CHAPTER I INTRODUCTION

I.1 Background

Workout has been a popular lifestyle these days, many people do some physical exercise due to their goals, whether it's to increasing endurance, building muscle, losing weight, or any other health – related reasons (Novita, 2024). Generally, physical activity is divided into aerobic and anaerobic, such as cardio exercises and weightlifting, these are most popular exercise for improving overall physical fitness (Powers & Howley, 2012). Aerobic exercise, such as running, involves prolonged, continuous activity, and utilizes oxygen as the primary energy source, which can improve cardiorespiratory endurance and increases oxygen consumption capacity, known as VO_2 max (Maclnnis & Gibala., 2017). In contrast, anaerobic exercise such as weightlifting, relies on short bursts of high intensity muscular effort powered by energy systems that do not primarily depend on oxygen, such as ATP-PC and glycolytic pathways (Stone et al., 2006).

The usage of human energy is dominant especially when doing the exercises, this is because human has a different mental and physical condition, intensity level that is too high can lead to excessive energy expenditure, whereas poor intensity level could cause a sense of boredom and does not lead to progress in the physical aspect (Novita, 2024). In the context of finding the differences of physiological response by aerobic and anaerobic exercise and finding optimal intensity to achieve physical fitness without any exaggerated physiological strain by considering the limitations that have been mentioned, physiological measurements such as oxygen consumption (VO_2) and heart rate are essential for evaluating the intensity of the exercises (Charlot et al., 2014). Both aerobic and anaerobic exercises contribute to overall energy expenditure, even with different physiological responses, oxygen consumption shows the energy demand during physical activity, while heart rate provides insights into the cardiovascular system's response to exercise loads (Keytel et al., 2005). The measurements of these physiological parameters are essential in determining whether the exercise is intense enough, knowing a person's physiological condition provide sufficient information to determine and design training programs that tailored specific percentages of their maximum capacity to optimize training effectiveness and monitoring the progress (Powers & Howley, 2012). As individual adapt to their training, the VO_2 max may increase indicating improvement on aerobic performance (MacInnis & Gibala, 2016). There are several factors such as initial fitness level, gender, and age can influence physiological responses to exercise due to individual limitations (Hidayat, 2023). By having the knowledge about individual

physiological needs and conditions, the intensity of the workout can be tailored to maximize effectiveness as well as minimize the risks (Setyaningrum, 2019).

Many people in the gym often don't know how to maximize their exercises and the progress due to their goals, because the lack of awareness on their physiological condition for energy consumption and heart rate, weightlifting relies on anaerobic metabolism, which lead to short periods of high–intensity work with raised post-exercise oxygen consumption (EPOC), while the high loads and the contractions experienced with the muscle increase heart rate and make the local muscle fatigue (Cerqueira et al., 2020). Treadmill cardio, on the other hand, uses the aerobic energy system, where energy expenditure and oxygen consumption remain steady for prolonged duration tends to increase VO_2 max and cardiovascular fitness, but can also overstress the heart under excessive intensity. Exercise can improve overall health outcomes, but excessive intensity reverses the benefits, leading to physiological strain, injury, and a potential long-term cardiovascular risk (Lee et al., 2016).

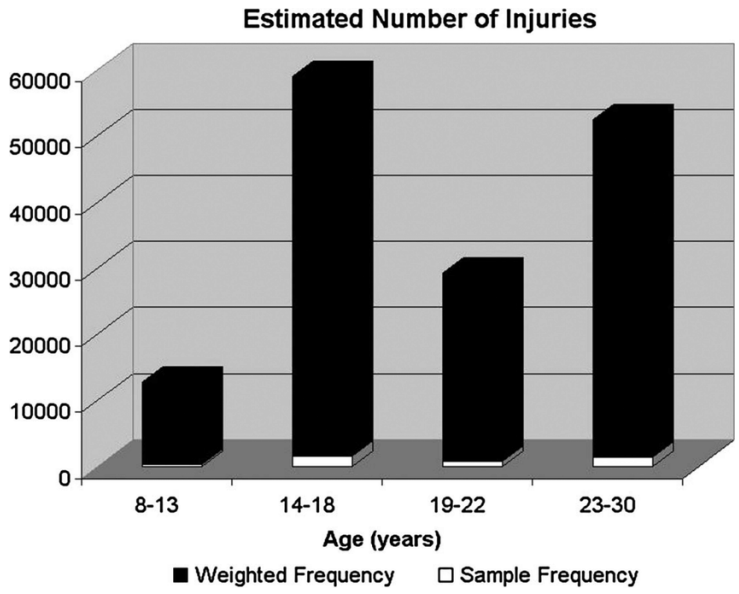

Figure I.1. Total Weightlifting Injuries Caused by Physiological Strain

Based on **Figure I.1.** it reveals that the age group 8-13 years group has the fewest injuries, but at the young age the injuries still occur, the 14-18 years experiences the highest number of injuries, making them vulnerable for weightlifting-related problems, injuries slightly decrease in the 19-22 years and 23-30 years groups, due to increased experience and developed better techniques, but the risk of injuries remains (Myer et al., 2009). The graph stresses the importance of using proper techniques and having enough supervision to avoid injuries, especially in younger age groups because they barely develop a good technique, there are several reasons for injury including strain, fatigue failure, and overtraining, one of the dominant

causes is because they don't pay attention to their own body condition and physiology, so they train with a very high intensity that exceeds their abilities (Myer et al ., 2009).

Overuse injuries and overtraining frequently occur in sports, especially when training loads are not matched with adequate rest and recovery, such conditions can negatively impact the performance and delay physical recovery, especially when people push beyond their physiological capacity without proper program (Novita, 2024). Training injury rate are 4 injuries per 1000 athletes, over 50% of these injuries involve the lower limbs, with ankle ligament sprains being the most frequent, for about 15% of all reported sports injuries, majority of these injuries resulted from non-contact mechanisms (48.4%) or gradual overuse (20.4%) rather than direct trauma (Setyaningrum, 2019). Below is the fishbone or cause and effect diagram that provide the root cause of the problem that has been explained.

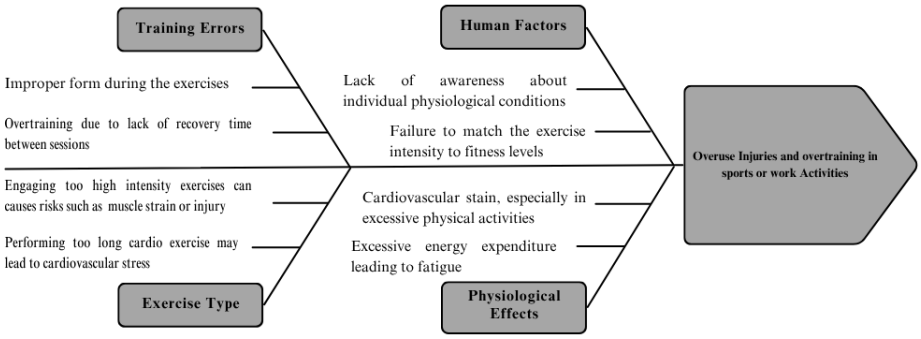

Figure I.2. Fishbone Diagram

The problem shown by several factors such as human factors, physiological effects, training errors, and exercise type. The detailed information of the diagram will be explained below:

1. Human Factors

In the human factors, it shown that the individual is lack of awareness about their physiological conditions and failed to match their exercise intensity based on fitness levels because some people may not understand their fitness levels that will limiting their ability to match the intensity which is suitable for them. Misalignment between exercise and physical capacity may result in inefficiency or even injury.

2. Physiological Effects

It mentioned in the physiological effects, there are cardiovascular strain, especially in excessive physical activities and excessive energy that can lead to fatigue because of overtraining can cause cardiovascular stress leading to temporary or lasting illness. Energy demands from inappropriate intensity can cause excess exhaustion and could reduce exercise efficiency.

3. Training Errors

Training errors can be caused by improper form during the workout and overtraining due to lack of awareness of the physiological condition. Because incorrect technique during the execution of the exercises can strain the muscle or joints, leading to temporary or lasting injury, and exercising beyond the body's limit or capacity can increase the risk of fatigue and chronic injuries.

4. Exercise Type

The cause of this issue is engaging in too high intensity workout and performing too long cardio exercises. Excessive intensity in activities like weightlifting and cardiovascular exercise could reverse all the benefits of the exercise itself and even increasing the health risks.

Based on the problem identification, this study goals are to compare oxygen consumption and heart rate during weightlifting and treadmill cardio exercises. To find the difference for both exercises based on physiological response to each individual based on their energy expenditure through the oxygen consumption and heart rate as well as minimizing the risks of physiological strain and injury.

I.1 Problem Formulation

Based on what have been discussed in the background of the proposal, the problem formulations are shown below:

1. What has a higher physiological impact between aerobic and anaerobic exercise in terms of physiology?
2. Which intensity of aerobic and anaerobic exercise provides higher physiological impact?
3. What is the optimal rest period required after different intensities of aerobic and anaerobic exercise to support adequate physiological recovery?

I.2 Purpose

Based on the background and the problem formulation that has been identified, the purposes of the proposal are:

1. To analyze and compare the physiological impacts of aerobic and anaerobic exercises.
2. To determine optimal intensities for aerobic and anaerobic exercise based on physiological data.
3. To identify the optimal rest period required after aerobic and anaerobic exercise at different intensity levels to ensure sufficient recovery.

I.3 Benefit

Based on the purpose, the benefits that will be able to implement are:

1. To enhance understanding of how aerobic and anaerobic exercises influence physiological systems.
2. To identify which type of exercise provides greater physiological responses.
3. To provides insights for optimizing exercise by comparing aerobic and anaerobic exercise.
4. To provide recommendations for selecting the most appropriate exercise intensity for improving fitness levels based on physiological responses.
5. To provides insights for the most appropriate rest period based on the physiological conditions.

I.4 Limitations and Assumptions

Limitations and assumptions are foundation from the problem solving which intends to avoid misunderstanding between the author and the readers. These limitations and assumptions are made for the research to align with the results. These limitations and assumptions are as follows:

1. Differences in participants body composition and exercise experience may affect the variability in the results.
2. Statistical test for this research is only done until the significance results from the ANOVA test.
3. As a parametric test, ANOVA is based on the following assumptions: normal distribution of data within each group, homogeneity of variances, and independence of observations.
4. The study focuses only on a small sample participant, this may limit the generalizability of the findings.
5. The study focuses on immediate physiological responses before, during, and after exercise, long-term adaptations or cumulative effects and muscular fatigue are not assessed.

I.5 Writing Systematics

This proposal writing systematics are shown below.

Table I.1. Writing Systematics

Chapter I	**Introduction** This chapter discusses the background information of the process based on the case of the problem identification, potential solutions, problem formulation, goals, advantages, and writing systematics of the report.
Chapter II	**Theoretical Basis** This chapter includes the reference of the literature that will be use related to the problem. This incorporates the methods that are used as a hypothetical framework to finish the proposal.

Chapter III	**Methodology of Research** This chapter incorporates a detailed explanation using the conceptual model that serves as a tool for gathering data and processing it from beginning to end to solve the problem.
Chapter IV	**Data Collection and Processing** This chapter explain about the methods of data collection and how the data is being processed to be aligned with the problem that need to be solved.
Chapter V	**Analysis** This chapter provides the analysis from the data that has been obtained from the previous chapter for the suggested tool design.
Chapter VI	**Conclusion and Suggestions** This chapter provides the summary of the report and add an opinion that can give insight for future research.