VIRTUAL REALITY INTERVENTION FOR REHABILITATION AND PAIN MANAGEMENT

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A Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of Master of Science at the University of Cyprus

May 2023

Abstract

Breathing problems can be a frequent and difficult symptom for those with lung cancer. The quality of life can be impacted by symptoms such chronic coughing, wheezing, chest pain, and shortness of breath. Fortunately, it has been discovered that deep breathing techniques, like diaphragmatic breathing and pursed lip breathing, can enhance lung function and help control these symptoms.

Deep breathing exercises and relaxation techniques like meditation or visualization can help people with lung cancer feel less stressed and anxious, according to research. It's crucial to collaborate with a healthcare professional to create a personalized breathing routine that is secure and appropriate for each person's unique medical requirements.

Along with deep breathing techniques, lifestyle changes like stopping smoking and getting regular exercise can also help with lung function and symptom management. A study published in the European Respiratory Journal found that fitness training can enhance lung function and quality of life in people with lung cancer.

Overall, deep breathing exercises can be a secure and efficient way to treat lung cancer symptoms including coughing and breathlessness.

In this thesis the VR game was created to help people with lung cancer learn how to breath better and reduce their pain.

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Chapter 1

Introduction

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1.1 Introduction

Breathing can be challenging for those who have lung cancer, a disorder that damages the lungs. Numerous symptoms, including a persistent cough, wheezing, chest pain, and trouble breathing, can be brought on by this condition. People with lung cancer have proved to benefit greatly from deep breathing exercises as a supplemental therapy for symptom management and lung function improvement.

Diaphragmatic breathing is a popular deep breathing practice. With this method, the emphasis is on breathing from the diaphragm rather than the chest muscles. Diaphragmatic breathing has been shown to help persons with lung cancer have better lung function in numerous trials [1].

Another deep breathing technique that has been proven to be useful in easing lung cancer symptoms is pursed lip breathing.

By taking a deep breath in through the nose and gently exhaling through pursed lips, resistance is created that keeps the airways open. In patients with lung cancer, pursed lip breathing enhanced respiratory muscle strength and decreased shortness of breath, according to research published in the Journal of Thoracic Oncology [1].

As stress and anxiety are common in people with lung cancer, breathing exercises can be used in conjunction with other strategies like meditation or visualization to help

them feel better. By encouraging relaxation, these methods can lessen muscle tension and facilitate better breathing. According to a study in the European Journal of Cancer Care, deep breathing exercises combined with relaxation methods helped patients with symptoms like weariness, anxiety, and dyspnea [2].It's crucial to collaborate with a healthcare practitioner to create a customized breathing regimen that is safe and suitable for your particular health situation. Working with a healthcare provider to create a strategy that is customized to your unique needs is vital since people with lung cancer may have varying degrees of lung function and different types of lung cancer.

In addition to deep breathing exercises, additional lifestyle modifications can help manage the symptoms of lung cancer. For instance, giving up smoking can enhance lung health and lower the risk of lung cancer. Regular exercise can also help to minimize symptoms like shortness of breath and improve lung function [3].

According to a study that was published in the European Respiratory Journal, fitness training enhanced lung function and quality of life in lung cancer patients [2].

In conclusion, deep breathing exercises are a secure and efficient strategy to enhance lung function and lessen lung cancer-related symptoms including coughing and shortness of breath. Breathing exercises come in a variety of forms, and they can be used alone or in conjunction with other methods like visualization or meditation to help lower stress and anxiety.

1.2 Thesis Objective

Breathing difficulties are a common symptom of lung cancer, and patients often experience shortness of breath, coughing, and wheezing. These symptoms can have a significant impact on a patient's quality of life and managing them is an essential part of the treatment process. One way to manage these symptoms is by teaching patients

deep breathing techniques that can help them breathe more efficiently and with less discomfort.

The VR game developed in this thesis aims to overcome these challenges by providing patients with a fun and engaging way to learn and practice deep breathing techniques. The game's visual environment of a boat in a lake is designed to provide a relaxing and calming atmosphere that can help patients to focus on their breathing. The game's instructions to inhale, exhale, and pause are timed to coincide with the patient's breathing, providing real time feedback and reinforcement of the correct technique.

The game's use of VR technology also has several advantages. VR has been shown to be an effective tool for pain management, reducing the need for medication and providing a distraction from pain. The game's measurements of the duration of each action provide objective feedback to the patient, which can help motivate them to continue practicing the techniques regularly.

The game is designed to be used with a Cardboard VR device and a mobile phone, making it accessible and affordable for patients. The use of a mobile phone also means that patients can practice the techniques at home, reducing the need for hospital visits and allowing patients to take control of their own care.

In conclusion, the VR game developed in this thesis has the potential to improve the quality of life of patients with lung cancer by providing them with a fun and engaging way to learn and practice deep breathing techniques. The game's use of VR technology, real time feedback, and accessible design make it a promising tool for managing the symptoms of lung cancer and improving patient outcomes.

1.3 Thesis Structure

Chapter 1: Introduction

The introduction provides an overview of the research problem and presents the research questions or hypotheses being addressed. The chapter discusses the importance of addressing the breathing difficulties faced by lung cancer patients during chemotherapy and surgery. This chapter also provides a brief review of the literature on the effects of deep and controlled breathing on lung cancer patients and the use of virtual reality (VR) technology to facilitate breathing techniques. Furthermore, this chapter discusses the rationale for using VR games in the context of breathing exercises for lung cancer patients. Finally, the chapter outlines the objectives and scope of the study.

Chapter 2: Literature Review

This chapter presents a comprehensive review of the relevant literature on the effects of lung cancer, treatments, and the benefits of breathing exercises for lung cancer patients. It also examines the principles and features of VR technology, including its application in healthcare and medical settings. This chapter discusses the advantages and disadvantages of using different sensors to capture breathing data during VR games. Finally, the chapter provides an overview of the state-of-the-art research on the use of VR games for breathing exercises for lung cancer patients.

Chapter 3: Project Representation

This chapter discusses the technical aspects of the VR game developed for the study. It provides a detailed description of the visual environment of the game, which simulates a boat floating on a lake. The chapter discusses how the game's instructions were designed to guide the patient through deep and controlled breathing exercises. It also presents the types of measurements captured by the breathing sensors during the game, including breathing rate, inspiratory volume, and exhalation volume.

Chapter 4: Results and Analysis

This chapter presents the results of the study, including statistical analysis and data visualization. The chapter reports on the data collected from eighteen participants and

analyses the effect of the VR game on their breathing patterns. The chapter examines the relationship between the duration of breathing exercises and the measurements of breathing rate, inspiratory volume, and exhalation volume. The chapter presents the results in graphical format, illustrating the changes in breathing patterns over time during the VR game.

Chapter 5: Conclusion and Future Work

This chapter summarizes the findings of the study, discussing the implications of the results for the use of VR games in breathing exercises for lung cancer patients. The chapter highlights the limitations of the study and suggests areas for future research. This chapter concludes with a discussion of the potential applications of VR games for healthcare, including their use in training patients to develop deep and controlled breathing techniques. Finally, the chapter discusses the implications of the study for healthcare professionals and policymakers, outlining the potential benefits and challenges of implementing VR games for breathing exercises in clinical settings.

References

This section lists all the sources cited in the thesis, following the appropriate referencing style.

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2.1 Lung Cancer

An instance of cancer that arises in the lungs is lung cancer. The lungs are the breathing apparatuses and are in charge of the body's exchange of oxygen and carbon dioxide. If left untreated, lung cancer can originate anywhere in the lungs and progress to other body areas. It is one of the main reasons for cancer-related fatalities worldwide, and its prevalence has increased over time.

Non-small cell lung cancer (NSC-LC) and small cell lung cancer are the two main kinds of lung cancer. (SC-LC) [4].

Approximately 85% of instances of lung cancer are NSC-LC, making it the most prevalent form. Adenocarcinoma, squamous cell carcinoma, and big cell carcinoma are a few of the subtypes of NSC-LC. The most prevalent NSC-LC form, adenocarcinoma, typically appears in the outer regions of the lung. On the other hand,

big cell carcinoma can form anywhere in the lung, while squamous cell carcinoma frequently manifests in the middle of the lung.

Comparatively, SCLC is less frequent, making up only 15% of cases of lung cancer. It is a lung cancer that is aggressive and has a propensity to spread swiftly to other body regions [4].

Smoking is the main factor in lung cancer development. Smoke from cigarettes contains dangerous chemicals that can injure lung cells and cause cancer to grow. Lung cancer is more likely to occur in those who smoke cigarettes or are among others who do.

Lung cancer risk can also be raised by radon exposure, a naturally occurring gas that is present in dwellings. Lung cancer risk can also rise with exposure to other toxins like asbestos and air pollution [4].

The size and location of the tumor, the degree of lymph node involvement, and whether the cancer has spread to other body areas all contribute to determining the stage of lung cancer.

The TNM staging system, which stands for Tumor, Node, and Metastasis, is the most often used staging approach for lung cancer. The N stage describes the level of lymph node involvement, the T stage describes the size and location of the tumor, and the M stage describes whether cancer has disseminated.

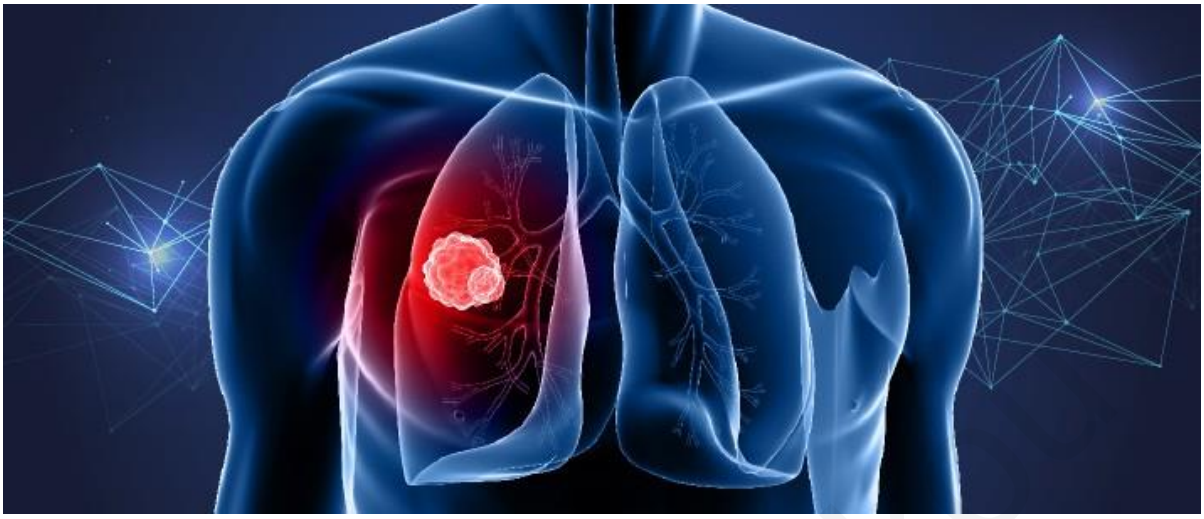

Figure 1 This picture illustrate lung cancer[10]

2.2 Lung cancer symptoms

Depending on the type and stage of cancer, the symptoms of lung cancer can change. The following are some of the most typical signs of lung cancer:

The most typical sign of lung cancer is a persistent cough. The cough could be dry or mucus producing, and it might persist. The cough could get worse in the morning and get better all day. A chronic cough can be an indication of other respiratory illnesses, so it's important to consult a doctor if it persists for more than a few weeks [5].

Breathlessness is another typical sign of lung cancer. It could happen while you're exercising or even just lying down. Breathing is difficult due to the tumor's obstruction of the airways, which might be indicated by shortness of breath.

A common sign of lung cancer is chest pain. The chest, back, or shoulder may be the location of the pain, which can be either intense or dull. It's possible that coughing, laughing, or deep breathing will make the pain worse. It's crucial to consult a doctor if chest pain persists even though it may also be a symptom of other ailments [6].

When breathing, wheezing produces a high-pitched whistling sound. It might be an indication of an obstruction in the airways, which lung cancer can bring about. Other respiratory diseases can also be indicated by wheezing, so it's crucial to visit a doctor if it persists.

Hoarseness is a vocal alteration that gives it a harsh or raspy quality. It can be a symptom of a tumor pressing against the voice cords' control nerve. Although hoarseness can also be a symptom of other illnesses, it's crucial to contact a doctor if it persists for more than a few weeks [6].

Hemoptysis, or coughing up blood, is a sign of lung cancer. It can indicate that a blood vessel has burst or that malignancy has gone to the airways. Although it's crucial to consult a doctor if it happens, coughing up blood can also be a sign of other diseases.

Extreme exhaustion or weakness that doesn't go away with rest is referred to as fatigue. Particularly if it's accompanied by additional symptoms like shortness of breath or chest pain, it may be an indication of lung cancer. It's crucial to contact a doctor if fatigue persists even if it can also be a symptom of other ailments [6].

Lung cancer frequently exhibits the sign of unexplained weight loss. It can be an indication that the malignancy is consuming body energy or interfering with metabolism. Unexpected weight loss can also be an indication of other illnesses, so it's crucial to visit a doctor if it's severe or coupled with other symptoms.

A common sign that lung cancer has migrated to the bones is bone pain. The back, hips, or other bones may experience the ache. Bone pain can also be a symptom of other illnesses, so it's crucial to visit a doctor if it persists.

A common sign of lung cancer that has spread to the brain are headaches. The headaches could be strong or persistent, and they might come with accompanying symptoms including confusion or seizures. Although frequent or severe headaches may be a sign of another alignment, it's crucial to contact a doctor [6].

It's crucial to remember that not everyone with lung cancer will have all these symptoms, and many of them can also be brought on by other illnesses.

Figure 2:This picture shows lung cancer signs[11]

2.3 Treatment

The dangerous condition of lung cancer needs immediate medical intervention. The stage and type of the cancer, as well as the patient's general condition, all influence how lung cancer is treated. Surgery, radiation therapy, chemotherapy, targeted therapy, and immunotherapy are all available as lung cancer treatments.

The most frequent form of treatment for early-stage lung cancer is surgery. The aim of surgery is to remove the lung tumor that is malignant. There are various surgical procedures for lung cancer.

One surgical method involves removing the lung lobe where the cancerous tumor is located, known as a lobectomy.

Pneumonectomy is a different approach that entails removing the entire lung containing the malignant tumor.

Wedge resection or segmentectomy These are less invasive procedures where only a

little piece of the lung is removed.

Surgery may not be an option for patients with advanced lung cancer or for those who have other health problems that make surgery too risky.

Radiation therapy, which employs high energy beams to kill cancer cells, is another form of treatment. It can be used either on its own or in conjunction with chemotherapy or surgery. Before or after surgery, radiation therapy may be performed to reduce the size of the tumor or to eradicate any cancer cells that may still be present. Additionally, advanced lung cancer symptoms including discomfort or breathing issues may be treated with radiation therapy.

An alternative therapy is Drugs are used in chemotherapy to kill cancer cells. It can be applied either alone or in conjunction with radiation therapy or surgery. Chemotherapy medications are often administered via intravenous (IV) infusion, and the procedure is typically carried out in cycles with breaks in between. Hair loss, nausea, and vomiting are possible ad-verse effects of chemotherapy, however these side effects are typically treatable with medicine [4].

A type of therapy known as targeted therapy focuses on particular genes, proteins, or other substances that support the growth and division of cancer cells. Typically administered as pills, targeted therapy medications can be used either alone or in conjunction with chemotherapy. Patients with certain kinds of lung cancer, such as non-small cell lung cancer (NSC- LC), that have particular genetic alterations may have the option of targeted therapy.

The type of treatment known as immunotherapy makes use of the immune system to combat cancer. Drugs used in immunotherapy aid the immune system's recognition and destruction of cancer cells. A targeted therapy or chemotherapy regimen may be combined with immunotherapy. Patients with NSC-LC that has progressed to other body parts may qualify for immunotherapy.

Clinical trials are research projects that examine potential lung cancer therapies. If a patient satisfies certain requirements, they may be qualified to take part in clinical trials. Patients participating in clinical trials may have access to cutting edge therapies that are not yet accessible to the general population [4].

The goal of palliative care is to enhance the quality of life for patients with advanced lung cancer. Medication to treat pain and other symptoms, such as coughing or breathlessness, may be part of palliative care. Support for the patient and their family on an emotional and spiritual level may also be part of palliative care.

It's crucial to understand that treating lung cancer is a difficult process, and each patient's course of treatment may vary. The majority of the time, lung cancer treatment decisions are made by a team of doctors and other medical specialists. Curing cancer or controlling the symptoms while enhancing the patient's quality of life are the two main objectives of treatment.

The treatment of patients with lung cancer must include pain management. Lung cancer is accompanied by a variety of pains, such as pain from the tumor itself, pain from the treatment, and pain from additional illness symptoms. Effective pain management can help patients live better lives and experience less suffering. Here are some techniques for reducing lung cancer pain.

When it comes to treating the pain brought on by lung cancer, painkillers are frequently the first line of defense. There are various sorts of painkillers, including opioid pharmaceuticals like morphine or oxycodone as well as non-opioid drugs like acetaminophen or non-steroidal anti-inflammatory drugs (NSAIDs). The kind and degree of the pain will determine the medication to be used. Medications may be administered orally, topically via patches, or intravenously with injections [4].

It's crucial to stick to the doctor's advised prescription schedule and not take more than the suggested dosage. Any modifications to their pain and any adverse drug

reactions should be discussed with the patient's healthcare physician [4].

Pain brought on by lung cancer may be effectively treated with radiation therapy. High energy beams are used in radiation therapy to kill cancer cells. It can also help shrink the tumor, relieving pressure on any adjacent tissues that may be inflamed. To reduce adverse effects, radiation therapy can be applied specifically to a particular location.

An example of a pain management treatment known as a "nerve block" is the injection of medicine into or close to pain transmitting nerves. For the treatment of lung cancer discomfort that has spread to the bones or nerves, nerve blocks can be helpful. The surgery, which is typically performed under local anesthetic, may offer comfort for a few weeks or months.

Thin needles are inserted into precise body sites during acupuncture, a form of conventional Chinese medicine. By promoting the body's natural painkillers, acupuncture may help control the discomfort brought on by lung cancer. When carried out by a qualified professional, acupuncture is regarded as safe [4].

It's possible that mindfulness exercises and meditation can lessen lung cancer pain. These techniques entail keeping the attention on the present moment, which can lessen stress and worry, both of which can exacerbate pain. You can practice mindfulness and meditation on your own or with a professional.

Pain brought on by lung cancer may be effectively treated with physical therapy. Physical therapy can help muscles become stronger and range of motion become better, which can help lessen pain and suffering. Physical therapy can also aid in the management of pain brought on by adverse effects of medications, such as radiation therapy.

Alternative and complementary therapy may be able to reduce lung cancer related pain. Massage, aromatherapy, and herbal supplements are some of these therapies.

Before utilizing any complementary or alternative therapies, patients should consult with their healthcare physician to be sure they are safe and won't conflict with existing medicines [4].

It's crucial to remember that pain management is a difficult process that calls for a customized strategy. The patient and the healthcare professional will collaborate to create a pain management strategy that considers their individual requirements and preferences. Any changes in pain and any adverse treatment side effects should be discussed with the patient's healthcare practitioner. For the patient to concentrate on the other components of their therapy and care, pain management can help them have a higher quality of life and experience less suffering.

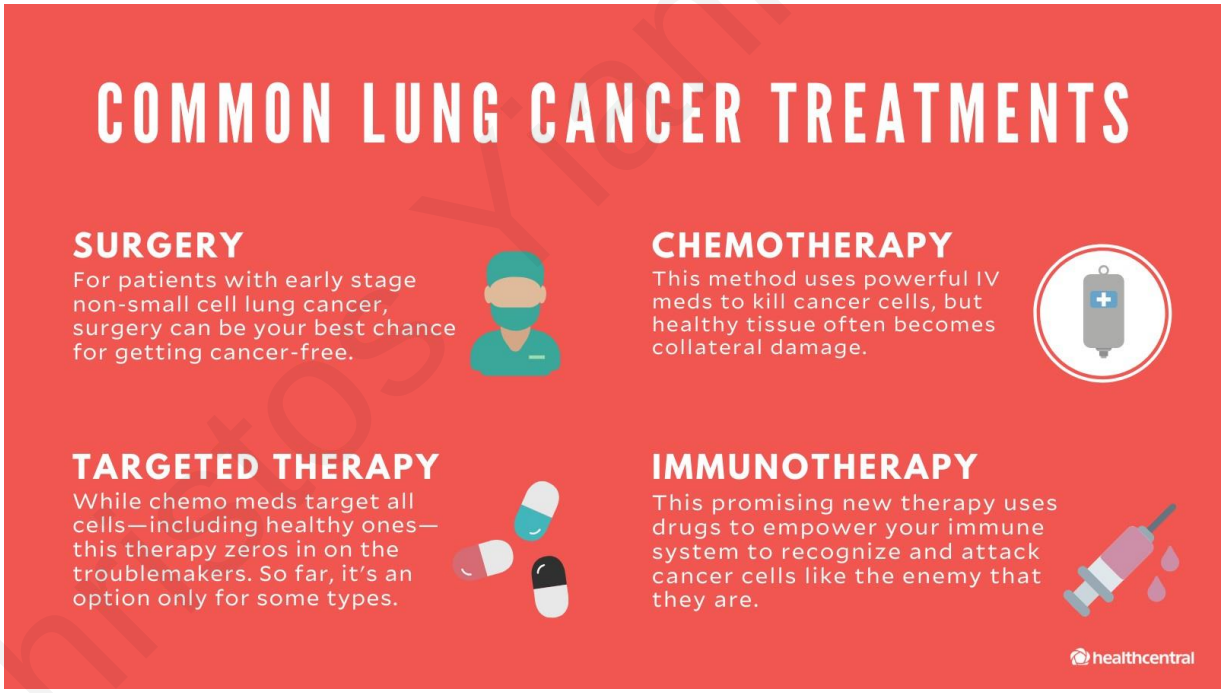

Figure 3:This picture represents lung cancer treatments[12]

2.4 Respiration

Respiration is the biological process through which living things exchange gases with their surroundings, especially oxygen and carbon dioxide. Respiration is a crucial process that permits the body to take in the oxygen required for cellular

respiration, which generates energy, and to expel carbon dioxide, a waste product of metabolism, in humans and many other animals.

External and internal respiration are the two main categories of respiration. The process through which carbon dioxide and oxygen are transferred between the body and the outside environment is known as external respiration. In the human lungs, this process takes place where oxygen from the air is taken up into the bloodstream and carbon dioxide is released into the lungs' air to be expelled [7].

In contrast, internal respiration is the mechanism by which the body's tissues get oxygen and exhale carbon dioxide. At the cellular level, carbon dioxide diffuses out of the cells into the bloodstream to be carried to the lungs for elimination as oxygen diffuses in from the blood stream into the cells [7].

In addition to these fundamental procedures, respiration also involves a number of important physiological systems and mechanisms. These include the cardiovascular system, which transports oxygen and nutrients to the body's tissues, the nervous system, which regulates and coordinates respiration, and the respiratory system, which includes the lungs, airways, and other organs and tissues involved in breathing.

Numerous factors, such as air pollution and altitude, as well as medical problems that may impair lung function or other components of the respiratory system, can have an impact on one's ability to breathe. Breathing can be impacted by illnesses like asthma, chronic obstructive pulmonary disease (COPD), and lung cancer, all of which may need specialized care to alleviate the symptoms and enhance lung function [3].

Depending on the type and stage of the illness, lung cancer can have a variety of effects on respiration. Here are a few ways that lung cancer can affect breathing.

a blockage of the airways Lung cancer has the potential to spread and obstruct airways, making breathing difficult. This may result in symptoms like coughing, wheezing, and shortness of breath.

By reducing the amount of healthy lung tissue, lung cancer can lower lung capacity and make it more difficult to take deep breaths.

Fluid accumulation in the pleural area, which surrounds the lungs, is a potential side effect of lung cancer. Breathlessness, chest pain, and a dry cough may result from this.

Chest pain, breathing problems, and coughing are signs of lung cancer that might disrupt respiration if it spreads to other parts of the body.

Nevertheless, not all lung cancers cause respiratory issues. Some lung cancers may be detected through routine tests or other indicators, such as unexplained weight loss or tiredness. If you are experiencing respiratory symptoms or are concerned that you could have lung cancer, it is imperative to consult with your healthcare provider.

In a variety of methods, controlled breathing techniques help lessen the pain and suffering brought on by lung cancer. Here are a few advantages of controlled breathing.

Relaxation Examples of controlled breathing techniques that can ease stress and encourage relaxation include deep breathing and diaphragmatic breathing. This can reduce discomfort and muscle tension while reducing pain.

The amount of oxygen that gets to the lungs and the rest of the body can be increased through controlled breathing. This can lessen the signs of shortness of breath and enhance general health [7].

Coughing, which can be a typical sign of lung cancer, can be controlled with the aid of controlled breathing techniques. Patients can better manage their coughing and lessen the pain and discomfort it causes by managing the depth and rate of their breathing.

A sensation of calm and inner serenity can be encouraged and increased via the use of controlled breathing exercises. This can make it easier for people to deal with the

discomfort and pain that come with lung cancer.

It's critical to understand that controlled breathing techniques for lung cancer are not a replacement for medical care. To treat symptoms and enhance general wellbeing, they might be used as an adjunct therapy. It's crucial to discuss the best symptom management techniques with your healthcare physician if you have lung cancer [1].

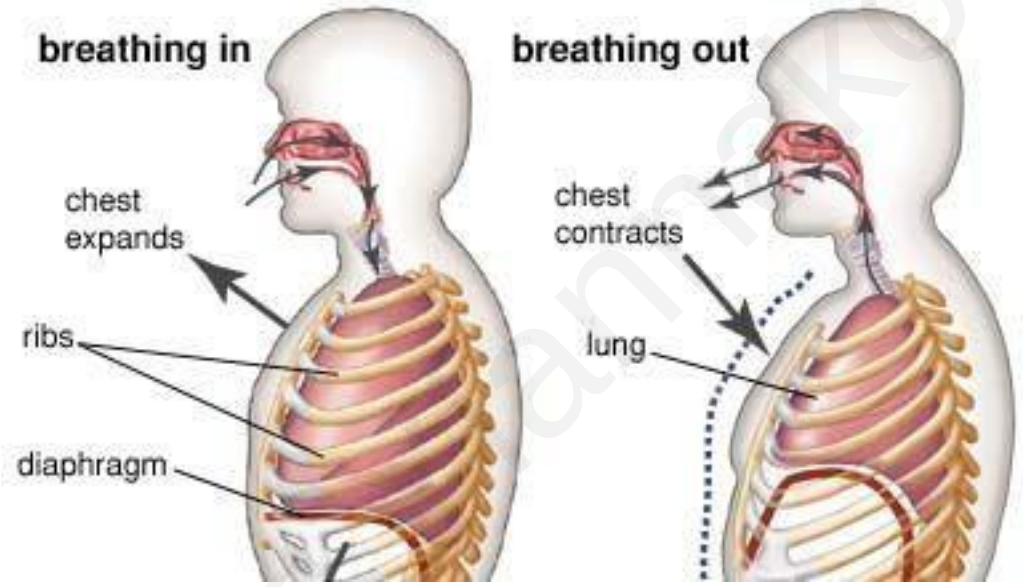

Figure 4:This picture represents respiration process[13]

2.5 Pulmonary Rehabilitation

The goal of pulmonary rehabilitation is to help people with chronic lung disorders manage their symptoms and enhance their overall quality of life. It is a complete program that incorporates exercise, education, and breathing methods. The program aims to increase physical activity, promote lung function, and aid people in more efficient symptom management. Patients with respiratory problems like Asthma, Bronchitis, Pulmonary Fibrosis, Chronic Obstructive Pulmonary Disease (COPD), and other respiratory ailments can benefit from this program.

The main objective of pulmonary rehabilitation is to help patients with chronic lung disorders breathe better and feel better overall. A group of medical experts, including

doctors, respiratory therapists, physical therapists, and dieticians, often manage the program.

A thorough evaluation of the patient's physical capabilities, overall health status, and lung function typically marks the start of the program. The patient receives a customized course of treatment that combines exercise, education, and breathing exercises based on the findings of this examination.

Additionally, breathing exercises are a crucial component of pulmonary rehabilitation. These methods aim to enhance the patient's breathing pattern, expand their lung capacity, and lessen their shortness of breath. Diaphragmatic breathing, lip pursing breathing, and abdominal breathing are a few examples of typical breathing techniques. Patients are instructed on how to properly use these approaches and are urged to do so frequently.

The key to successful pulmonary rehabilitation is education. Patients receive education about their disease and practical management techniques. Education may cover topics like understanding prescription drugs, using inhalers correctly, and the value of self-management. Additionally, patients are instructed on how to identify and treat symptoms like coughing, chest pain, and shortness of breath. To effectively control their symptoms, they learn how to modify their breathing patterns and amount of exercise [3].

Another essential component of pulmonary rehabilitation is dietary guidance. Dietary counselling can assist patients with lung illness in meeting any special nutritional requirements they may have. The program offers guidance on healthy eating, staying hydrated, and managing your weight.

Emotional support is also a vital part of pulmonary rehabilitation. Patients who have a chronic lung condition may struggle with anxiety, depression, and other emotional problems. To assist patients in navigating the emotional difficulties of their disease,

support services are offered.

A thorough program called pulmonary rehabilitation can significantly improve the lives of people with chronic lung diseases. According to research, it can enhance lung health, lessen breathlessness, and enhance general quality of life. Additionally, it has been demonstrated that the program lowers hospital stays and medical expenses.

Pulmonary rehabilitation has other benefits in addition to those already discussed. These include a higher tolerance for physical activity, stronger muscles, and reduced breathlessness when performing regular tasks. Patients who take part in pulmonary rehabilitation could also feel less tired and sleep better [3].

People with chronic lung illness who desire to enhance their general health and quality of life might consider pulmonary rehabilitation. The program may be tailored to each patient's unique needs and is both secure and efficient. The treatment is accessible in both inpatient and outpatient settings and is covered by the majority of insurance carriers.

To sum up, pulmonary rehabilitation is a thorough program that can greatly raise the quality of life for people with chronic lung conditions. The program includes physical activity, knowledge, breathing exercises, and emotional support to assist patients in better managing their symptoms. It has been demonstrated to enhance lung function and is an evidence-based therapy.

An evidence-based therapy called pulmonary rehabilitation can assist people with lung cancer manage their symptoms and enhance their general quality of life. The program can be tailored to each patient's unique requirements and may combine exercise, education, and breathing exercises [3].

Improved lung function is one of the main advantages of pulmonary rehabilitation for people with lung cancer. The treatment can assist patients with expanding their lung capacity, which may be especially beneficial for those who have undergone surgery

to remove a portion of their lungs. Patients may experience decreased fatigue, shortness of breath, and other lung cancer-related symptoms by expanding their lung capacity.

Pulmonary rehabilitation can help patients increase their levels of physical activity in addition to improving lung function. Due to their symptoms, many people with lung cancer may be reluctant to exercise, but exercise is crucial for preserving overall health and wellbeing. The program can assist patients in creating a secure and productive workout regimen that will enable them to strengthen, increase their endurance, and better manage their symptoms.

Additionally, breathing exercises are a crucial component of pulmonary rehabilitation for those with lung cancer. Breathlessness is a potentially disturbing lung cancer symptom that can make it difficult for patients to carry out daily tasks. Patients can improve their breathing patterns and lessen shortness of breath by using breathing techniques including pursed lip breathing and diaphragmatic breathing. Patients may feel more in control of their symptoms and have less anxiety connected to breathing problems by frequently using these approaches. Another crucial element of pulmonary rehabilitation for those with lung cancer is education. Symptom management, what to expect during therapy, and how to maintain a healthy lifestyle both during and after treatment are all topics that patients may have questions about. The program can enlighten patients about these subjects and offer advice on how to deal with side effects of cancer therapy, like nausea and exhaustion [3].

Additionally crucial to pulmonary rehabilitation for those with lung cancer is dietary guidance. Due to their disease and treatment, patients with lung cancer could have particular nutritional requirements. During and after treatment, patients can maintain their health and wellbeing with the support of a qualified dietitian's advice on healthy eating, staying hydrated, and managing their weight.

The final point is that pulmonary rehabilitation for those with lung cancer must include emotional support. Cancer patients may struggle with anxiety, sadness, and other emotional problems as a result of their diagnosis and medical care. Patients' overall quality of life can be improved by using support services like counselling and support groups to assist them deal with these emotional difficulties.

In conclusion, pulmonary rehabilitation may be an effective treatment for those with lung cancer. The program can enhance physical activity levels, lessen breathlessness, and improve lung function in addition to provide information and support on how to handle symptoms of lung cancer and its treatment. Lung cancer patients may benefit from enhanced quality of life and better symptom control by taking part in pulmonary rehabilitation.

2.6 Virtual Reality

Users of virtual reality (VR) technology can encounter a simulated environment that is either entirely fictitious or similar to the real world. With VR, users may interact with items and their surroundings while immersed in a 3D environment that makes them feel as though they are actually there. Since its inception in the 1960s, technology has advanced significantly, and now, VR is used in a wide range of applications, from gaming and entertainment to education and training.

Although the idea of virtual reality was first put forth in the 1960s, it wasn't until the 1980s that the technology really began to take shape. Early VR systems were cumbersome, expensive, and difficult to use due to their complexity. The wonders of virtual reality, however, are now available to anyone with a VR headset thanks to advancements in technology.

The potential of VR to transfer people to novel and interesting surroundings is one of its key benefits. Users can, for instance, travel to locations they would never be able

to reach in the real world, such the surface of Mars, the ocean's depths, or another planet. VR can also be utilized to build lifelike simulations for training and educational reasons. Pilots can rehearse for emergency circumstances without endangering themselves or others, and doctors can conduct intricate procedures in a controlled setting.

A user typically dons a VR headgear, which includes a display screen and sensors that measure head movements, to produce a VR experience. The 3D environment that the user sees through the headset is created by a computer or gaming console that is connected to the headset. In some circumstances, the user may additionally put on hand controllers that let them move their hands and make motions to engage with the virtual world.

Motion sickness is one of the difficulties with VR since it can happen when a user's motions in the virtual environment do not correspond to their actual movements. Other symptoms like nausea and disorientation may also result from this. Developers utilize a method known as "locomotion" to produce fluid and realistic movements within the virtual environment to lower the chance of motion sickness.

Despite its difficulties, virtual reality (VR) has a great deal of potential to alter how we engage with technology and the outside world. VR has already begun to transform the game business by enabling levels of immersion and involvement that were previously unattainable.

For their creative usage of VR, titles like Beat Saber and Half-Life: Alyx have won praise from critics.

VR is being employed in fields other than gaming, including healthcare, education, and architecture. For instance, by exposing patients with phobias to virtual settings in a safe and regulated manner, VR can be used in the healthcare industry to help patients overcome their concerns. In the classroom, virtual reality (VR) may give students

immersive experiences that make learning about historical events or scientific ideas more interesting. Before they are built, virtual reality (VR) can be used to produce walkthroughs of buildings and other structures, giving architects and designers the chance to test and improve their concepts.

The potential of VR is amazing in the future. We may anticipate increasingly lifelike and engaging experiences that blend the real and the virtual as technology advances. Additionally, the creation of standalone VR headgear that work independently of a console or computer may increase the popularity and accessibility of VR.

Concerns exist, though, over how VR will affect society. For instance, some professionals are concerned that the degree of immersion offered by VR can result in addiction or social isolation. Concerns have also been raised regarding the potential for VR to be utilized for evil, such as to stage realistic simulations of crimes or terrorist attacks.

In general, virtual reality has the power to change how we relate to technology and the outside world. from entertainment and gaming to healthcare and instruction.

Technology for virtual reality (VR) has a big impact on the healthcare sector in addition to gaming and entertainment. VR is being used to raise patient outcomes and improve the quality of care, from teaching medical staff to actually treating patients. We shall examine how virtual reality is transforming healthcare in this essay.

VR is mostly employed in the field of medical education. Medical students can learn about numerous medical procedures and conditions in a secure and regulated setting thanks to the technology that is being utilized to build immersive simulations. This makes it possible for students to try numerous techniques without endangering actual patients. Students who use virtual reality (VR) can better visualize difficult medical ideas and gain practical experience in a relaxed setting.

For instance, medical students can utilize virtual reality to study human anatomy.

Students can visually explore the human body in 3D via VR, which helps them comprehend how various body parts function. Students who do not have access to cadavers or other study resources can particularly benefit from this.

Surgeons are being trained using VR as well. With VR, surgeons may try different techniques including laparoscopic surgery without endangering their patients. Before performing the treatment on a live patient, this enables them to polish their skill and gain confidence. Surgery related complications can be simulated and practiced by surgeons using virtual reality (VR).

VR is being used to treat patients as well as train medical staff. Pain management is one application of VR in healthcare. VR technology is a helpful tool for pain management since it can be used to divert patients' attention away from the pain they are feeling. For instance, a patient getting chemotherapy might utilize VR to block out the discomfort of the procedure.

Additionally, VR technology can be applied to the treatment of people with mental health issues. Patients with anxiety problems are frequently treated using exposure treatment. Traditional exposure therapy, however, can be costly, time-consuming, and occasionally challenging to implement. Virtual reality (VR) can be used to replicate various situations that could make a patient anxious and provide them a chance to practice coping skills. Patients can develop confidence and resilience to their triggers in this secure and controlled environment.

VR is also being utilized to treat PTSD, which is another application in mental health. VR has been proved to be an effective treatment for PTSD, which is a condition that many veterans suffering from active-duty experience. Veterans who may have faced different war circumstances might process the trauma in a secure setting by using virtual reality exposure therapy (VRET).

The quality of life for those with physical limitations is also being improved through

VR. For instance, VR may help stroke victims restore their motor skills. Patients can develop strength and coordination by participating in simulations that teach them to use their limbs in particular ways using virtual reality technology.

The usage of VR technology can benefit people with dementia and other cognitive impairments. VR simulations can be utilized to give patients cognitive stimulation, which can halt the disease's course. For instance, a dementia sufferer might utilize virtual reality to imitate a stroll around the park, which can be a soothing and enjoyable activity.

Patient education is another application of VR in healthcare. VR can be used to educate patients about their conditions and available treatments. For instance, a diabetic patient might utilize virtual reality to understand how insulin works and how to give the drug. Patients may be more compliant and involved in their own care as a result of this.

VR has advantages for both patients and medical professionals, as well as the potential to lower healthcare expenses. For instance, telemedicine services can be delivered with VR, enabling doctors to consult with patients from a distance. This can lessen the need for in-person appointments and increase patient access to care.

Technology known as virtual reality (VR) has become a potent tool for improving the management and treatment of many medical diseases. A difficult and deadly condition, lung cancer affects millions of individuals worldwide. Both lung cancer patients and medical personnel can benefit from the usage of VR technology in education and training programs. The use of virtual reality (VR) technology to enhance the standard of treatment for patients with lung cancer will be discussed in this essay.

Patients with lung cancer frequently experience discomfort and worry. An essential component of their management is controlling these symptoms. Through realistic and

captivating experiences, VR technology can help patients control their symptoms. For instance, patients can experience peaceful and relaxing environments using virtual reality (VR) headsets, which can help them lower their anxiety levels. According to research, virtual reality (VR) technology effectively lowers pain and anxiety in patients with a range of illnesses, including cancer. Patients may need rehabilitation following lung cancer surgery in order to regain lung function. Exercises that are interactive and entertaining can be developed using VR technology to aid patients in regaining their strength and mobility. For instance, patients can utilize VR simulations to practice breathing techniques and expand their lung capacity. Patients can track their progress in the virtual setting, which can serve as inspiration and support.

Lung cancer sufferers can access instructional materials using VR technology. For instance, patients can learn about the progression of lung cancer by using VR headsets to examine 3D replicas of their lungs. Additionally, they can learn about various medical procedures and their associated negative effects. Through the use of VR technology, patients can more easily acquire and enjoy complex medical information. They will be better able to decide on their care and treatment as a result.

Medical practitioners can be trained in the treatment of lung cancer using VR technology. For instance, using virtual simulations can assist medical professionals practice operations like bronchoscopy, which involves seeing into the airways using a flexible tube. Medical practitioners can practice and develop their abilities in a secure, low risk setting with the help of these simulators. Virtual reality (VR) technology can assist medical personnel in becoming more competent and confident in their ability to treat lung cancer, which will eventually benefit patients.

Lung cancer sufferers may feel more empowered because to VR technology. Patients can follow their progress and keep an eye on their symptoms using VR headsets.

This may increase their sense of agency and control over their care. Additionally, patients and healthcare professionals may communicate more effectively thanks to VR technology. Patients can show their doctors where they are in pain or uncomfortable via VR simulators, for instance. This can assist healthcare professionals in creating more individualized treatment programs that cater to the needs of the patient.

While virtual reality technology has the potential to offer patients with lung cancer tremendous support, it also has certain drawbacks. For instance, not every patient may feel at ease wearing VR headsets. When using VR technology, some people may become queasy or feel dizzy. Additionally, not all patients will have access to VR technology, particularly those who reside in rural or isolated places.

A difficult and deadly condition, lung cancer affects millions of individuals worldwide. VR technology has become a potent tool for improving this disease's management and therapy. Utilizing VR technology can help with rehabilitation, education, clinical training, and the management of pain and anxiety. Patients with lung cancer may feel more empowered and be able to communicate better with medical professionals because to it. Even while VR technology has some drawbacks, there are a lot of potential advantages. Virtual reality (VR) technology is expected to advance and become a more vital tool in the management and treatment of lung cancer.

2.7 Breath Sensors

Breath sensors are tools for identifying and quantifying different elements of respiration. From medical monitoring to sporting performance analysis, these sensors offer a wide range of uses. Breath sensors collect important information about a person's respiratory function by sensing changes in the air that is breathed in and out

[5].

In medical contexts, breath sensors are used rather frequently. For instance, medical professionals may utilize breath sensors to track the health of patients with respiratory conditions like asthma or chronic obstructive pulmonary disease. (COPD). These sensors are capable of identifying changes in a patient's breathing patterns, including the rate and depth of their breaths, and can offer insightful information about the patient's health. Breath sensors can also be employed to determine whether a person's breath contains specific gases or compounds. In order to identify drunk driving and other alcohol related offenses, breathalyzers, for instance, can be used to detect the presence of alcohol in a person's breath. Similar to this, breath sensors can be used to find specific compounds that are signs of illnesses like lung cancer.

Analyzing sporting performance is another use for breath sensors. Breath sensors can be used by athletes to track their breathing patterns while they are working out, which can reveal important information about their levels of cardiovascular fitness and health. The presence of specific gases in an athlete's breath, like as carbon dioxide, can be detected using breath sensors, and this information can be used to gauge how effectively the athlete's body is utilizing oxygen during exercise.

In industrial environments, breath sensors can be used to monitor air quality and find the presence of hazardous gases. As an illustration, breath sensors can be used in coal mines to find methane gas, which can explode at certain amounts. Similar to this, breath sensors can be used in industrial settings like factories to monitor the air quality and find dangerous chemicals like carbon monoxide.

Breath sensors can also be used in industrial settings to monitor air quality and detect the presence of dangerous gases. For example, breath sensors can be used in coal mines to detect the presence of methane gas, which can be explosive if it reaches certain concentrations. Similarly, breath sensors can be used in factories or other

industrial settings to monitor the air quality and detect the presence of toxic gases such as carbon monoxide.

A flow sensor is an additional kind of breath sensor that gauges how much air is entering and leaving the lungs. In medical settings, flow sensors are frequently employed to track patients' breathing patterns and can provide important information regarding respiratory function.

There are additional kinds of breath sensors that are utilized for particular applications in addition to gas and flow sensors. For instance, some breath sensors use biosensors to find the presence of certain biomolecules like lactate or glucose in a person's breath. The monitoring of medical diseases like diabetes or metabolic disorders can be done using these kinds of sensors.

Using breath sensors presents a number of additional difficulties, particularly in medical situations. As elements like humidity and temperature can alter the sensor's performance, one problem is verifying the accuracy of the sensor readings. Furthermore, the calibration and upkeep of breath sensors can be difficult, requiring specialized knowledge and tools.

Breath sensors have the potential to change numerous fields, including healthcare, sports performance analysis, and industrial safety, despite these obstacles. Breath sensors are likely to become much more precise and dependable as technology advances, opening the door to even more sophisticated uses in the future.

Several breathalyzers are To assess the amount of alcohol in a person's breath, law enforcement agencies and other organizations utilize breathalyzers under the Alco Sensor brand. Intoximeters, Inc., a top manufacturer of breath alcohol testing equipment, produces the Alco-Sensor product line.

In order to calculate a person's blood alcohol concentration (BAC), Alco Sensor devices measure the amount of alcohol in their breath. The system makes use of a fuel

cell sensor, which when in touch with alcohol generates an electrical current. The person's BAC level is then calculated from this current and shown as a digital reading.

Law enforcement agencies frequently employ Alco Sensor equipment to help identify drunk driving and other alcohol related crimes. These tools can offer an accurate assessment of a person's level of drunkenness and are frequently used in conjunction with roadside sobriety tests.

The cutting-edge Smart Peak breath sensor measures several biomarkers in exhaled air via breath analysis. There are numerous potential uses for it in the realms of healthcare, sports medicine, and other industries. It is a non-invasive and incredibly accurate way for tracking health and sickness.

The Smart Peak breath sensor operates by taking breath samples with a small instrument and analyzing them. The device measures levels of different gases and volatile organic compounds (VOCs) in the breath using sophisticated sensors and algorithms, which can provide important information about a person's health.

Nitric oxide (NO), carbon monoxide (CO), and numerous VOCs linked to various diseases and disorders are some of the biomarkers that may be evaluated using the Smart Peak breath sensor. The sensor can shed light on a variety of medical conditions, such as asthma, chronic obstructive pulmonary disease (COPD), and even some forms of cancer, by examining these biomarkers.

Since the Smart Peak breath sensor is still a relatively new invention, additional study is required to fully comprehend its potential uses and restrictions. However, it has a lot of potential as a quick, easy, and extremely accurate method of illness detection and health monitoring.

In industrial and scientific contexts, Flow Sensor is a technology that is used to detect the flow rate of fluids, such as gases or liquids. It has a wide range of applications in numerous sectors and is a very accurate and dependable tool for flow monitoring.

A tiny gadget is inserted into the fluid stream to power the Flow Sensor. The apparatus has a sensor that gauges the flow rate based on the cross-sectional area of the flow route and fluid velocity. The device is often attached to a control system, which can modify various parameters, such temperature or pressure, using the flow rate information.

The excellent accuracy and reproducibility of Flow Sensor technology is one of its main benefits. The sensors are made to deliver accurate readings even under adverse conditions like those with high temperatures, pressures, or corrosive fluids.

Numerous industries, including oil and gas, chemical processing, pharmaceuticals, and water treatment, utilize Flow Sensor technology. It is also employed in scientific settings to gauge the flow rate of gases or liquids during investigations, such as in analytical chemistry or medical research.

In general, Flow Sensor technology is an effective instrument for observing and managing fluid flow in a variety of applications. It is a crucial component of numerous industrial and scientific processes due to its accuracy, dependability, and versatility.

Hexoskin is a wearable system that tracks and monitors several physiological indicators via smart clothes. It is intended to assist people and professionals in the fields of sports, fitness, and healthcare in understanding and improving their physical wellbeing and performance.

The Hexoskin system consists of a number of smart clothing items, such as shirts, bras, and shorts, that are fitted with sensors that can track various physiological data, including heart rate, breathing rate, and degree of exercise. The clothing is made to be cozy and nonintrusive, and it may be worn for a variety of activities, from casual wear to rigorous exercise.

Users of the Hexoskin system can track changes over time and monitor their physiological indicators in real-time by uploading the data acquired by the system to

a mobile app or web-based dashboard. Additionally, the system has sophisticated analytics capabilities including machine learning algorithms that may assist users in finding patterns and trends in their data and in making decisions about their fitness and health.

Hexoskin technology has a wide range of potential uses in sports and fitness, such as improving training, preventing injuries, and tracking performance. Additionally, it can be used in healthcare to keep an eye on those who have a chronic illness, including heart disease or respiratory problems, and to monitor their development over time.

Overall, Hexoskin is a potent and adaptable technology that has the ability to completely change how we keep tabs on our physical well-being and performance. It is a vital tool for anybody who wants to improve their health and fitness due to its noninvasive and comfortable design as well as its superior analytics and machine learning capabilities.

Additionally, wearable Chest Belt Breath Sensors are available to track respiratory parameters while engaging in physical exercise. They are frequently worn around the chest and use sensors to detect a number of things, including breathing depth, volume, and pace.

Athletes, coaches, and trainers frequently utilize these sensors to track and improve their breathing patterns while working out. Athletes might spot patterns and trends in their breathing data that might point to training areas for improvement, such ineffective breathing or breathing problems.

Breathing parameters are commonly measured by chest belt breath sensors using noninvasive techniques like pressure sensors. The users can monitor their respiratory data in real time and follow changes over time thanks to the sensors' normal connection to a small data logger or mobile app.

The information gathered by the breath sensors on the chest belt can be utilized to

optimize training plans and boost sports performance. Additionally, it can be used to track respiratory health and spot future breathing issues like asthma or other respiratory illnesses.

Overall, chest belt breath sensors are a useful tool for athletes and trainers who want to optimize their breathing patterns and improve their physical performance. They are also a valuable tool for monitoring respiratory health and identifying potential breathing problems.

2.8 Virtual Reality and Breath Sensors

A new technology called virtual reality (VR) has the potential to completely transform many facets of our life. It provides a wholly immersive experience that whisks users away to a virtual setting that mimics the real world. However, the user's physiological response to the environment is just as important in producing a completely realistic experience as the pictures and sounds. Breath sensors come into play here.

Breath sensors are tools that gauge how quickly and deeply people breathe. They can be built into a VR headset or worn as a wearable gadget. Real time feedback from these sensors on the user's breathing patterns can be used to develop more immersive and compelling VR experiences [8].

The topic of relaxation and stress reduction is one of the most important areas in which breath sensors are used in VR. With the inclusion of breath sensors, virtual reality which has been demonstrated to be a useful tool for lowering stress and anxiety becomes even more potent. VR experiences may be created to lead users through breathing exercises that encourage tranquility and relaxation by monitoring their breathing patterns and giving feedback.

As an illustration, a VR meditation software may use breath sensors to monitor the user's respiration and offer both visual and audible cues to encourage them to slow

down and unwind.

The VR environment might also be altered by the app based on the user's breathing patterns, for example, by reducing the speed at which virtual objects move or altering the colors and lighting to promote relaxation.

Additionally, breath sensors can be utilized in VR games to enhance immersion. As an illustration, a VR horror game might employ breath sensors to identify when a player is holding their breath in anticipation and use that information as a cue to start a horrific scene. Due of the player's need to regulate their breathing in order to prevent starting the terrifying occurrences, this would make the game feel more genuine and compelling. It might even make it more difficult [8].

The use of breath sensors in virtual reality for physical therapy and rehabilitation is another use. Breath sensors can make VR therapy even more individualized and effective. VR has previously been demonstrated to be a useful tool for rehabilitation. For instance, a VR physical therapy program for those with lung issues may watch the patient's breathing and modify the exercises based on their current breathing capacity using breath sensors.

In order to build more immersive virtual reality training programs, breath sensors can also be used in VR. Breath sensors could be utilised, for instance, in military training simulations to replicate the effects of low oxygen or high-altitude conditions. By doing so, the training would be more realistic and better prepare the soldiers for any physical difficulties they might encounter in actual combat.

The use of breath sensors in VR does have some restrictions, though. Making sure the sensors are precise and dependable represents one of the major problems. The sensors must be sensitive enough to pick up even minute variations in breathing patterns while remaining free of background noise and motions. For the VR experience to remain uninterrupted, the sensors must also be comfortable and inconspicuous.

Another challenge is the potential for users to become overly reliant on the breath sensors. If users rely too much on the sensors to guide their breathing, they may lose the ability to control their breathing on their own, which could have negative consequences for their health and wellbeing [8].

In conclusion, breath sensors have the potential to enhance the immersive and interactive nature of VR experiences. By measuring the user's breathing patterns, VR experiences can be designed to promote relaxation, increase engagement, and even improve physical and mental health. However, there are still challenges to overcome, such as ensuring the accuracy and reliability of the sensors and avoiding overreliance on the technology. With continued research and development, breath sensors could become a valuable tool for creating more engaging and personalized VR experiences.

Chapter 3

Project Representation

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3.4 Rehabilitation Exercise 53

3.1 Project Representation

The project has as a goal to help people with lung cancer to breathe right with the major cause of helping them with the pain and the breath flow.

Is prove that respiratory exercises can help lung cancer patients feel better emotionally in addition to increasing lung function and lowering shortness of breath. Respiratory exercises can give you a sense of control and empowerment after receiving a cancer diagnosis, which can be daunting and distressing. Patients can actively participate in their own health and recovery by taking part in an exercise program, which can help to lessen symptoms of worry and despair.

Patients with lung cancer can also benefit from respiratory exercises by lowering their risk of problems. Respiratory workouts can assist to lower the risk of complications from lung cancer and its treatments, such as pneumonia.

Respiratory exercises can assist in lowering the risk of problems and enhancing general health by strengthening the lungs and increasing lung function.

Patients with lung cancer may benefit from a variety of respiratory exercises, including deep breathing exercises, diaphragmatic breathing, pursed lip breathing,

and chest physical therapy. You can practice deep breathing by inhaling deeply and slowly expelling. The lungs may open up and take in more oxygen as a result. By controlling breathing using the diaphragm muscle, diaphragmatic breathing can assist to increase lung capacity and lessen breathlessness. In order to control breathing and lessen shortness of breath, pursed lip breathing requires exhaling while maintaining pursed lips.

Respiratory workouts can assist in lowering the risk of problems and enhancing general health by enhancing lung health and lungs' structural integrity.

Deep breathing exercises, diaphragmatic breathing, pursed lip breathing, and chest physical therapy are a few of the respiratory activities that can be helpful for people with lung cancer. It is important to take long, deep breaths and exhale gently when practicing deep breathing. This may facilitate lung expansion and boost oxygen absorption. Using the diaphragm muscle to control breathing, or "diaphragmatic breathing," can help to increase lung capacity and lessen breathlessness. Pursed lip breathing is the act of exhaling while maintaining pursed lips, which can help control breathing and lessen shortness of breath.

So, in that project we create an VR environment using google cardboard in unity game platform to help people with lung cancer to do their respiratory exercises with fun and with the goal to correct them to do them right.

3.2 Hardware

For that particular project we use the build-in phone microphone to capture the breath of the patient, we use the Esperanza VR GLASSES that is a headset that allows you to create a VR filling by using your phone, this project is built in unity and is compatible with android operating systems and also, we use the google cardboard to give the sense of VR through phone.

Figure 5 Cardboard VR Device

3.3 Code and Implementation The system has six scenes.

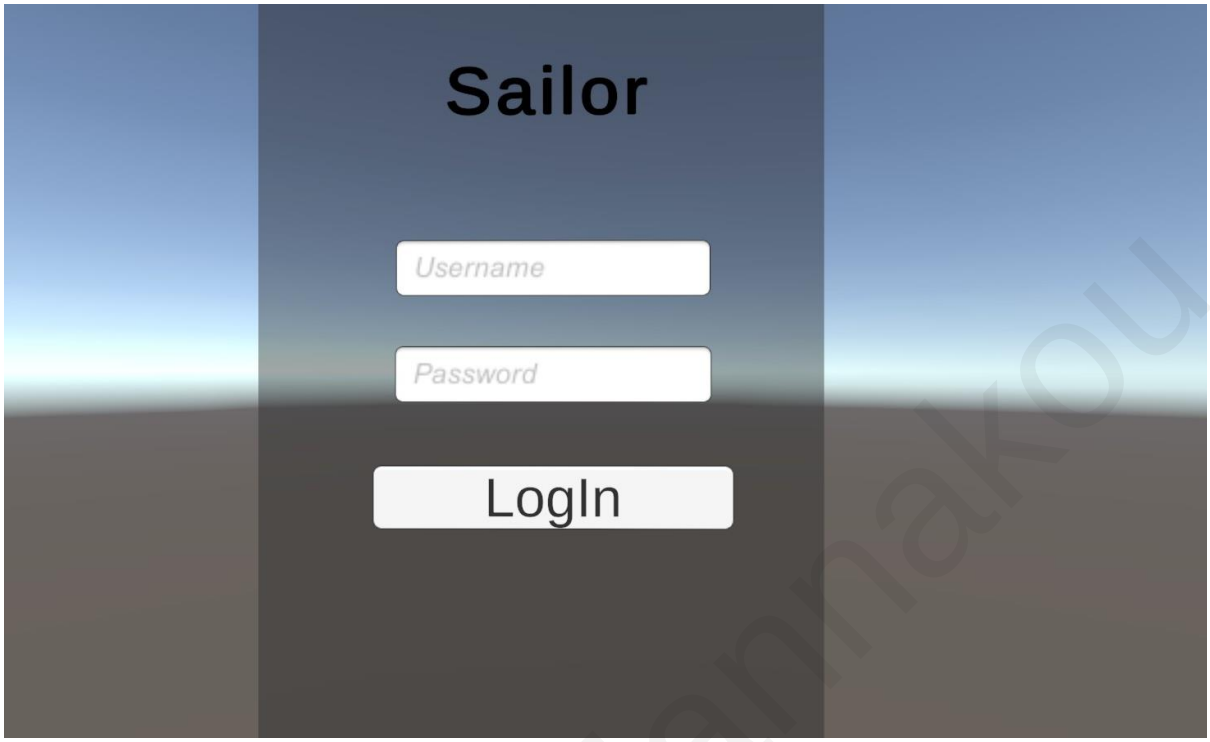

Figure 6:This picture represents the log in scene of the system

Access to private health information is typically only permitted for authorized users in healthcare systems. So, the first point of access to the system is typically a login page. This page is intended to verify the user's identification and to only allow those with the proper permissions to view or alter patient information access to the system.

The login page acts as a secure entry point for both doctors and patients in the context of a healthcare application. To access patient information, check test results, and carry out other patient care related tasks, doctors often log in with a login and password.

Instead, patients can log in to access their own medical records, make appointment requests, or get in touch with their medical professionals.

The login page should be created with security in mind and adhere to best practices including strong password policies, two factor authentication, and session management. These precautions aid in safeguarding private patient information and limiting unauthorized system access.

The Patient Form scene, which is located on the second page of our application, is where we

Figure 7:This picture represents the form with the patient details

collect the patient's crucial personal data. We recognize the need of maintaining accurate records, and this scenario enables us to gather vital patient information such their complete name, last name, age, and ID number. Using this data, a special patient folder is made, which will house their test results and other pertinent medical records. We take patients' privacy extremely seriously, and we strictly maintain the confidentiality of all the information we gather. To give the patient the best care possible, we only use this information for that purpose.

We can better comprehend the patient's medical history and adapt our treatment plan to suit their particular needs if we have access to all of their personal data.

Patients may quickly enter their personal information into the patient form scene because it is made to be user-friendly. Patients may relax knowing that their privacy is secured because this information is safely saved on our database. We acknowledge

that patients could feel awkward disclosing personal information, but we want to reassure them that their information is secure.

In summary, the Patient Form scenario is an essential component of our application since it enables us to gather important data about the patient and deliver the best care. To ensure that we have all the information required to give patients the best medical care possible, we encourage patients to fill out the form completely and precisely.

Figure 8:This picture represents the microphone adjustment

The Microphone Sensor Adjustment is the third scene in our program. This crucial function permits manual microphone sensitivity adjustments to better record patients' breaths during exercise routines. The user can adjust the threshold level in this scene to block out background noise.

This threshold change is an essential feature since it increases our system's precision

and enables us to give patients better treatment outcomes. The quality of our data can be considerably improved by cutting out background noise so that we can concentrate on recording only the pertinent sounds.

Additionally, we are aware that if the sensitivity is set too high, breathing exercises might be uncomfortable for the patient and be physically demanding. As a result, we created this scene with a threshold level that is adjustable, allowing patients to exercise at their own speed without getting tired.

In conclusion, the Microphone Sensor Adjustment scene is a crucial component of our program that enables users to manually modify the microphone sensitivity, improving the accuracy of our system. Additionally, this function enables patients to exercise easily without experiencing stress or fatigue. Users are encouraged to use this tool to enhance their breathing exercise practice since we believe it will help us give our patients with the finest care possible.

Figure 9:This picture represents the waiting scene

The patient has the chance to get ready for the virtual reality experience in the fourth scenario. This stage is vital because it gives the patient a chance to become familiar with the tools and set up their phone to work with their VR glasses.

The healthcare professional can also go through the specifics of the VR experience and what the patient can anticipate. Before starting the actual virtual reality session, it's crucial to take the time to answer any queries or worries the patient may have.

The preparation stage can aid in reducing any worry or tension the patient may be experiencing in addition to giving them time to adjust the equipment. The patient can feel more at ease and open to the therapeutic benefits of the virtual reality experience by providing a quiet and encouraging setting.

The game scene represents the environment in which the exercise is executed. The patient's name, located in the top left corner of the screen, serves as a unique identifier for the individual using the system, ensuring that the results obtained are specific to the patient. The action to be performed, located below the patient's name, represents the task that the patient needs to execute. In this scenario, the task is inhaling. It is important to note that each cycle consists of three actions, including inhaling, exhaling, and pausing.

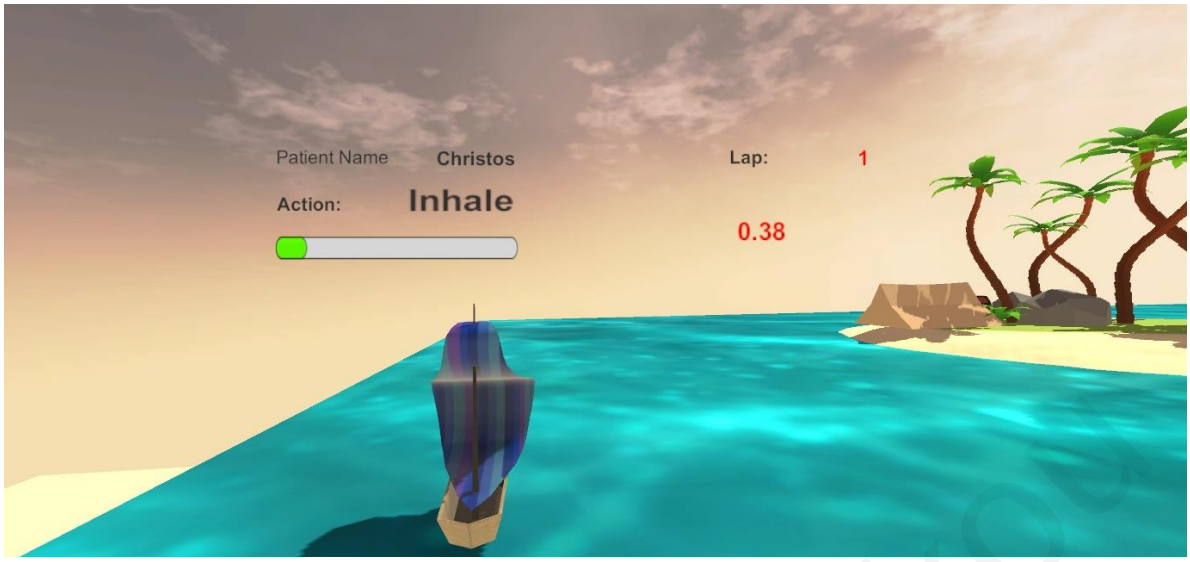

Figure 10:This picture represents the game scene

The breath bar, located below the action, serves as an indicator for the patient to follow and provides a measurable goal to the patient. It captures the patient's breath and indicates how long they should inhale or exhale.

On the right side of the screen, at the top, the lap counter provides a visual representation of the patient's progress. It indicates the number of laps completed by the patient and informs them of their progress toward completing the exercise.

Finally, at the bottom of the screen, the time spent on each action is recorded. The time is captured only when the microphone detects sound, and it is related to the progress bar filling up. This allows for accurate measurement of the total time spent by the patient on each action, which is crucial for capturing accurate results.

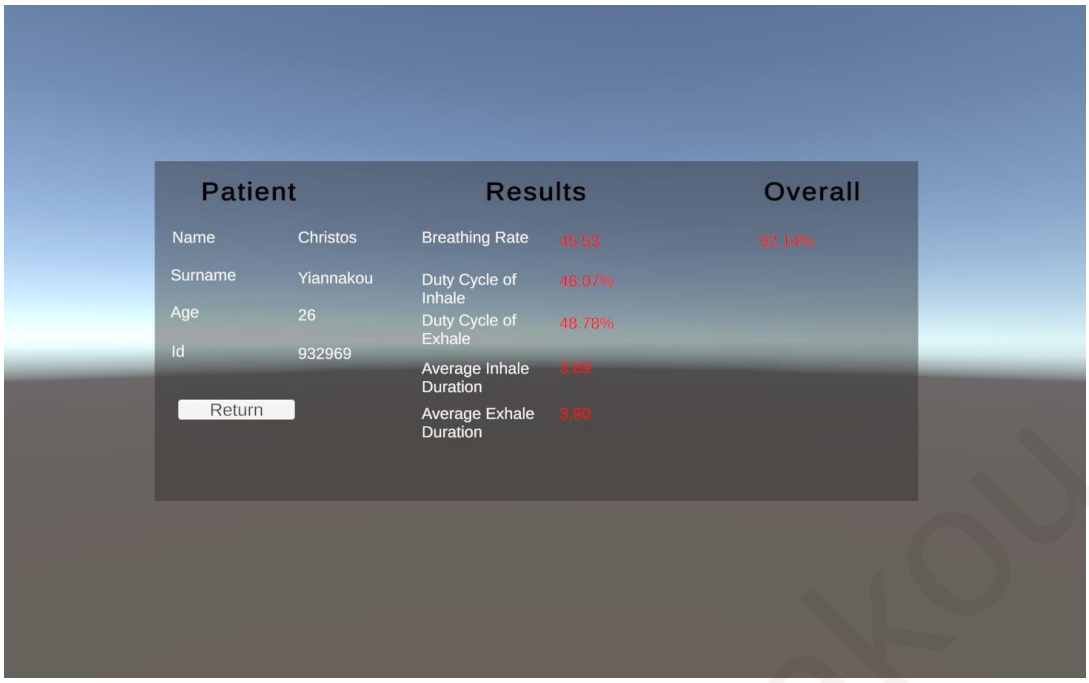

Figure 11:This picture represents the results scene

Results is the last scene of the virtual reality therapy process, where all of the information gathered from the patient throughout their VR session is displayed.

Along with giving important details about the patient's development the patient with encouragement and motivation by using the Results scene. The patient can feel more inspired to keep up with their therapy and work toward their treatment goals by being shown the progress they have achieved.

This can guarantee that the patient feels educated and engaged in their treatment, which can improve overall results.

In conclusion, the Results scene is an important step in the VR therapeutic procedure.

The results that are collected are the Breathing Rate which is the number of breaths an individual takes per minute is referred to as breathing rate. An adult's resting breathing rate is usually between 12 and 20 breaths per minute. However, this can change depending on things like age, level of physical activity, health, and environmental circumstances. In general, breathing rates are higher in newborns and infants and lower in maybe older adults. It's important to remember that breathing

patterns can vary as a result of a number of medical disorders.

In this case the breathing rate is the time of each breath that an individual takes in the 7 labs of the exercise and it calculated by the time of inhale and exhale in each breath.

Next, we have the Duty Cycle of Inhale refers to the ratio of time spent inhaling to the total time of a breathing cycle. It is expressed as a percentage and represents the amount of time a person spends inhaling relative to the duration of a full breathing cycle.

The duty cycle of inhale can vary depending on factors such as activity level, respiratory function, and medical conditions. In a healthy adult at rest, the duty cycle of inhale is typically around 40% to 50%, which means that the person spends slightly more time exhaling than inhaling during each breathing cycle. During exercise or physical activity, the duty cycle of inhale may increase to allow for more oxygen intake and carbon dioxide removal.

It's important to note that changes in the duty cycle of inhale can be a sign of respiratory dysfunction or other medical conditions, so it's always a good idea to consult a healthcare professional if you have concerns about your breathing patterns.

Next is the duty cycle of exhale refers to the ratio of time spent exhaling to the total time of a breathing cycle. It is expressed as a percentage and represents the amount of time a person spends exhaling relative to the duration of a full breathing cycle.

In a healthy adult at rest, the duty cycle of exhale is typically around 40% to 50%, which means that the person spends slightly more time exhaling than inhaling during each breathing cycle. During exercise or physical activity, the duty cycle of exhale may decrease to allow for more time for inhalation and oxygen uptake.

It's important to note that changes in the duty cycle of exhale can be a sign of respiratory dysfunction or other medical conditions, so it's always a good idea to consult a healthcare professional if you have concerns about your breathing patterns.

Also, the system measures the Average Inhale Duration, also known as the inspiratory

time, refers to the amount of time a person spends taking a breath in during a single respiratory cycle.

In a healthy adult at rest, the average inhale duration is typically between 1.5 to 2 seconds. However, this can vary depending on factors such as age, physical activity, and respiratory function. During exercise or physical activity, the average inhale duration may decrease to allow for more rapid breathing and increased oxygen intake. It's important to note that changes in the average inhale duration can be a sign of respiratory dysfunction or other medical conditions, so it's always a good idea to consult a healthcare professional if you have concerns about your breathing patterns. In the exercise of the system the patient should inhale 4 seconds instead of 2 that is the normal.

The average exhale duration, also known as the expiratory time, refers to the amount of time a person spends exhaling during a single respiratory cycle. In a healthy adult at rest, the average exhale duration is typically between 2 to 3 seconds, which is slightly longer than the average inhale duration. However, this can vary depending on factors such as age, physical activity, and respiratory function. During exercise or physical activity, the average exhale duration may decrease to allow for more rapid breathing and increased carbon dioxide removal.

Also, in the system for the exhale the patient should exhale for 4 seconds.

A number representing the patient's performance in the breathing exercise game or application is the overall score. This score is determined by comparing various measurement values, including breathing rate, duty cycle, and inhale/exhale length, to expected values based on the patient's age, personal health status, and other pertinent criteria.

The measurement values are divided by the corresponding predicted values to arrive at the overall score, which is then calculated by averaging the three values. A percentage score is then calculated by multiplying this number by 100. The patient

performed better in the breathing exercise regimen, as indicated by a higher percentage score.

The score system's goal is to give the patient a precise indication of their development and improvement over time. The patient can strive to improve the outcomes of their breathing exercises by setting a target based on their overall score. Healthcare providers can keep track of the patient's progress and modify the workout regimen as necessary using the total score.

The scoring system should be used in conjunction with advice and criticism from a healthcare professional, it is vital to remember. To ensure the program is used safely and effectively, breathing exercises should be customized to the patient's specific requirements and health status.

3.4 Rehabilitation Exercise

Rehabilitation exercises play a crucial role in helping patients recover from injuries, surgeries, or chronic conditions. They are designed to improve physical function, reduce pain, and restore range of motion, strength, and flexibility. These exercises can also help patients regain confidence and independence in their daily lives.

The Rehabilitation exercise is a simple yet effective exercise that can be incorporated into a patient's rehabilitation routine. It consists of three steps that are easy to remember and execute: inhale for 4 seconds, pause for 2 seconds, and exhale for 4 seconds. These steps are incorporated into a game-like interface to make it more engaging and fun for the patient.

During the game, the patient is prompted to follow the three-step exercise by performing the actions in the time given for each step. The patient must inhale for 4 seconds, hold their breath for 2 seconds, and then exhale for 4 seconds. By following these steps, the patient is practicing controlled breathing, which can help improve

lung capacity, reduce stress, and promote relaxation.

The game interface also provides real time feedback to the patient, allowing them to track their progress and adjust their technique as needed. This feedback can include visual cues, such as a graphical representation of their breathing pattern, or audio cues, such as a tone or voice prompt.

In summary, the Rehabilitation exercise is a valuable tool for patients undergoing rehabilitation. It is a simple, easy to remember exercise that can be incorporated into a game-like interface to make it more engaging and fun. By practicing controlled breathing, patients can improve their lung capacity, reduce stress, and promote relaxation, all of which can help them in their recovery journey.

The Rehabilitation exercise has 3 steps:

Step 1: Inhale for 4s.

Step 2: Pause for 2s.

Step 3: Exhale for 4s.

Chapter 4

Results And Discussion

4.1 System evaluation results 55

4.2 Evaluation 84

It's crucial to develop a trustworthy standard to assess the accuracy of a time measuring system against. I tested the system's time measuring capabilities for this using a stopwatch. Al though there was a little disagreement between the system's and the stopwatch's readings during testing, I carefully examined the situation and came to the conclusion that my oversight was to blame.

Particularly, the lag in my reaction time while pressing the lap button on the stopwatch could have caused the results to be inconsistent. However, the automated time measurement system, which was able to measure time with high levels of consistency and precision, did not include this possible inaccuracy.

Additionally, this research illustrated the benefits of employing an automatic method rather than a manual timer. Manual measurements frequently include human error, and even little delays in reaction time can result in substantial disparities. Such mistakes may be avoided by employing an automated system, leading to even higher accuracy and precision.

Overall, the testing outcomes showed that the time measurement system was an accurate and consistent instrument for measuring time. This is significant for a wide range of applications, from industrial processes to scientific research, where exact timing might be essential for obtaining the best outcomes.

To evaluate the system, I recruited a panel of twenty individuals to provide feedback on their experience with the system. To gather their input, I created a form that

allowed them to rate their hands-on experience with the system and provide feedback on its usability and effectiveness.

In the survey, participants were asked to rate how comfortable their experience with the system was and whether it helped them to understand the exercises better. They were also asked if the system helped them to improve their performance over time and if they noticed any improvements in their breathing.

To gather additional qualitative feedback, participants were given the opportunity to provide their thoughts on the system and offer suggestions for improvement. They were also asked if they would consider purchasing the system at its current price point of five euros.

Overall, the evaluation process provided valuable insight into the system's usability and effectiveness. The feedback from the panel will be used to improve the system and make it even more beneficial to users.

In addition to the questions mentioned earlier, the survey also asked participants to provide their demographic information such as age, gender, and previous experience with similar systems or exercises. This information will help us understand the target audience better and tailor the system to their specific needs.

To ensure the accuracy and reliability of the results, I made sure to provide clear instructions and guidelines for completing the survey. I also emphasized the importance of providing honest and constructive feedback to help us improve the system.

After collecting the survey data, I analyzed the results to identify common themes and patterns. This analysis helped me to identify areas of the system that were working well and areas that needed improvement.

Based on the feedback provided by the participants, I developed a list of recommendations for improving the system. These recommendations included improving the clarity of the instructions, incorporating more visual aids to help users

understand the exercises, and adding more variety to the exercises.

In summary, the system evaluation process involved recruiting a panel of participants, collecting feedback through a survey, analyzing the results, and developing recommendations for improvement. This process helped us to identify areas for improvement and ensure that the system is tailored to the needs of its users.

During the system evaluation, participants are required to follow a specific protocol to test the system thoroughly. Firstly, they must attempt an exercise five times, with each attempt consisting of the following steps:

Inhale for four seconds

Pause for two seconds

Exhale for four seconds

This process should be repeated for a total of seven laps, followed by a two-minute break to allow for rest. Once the participants are ready to proceed, they can continue with the exercise for a total of five times in order to obtain more accurate results.

By conducting multiple attempts for each participant, we can monitor their progress and identify any improvements or changes in their performance. It also enables us to compare their results with those of other participants, taking into account factors such as gender, age, stamina, and other relevant metrics.

By analyzing the values of each attempt, we can gather important data about the system's effectiveness and how it interacts with different participants. This information can be used to improve the system and make it more efficient and user friendly. Additionally, by monitoring progress over time, we can identify any long-term changes or improvements in participants' performance, which can be useful in developing targeted interventions and treatments.

Overall, following a structured protocol such as this can help to ensure that the system evaluation is conducted in a thorough and consistent manner, producing reliable results that can be used to enhance the system's effectiveness and usability.

To begin with, it is important to note that the exercise used for testing is a controlled breathing technique, which has been shown to have various benefits for both physical and mental health. The specific breathing pattern used in this protocol is designed to optimize oxygen intake and reduce stress and anxiety, which are common factors that can impact system performance.

During the exercise, participants are instructed to maintain a steady pace and rhythm, inhaling deeply for four seconds, holding their breath for two seconds, and then exhaling slowly for four seconds. This pattern is repeated for a total of seven laps, with each lap consisting of one full breath cycle. After the seventh lap, participants are given a two-minute break to rest and recover before continuing with the exercise for a total of five times.

By using this protocol, we can gather detailed information about how the system interacts with participants and how it affects their physical and mental states. For example, we can monitor changes in heart rate, blood pressure, and other physiological metrics before, during, and after the exercise. We can also track participants' self-reported levels of stress, anxiety, and other emotional states, which can provide valuable insights into how the system impacts their overall wellbeing.

Furthermore, by conducting multiple attempts for each participant, we can account for factors such as learning curves, fatigue, and other variables that may impact performance. This enables us to obtain more accurate and reliable data that can be used to improve the system and tailor it to the needs of different users.

In summary, the protocol followed by participants during system evaluation is a standardized and rigorous process that is designed to produce accurate and reliable data about the system's performance. By using controlled breathing exercises and multiple attempts for each participant, we can gather detailed information about how the system interacts with different users and identify areas for improvement.

The system captures several important results, including the breathing rate, duty cycle

for inhalation, duty cycle for exhalation, average inhale time, and average exhale time. These metrics provide valuable insights into each participant's breathing patterns and can be used to track progress and identify areas for improvement.

To help visualize and interpret these results, we generate individualized graphs for each participant and each attempt. These graphs offer a clear and detailed overview of the data, allowing for easy comparison between different attempts and highlighting any trends or patterns in the breathing behavior.

By analyzing these results and graphs, participants can gain a deeper understanding of their breathing habits and make informed decisions about how to optimize their breathing for better health and wellbeing. Overall, the system provides a powerful tool for tracking and improving breathing performance.

Breathing is a vital aspect of human physiology, and optimal breathing habits are essential for maintaining good health and wellbeing. The system captures several key metrics that can provide valuable insights into a person's breathing patterns.

The breathing rate is an important metric that refers to the number of breaths a person takes per minute. It can vary depending on a person's age, level of physical activity, and other factors. A higher breathing rate may indicate that a person is breathing shallowly or experiencing stress or anxiety. A lower breathing rate, on the other hand, may indicate that a person is breathing deeply and efficiently.

The duty cycle for inhalation and exhalation refers to the ratio of time spent inhaling and exhaling compared to the total breathing cycle. It is expressed as a percentage and can provide insight into a person's breathing efficiency. A high duty cycle for inhalation may indicate that a person is taking in too much air, while a high duty cycle for exhalation may suggest that a person is not exhaling enough air.

The average inhale and exhale times provide further information on a person's breathing patterns. They refer to the length of time it takes to complete an inhalation or exhalation cycle. Longer inhale or exhale times may indicate that a person is

breathing deeply and efficiently, while shorter times may suggest shallow or inefficient breathing.

To help visualize and interpret these metrics, the system generates individualized graphs for each participant and each attempt. These graphs provide a clear and detailed overview of the data and can help identify any trends or patterns in a person's breathing behavior over time. This information can be used to track progress, set goals, and optimize breathing habits for improved health and wellbeing.

Overall, the system offers a powerful tool for monitoring and improving breathing performance. By using this technology, individuals can gain a better understanding of their breathing habits and take steps to optimize their breathing for optimal health and wellbeing.

Breathing Rate Graph

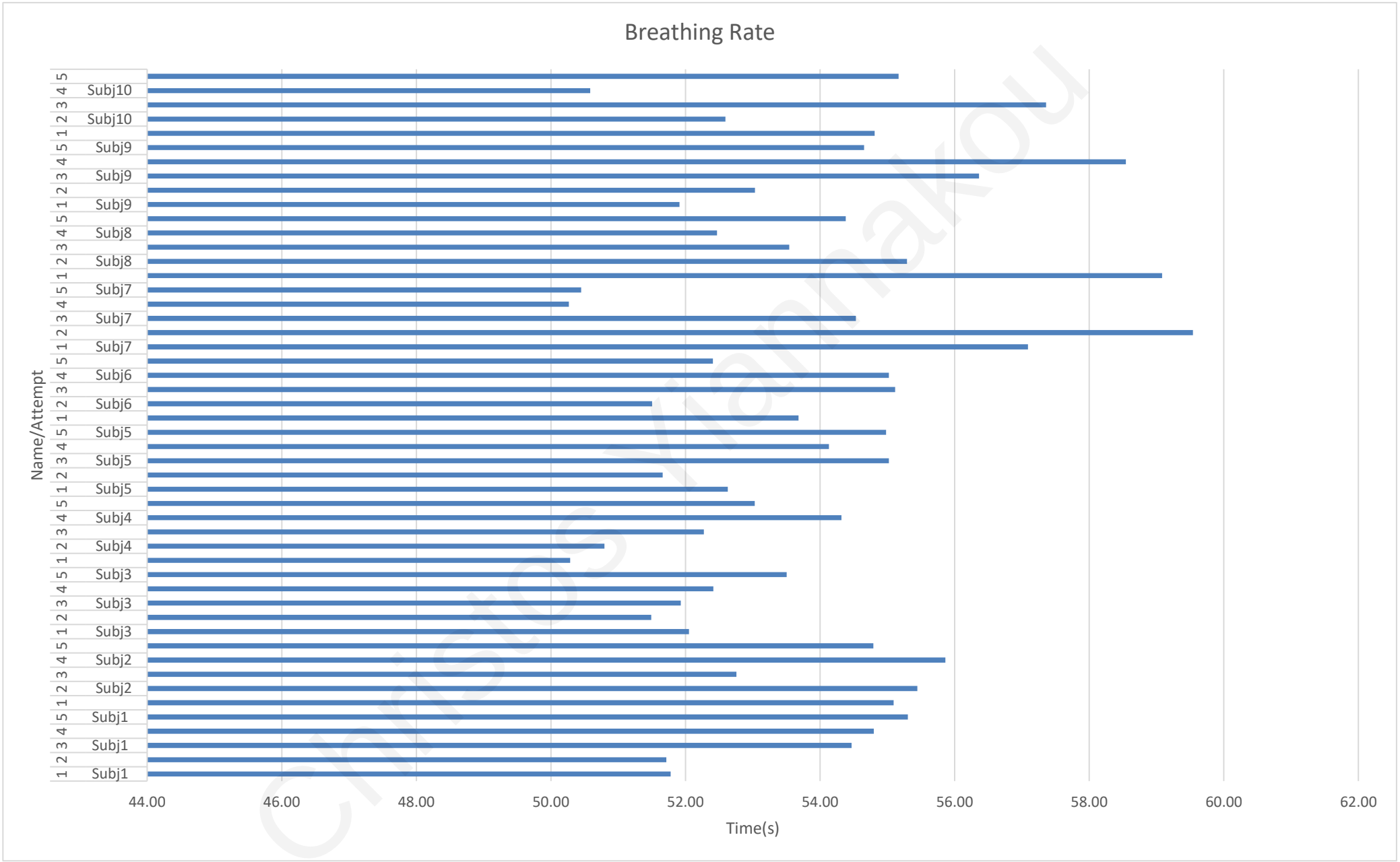

Figure 12 Breathing Rate Graph

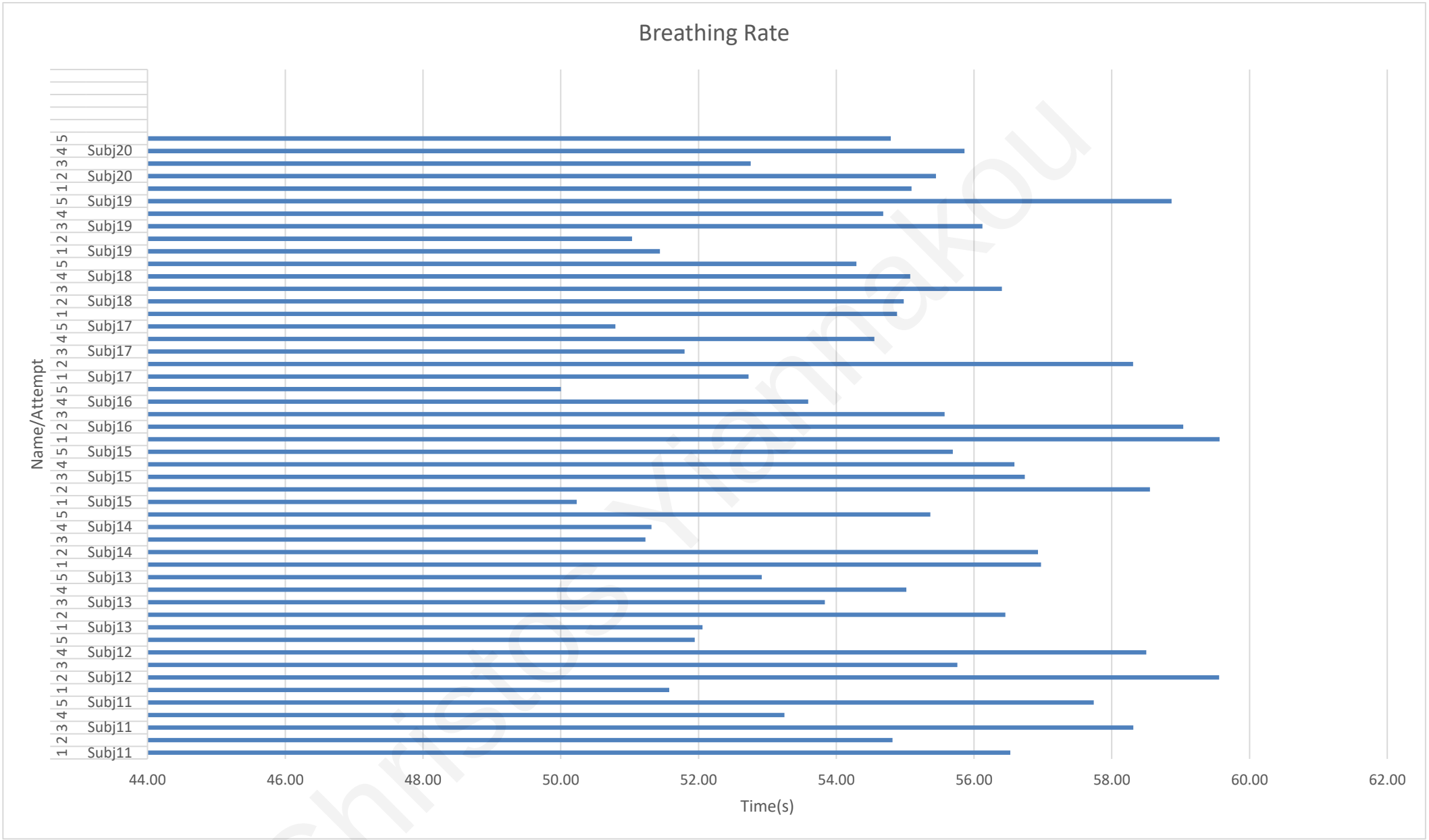

Figure 13 Breathing Rate Graph

In this graph, we can observe the participants' breathing rate, which refers to the number of breaths a person takes per minute. However, in this particular experiment, the breathing rate is measured differently than its original definition. Instead of counting the number of breaths per minute, the time required to complete one breath cycle (one inhale and one exhale) is captured by summing up the durations of both inhale and exhale modes. This approach allows us to assess the participants' progress through the various attempts of the exercise and calculate an overall score at the end.

It is worth noting that the breathing rate can vary depending on various factors, such as age, physical activity level, and other individual characteristics. However, the measurement method used in this experiment standardizes the evaluation of participants' breathing patterns, allowing for a more accurate assessment of their progress over time. By analyzing the data collected through this method, we can gain insights into the effectiveness of the exercise and

identify areas for improvement. This happens because we need to capture this by time so we can evaluate the participant progress through the variant attempts with the exercise and to capture an overall score at the end.

Additionally, this research illustrated the benefits of employing an automatic method rather than a manual timer. Manual measurements frequently include human error, and even little delays in reaction time can result in substantial disparities. Such mistakes may be avoided by employing an automated system, leading to even higher accuracy and precision.

Overall, the testing outcomes showed that the time measurement system was an accurate and consistent instrument for measuring time. This is significant for a wide range of applications, from industrial processes to scientific research, where exact timing might be essential for obtaining the best outcomes.

Based on the graph displaying the breathing rate as calculated by the duration of

inhale and exhale, we can observe that the patients' breathing cycles were longer during their last two attempts compared to their initial attempts. This pattern suggests that the participants are improving with repeated practice and are gradually becoming more proficient in performing the breathing exercise.

The purpose of this system is to educate, assist and entertain the participants in learning this specific breathing technique, and the graph serves as an essential tool to monitor their progress. By analyzing the data presented in the graph, we can clearly see the positive impact of consistent practice on the participants' breathing duration and overall performance.

Furthermore, it is worth mentioning that mastering the art of controlled breathing can offer a myriad of benefits such as reducing stress, improving focus and concentration, and promoting overall wellbeing. Therefore, it is crucial to encourage participants to continue their practice and track their progress using tools such as the one presented in the graph.

The breathing rate graph is an excellent tool to evaluate the effectiveness of a breathing exercise program. It helps to track progress over time, and it is a clear visual representation of the participant's performance. The graph displays data on the duration of inhale and exhale, which are the essential components of the breathing technique.

In the first attempts, the participants may struggle to synchronize their inhales and exhales, leading to shorter breath cycles. However, with continued practice, participants become more skilled at the exercise, resulting in longer breathing cycles. The increased duration of breath

cycles indicates that the participants have learned to regulate their breathing and control their respiratory rate, leading to an overall improvement in breathing efficiency.

It is worth noting that improving breathing efficiency can offer several benefits. For

instance, it can help to reduce feelings of anxiety and stress, which are often associated with shallow and rapid breathing. Additionally, controlled breathing can increase the amount of oxygen in the bloodstream, leading to improved physical and cognitive performance.

In conclusion, the breathing rate graph provides valuable insights into the participants' progress in learning the breathing technique. It demonstrates how repeated practice can lead to improvement and highlights the importance of monitoring progress to motivate participants to continue their journey towards better breathing and overall wellness.

The graph displays the breathing rates of participants during a series of attempts, with one example being the attempts of a participant named Christos. The data shows that Christos had a breathing rate of 51.78 on his first attempt, which slightly decreased to 51.72 on the second attempt. However, on the next two attempts, there was a significant increase in his breathing rate, with values of 54.47 and 54.80 respectively. Christos demonstrated his best performance on his final attempt, with a breathing rate of 55.09.

This data suggests that the system was helpful in improving Christos' performance over the course of the attempts, leading to an increase in his breathing duration. This information could be useful in optimizing the system for future users and improving its effectiveness. Further analysis of the data could reveal additional insights and trends that could help inform future research in the field of breathing rate monitoring and optimization.

Additionally, this research illustrated the benefits of employing an automatic method rather than a manual timer. Manual measurements frequently include human error, and even little delays in reaction time can result in substantial disparities. Such mistakes may be avoided by employing an automated system, leading to even higher accuracy and precision.

Overall, the testing outcomes showed that the time measurement system was an accurate and consistent instrument for measuring time. This is significant for a wide range of applications, from industrial processes to scientific research, where exact timing might be essential for obtaining the best outcomes.

Duty Inhale Graph

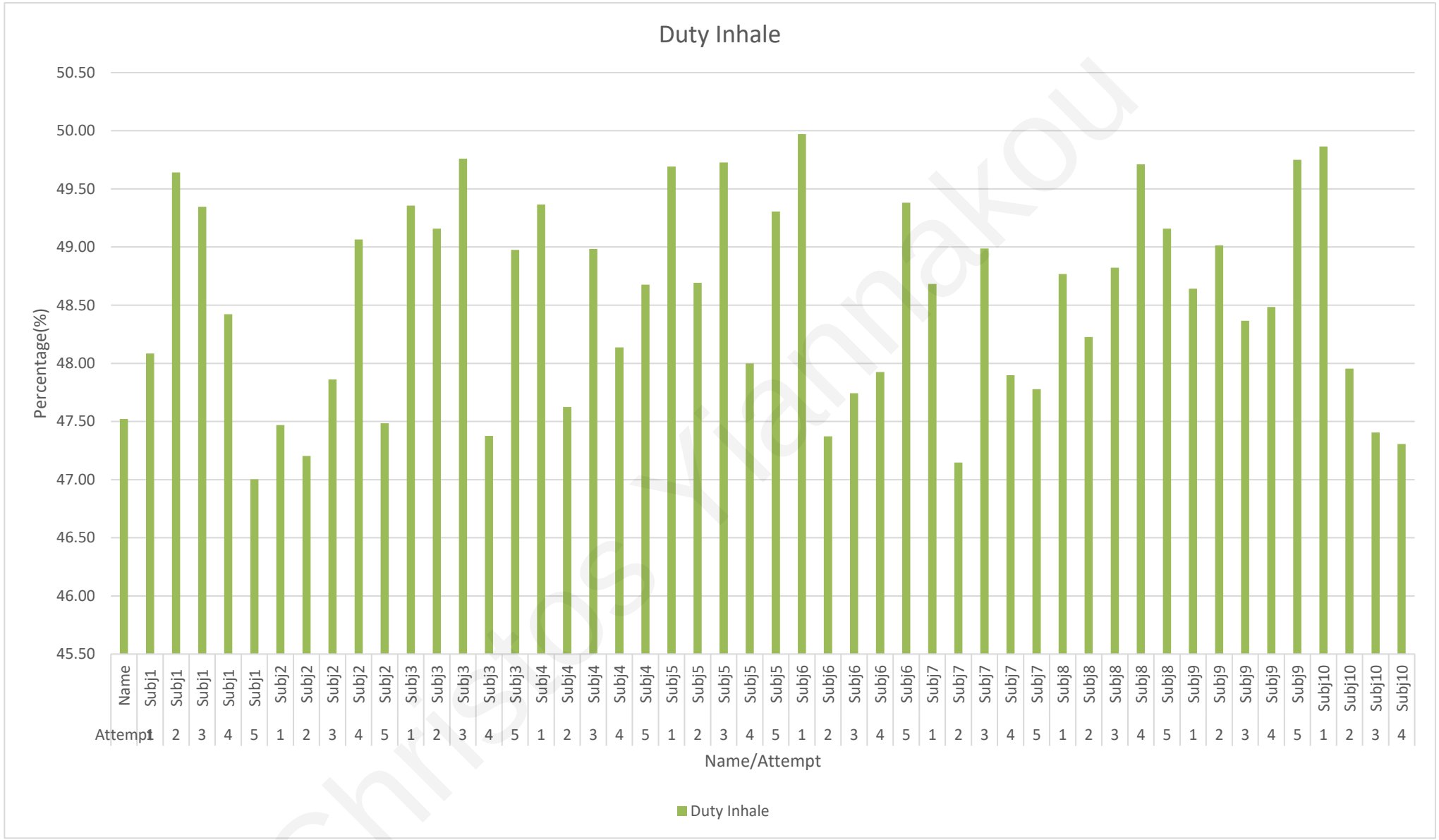

Figure 14:Duty Inhale Graph

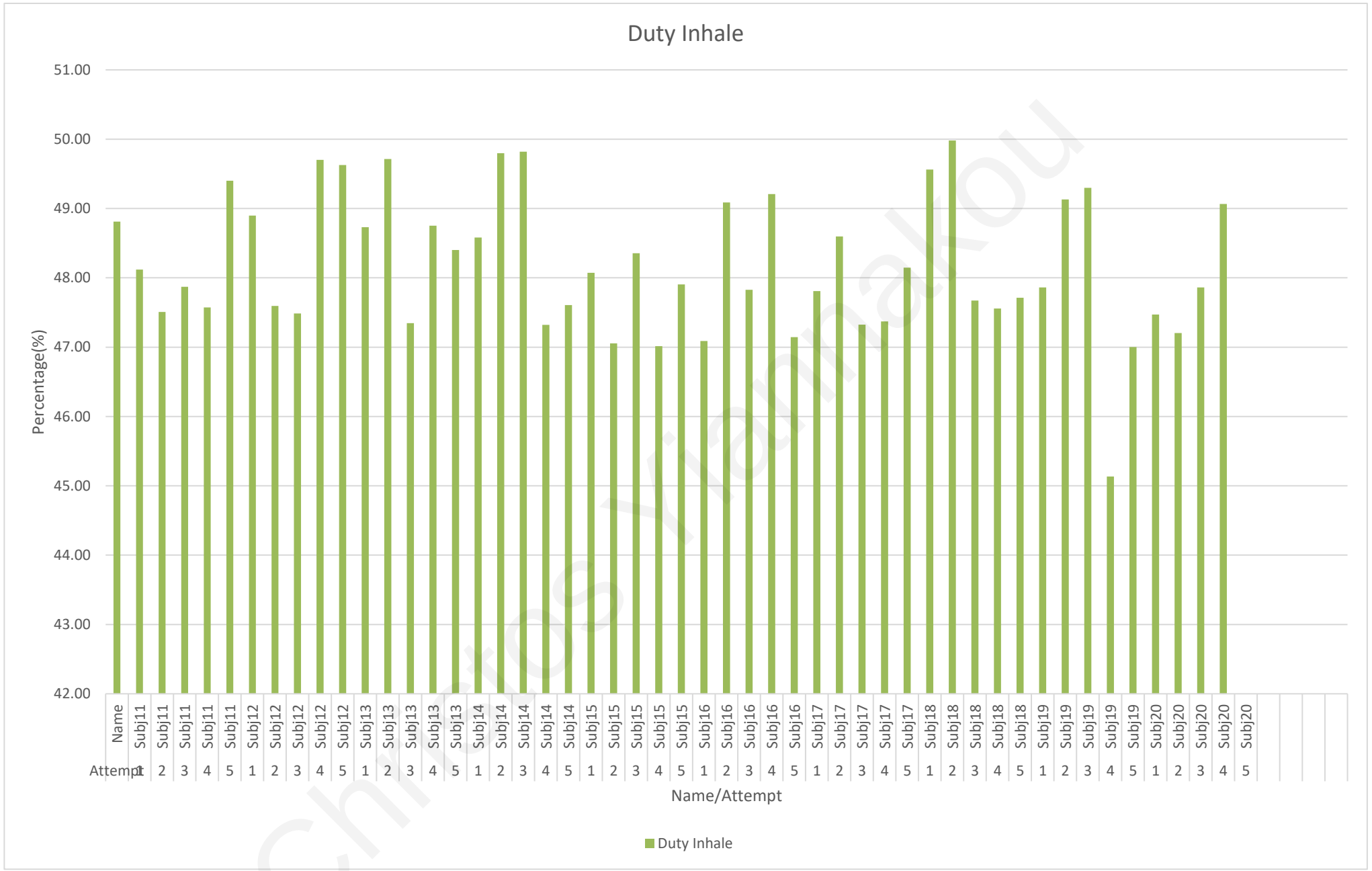

Figure 15 Duty Inhale Graph

The Duty Inhale graph represents the percentage of time a participant spends in the inhalation phase during a breathing exercise. In order for the exercise to be completed correctly, the participant must inhale continuously for four seconds, which translates to a duty cycle of 50% for the inhalation phase.

In real life situations, people typically spend around 40% to 50% of their breathing cycle in the inhalation phase. This percentage is expressed as a duty cycle and can provide insights into a person's breathing efficiency. A high duty cycle for inhalation may suggest that a person is taking in too much air, which can result in hyperventilation or over-breathing. On the other hand, a high duty cycle for exhalation may indicate that a person is not exhaling enough air, which can lead to a buildup of carbon dioxide in the body and contribute to respiratory issues.

By monitoring and analyzing the Duty Inhale graph, individuals can gain a better understanding of their breathing patterns and make adjustments to improve their overall respiratory health.

Another effective technique for improving breathing efficiency is to maintain good posture. Poor posture can restrict the movement of the diaphragm, which can lead to shallow breathing and reduced oxygen intake. By maintaining a straight spine and relaxed shoulders, individuals can create more space for the diaphragm to move freely and breathe more efficiently.

In addition, regular exercise can also help to improve breathing efficiency. Aerobic exercise such as jogging, cycling, or swimming can help to strengthen the respiratory muscles and increase lung capacity, which can lead to more efficient breathing.

In conclusion, the Duty Inhale graph provides valuable insights into breathing efficiency and can help individuals to identify areas for improvement. By incorporating deep breathing exercises, maintaining good posture, and engaging in regular exercise, individuals can improve their breathing efficiency and enjoy a range

of health benefits.

From the graph above we can see from the percentages again that the participants can increase their percentage in inhale state during the variant attempts.

Let's see the example of the participant with name Andreas.

Andreas' initial attempt at measuring the percentage of inhale state during his exercise was slightly off, as it showed a value of 40.53%. However, this value is still considered normal, as it falls within the average spectrum of the normal percentage of the human duty cycle of inhale, which is typically between 40%-50%.

As Andreas continued with his attempts, we can observe an increase in the percentage of inhale state during the birthing cycles. In fact, within the next 3 attempts, his performance increased from 40.53% to 46.97%, showing significant improvement. It's noteworthy that the last attempt resulted in the highest value of 49.16%, indicating that the system had helped him to increase his performance dramatically.

This increase in performance highlights the effectiveness of the system in assisting Andreas to achieve his breathing goals. Starting from the low end of the spectrum at 40%, he was able to reach as high as 49% of the inhale duty cycle. Such a substantial improvement in a short period is a promising sign of the system's ability to assist individuals in improving their breathing techniques.

Duty Exhale Graph

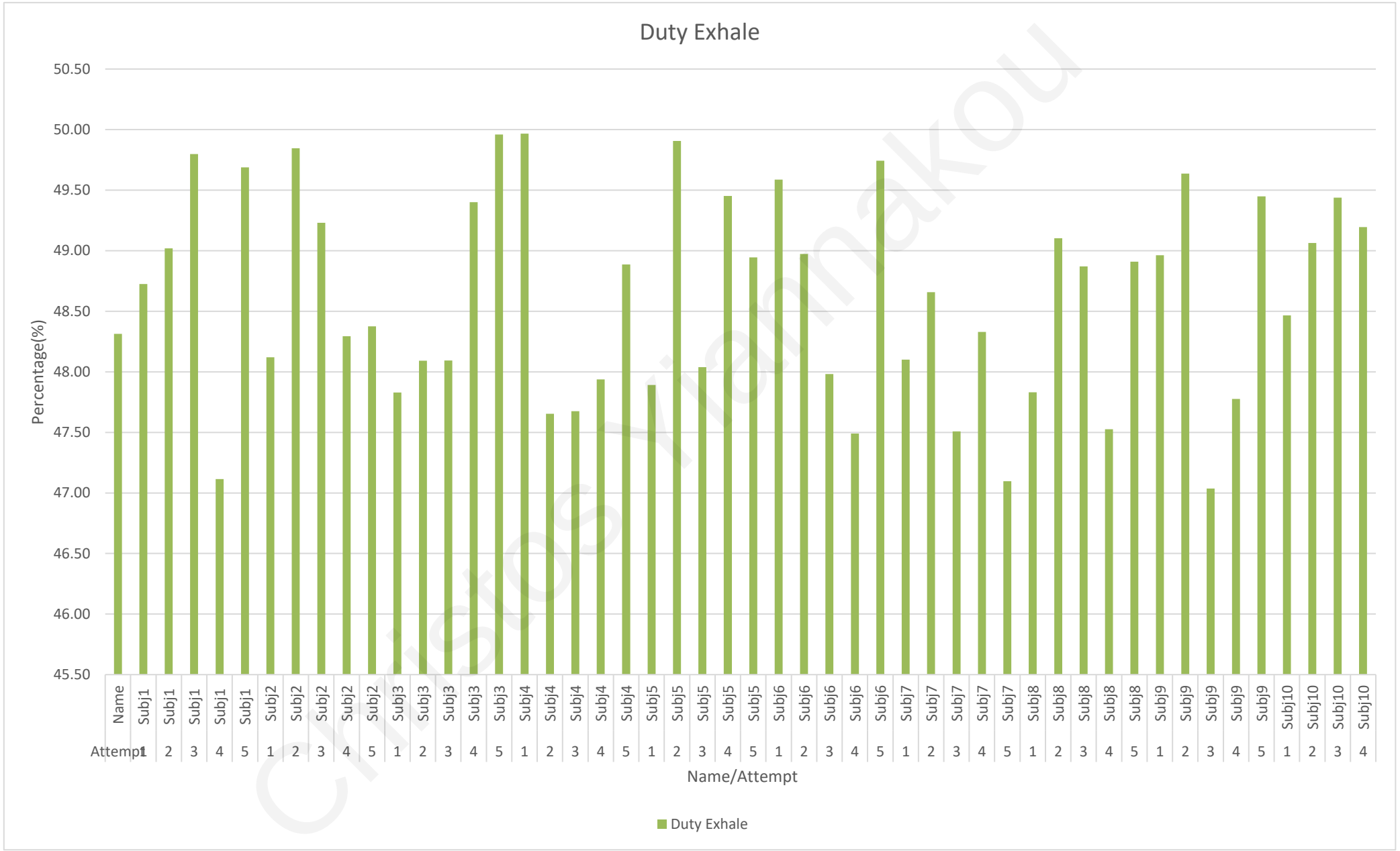

Figure 16:Duty Exhale Graph

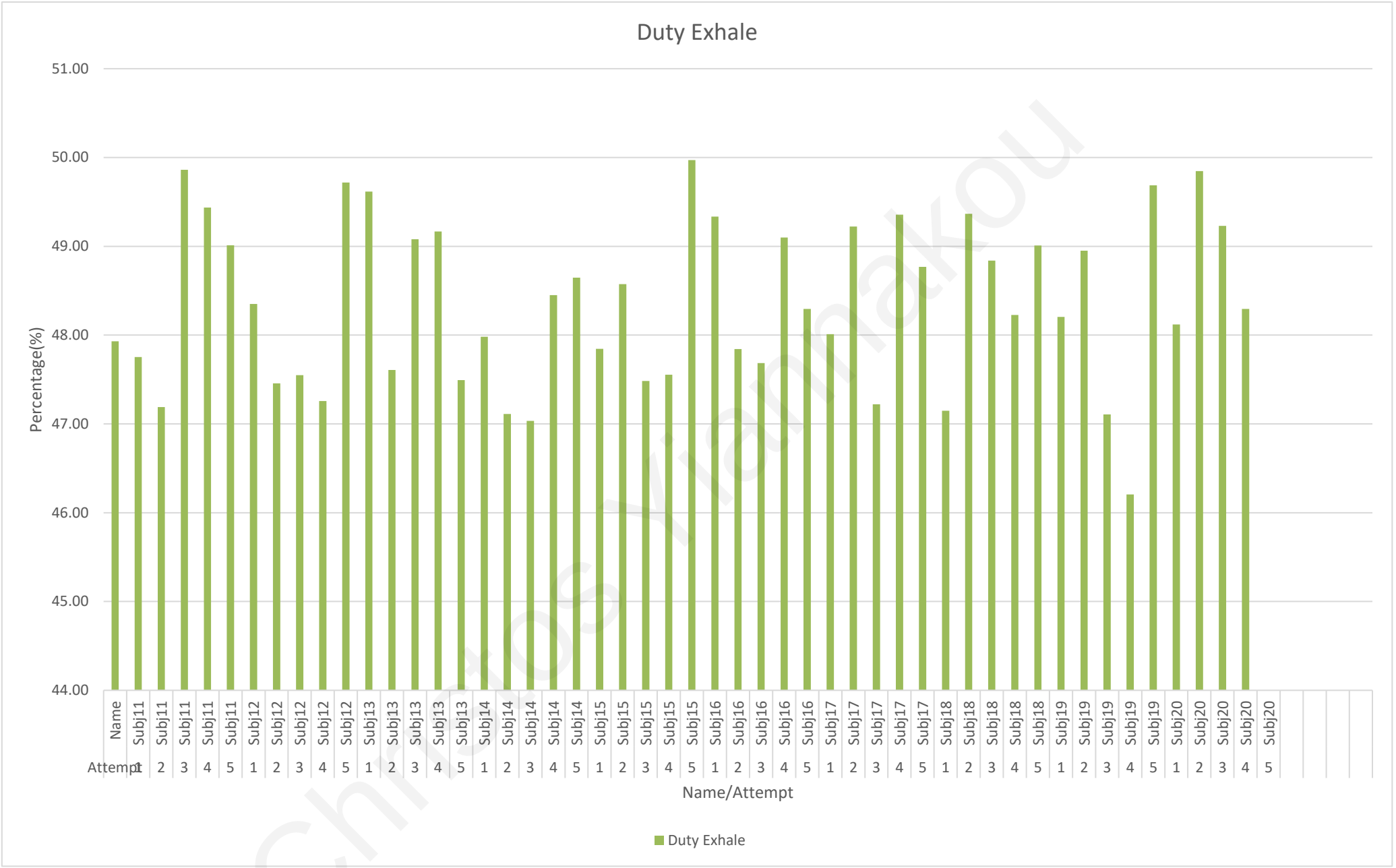

Figure 17 Duty Exhale Graph

The Duty Exhale graph represents the percentage of time a participant spends in the exhale phase during a breathing exercise. In order for the exercise to be completed correctly, the participant must exhale continuously for four seconds, which translates to a duty cycle of 50% for the exhalation phase.

In real life situations, people typically spend around 40% to 50% of their breathing cycle in the inhalation phase. This percentage is expressed as a duty cycle and can provide insights into a person's breathing efficiency. A high duty cycle for exhalation may suggest that a person is taking in too much air, which can result in hyperventilation or over breathing. On the other hand, a high duty cycle for exhalation may indicate that a person is not exhaling enough air, which can lead to a buildup of carbon dioxide in the body and contribute to respiratory issues.

By monitoring and analyzing the Duty Inhale graph, individuals can gain a better understanding of their breathing patterns and make adjustments to improve their overall respiratory health.

Another effective technique for improving breathing efficiency is to maintain good posture. Poor posture can restrict the movement of the diaphragm, which can lead to shallow breathing and reduced oxygen intake. By maintaining a straight spine and relaxed shoulders, individuals can create more space for the diaphragm to move freely and breathe more efficiently.

In addition, regular exercise can also help to improve breathing efficiency. Aerobic exercise such as jogging, cycling, or swimming can help to strengthen the respiratory muscles and increase lung capacity, which can lead to more efficient breathing.

In conclusion, the Duty exhale graph provides valuable insights into breathing efficiency and can help individuals to identify areas for improvement. By incorporating deep breathing exercises, maintaining good posture, and engaging in regular exercise, individuals can improve their breathing efficiency and enjoy a range

of health benefits.

From the graph above we can see from the percentages again that the participants can increase their percentage in inhale state during the variant attempts.

Let's see the example of the participant with name Kiriaki.

Andreas' initial attempt at measuring the percentage of inhale state during his exercise was slightly off, as it showed a value of 48.11%. However, this value is still considered normal, as it high within the average spectrum of the normal percentage of the human duty cycle of inhale, which is typically between 40%-50%.

As Kiriaki continued with she’s attempts, we can observe an decrease in the percentage of

exhale state during the birthing cycles. In fact, within the next 3 attempts, his performance was stable from 43.86% to 45.45%, showing significant improvement. It's noteworthy that the fourth attempt resulted in the value of 46.00%.

Average Inhale Time

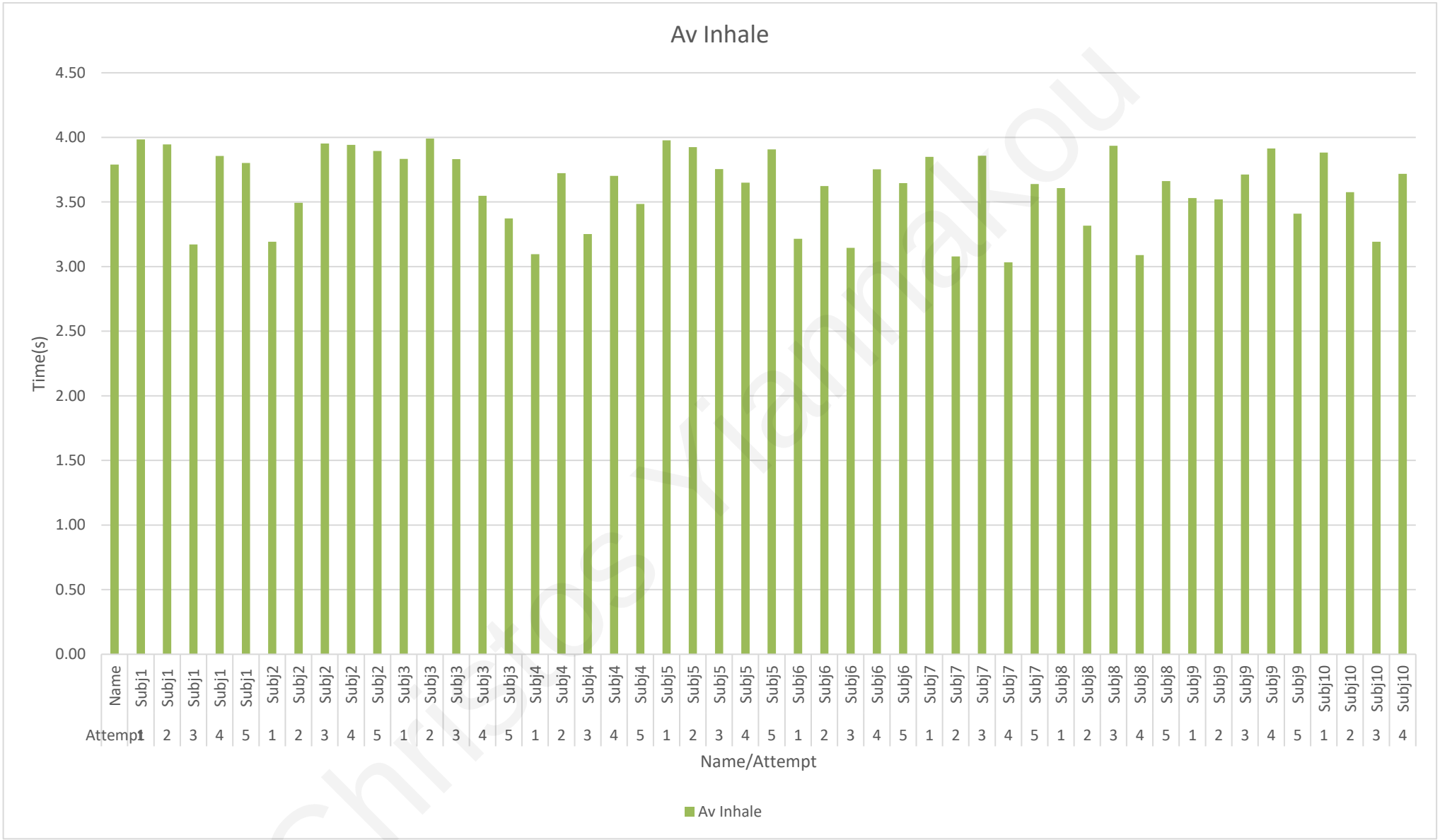

Figure 18:Average Inhale

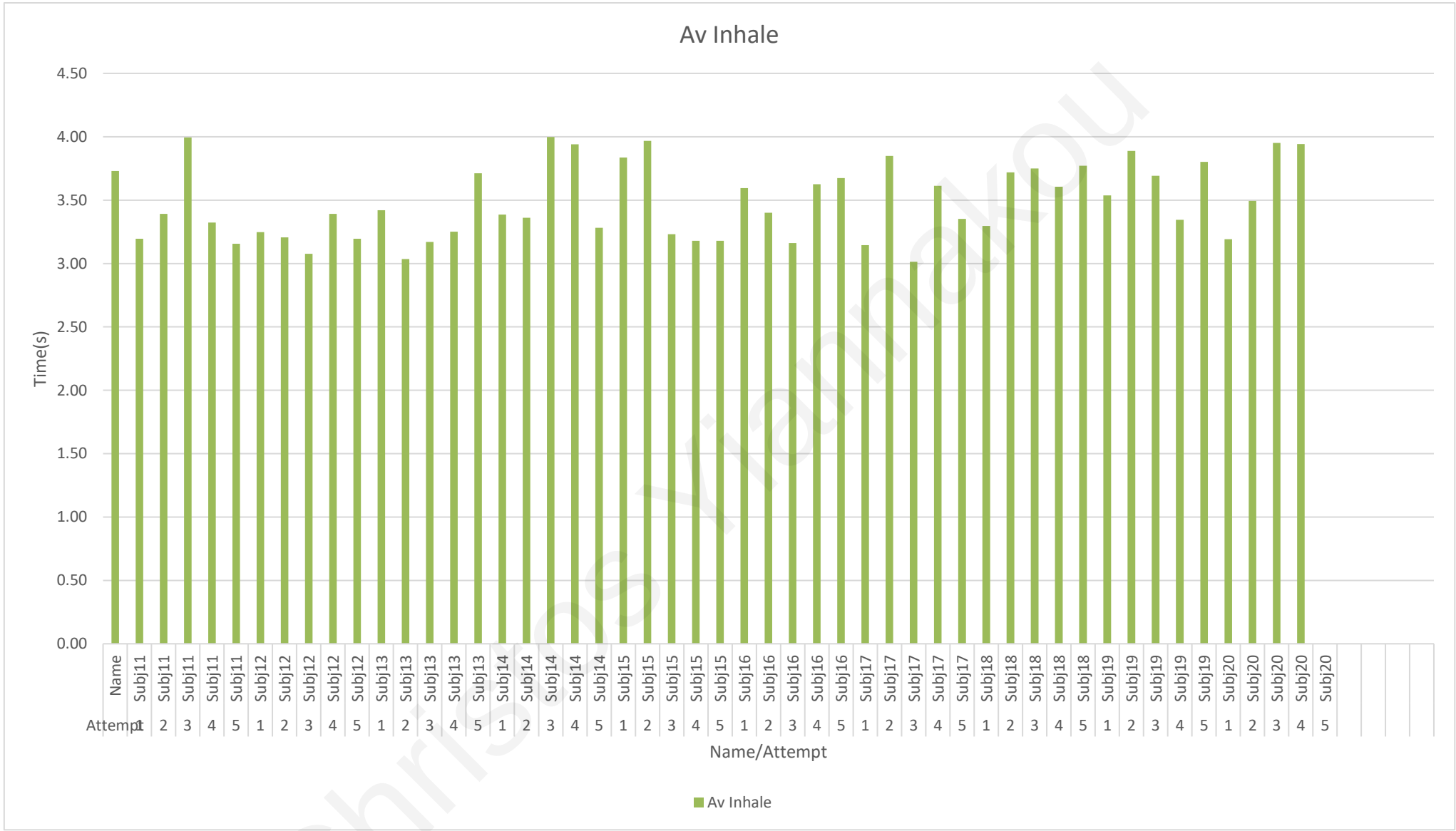

Figure 19 Average Inhale Graph

The Average Inhale graph presented here displays the average time that participants were inhaling during the exercise. The data was collected from 7 different laps, where the inhale time was measured for each attempt. Subsequently, we calculated the average inhale time for all cycles and represented it in the graph above. This data was collected for each participant, for every attempt made.

Upon observing Erin's attempts in the graph, it is evident that the second and third attempts had the highest average inhale time values, and subsequent attempts showed a reduction in performance. We believe that this reduction in performance could be attributed to exhaustion. As discussed earlier, a normal person's average inhale time is around 2 seconds, and inhaling for 4 seconds can be challenging and exhausting. Therefore, it is possible that exhaustion played a role in the observed drop in Erin's performance.

It is worth noting that this graph provides valuable insights into the participants' performance and can be used to track progress and improvement over time. By analyzing the data, we can identify patterns and make informed decisions regarding training and treatment plans. Overall, the Average Inhale graph serves as a useful tool for monitoring respiratory performance and optimizing treatment plans for patients.

Average Exhale Time

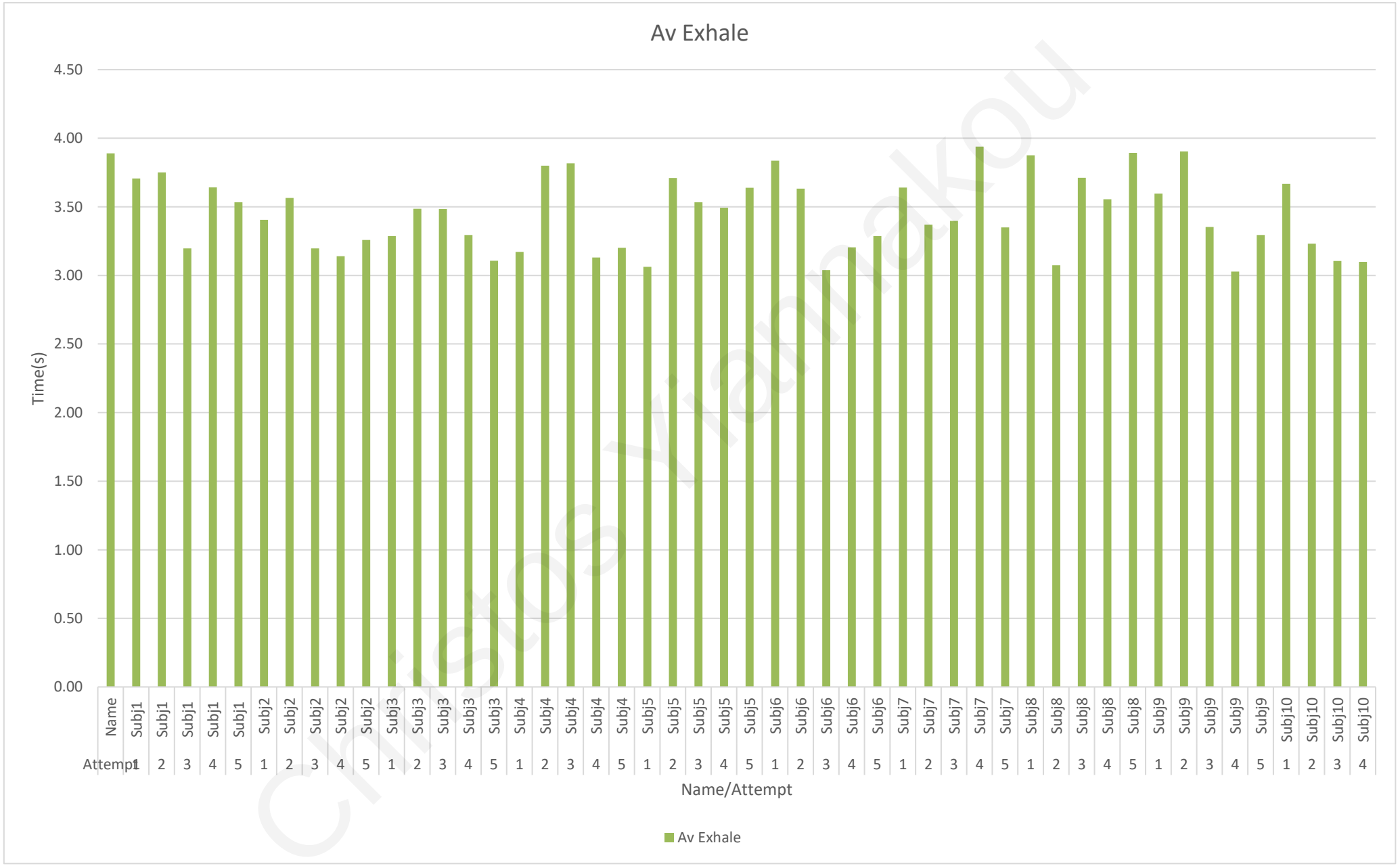

Figure 20:Average Exhale

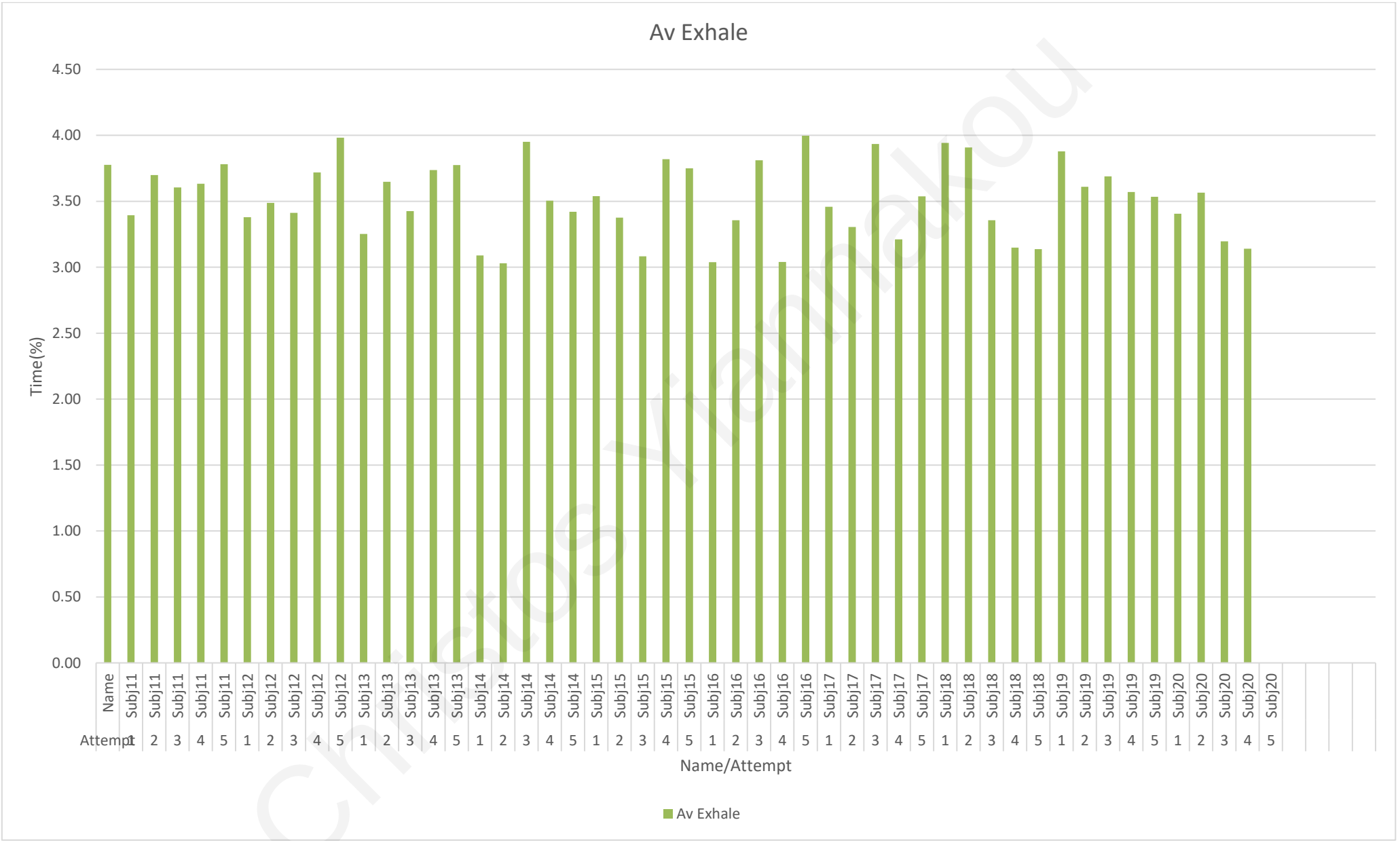

Figure 21 Average Exhale Graph

The Average Exhale graph represents the average time that participants were exhaling during the exercise. We collected data from 7 different laps, where we measured the exhale time for each attempt. We then calculated the average exhale time for all cycles and represented it in the graph above. This data was collected for each participant, for every attempt made.

Looking at Erin's attempts in the graph, we can see that the third attempt had the highest average exhale time value. Additionally, the subsequent attempts showed a slight reduction in performance, but still better than the first attempt. This suggests that the participant was becoming more familiar with the system, but as we observed in the Average Inhale graph, there was also a slight drop in performance due to exhaustion.

We believe that this reduction in performance is attributable to exhaustion. As previously discussed, a normal person's average inhale time is around 2 seconds, and inhaling for 4 seconds can be difficult and exhausting. Therefore, it is possible that exhaustion played a role in the observed drop in Erin's performance.

It is worth noting that this graph provides valuable insights into the participants' performance and can be used to track progress and improvement over time. By analyzing the data, we can identify patterns and make informed decisions regarding training and treatment plans. Overall, the Average Exhale graph serves as a useful tool for monitoring respiratory performance and optimizing treatment plans for patients.

Overall Score Graph

The graph presented above displays the overall scores of the eighteen participants. As we can observe from the graph, most participants achieved their best performance on the third attempt. This can be attributed to the fact that, by the third attempt, participants were already familiar with the system and the protocol of the exercise. Moreover, their stamina was in good shape and they had not yet experienced exhaustion due to the repeated attempts.

After the third attempt, there is a noticeable drop in performance for most of the participants. This drop in performance is likely due to the exhaustion caused by the large number of attempts in a relatively short time. As previously discussed, inhaling for 4 seconds can be challenging and exhausting for a normal person. Therefore, it is reasonable to assume that repeated attempts at the exercise could cause fatigue and impact respiratory performance.

It is essential to note that this graph provides valuable information about the performance of each participant, which can be used to identify strengths and weaknesses. By analyzing the data, we can make informed decisions regarding training and treatment plans. It is important to tailor the exercise protocol to each participant's abilities and limitations to optimize their performance and avoid exhaustion.

In conclusion, the overall scores graph serves as a useful tool for monitoring the performance of participants in respiratory exercises. By taking into account the factors that impact performance, we can improve the effectiveness of these exercises and promote better respiratory health.

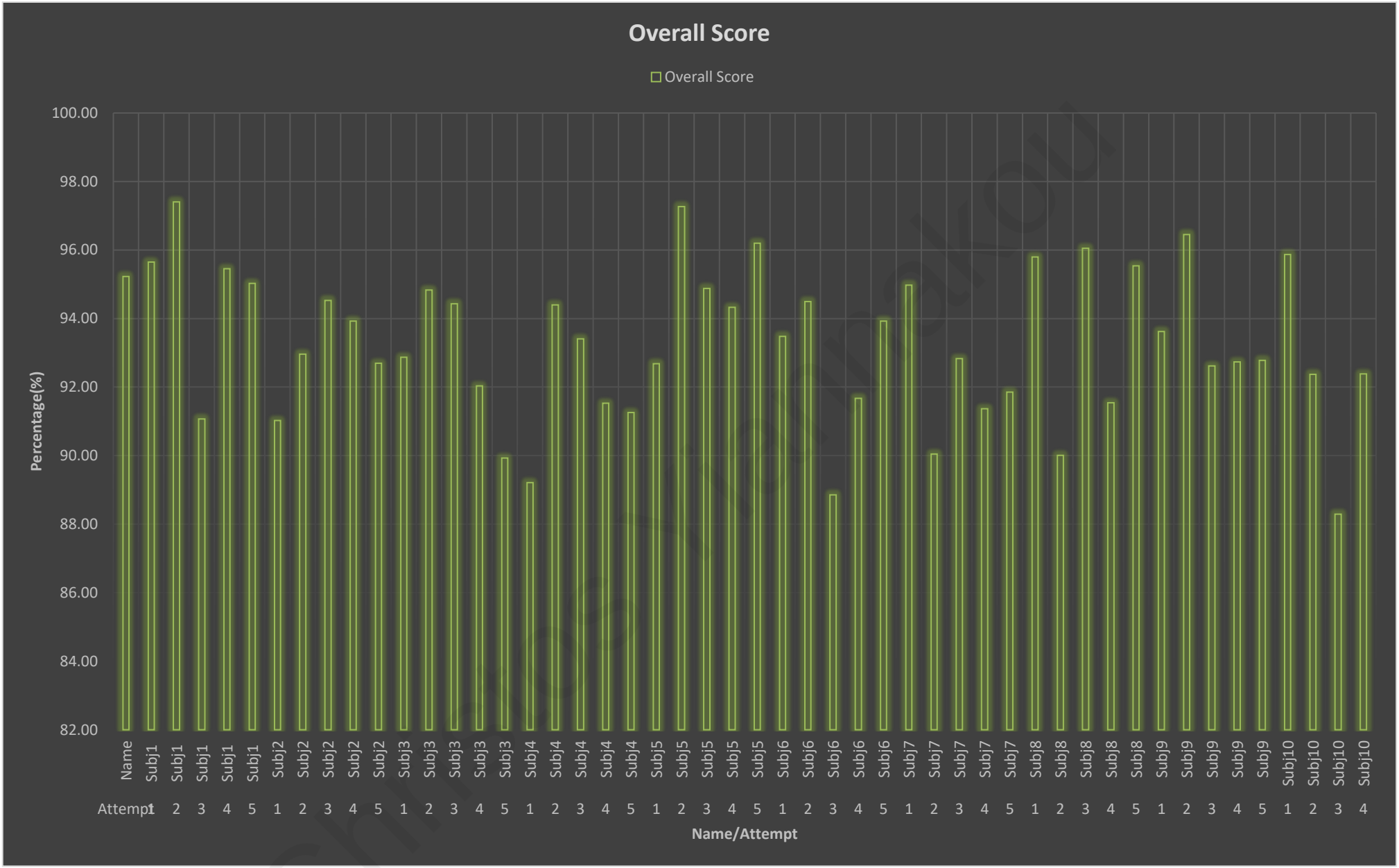

Figure 16: Overall Score

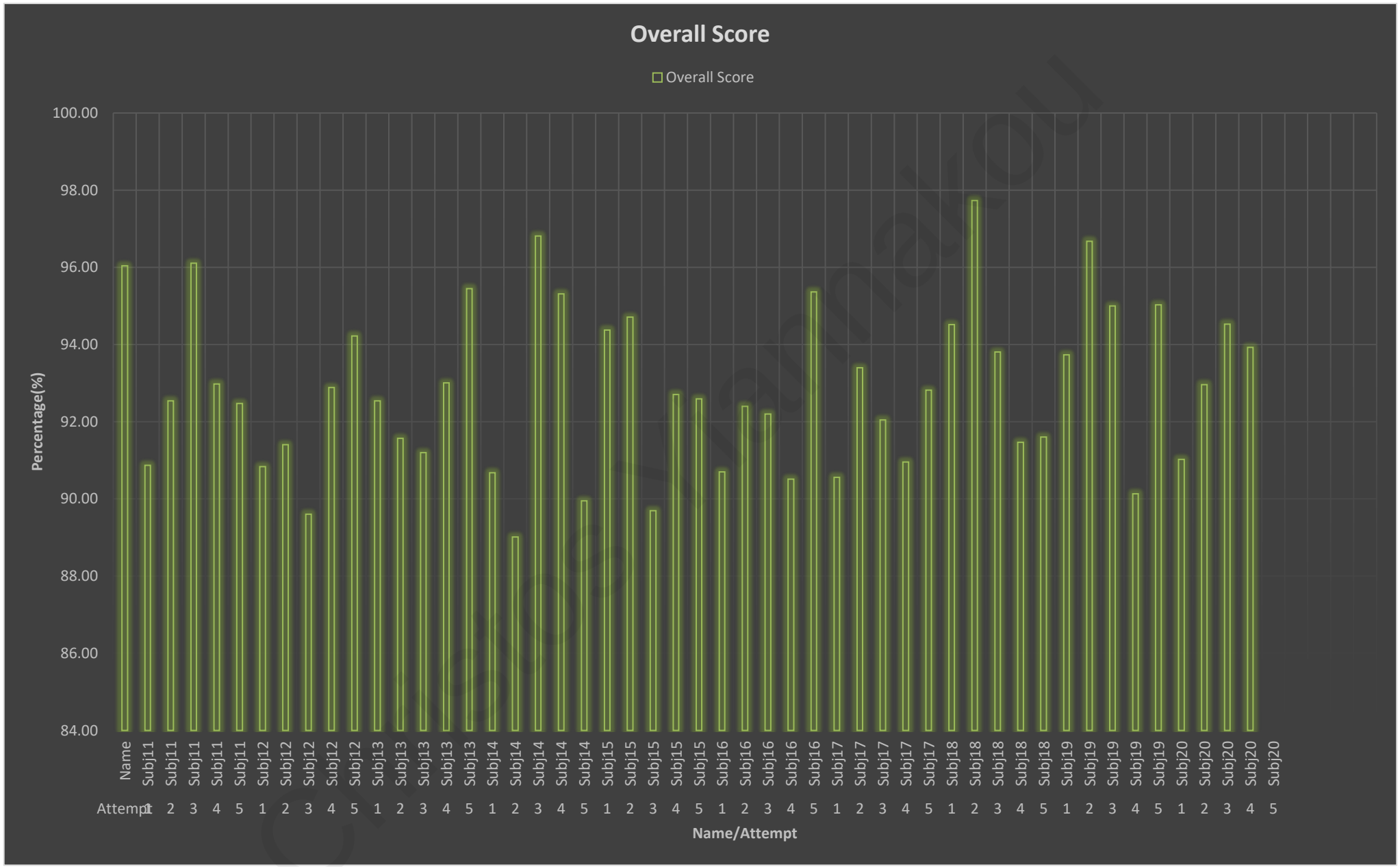

Figure 22 Overall Score Graph

4.2 Evaluation

At the conclusion of their exercise session, all participants are required to complete a questionnaire that aims to gather their feedback on their experience with the system. The questionnaire includes a set of targeted questions designed to help us improve the current system based on the users' opinions and suggestions.

The questions in the questionnaire cover various aspects of the participants' experience with the system, including its usability, effectiveness, and overall satisfaction. For example, some questions ask the participants to rate the ease of use of the system, the clarity of instructions provided, and the level of support received from the system. Other questions inquire about the participants' perceived benefits and drawbacks of the system, their level of motivation and engagement, and their willingness to continue using the system in the future.

By collecting and analyzing the responses from the questionnaire, we aim to gain valuable insights into how the system is perceived by its users, identify areas for improvement, and make necessary changes to enhance the user experience. Additionally, the feedback received from the participants can help inform future research and development efforts to create more effective and user-friendly exercise systems.

The first question was if the system was easy to use.

Based on the participants' responses to the questionnaire, it appears that the majority of them found the system easy to use. However, seven participants gave a rating of three, which indicates that they felt the system was not too difficult to use, but also not the easiest they have ever used in their lives.

While it's encouraging that most participants found the system user-friendly, we still need to take into account the feedback from those who found it less intuitive. One possible approach to address this issue is to provide additional training or support for

those participants, such as personalized tutorials or one-on-one assistance. Another approach could be to further simplify the interface or streamline the user flow to make the system more straightforward and accessible to a wider range of users.

It's also important to note that the feedback received from the participants who found the system easy to use can provide valuable insights into what aspects of the system are working well and should be retained or improved upon. By analyzing the responses in more detail and looking for patterns or common themes, we can identify areas of strength and weakness in the system and make informed decisions about how to enhance the user experience for future participants.

Overall, the feedback from the questionnaire is a valuable tool in understanding how users perceive the system and how we can improve it to better meet their needs and expectations.

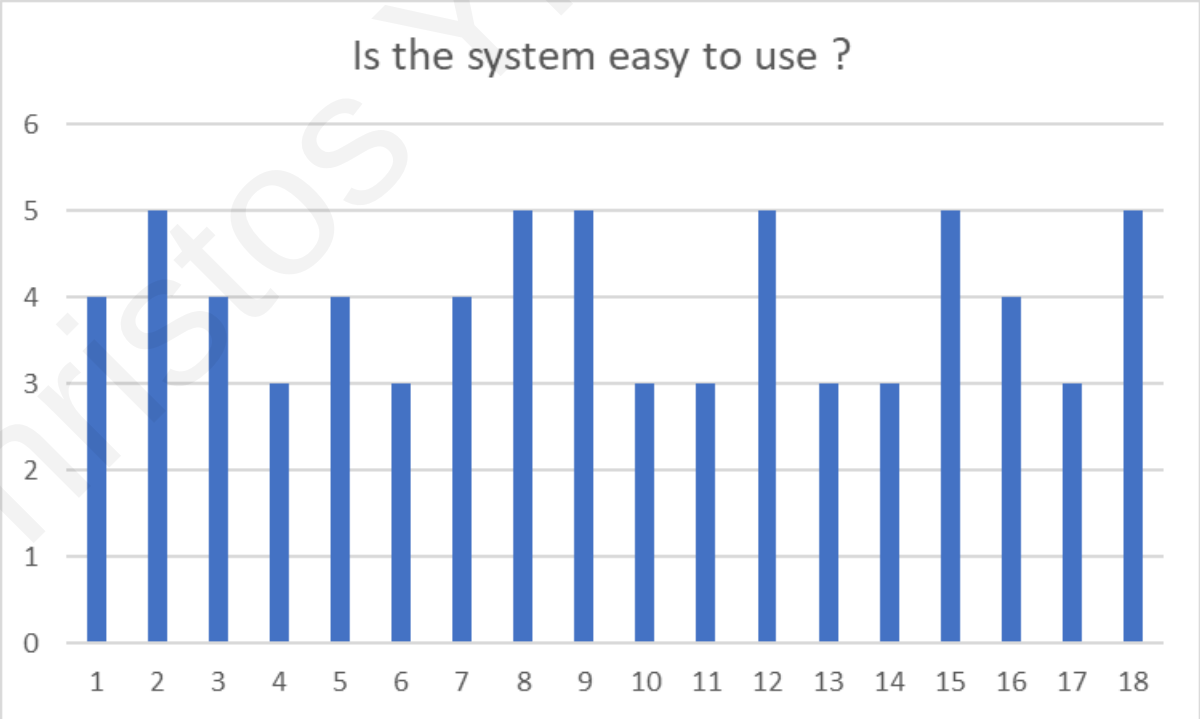

Figure 23:Answers from questionnaire

The next question was Rate the experience with the Cardboard VR.

The graph clearly indicates that the participants were not satisfied with the Cardboard VR experience. This was not unexpected, as the Cardboard VR technology is relatively outdated and there are now more advanced VR systems available on the market.

While it's important to take the participants' feedback into account, it's also worth noting that the Cardboard VR system may have been used for reasons such as cost-effectiveness or ease of implementation. It's possible that the participants were aware of the limitations of the technology and did not have high expectations going into the experience.

Furthermore, it's worth considering that not all users may have the same preferences when it comes to VR systems. Some users may prefer more basic systems that are easier to use, while others may prefer more immersive and advanced systems. Therefore, it's important to take a user-centered approach when selecting VR technology for different use cases and user groups.

Overall, while the feedback from the participants regarding the Cardboard VR experience was not positive, it's important to take into account the context and limitations of the technology. As VR technology continues to evolve, it's likely that more advanced and immersive systems will become more widely available and affordable, and it will be important to continue gathering feedback from users to inform future decisions about which systems to use.

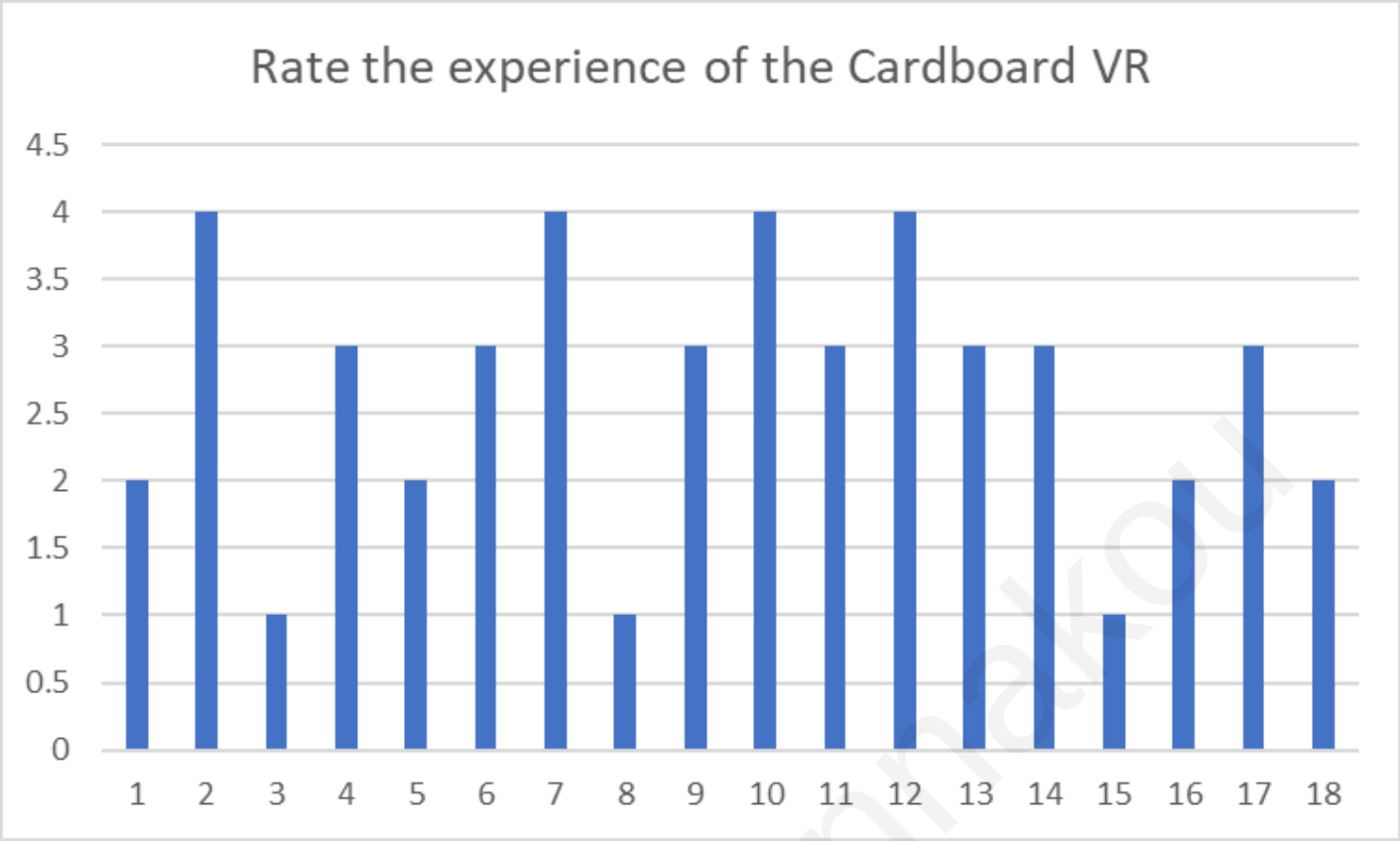

Figure 24:Answers from questionnaire

The next question was if the environment was friendly with the user.

The feedback from the participants suggests that they had a positive experience with the environment and graphics of the system. This is likely due to the use of high-quality objects and materials, as well as the incorporation of a sunset skybox, which provides a calming and peaceful atmosphere.

Creating an immersive and visually appealing environment is important for providing a positive user experience, especially in a healthcare or therapy setting. Studies have shown that exposure to nature and natural environments can have positive effects on mental and physical health, such as reducing stress and anxiety.

By using a sunset skybox and other natural elements in the VR environment, we aimed to create a calming and relaxing experience for the participants. The use of high-quality objects and materials also contributes to the realism and immersion of

the experience, which can enhance the therapeutic benefits of the VR intervention.

Overall, the positive feedback from the participants regarding the environment and graphics of the system is encouraging and suggests that we are on the right track in creating a user friendly and immersive VR therapy system. Moving forward, we can continue to explore ways to further enhance the visual appeal and therapeutic benefits of the system, while also taking into account feedback from participants regarding other aspects of the experience, such as ease of use and level of engagement.

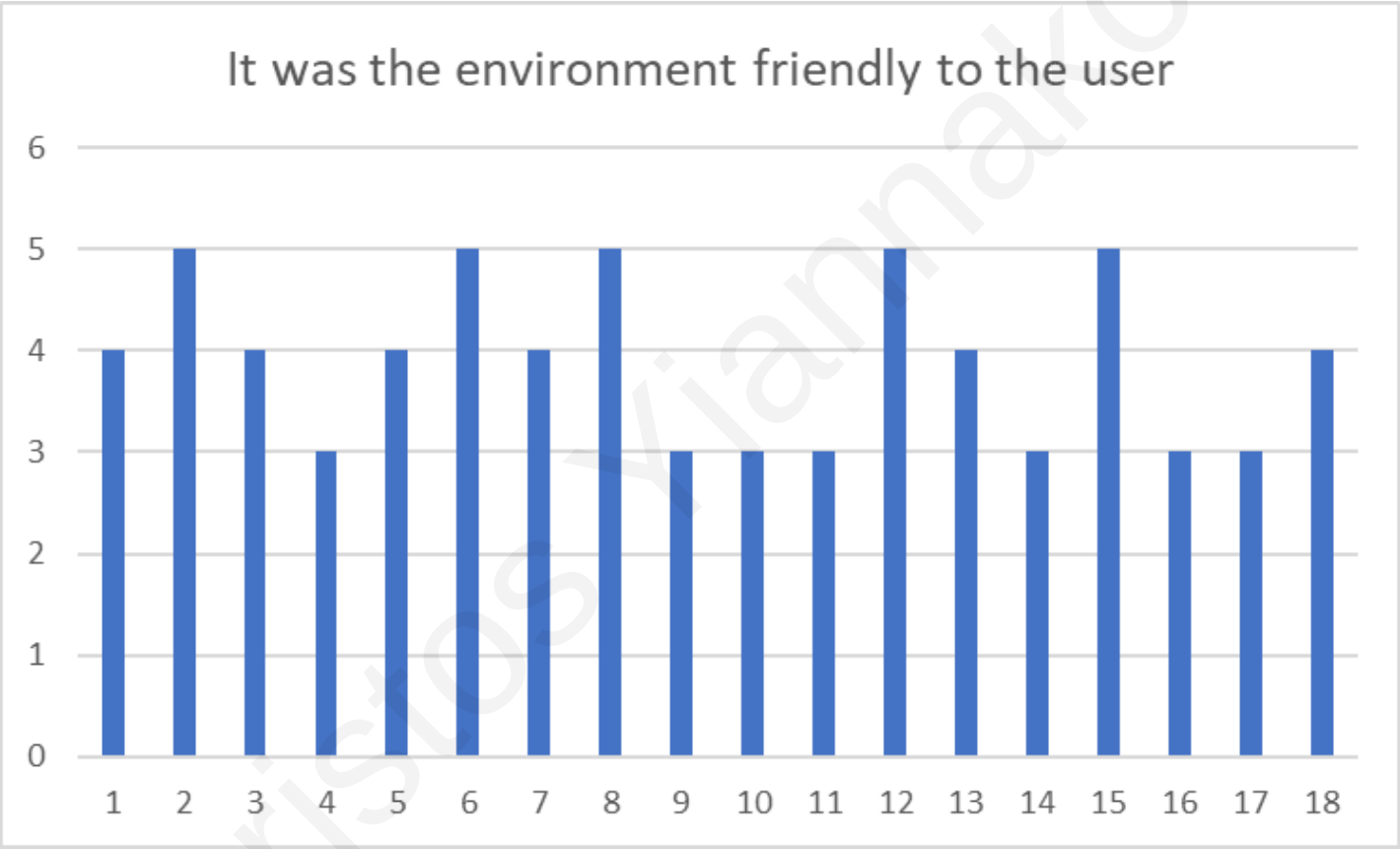

Figure 25:Answers from questionnaire

The next question was if the system was responsive?

The responses from the participants indicate that the responsiveness of the system while taking breaths was not optimal, with most answers being closer to the value of three. While this suggests that there is room for improvement in this area, it's important to note that the near zero noise environment likely contributed to a more accurate breath capture.

In a healthcare or therapy setting, accurate breath tracking is essential for ensuring the effectiveness of the intervention. While the VR system can provide a controlled and immersive environment for breathing exercises, it's important to ensure that the technology used for tracking breaths is reliable and responsive.

There are a number of factors that can influence the accuracy of breath tracking in a VR system, including the quality of the hardware and software used, the calibration of the system, and the user's position and posture. It may be useful to conduct further testing and analysis to identify specific areas where improvements can be made to enhance the accuracy and responsiveness of the breath tracking system.

In addition to improving the technical aspects of the system, it may also be helpful to provide participants with more guidance and feedback during the breathing exercises. This could involve providing real time visual or audio cues to help participants adjust their breathing and achieve the desired pace and rhythm.

Overall, while the responsiveness of the system during breath capture could be improved, the near zero noise environment appears to have had a positive impact on the accuracy of breath tracking.

By continuing to explore ways to enhance the technical and user facing aspects of the system, we can improve the effectiveness and user experience of the VR therapy intervention.

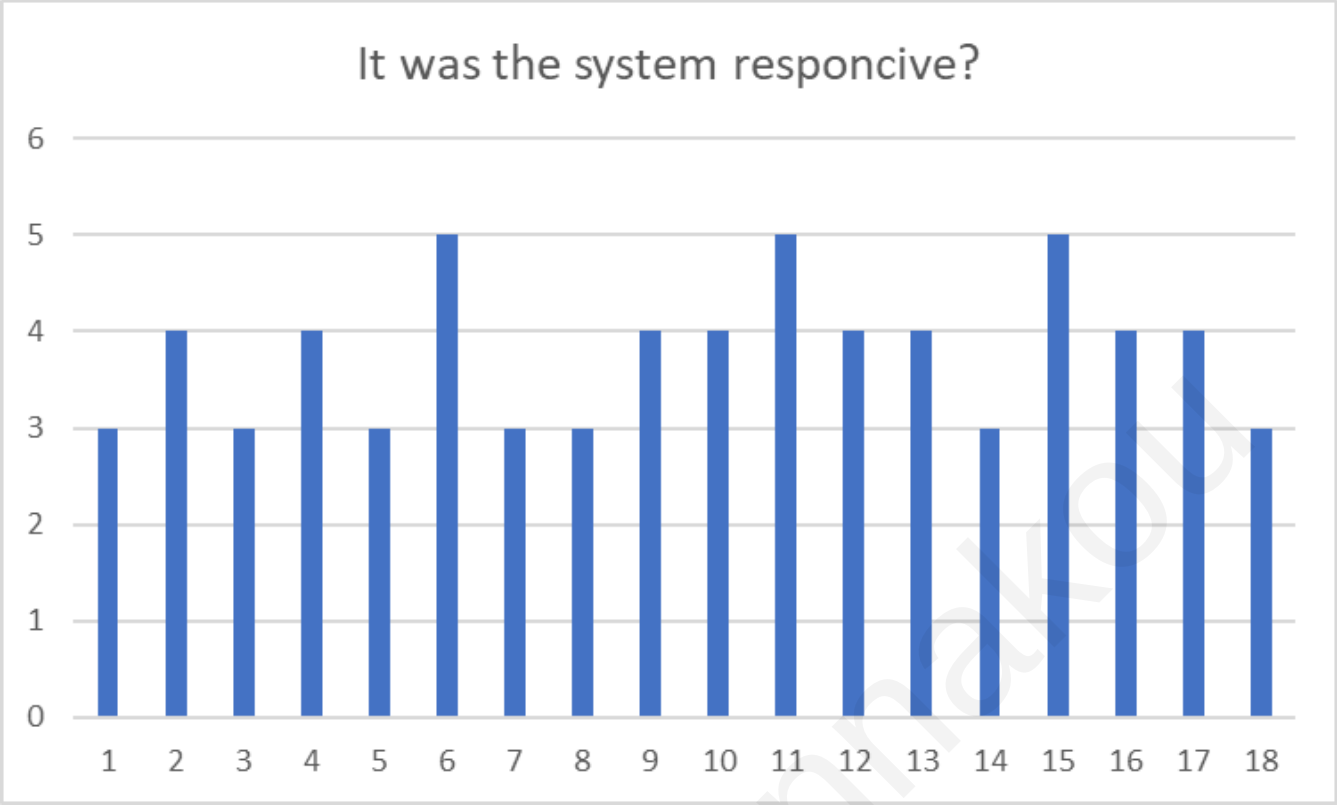

Figure 26:Answers from questionnaire

The next was asking to the participants to rate the whole experience with the system.

The majority of participants reported being satisfied with the VR therapy system, with one exception being participant number 5. This participant reported neither being impressed nor disappointed with the system.

While it's unclear why this participant did not have a strong positive or negative reaction to the system, it's important to take their feedback into account and consider ways to improve the user experience for all participants.

One approach could be to gather more detailed feedback from this participant, either through follow-up interviews or additional survey questions, to better understand their perspective and identify areas where improvements can be made. It's possible that this participant had specific expectations or preferences that were not met by the current system.

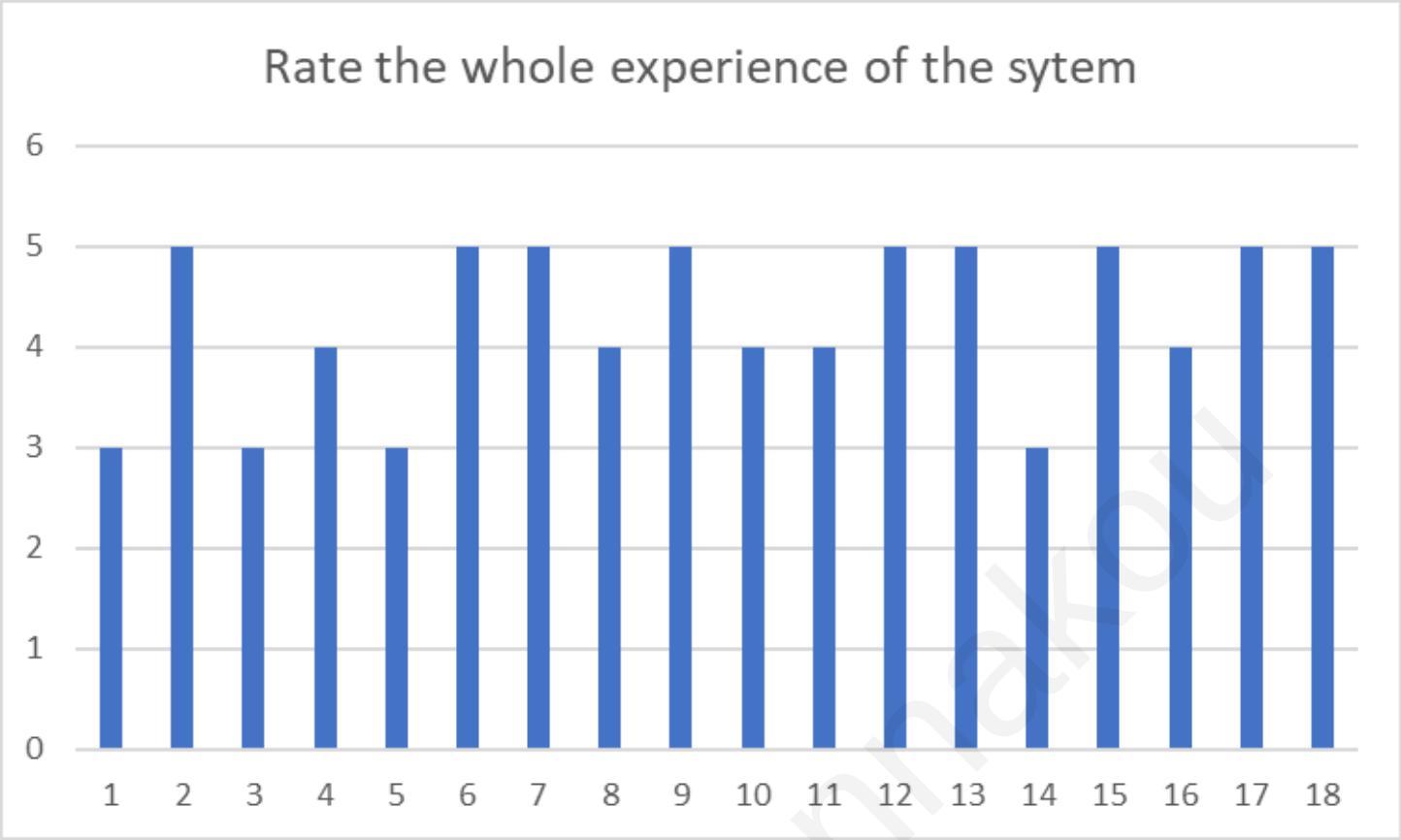

Figure 27:Answers from questionnaire

In addition to gathering more feedback from this participant, it may also be helpful to collect data from a larger sample size to further validate the findings of the survey. This could involve conducting additional testing with different user groups, or expanding the scope of the current study to include more participants and a wider range of VR therapy interventions.

Overall, while the majority of participants reported being satisfied with the VR therapy system, it's important to consider the feedback of all participants, including those who may not have had a strong positive or negative reaction to the system. By gathering more feedback and data, we can continue to improve the effectiveness and user experience of VR therapy interventions.

During the exercise, participants were asked to identify any difficulties they encountered while using the system. Some participants reported that the system

required absolute silence and zero noise to function properly, while others found it challenging to maintain deep breathing for extended periods of time.

Despite these challenges, participants also provided positive feedback on the system. Many appreciated the clear guidance provided for using the system, and several participants commented on the high-quality graphics.

When asked about potential improvements to the system, participants suggested that the breath tracking sensors could be more accurate if they captured actual breathing movements rather than relying on sound. Participants also suggested that the system would be more comfortable and less dizzying if a standard VR headset was used instead of the Cardboard VR setup.

Finally, participants were asked whether they would be willing to purchase the system for five euros. All participants responded affirmatively, citing the potential benefits of using the system for therapeutic purposes.

The feedback provided by participants highlights both the strengths and weaknesses of the VR therapy system. While there were some technical and usability challenges, participants generally found the system to be valuable and effective. By addressing the feedback provided by participants, developers can continue to improve the system and enhance its effectiveness as a therapeutic tool.

Chapter 5

Conclusions and Future work

5.1 Conclusion 93

5.2 Future work. 95

5.1 Conclusion

In conclusion, the development of a trustworthy standard to assess the accuracy of a time measuring system is crucial. Through the testing process, it was determined that the automated time measurement system proved to be accurate and consistent in comparison to a manual stopwatch. The discrepancy observed during testing was attributed to human error rather than the system's performance.

The research highlighted the advantages of employing an automated method for time measurement, as it eliminates the potential for human error and ensures higher levels of accuracy and precision. This has significant implications for various applications, including industrial processes and scientific research, where precise timing is essential for optimal results.

To evaluate the system's usability and effectiveness, a panel of twenty individuals was recruited, and their feedback was collected through a comprehensive survey. The evaluation process provided valuable insights that will be used to improve the system and cater to the specific needs of users.

The survey not only assessed participants' experience with the system but also gathered demographic information, allowing for a better understanding of the target audience. Clear instructions and guidelines were provided to ensure the accuracy and reliability of the survey results.

Following the collection of survey data, a thorough analysis was conducted to identify patterns and themes. This analysis facilitated the development of recommendations for system improvements, such as enhancing instruction clarity, incorporating visual aids, and diversifying exercises.

Overall, the system evaluation process, including participant recruitment, feedback collection, result analysis, and recommendation development, ensured a comprehensive assessment and customization of the system. By adhering to a structured protocol during evaluation, the reliability and consistency of results were maintained, enabling the enhancement of system effectiveness and usability.

The exercise used for testing, a controlled breathing technique, has well-documented benefits for physical and mental health. The specific breathing pattern employed in the protocol optimized oxygen intake and alleviated stress and anxiety, factors that can impact system performance.

By implementing a structured protocol during the exercise, detailed data on the system's interaction with participants and its influence on their physical and mental states were obtained. This included monitoring physiological metrics and self-reported emotional states, providing valuable insights into the system's impact on overall well-being.

Furthermore, conducting multiple attempts for each participant accounted for various variables such as learning curves and fatigue, resulting in more accurate and reliable data. This data can be leveraged to refine the system, tailoring it to the specific needs of different users.

In conclusion, the establishment of a trustworthy standard, the thorough evaluation process, and the adherence to a structured protocol have contributed to the improvement of the time measurement system's accuracy, consistency, effectiveness, and usability. These findings have significant implications for a wide range of applications, promoting optimal outcomes in fields where precise timing is crucial.

5.2 Future work.

In order to improve the current breathing app for lung cancer patients, several enhancements can be made. First, a database can be utilized to store all patient data, allowing for easy access by both the patient and their doctor. The patient can access the environment to track their progress, while the doctor can monitor their patient's progress through the same platform. Additionally, to ensure the security of the sensitive patient data, a robust security system should be implemented for the login action of the application. The application should also be compatible with multiple platforms such as Android, iPhone, and desktop.

In terms of improving the current system, more accurate sensors can be used to capture breathing data. For instance, respiratory rate, tidal volume, forced vital capacity (FVC), peak expiratory flow (PEF), and oxygen saturation are essential measurements that can provide valuable insights into lung function. Measuring respiratory rate using a spirometer can indicate the patient's health condition as changes in respiratory rate can signify a decline in health. Measuring tidal volume can help assess the lung's functionality and measuring FVC can provide further insights into lung capacity. Additionally, measuring PEF can help determine airway functionality, and measuring oxygen saturation can provide valuable information regarding the patient's oxygen levels. These measurements can be useful for doctors to monitor the patient's lung function from a distance, allowing for timely intervention if necessary.

In conclusion, enhancements to the current breathing app for lung cancer patients can significantly improve the quality of patient care. A database to store patient data, an environment for patients to track their progress, and a secure login system are essential features of a useful and user-friendly application. Additionally, more accurate sensors that can capture essential breathing data, such as respiratory rate, tidal volume, FVC, PEF, and oxygen saturation, can provide valuable insights into

the patient's lung function and help doctors monitor their progress from a distance.

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