-value of 2.92×10^{-5} . This showing there is a significant correlation between total coaching minutes and the difference in PHRS scores since the p-value is less than alpha which is equal to 0.05. The graph shown in figure 2 shows the best fit line with a slope of 0.017. This is interesting because even though it supports the inference it was expected to have a significantly higher slope. The graph shows there is almost 0 change in PHRS score as coaching minutes increases.

Also, a plot was done plotting x, coaching in minutes by y, the difference in BMI then using linear regression to plot the best fit line. The inference was that the results would be inverse of those from figure one. That BMI difference would decrease while the length of coaching increases. The Pearson correlation test showed a t value of -2.46 and a p-value of 0.014. This shows there is a significant correlation between total coaching minutes and difference in BMI scores since the p-value is less than alpha which is equal to 0.05. The graph shown in figure 3 shows the best fit line with slope -0.002. Similar to figure 2 this is interesting because even though it supports the inference it was expected to have a significantly higher slope, and the graph is showing there is almost 0 change in BMI score as coaching increases.

To better understand the results Dr. Jacobsohn helped interpret the results. He explained that many factors could create these results. The first thing to note is that there is plenty of time to see changes in both PHRS and BMI scores. The results could be due to bad coaching. There was no information on what the coaching involved and no record if the individuals applied to change their lifestyle. Additionally, if the coaching was only done during one month, then positive change could have happened then reversed during the length of the two PHA. Also, there was no information if an incentive was given, thus was this result of a lack of incentives? Overall the graph shows a bad investment for employers.

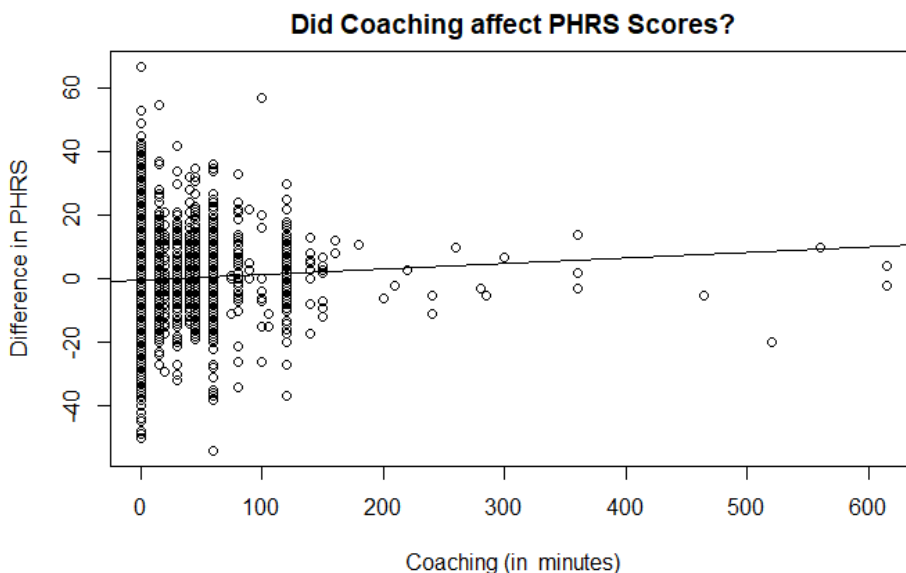


Figure 2: Coaching did not cause a large impact on PHRS scores unlike what was predicted.

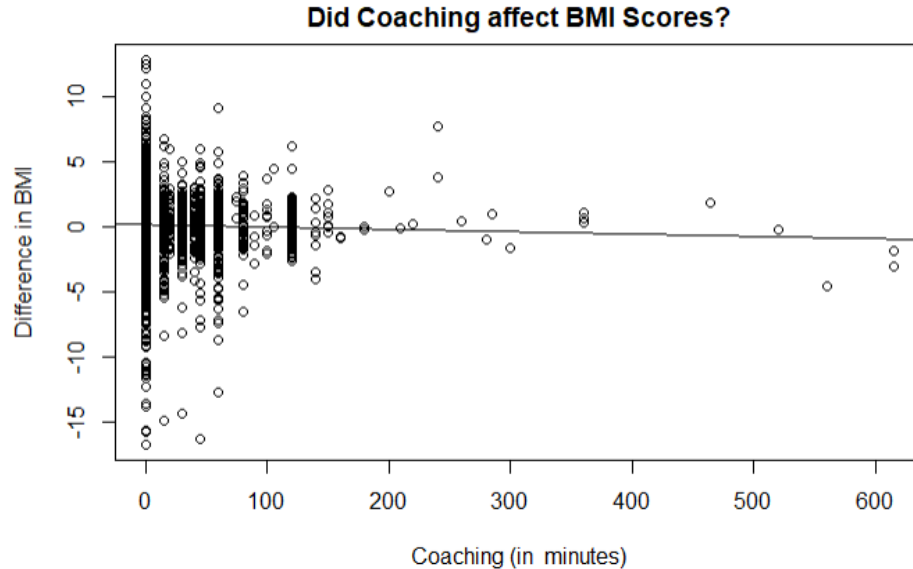


Figure 3: Coaching did not cause a large impact on BMI scores unlike predicted.

C. Does gender play a role in self-selection health coaching? What psycho-demographics aid in self-selection?

First using the package “ggplot2” which gave the ability to look at the patterns between the qualitative variable on the graphs. Zero patterns for qualitative variables for gender were found visually. The next step was to look for patterns using descriptive analysis. The percentage of men and women that enrolled in health coaching who fall into a BMI category was found. This was done by a count function that counted those of the same gender, within a BMI category, and that participated in at least 1 coaching session divided by the count of the same gender and BMI category as the numerator. The results are shown in figure 4. When looking from best to worst BMI category, the percent of those enrolled in coaching increased for both men and women. The highest percent was with those in the chronically obese category with 20.2% of men and 28.0% of women who participated in at least one health coaching session. This led to the next step of finding what is the percent that is enrolled in coaching sessions. The table is found in figure 5. This showed that the largest percent enrollments are for 1 and 3 sessions and most of the data falls within the first 3 sessions for both men and women. Note that sessions can vary in length; some individuals did sessions for 15 minutes and others for 30 minutes.

Dr. Jacobsohn explained that gender and BMI would be something good to screen for; however, what truly makes someone more willing to implement health coaching is a lot harder to screen for. With there being a lack of psycho-demographics and with roughly half of the data set falling into the two best BMI categories it is hard to determine with this data set. Also, knowing if an incentive was in place would help better understand why the majority of the data only participated in 1-3 health coaching sessions. However, if there was no incentive in place majority

of the people will only try something 1-3 times and if they are not seeing results, it would make sense why they would stop health coaching.

Percent of those that enrolled in coaching that fall into a BMI category

BMI Category	Male (%)	Female (%)
18.5 – 24.9	8.46	9.19
< 18 or 25 – 29.9	9.37	11.5
30 – 34.9	12.6	18.2
35 – 39.9	19.5	22.2
>= 40	20.2	28.0

Figure 4: Both genders and the same pattern that as BMI category gets worse the percent that enrolls in coaching increases.

Percent that are Enrolled in Coaching Sessions

# Of Sessions	Male (%)	Female (%)
1	30.83	30.15
2	22.99	19.79
3	29.98	34.16
4	13.97	9.54
>4	2.22	6.36

Figure 5: Both genders have the same pattern, that the number of sessions that are enrolled in are highest between 1-3 with the highest majority participated in 1 or 3 sessions.

IV. DISCUSSION

A. Findings

Through evidence, it was found that between year 1 and year 2 there is a lack of improvement in the health of the employees. Thus the evidence does not support a health risk appraisal. These results do not support the literature review research conducted. To support research it was found that both genders have the same trends in enrollment into health coaching and there shouldn't be different approaches for men and women. Lastly, body mass index is a category that could be screened for self-selection. It is predicted that as the category of BMI worsens the percent enrolled in health coaching increases.

B. Discussion with Experts

With aid of lifestyle medicine certified urologist, Dr. Jacobsohn, the results are interpreted that the health coaching technique conducted was unsuccessful. A lack of knowledge given on the type of health coaching and if there were incentives at place leads us with more questions as to why the results were unsuccessful.

C. Limitations

Throughout the research, there was some major setback. Starting with having access to a data set. There was not a secure data set at the beginning of the project and the one originally intended to use did not work out. Thus the project proceeded by working on literature reviews and conducting discussions with experts until a data set that fit-out project goals was found. Since this became more challenging, there were adjustments to the project goals to fit the data set received. The data set had a lack of psycho-demographics, so gender and BMI were the only demographics that were focused on. Since there were only two weeks of availability to analyze the data set there wasn't much room for creativity. Within the data set acquired there were some additional limitations. The data set was a two-year study that only collected data twice. Finally, there was little description of the techniques used during health coaching and tracking the lifestyle changes of those individuals. Thus there is some future work to still complete.

V. CONCLUSIONS

A. Summary

Lifestyle Medicine is focused on preventing and reversing chronic diseases through whole & plant-based nutrition, increases fitness, forming and maintaining relationships, managing stress, improving sleep, and avoiding risky substances (1). Lifestyle Medicine is needed to be implemented to reduce the prevalence and the incidence of chronic diseases. As well as help reduce the medical claim costs for employers, and improve life expectancy for employers from improved well-being. The goal for this project was to create a list of psycho-demographic variables that are known to play in the likelihood for self-selection into comparable lifestyle medicine programs, as well as the likelihood for completion of the program in its entirety. This included research through literature reviews and discussion with experts in the field, performing data analysis, and creating a prediction model. Through these projects limitations, it was found that gender does not play a role in self-selection and BMI can be used to predict the likelihood of self-selection. Furthermore, the health coaching that was used shows a lack of improvement in

the health of the individuals. Thus the evidence does not support a health risk appraisal. A prediction model was not able to be made due to the time restrictions and the unavailability of a dataset with a list of psycho-demographics.

B. Future work:

Due to the time constraint and difficulty in finding a data set future work still needs to be done to make a larger list of psycho-demographics to screen for. Such psycho-demographics as income level, race, and occupation are some of the factors still needing to be considered. This led to a future goal of creating a prediction model of the likelihood of self-selection based on psycho-demographics.

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