MTFC Project Proposal 2025-26

Team Name	Space Rangers
Team ID #	23922
Short Title for Proposal	Modeling Exercises Strategies to Delay Muscle Decay
Topic Category	Healthcare/Injuries

Part 1: Project Definition *(Team's Topic*

Team Responses:

#1: Identify the topic
Our topic focuses on mitigating the risks of getting muscle atrophy for elderly, disabled, and chronically ill people. Reducing muscle atrophy is very important because it can impair people's mobility and increase their risk of disability and disease. While there hasn't been a recent change in muscle atrophy cases that increase its severity, this has still been a huge issue across the general population for a long time.

#2: Identify potential risks
Potential risks regarding muscle atrophy would be the following:

- Muscle atrophy - effect on their muscles (prolonged inactivity or immobilization) that can cause long term issues, primarily the loss of muscle mass.
- Any issues on health resulting from muscle atrophy, including risk of falls, reduced metabolisms, worsening of chronic illness and increased inflammation.
- Functional decline
- Individual medical and insurance costs from seeking treatment or care.
- Financial burdens on the health care system.
- Loss of financial stability for affected youth and non-supported elderly.

The best case scenario if the risk is identified, is the complete reversal of muscle atrophy. The worst case scenario is if the patient's muscle atrophy grows so severe that it permanently disables them.

#3: Identify a behavior change risk mitigation strategy
One possible behaviour change strategy related to this topic is choosing an exercise regiment specifically built for muscle atrophy to help the person heal and reduce the severity of the muscle atrophy.

#4: Identify a modifying outcomes risk mitigation strategy
Hosting exercise classes for the people at risk will keep them moving while their muscles are still healthy, which prevents atrophy from a sedentary lifestyle.

#5: Identify an insurance risk mitigation strategy

Government funded health insurance programs such as Medicaid and Medicare can help reduce the severity of the financial loss due to muscle atrophy. Private health insurance programs, such as the Health Maintenance Organization, are also another alternative insurance option.

#6: Identify driving research questions for your topic
Here are the questions we have regarding our topic:

- How should those with muscle atrophy reduce costs incurred because of those health problems?
- What exercises directly correlate with improved muscle improvement? What kinds of movement, in what span of time, and what is its relation to the person's age and severity of muscle atrophy?
- Would there be any dietary implications or sleeping implications that would be important for the exercise regimen to make an effect on muscle atrophy (that too positively)?
- What is the relationship between age and muscle atrophy in patients?

Part 2: Data Identification & Assessment *(Team's Topic)*

Team Responses:
#7: Identifying the type of data you hope to find

Our perfect data would look for three things, namely historical frequency, historical severity and range, and data that categorizes range and potential outcomes. More specifically, this would look like data that shows a person doing certain exercises over a span of time and how it affect their muscle strength, any data that shows age vs. medical conditions related to atrophy, data about the causes of muscle atrophy and how severely they affect the likelihood of developing it, and specific exercise vs. weakness in mobility for elderly individuals.

#8: Identify potential data sources for your topic
These are potential datasets we found for our topic. Below are datasets as well as a short description of them and their applicability in our project:

- Minimum Dataset is a federally mandated assessment tool used in nursing homes to evaluate patient health. Will likely contain information on muscle decline, though expensive measuring techniques are likely absent. Highly credible; federal source. Primarily categorizes risks and potential outcomes, but could also be extended to historical frequency and range of severity. We could find mean levels of atrophy versus different patterns (e.g. diets, exercises, age).
  https://www.cms.gov/medicare/quality/nursing-home-improvement/minimum-data-set-technical-information
- Datasets on 5 neuromuscular conditions recording degeneration of muscle. NOTE** Only ONE covers ATROPHY. The rest are on DYSTROPHY, which is distinctively different (atrophy is caused by lack of use, dystrophy is due to genetic conditions). Also highly credible; global academic network. Best used for historical range of severity. Could create graphs for mean costs per atrophy level, average progression, if/how many deaths.
  https://www.treat-nmd.org/what-we-do/core-datasets/
- Dataset from a study testing muscle atrophy related to age. Highly credible; established academic institution. Best used for historical frequency and range of severity. Could study average atrophy levels by age, and mean costs by atrophy level, mean therapy levels needed for treatment, etc.
  https://deepblue.lib.umich.edu/data/concern/data_sets/z029p559k?locale=en

Part 3: Mathematical Modeling *(Team's Topic)*

Team Responses:

#9: Modeling research on your topic
There are existing models for muscle atrophy, typically related to a specific disease, such as the papers "Mathematical Model of Muscle Wasting in Cancer Cachexia," which looks at specific cell-to-cell interactions between 3 different cell types and recognizing a certain therapeutic method as the most effective to reverse the muscle atrophy of Cachexia (https://pmc.ncbi.nlm.nih.gov/articles/PMC7409297/). Additionally, a review on mathematical models for muscular atrophy show that most models focus on genetic, muscular, mitochondrial or immunological information (https://currents.plos.org/md/article/a-review-of-mathematical-models-for-muscular-dystrophy-a-systems-biology-approach/) Therefore, this leaves a gap in research for a broader source of input: patient data. Here are mentioned many types of models we are unfamiliar with and may need to familiarize ourselves with, for successful modeling, including Differential Equation Models and Cellular Automata.

#10: Goals of a mathematical model in the project phase
The purpose of our mathematical model will be to be able to identify behaviors in patients that lessen or mitigate the severity of muscular atrophy in patients. A potential successful outcome of the model would be the ability of the model to recognize lack of sleep as a contributor to muscle atrophy, and subsequently recommend a certain amount of hours to mitigate it. Therefore, the primarily mathematical analysis should be looking at elements held in common across different severity groups.

#11: Assumption development
The time range would ideally be within weeks, as muscle atrophy declines quickly, however our model may recognize more subtle behavioral strategies for muscle atrophy that make changes over years, not days. As an upper limit, we will define our time range as a maximum of 5 years, as this model would ideally be applicable to elderly homes and therefore should remain relevant. It is possible that our data will show less severity of muscle mass decline as the data becomes more recent as medicine is constantly improving. We assume to see a slight decline in rates.

Part 4: Risk Analysis *(Team's Topic)*

Team Responses:

#12: Goals for mitigation strategy
Potential outcome scenarios for the risk(s) identified in Step 1: Project Definition:

Potential outcomes include the decline of the patient to the point of disability, considerably high medical costs, and significant burden on the healthcare system.

Not addressing the issue of muscle atrophy can lead to severe physical disability, loss of ability to live independently, increased risks of falling due to poor balance, and frailty, especially in older individuals. Prolonged exposure to this risk can lead to worsened chronic health conditions, as muscle health is necessary for metabolic function. Muscle atrophy can worsen existing body conditions such as diabetes and heart disease.

Our action plan for potential risks would be the following: developing an exercise routine, researching any dietary factors that could impact muscle atrophy, identifying optimal sleep patterns, and other behavioral

changes that benefit the patient. By identifying these factors, we would be capable of building a solution that can tackle any root issues which are responsible for muscle atrophy in individuals.

Part 5: Recommendations *(Team's Topic)*

Team Responses:

#13: Recommendation differences between mitigation strategies

Two types of metrics we would be interested in using are ultrasound and goniometry, ultrasound being a technique to measure muscle thickness, goniometry being the measurement of the range of motion (ROM) of a joint, both serving to quantify muscle function. Additionally, costs and complexity would be ideal, as the issue occurs in a wide range of the population, including those who may not have access to large sums of money or complex treatments.

#14: Audience for recommendations

One potential audience for our recommendations would be a physical therapist, particularly one at a high-risk area such as a nursing home or hospice. They would be able to implement the best strategies into their patients care routine.

#15: Goals for situation improvement

The goal of this project is to ultimately develop an exercise regimen capable of improving muscle function and strength. This exercise regimen would mostly be focused generally for older patients and disabled, however it could be adaptable and applicable for any age range. By mathematically modeling the exercise regimen and observing patterns in multiple datasets we would find which changes in body movement correlates with the improvement of overall motor function.