Satakunnan ammattikorkeakoulu
Satakunta University of Applied Sciences

SAARA BENLAMINE

RECOVERY IN UNIVERSITY STUDENTS USING FIRST BEAT DEVICE - SATASPORT

DEGREE PROGRAMME OF PHYSIOTHERAPY

2020

Author(s)
Benlamine, Saara

Type of Publication
Bachelor's thesis

Date
November 2020

Number of pages
35

Language of publication:
English

Title of publication
Recovery in university students using firstbeat device - Satasport

Degree programme of physiotherapy

Abstract

The aim of this thesis was to study the recovery of university students. The study was carried out using Firstbeat Lifestyle Assessment and BODYGUARD 2 measurement device. The aim was to assess 20 student's recovery in total, but unfortunately due to technical issues with the measuring device and limited time only 18 measurements were successful.

The study was implemented on only students from Satakunta University of Applied Sciences (SAMK). The planning, measurements and analysis of the study was done between January to March 2020.

Students were chosen for the study through a questionnaire sent through email to all the students from SAMK. The chosen students were then sent an invitation to an information meeting about the aims of the study, how do they benefit from it, the use of Firstbeat BODYGUARD 2 device and a feedback session about the results once the measurements were done.

The results of the assessment showed that students stress levels were in the higher end of normal values (55%) but recovery in 24 hours was poor (23%). The average recovery during sleep (57%) were within normal values, 36% of students recovered poorly while another 36% recovered remarkably well during sleep. Leisure time recovery was within normal values but 41% of students recovered poorly during leisure time. The recovery during work was less than 5 minutes which is below normal values.

Key words
Firstbeat, autonomic nervous system, parasympathetic nervous system, sympathetic nervous system, recovery, stress, sleep, university student, heart rate variability

CONTENTS

1 INTRODUCTION

It is no surprise to anyone that university students go through a tremendous amount of stress. University students are usually in an age where they are growing to a stage of being independent adults. It is a huge step in life when moving away from parents, maybe even to a completely new city or even another country. Students step away far away from their comfort zone and from what they are used to. Students are loaded with assignments, exams, clinical practice placements as well as factors in their everyday life. Most students have to find a job to be able to be financially independent which is another huge loading factor both physically and psychologically.

Decrease in mood, fatigue and anxiety are symptoms should be taken seriously. Numerous students suffer from stress, anxiety, sleep deprivation, fatigue and other psychological symptoms. Most of the students suffer stress symptoms on a weekly basis. Chronic stress increases the risk of a burnout or depression. (Kunttu. 2016, 83). It is very crucial to recognize depression or anxiety symptoms early to decrease the risk of a serious depression or burnout.

Firstbeat Technologies Oy is a Finnish wellness technology company which has grown rapidly due to the interest of more and more people of wanting to know more about their current health state and wellbeing. Firstbeat products give effortlessly reliable and diverse information and results about wellbeing and physiological factors happening in the body. With Firstbeat products the reliability is very close to laboratory testing, but the results are a lot easier to understand and they are a lot more accessible. The interest of Lifestyle assessment created by Firstbeat has grown rapidly and measurements are done constantly both in Finland and internationally. (Website of Firstbeat Technologies Oy)

The purpose of this thesis was to measure the recovery of 20 Satakunta University of Applied Sciences students with Firstbeat measurement device. Due to technical issues with the measurement devices and limited time only 18 measurements were successful even though 27 measurements were done.

This thesis was a done together with CampusMowe and Finnish Student Sport Federation (OLL). Both of their main aims is to increase physical and mental wellbeing of students. With the findings of this study both companies are able to plan a suitable, safe and efficient actions related to physical activity, sleep and stress control.

2 AIM AND OBJECTIVES

The aim of this thesis was to make a study about the recovery of university students using Firstbeat BODYGUARD 2 - measuring device.

The objective of this study was to use Firstbeat measurement to study the recovery of university students.

Research questions: How good is the recovery of the student? What time of the day do the students recover the most? Do students recover during sleep?

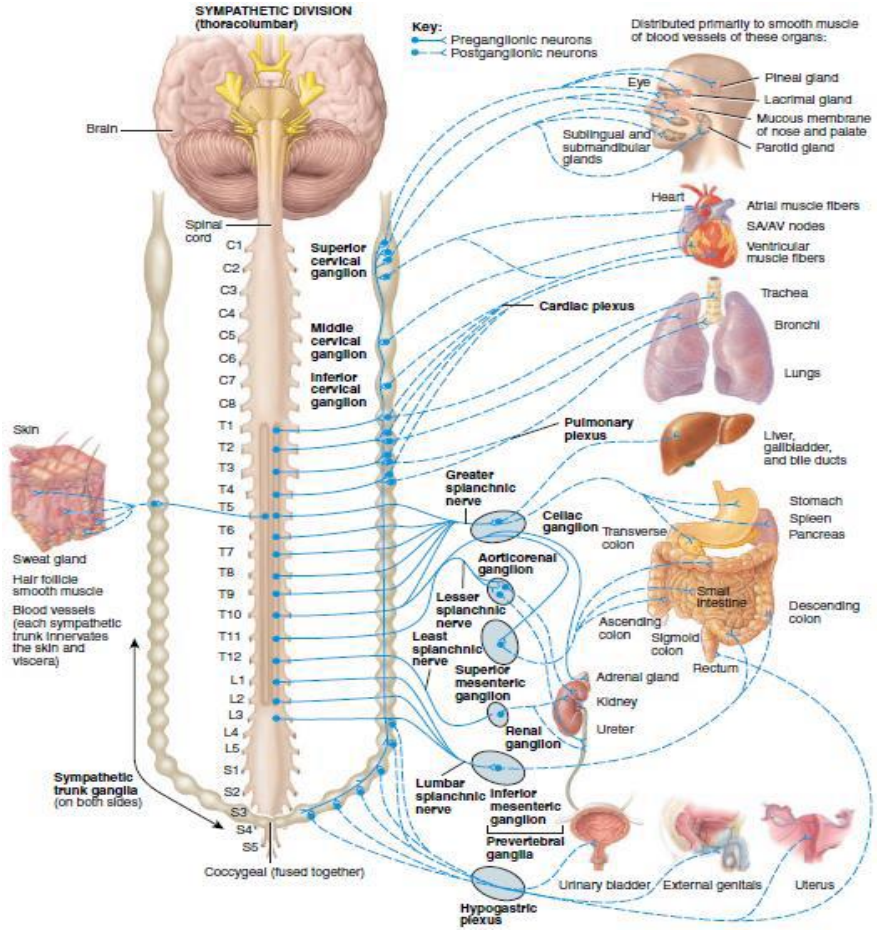
3 AUTONOMIC NERVOUS SYSTEM

Peripheral nervous system regulates involuntary actions of the body for example heart rate, blood pressure, breathing, sexual arousal and digestion. It also maintains internal homeostasis and stress responses. Autonomic nervous system is one segment of the peripheral nervous system.
The autonomic nervous system receives information from other parts of the body and environment. The autonomic nervous system is divided into three parts: sympathetic-, parasympathetic-, and entric nervous system. (Cherry, 2020.)

The body gets innervation from both sympathetic and parasympathetic nervous system. Autonomic tone is the balance of sympathetic and parasympathetic activity.

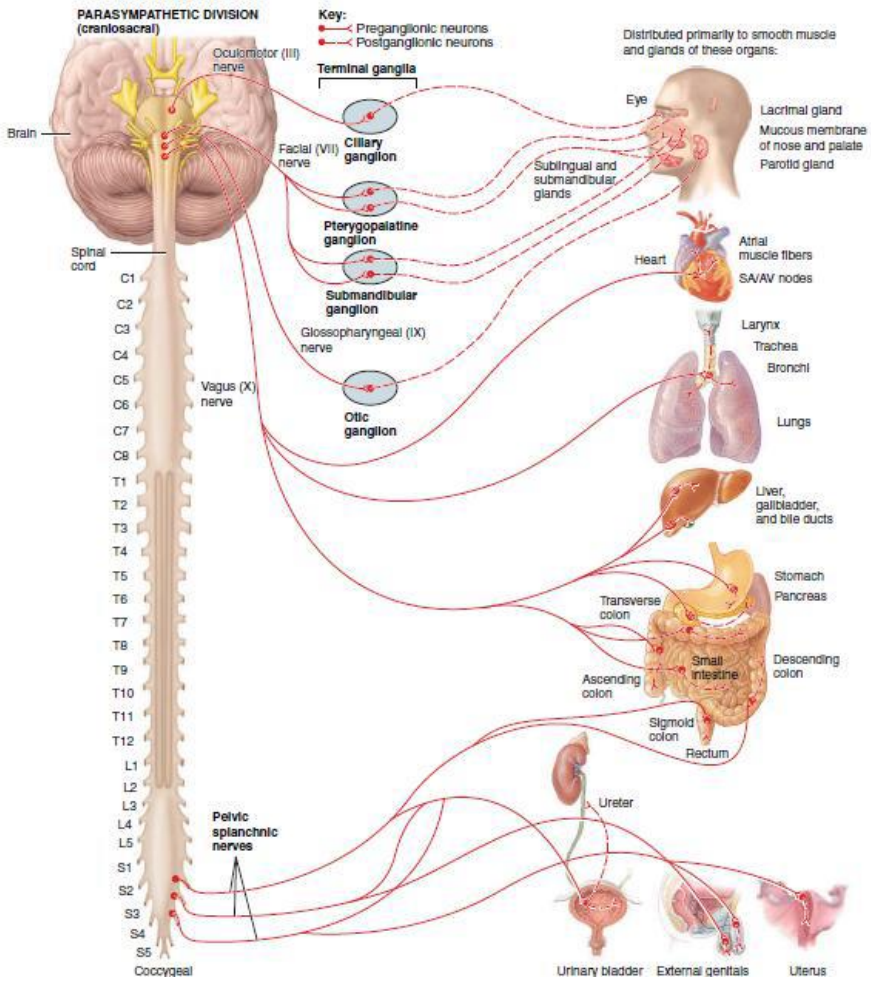
The autonomic tone is regulated by the hypothalamus, which has a vital role in controlling bodily functions including the release of hormones and keeping the body in stable condition. The hypothalamus activates the sympathetic system and lowers the activity of the parasympathetic system and vice versa. (Tortora & Derrickson, 2014, 536-537.)

The sympathetic nervous system (Picture 1) is also called fight-or-flight system, this will be discussed in chapter 5.1. During emotional or physical stress, the sympathetic nervous system is the dominator and parasympathetic nervous system is turned down. When the sympathetic nervous system is active it produces very rapidly adenosine triphosphate (ATP), which is an energy-carrying molecule that can support the body in physical activity, and it reduces bodily functions that favor the storage of energy. The effects of sympathetic nervous system last longer and spread wider than effects of parasympathetic nervous system. (Tortora & Derrickson, 2014, 537-538.)



Picture 1. The division of the sympathetic nervous system (Tortora & Derrickson, 2014, 527)

The system that calms us down is the parasympathetic system (Picture 2) can also be called the rest-and-digest system. It supports the body functions that restore body energy during rest and recovery. (Tortora & Derrickson, 2014, 538).
Parasympathetic is most likely to be activated when relaxing, sleeping and resting. It calms us down and starts the recovery process. The most important nerve that activates the parasympathetic system is the vagus nerve which is the tenth cranial nerve its travels from the brain all the way to the important organs for example the heart, lungs and bowel. Vagus nerve is the main activator of recovery by activating the parasympathetic system. (Tuominen, 2020.)
The enteric system is responsible of the function of the gastrointestinal tract. (Costa, Brookes & Hennig, 2000.)



Picture 2. The division of parasympathetic nervous system (Tortora & Derrickson, 2014, 528)

4 STRESS

Stress is the bodies' way of responding to any kind of internal or external threat or demand. It is a biological and psychological response by the sympathetic nervous system. Stress response is a way of the body to protect humans. (Vartiovaara, 2008, 18).
It can also be called the fight-or-flight reaction which will be talked about more in chapter 4.2.

Stress factors can be either imaginary or actual environmental situations. Stress is not always negative. There can be also positive stress for example feeling excitement or surprised. The human body is not able to define what is positive or what is negative stress. Everyone is an individual and experience and control stress in different ways. (Firstbeat Technologies Oy, 2020.)

If stress levels are constantly high and increased, it can already be called chronic and can impact on mental and physical health.
The psychosomatic part of humans can turn stress chronic. Even if the actual danger that made a human stress is gone it might still leave a person think about what happened. The mind is very strong, and some might overthink certain situations and start imagining something that might not even happen meaning the stress reaction is still on. Repetitive or chronic stress factors can be for example being in an abusive relationship which constantly consists of fighting, arguing and being mentally and physically abused. Another example could be a very important family member passing away. Constant reminders in the environment might trigger and remind of that certain family member.
If stress actually turns chronic the body will not be able to go back homeostasis which is the balance between stress and recovery. Chronic stress symptoms are hypersensitivity, anxiety, insulin resistance, sleep deprivation, memory problems, digestion problems and decrease of immune system. (Jaakkola, 2018, 32-33).

4.1 Eustress and distress

Stress can be positive or in other words called eustress. It can be very beneficial and give a boost to survive a complicated and tricky situations or tasks. The eustress-phenomenon was found already in 1960-70s, but it has not been studied a whole lot. Eustress can be a specific happening that might cause some stress for example interview, performance or wedding. (Heikkilä ym. 2016, 10.)

Eustress is a complete positive feeling which makes people very motivated and pleased to work hard and to live life to the fullest. Eustress is a feeling of energy and excitement which is the reason many have the will to live life to the fullest and it gives motivation to try new challenges in life. There are many things in life that in the beginning that might feel stressful and challenging but once getting the hang of the task and get the challenge going some actually get excited and intrigued by it. Eustress is basically felt after actually completing a challenge or task that they thought they might not be able to complete or are not competent enough. (Vartiovaara, 2004, 5-6.)

Distress is negative stress which a person faces repetitive challenges without relaxation or relief. Distress causes anxiety and concern. Distress can lead to physical and psychological symptoms for example upset stomach, increased blood pressure, headaches, anxiety, depression and body aches. Distress can be a cause of various reasons for example unemployment, financial issues, losing a loved one and conflicts in relationships. Stressors are not always from external situations but can also be internal, these include feelings and thoughts that are negative. (Robinson, 2017.)

4.2 Fight or flight

The stress response or as called fight or flight response starts in the brain. When humans visualize a threat that can be either real or imaginary, it sends information to the amygdala which is the area in the brain that provides takes part in emotional processing. Once it senses danger it sends the information to the hypothalamus which

acts as a command center to send signals and interconnects with the body. Autonomic nervous system is in charge of sending the signals.
It then activates the sympathetic nervous system that sends signals to adrenal glands which start to pump stress hormones (catechlomines) which include adrenalin and noradrenaline, sending them into the bloodstream. Once stress hormones are circulating through the body it starts making physiological changes. It increases heartrate, dilutes airways and increase blood pressure. Senses like eyesight and hearing improve momentarily. Nutrients like glucose and fat flow into the blood stream which is activated by epinephrine. These gives energy to all parts of the body to react to the threat. (Website of Harvard Health Publishing, 2020.)

Once the stress factor disappears the stress hormones goes away from the body and the body recovers. In acute stress it takes 60-90 minutes for stress hormones to leave the body, after that the body goes to homeostasis in about 20 minutes and the recovery starts (Jaakkola, 2018, 30.)

5 RECOVERY

Recovery is the physiological process that makes an individual's physical and mental state to recover from a stress reaction back to homeostatic balance where it is no longer under any physical or mental stress. Recovery takes time and it is important to find balance between working hard and giving self-time to recover. The parasympathetic system is the key for recovery. Once it is active it changes the heart rate into more irregular and heart rate variability increases. (Jaakkola, 2018, 35.)

Recovery is like the battery of the phone that you usually have to charge at least once a day. The more you use your phone, the faster the battery runs out. This is why charging only once is usually not enough. This also applies on humans. The higher the physical-, or mental load during the day the more recovery the body and mind needs. An extra couple of hours of sleep to compensate the exhaustion won't do the job. (Firstbeat Technologies Oy, 2020.)

A person who is well recovered has more energy and is capable of more load and feels happier. Proper recovery keeps humans healthy and more productive to complete work and other daily activities.
Recovery is very personal for all individuals. Some recover faster and easier than others. A big factor for recovery is healthy lifestyles and finding the stress factors that are keeping a certain individual from recovering. In the next chapters there will be some examples that can improve the recovery of students. (Firstbeat Technologies Oy, 2020.)

5.1 Physical Activity

One way of improving recovery is being physically active. It affects both psychological and physiological states in a positive way. Physical activity decreases the risk of chronic diseases and premature death. It makes the body stronger and improves the condition and function of the heart. Physical activity decreases the symptoms of depression because it decreases the release of stress hormones.
Firstbeat database shows that people who are more than 3 hours physically active have a very good balance between stress and balance. The ones who are less than 30 minutes a week physically active have a very poor balance between stress and recovery. (Firstbeat Technologies Oy, 2020.)

5.2 Breaks and rest

Proper amount of rest and recovery are crucial. It is important not to overload the body physically or mentally to the point where it gets completely worn out. This can be avoided by making time for recovery and proper sleep.
Stress causes sleep deprivation and sleep deprivation causes stress, meaning that one should find a way that rest, and sleep is pleasant which makes the body and mind recover. The higher the daily demand the body and mind has the more they recovery they require. Sleep will be spoken more about in chapter 6.
Having regular breaks, no matter if working or studying increases night time recovery. When studying or working a break every 30-40 minutes is recommended.

Having a break might not significantly activate the parasympathetic system, but psychologically boost energy and relieve some of the stress caused by work or studying. These breaks can include laying down, speaking to a friend or having a snack. (Jaakkola, 2018, 107.)

5.3 Alcohol

A huge factor that decreases recovery is the use of alcohol. Even though alcohol might help with falling asleep, but during sleep increases the activation of the sympathetic system and turns down the parasympathetic system. Consumption of alcohol before bedtime interferes with sleep-wake cycles and decreases the amount of REM-sleep that is crucial for the brain and for learning. (Firstbeat Technologies Oy, 2020).
Alcohol relaxes the muscles of the throat increasing the risk of sleep apnea and snoring. (Mesquita ym., 2010, 20.)

5.4 Nutrition

Our body needs food to nutrition all cells and organs of the body and to give us energy. Food is fuel to make the body and mind work in a proper way. It is not only the amount of food that matters but also the quality and having proper eating routine. The recommendations for adults per day is 50-60% of carbohydrates, 15-20% protein and 25-30% of fat.
Proper eating routine helps with staying energized and concentrated through the day. This will keep blood sugar steady, keeps away the feeling of hunger and prevents overeating and weight gain. A good time for food or a snack is every 3-4 hours. Meaning breakfast, lunch, dinner and a couple of snacks per day. (Ruokavirasto, 2020, 6).

5.5 Smoking

Smoking damages blood vessels, the heart as well as lungs. Nicotine is a highly addictive chemical which increases blood pressure, heart rate and narrowing of blood vessels.
Smokers might think that smoking actually makes them relax and calm down, when it actually increases anxiety and tension. The reason for this is the chemicals that interfere with the brain when a smoker has not smoked for a while the craving for another one makes them feel anxious and irritated. Once a smoker has a cigarette, they feel temporary relief until the feeling of the need for nicotine comes back. (Website of NHS, 2020.)
Smoking can be associated with poor sleeping quality. Insomnia can be a result of a smoker craving for nicotine during night time. This can also cause nightly disturbances and many awakenings during the night time. These factors will reduce the time of sleep and mixing of the sleep cycles. (Liao ym. 2019, 2.)

6 SLEEP

Sleep is regulated and a state of reduced responsiveness and awareness.
Sleeping is the main way of recovery in all humans, the body does not shut down but starts repairing and recovering itself mentally and physically. It affects hormones, brain, heart, immune function, lungs, mood, disease resistance and metabolism. Sleeping is important for the nervous system; it gives energy for the nervous system to work the next day. Proper night of sleep will help with being alert, be able to concentrate and have energy for the next day.
Sleep is a necessity that hugely impacts on physical and mental health. A huge number of research's show that lack of sleep can increase the risk in certain diseases and other health issues.
The amount of sleep needed by each person varies individually. Infants need 16 hours a day while the recommended amount of sleep for adults is six to eight hours every night. The amount of sleep needed by a person can vary, possible factors are

gender, age, personal life, diseases and overall health condition. (Website of Health Engine, 2020.)

There are two main biological mechanisms that regulate between being asleep or being awake. One of them being sleep homeostasis, which balances sleep and wakefulness. When braincells called astrocytes release adenosine it increases the feeling of tiredness and promotes sleepiness. When waking up the level of sleep homeostasis is low, throughout the day the levels start rising back towards the evening making the feeling of sleepiness.
The other mechanism regulating sleep is the circadian rhythm that follows a daily 24-hour cycle. Located in the hypothalamus is the body's biological clock which contains 20,000 neurons. This makes the suprachiasmatic nucleus (SCN). The SCN controls the production of the hormone that makes us sleepy, melatonin. THE SCN is highly sensitive to light. Light exposure sends signals to generate alertness and keep us awake. When circadian rhythm is off balance it can cause serious sleep deprivation and insomnia. (Website of National Institute of General Medical Sciences, 2020.)

When sleeping there are two different kinds of sleep, which are the rapid eye movement (REM) sleep and Non-REM sleep. The REM sleep can be defined as less restful sleep. REM sleep is when there are rapid eye movements present behind the eyelids during sleep and includes more dreaming and involuntary muscle movements. The brainwaves are more active and heartbeat increases. From time of sleep 20 to 25 percent of the time REM sleep. The rest 75 to 80 percent is Non-REM sleep. During REM sleep the sympathetic system is more active making the sleep restless. Non-REM has three stages that start from being awake to a deeper level of unconsciousness. The breathing rate and brain waves decreases, and the muscles and body relax. This is the result of parasympathetic system being active.
During sleep there are of both rapid eye movement and non-eye movement phases of sleep. During one night of sleep there is a cycle that goes through all these phases several times. (Colten & Altevogt, 2006, 1-7.)

7 UNIVERSITY STUDENTS, STRESS AND RECOVERY

Students, stress and recovery is a very important topic. According to a previous research done in Finland in 2016 by the Finnish Student Health Service, students' psychological issues have tripled since 2000. The Finnish Student Health Service sent a questionnaire to nearly 10 000 students across Finland. In the in the end 3114 student answered the questionnaire.

In the research 33 percent of students felt a high amount of stress. The highest reason for stress was said to be the difficulty getting into a proper study rhythm and the fear of presenting in front of a big audience or classmates.

Psychological symptoms were measured with GHQ12-measurement scale. According to the answers 30 percent of students had psychological issues. Main issues were overworked, depression, problems with concentration during assignments and sleep deprivation due to overthinking. Over one fifth of the students were felt decreased mood, planning their future and finding strength to complete tasks were found challenging. Also, 72 percent of the students had a medical diagnosis from a doctor, dentist or a psychologist that was chronic or a repetitive disease. (Kunttu ym. 2016, 83–86).

The lifestyle changes of going studying into university demands a lot of self-control between personal life and studying. Many students move into a new city, away from their parents and family for the first time in their lives.

In university students there are many factors that increase stress for example exams, assignments, time management, the amount of studying and filling the needed competences (Kunttu 2011, 35).

Feeling stress is always very individual, someone might feel stressed a lot easier than someone else. In some cases, the reason of increased stress might be the students themselves. Typically, the reason being poor time management, leaving assignments or study for exams only till last minute.

Anxiety, fatigue and decreased mood are a major issue in students and some experience them every day. When these symptoms turn chronic it increases the risk of burn out and depression. (Liuska, 1998, 9-13).

Aittola in 1992 (Table 1) has described the different stages of student's studies and what the common worries students go through in their different years of university studies.

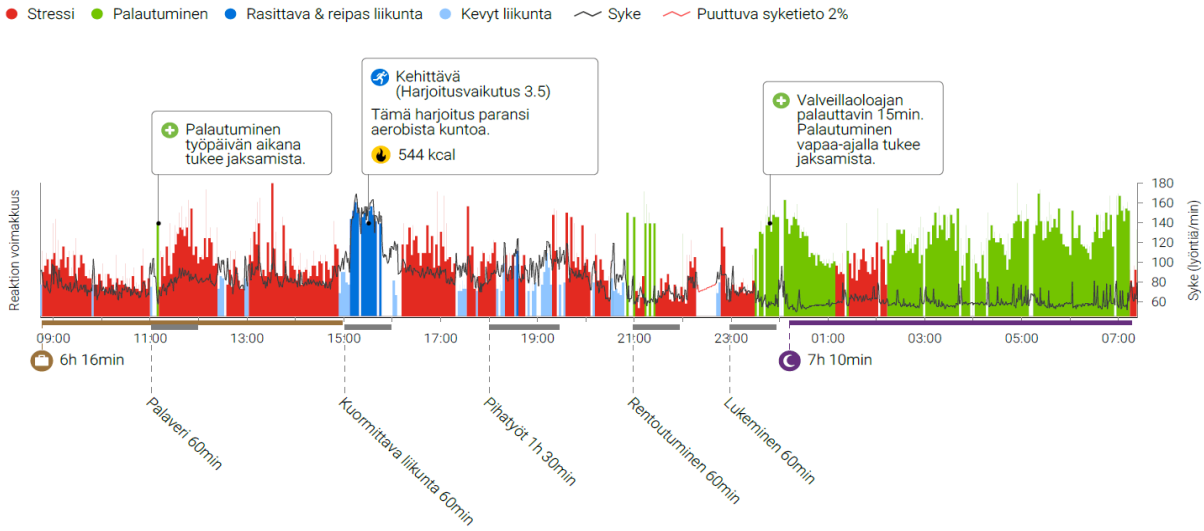
	1st year of university	**3rd year of university**	**4th year of university**
Basic life factors and features during specific a life stage	- adapting to changes - living away from parents	- Priority in university and relationship - Figuring out life and new experiences	- transferring away from studying and university
Personal and social identity	- learning to be independent and living away from parents - confusion and learning new things	- working hard and experimenting - frustration of student life	- starting a family and work life - calming down and growing mentally - world view encapsulated
Life situation and its main components	- apartment problems - learning to be financially independent - leaving old friends behind - learning to live more freely	- living in a student apartment - beginning of financial issues - relationships and dating - study load effecting on lifestyle and relationships - summer jobs and clinical placements	- moving away from student apartments - fear of financial issues - relationships at risk - finding a job
Studying and its main components	- adapting to a new study rhythm - mass lectures and general studies - learning - tutor-groups	- full-time studying - dedication to own university and staff - own class	- writing thesis - finishing advanced courses - finalizing the degree - seminar groups
Main features of the study process	- adapting to new study methods - fact-orientation harms the big picture - university seen very fascinating	- personalized study methods develop - cognitive relativism and critical thinking towards science - honeymoon phase is over	- independent studying - scientific aspects encapsulated - reflecting on relevancy of science - getting ready for paid work

Table 1. Different factors and stages of student's studies and personal life (Liuska, 1998, 13.)

8 FIRSTBEAT LIFESTYLE ASSESSMENT

Firstbeat Technologies Oy is a wellness technology company created in Jyväskylä, Finland in 2002. It was created in co-operation with Jyväskylä University and Research Institute for Olympic Sports. They are both highly respected and recognized research labs for their high knowledge on sport sciences. Firstbeat is widely used among healthcare-, and top athletes in Finland and internationally.
The lifestyle assessment is one of Firstbeats known products to get reliable information and data about a person's balance between stress and recovery, quality of sleep, health benefits of exercise and overall wellbeing. It is also an excellent way to determine and prevent long term unwanted stress. (Website of Firstbeat Technologies Oy)

Firstbeat lifestyle assessment (Picture 3) is done with BODYGUARD 2 device. It measures the function of the heart through heartrate variability to produce accurate information about physiological states and functions. Firstbeat analysis gives accurate individualized information about a person's overall wellbeing.
Missing measurements during the day are marked in the final report. If missing heart rate is under 10 percent, the measurement is successful. Firstbeat recommends doing a remeasurement incase the missing heart rate during the measurement day is over 15 percent. (Firstbeat Technologies Oy, 2020)



Picture 3. Example of Firstbeat lifestyle assessment results (Firstbeat Technologies Oy, 2020)

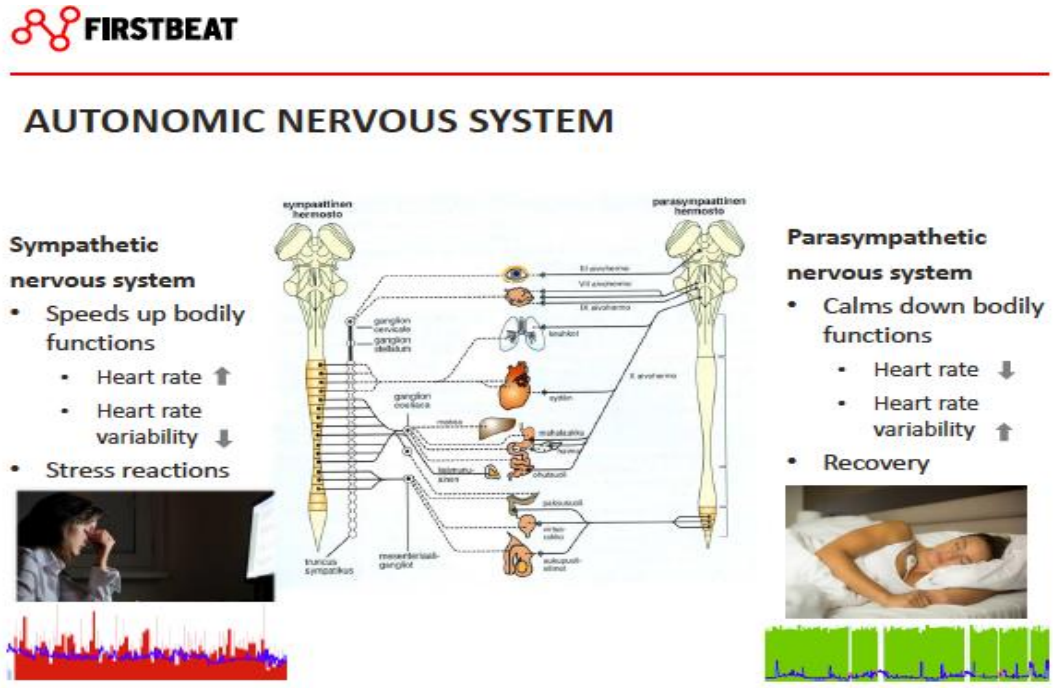
8.1 Heart rate variability

Heart rate variability (HRV) is defined by the time in between heartbeats that is measured in milliseconds. Heart rate variability is regulated by the autonomic nervous system and is affected by age, physical condition and stress. (Hye-Geum, 2018, 235). It is commonly said to be a non-invasive marker of the sympathetic and parasympathetic system. It is also a marker of the condition and function of the heart. A healthy heart does not beat evenly, but actually beats in constant variation. (Hoffman, 2020.)

When the heartbeat slows down the interval between beats get longer and when heart rate increases it gets shorter. So, the higher the heart rate variability the more active the parasympathetic system is, and the body is in recovery state (Picture 4). High heart rate variability is commonly seen in people who are healthy and physically active.

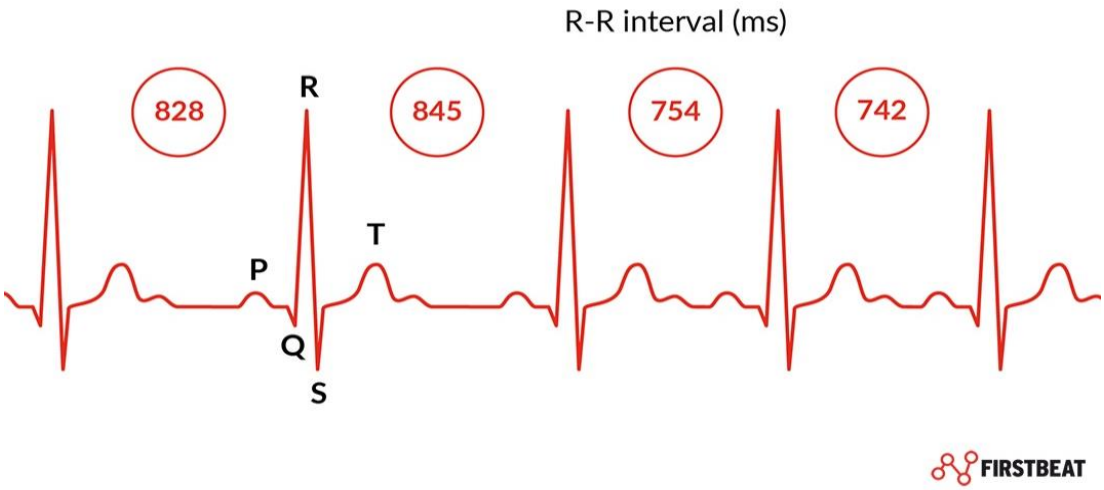
There are many other physiological factors that affect the heart rate variability for example hormonal reactions, breathing pattern, metabolism and mental state. Heart rate variability varies everyday depending on stress levels, workload and physical activity which all are environmental factors. The use of alcohol, tobacco,

healthy diet and diseases effect on heart rate variability. (Firstbeat Technologies Oy, 2020).



Picture 4. Sympathetic versus Parasympathetic system effects on HRV (Firstbeat Technologies Oy).

Firstbeat device uses root mean square differences of successive RR-intervals (RMSSD) (Picture 5) to figure out the HRV and the function and activity of sympathetic and parasympathetic nervous system which is marked in milliseconds. If the RMSSD value is low, it is a sign of parasympathetic system not being active and tells of poor recovery. (Peltomaa 2015, 38-39).



Picture 5. Illustrated picture of R-R interval of the heart rate (Firstbeat Technologies Oy, 2020)

8.2 BODYGUARD 2

The Firstbeat BODYGUARD 2 (Picture 6) device is used commonly for three to four days at a time. The days are commonly divided in a way that at least one day is during the weekend or a rest day to see if the recovery and stress vary during work and rest days.
The Firstbeat consists of the device and electrodes that are attached into it. The electrodes are changed once a day or after showering.

The electrodes are put on the device and then placed under the right clavicle bone and the other one on the left ribcage. It is placed on bare, hairless, clean and dry skin. Once a green light shows up in the device and blinks on the in the rhythm of the heartbeat, the device is on and working. If there is no light on it means the device is not on and not measuring. This can be due to broken electrodes, incorrect placement of the electrodes or problems with the device. If there is a yellow light blinking it means the device is on, but battery is low and if there is a red light it means the device memory is either full or the device needs charging.

The clients use a journal to fill daily activities including work, sleep, exercising, school, home chores and leisure time. This is used to determine possible stress or recovery factors. (Firstbeat Technologies Oy., 2020).

Picture 6. Firstbeat BODYGUARD 2 measuring device (Firstbeat Technologies Oy, 2020)

9 THESIS PROCESS AND METHODS

The thesis process started October 2019 (Figure 1) when the subject of student's recovery was offered by CampusMoWe. The initial thought was to measure teachers and student's recovery of Satakunta University of Applied Sciences. The subject would have been too broad which is why in the end the conclusion was to study only the recovery of students.

Meeting with client (OLL) was held January 2020 discussing the aims and plan of the study. OLL had a ready-made invitation email to send all students with a link to the preliminary questionnaire. The invitation email for the study was sent beginning of February 2020.

The whole implementation period was in February 2020. This is when students were chosen for the study, Firstbeat devices were booked, information session was held, measurements were done as well as feedback session.

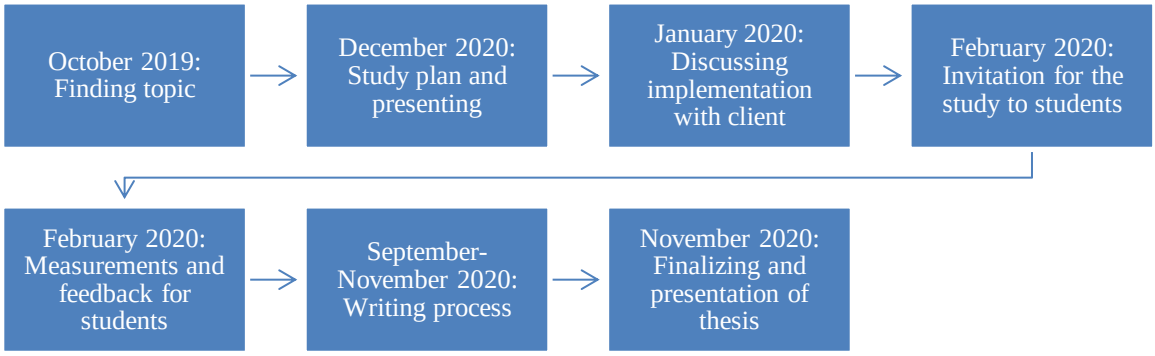


Figure 1. The timeline of the thesis process

This thesis is a quantitative study because the Firstbeat Lifestyle Assessment is shown statistically and numerically.

The reason for using quantitative research method is it analyzes and quantifies variables to find results. It finds answers using specific statistical techniques by implicating both utilization and analysis of numerical data. With this method it can answer questions like what, who, when, where and how much. It describes methods explaining a phenomenon through gathering data in numerical form. (Apuke, 2017, 1).

10 INTERVENTION

The intervention was ready to start in February 2020 after having signed study agreements were signed and every detail of the study and study process was discussed with OLL and CampusMoWe. Invitation emails for the students were sent and once there were enough students willing to participate in the study, it was time to decide on students who would be chosen.

Due to limited amount of Firstbeat devices available, the measurement periods had to be divided into three separate weeks. Another reason for the division was because during the first measurement week there were some measurements that were not successful due to technical issues with the devices. During the second measurement

date there were again some measurements that were unsuccessful due to the same reason. During third measurement period all of the measurements were successful (Table 2).

Due to limited time and COVID-19 pandemic there was no way to perform the missing two measurements. The author and client decided that another measurement would be done during autumn 2020 if the pandemic calms down. During Autumn 2020 the client and author agreed that the missing two measurements were not necessary.
The goal of the research was to get 20 successful measurements but unfortunately due to technical issues with the devices and limited time only 18 were successful.

Information session	**Measurements done**	**Successful**	**Failed**
12.02.2020	9	5	4
19.02.2020	11	7	4
26.02.2020	6	6	0

Table 2. Table of Firstbeat measurements done that were successful and failed

10.1 Satakunta University of Applied Sciences

Satakunta University of Applied Sciences (SAMK) is a university consisting of approximately 6000 students and 400 employees. The university is located in Satakunta region of Finland. The main campus is in Pori, but they also have additional campuses in Huittinen, Kankaanpää and Rauma.
They offer 30 different degree programmes in Finnish and 12 in English. The university is well known for their quality of education and has been ranked one of the best universities of applied sciences in Finland.
The university is very international and have around 200 partner institutions around the world. Every year there are over 300 exchange students and international students

from over 60 different nationalities wondering around campus. (Website of Satakunta University of Applied Sciences)

10.2 Finnish Student Sports Federation (OLL)

OLL is a national service organization and advocacy working to improve on Finnish students' sports. It was found by the Student union of Helsinki School of Economics, University of Helsinki Sports Club, the engineering students ports club, the Student union of the University of Turku and the Student Gymnasts Club in 1924. They offer support services and training. They work on both international and national fields to promote student sports. OLL represents all Finnish higher education students.
The main goal of OLL is to make sure students get enough of physical exercise to maintain and improve student's wellbeing and overall health. (Website of Finnish Student Sports Federation)

10.3 CampusMoWe

CampusMoWe was created and launched in spring 2019 that is funded by the Ministry of Education and Culture. CampusMoWe offers activities and wellbeing services around Satakunta region for students and staff members. Their aim is to promote physical activity and wellbeing by offering diverse and affordable services and products.
Services are meant for students and staff of Satakunta University of Applied Sciences (SAMK), Diaconia University of Applied Sciences (DIAK), University Consortium of Pori (UCPori) and Faculty of Education Department of Teacher education in Rauma. University access code (HAKA-authentication) is needed to be able to access CampusMoWe services and products.
CampusMoWe offers group exercise classes, sport games, workshops and courses weekly that are held by CampusMoWe instructors. Depending on the city of the university they also offer access to the gym services. (Website of CampusMowe)

10.4 Client group

The clients chosen for this study are all students Satakunta University of Applied Sciences. All students of Satakunta University of Applied Sciences were sent an email about the study on February 3rd, 2020 by the author of this thesis. The whole implementation process was done by the author of this thesis. The email included information about the aim and purpose of the study, how will they benefit from it and that only 20 students are chosen. The ones who wanted to participate in the study had to answer a preliminary questionnaire with information about their age, marital status, degree programme, year of studies and physical activity level.
Students who were selected that vary in age, degree programme, physical activity and if they had children or not. The aim was to get comprehensive understanding of student's stress and recovery no matter the background or life situation which is why students were selected.

Approximately 150 students answered the questionnaire and were interested and willing to take part in the study. Since there was a limited number of devices to use per week, each week 6-10 students were emailed which informed that they were selected for the study. The email had details about an information meeting for the following week in premises of Satakunta University of Applied Sciences.

Out of the 18 students who were selected and participated in the study, 12 were females and 6 were males. The average age of the participants was 26 years. The average physical activity level was 3,6/5. Out of the 18 participants 33% were business students, 22% physiotherapy students and the rest 45% were miscellaneous (nursing, social services, engineering, logistics and tourism).
The highest number of participants were 3rd year students (44%). There was an equal amount of both 1st and 2nd year students (28%).

10.5 Information meeting with clients

Once clients had been chosen, they were sent an email for an information meeting date. Due to limited amount of Firstbeat devices only a certain number of

measurements were done in one week. The students were asked to respond by a certain date to determine whether they are still interested in the study and if they were available to come to the information meeting since it was mandatory. They were informed that if a response was not sent two days before the meeting date, unfortunately another student would be chosen for the study. A classroom was booked for meetings and the meeting was held in a classroom in Satakunta University of Applied Sciences.

The meeting had a PowerPoint slide show and would start with information about what is the study is about, what is Firstbeat and how do they benefit from the study. They were instructed the proper use of the device, how to fill the journal and how change electrodes. They were instructed to inform the author in case of any problems with their devices and for example how to charge their device in case it was needed. The participants were given a two-paged information and instruction sheet to take home with them.
The participants were instructed to put on the device the next morning (Thursday), to remove it on Sunday morning and to bring back the device to the information desk in Satakunta University of Applied Sciences latest on Monday afternoon.
By the end of the meeting, they were asked if they still wanted to participate in the study. None of the students refused, everyone was given a consent form to fill in about willing to take part in the study and them giving a permission to use their data anonymously in the study. The students were also given a schedule form where they could book a time for the feedback session to speak about their results.

Once everyone had signed the consent form (Appendix 1), they were all given their Firstbeat devices with 8-10 after they would sign that they had gotten the device. The participants were instructed to inform the author immediately in case of any problems with the device not working.

10.6 Feedback session

Once the clients had used the device, the devices were one by one downloaded and ran through Firstbeat analysis program. The feedback sessions were held the

following week after measurements were performed. The feedback sessions took place in the premises of Satakunta University of Applied Sciences and lasted from 30 minutes to 1 hour in length. The results were shown from the laptop and later on sent through email to the participants.

All the results of the three days were gone through one day at the time in detail, starting from lowest and highest heartbeat. Common topics spoken about during the session were how they felt that day, did they miss filling somethings in the journal and how do they feel about the results compared to how they actually felt during that time. Clients had many questions about what everything meant, how to improve recovery or sleeping and their results in general. All 18 clients participated in the feedback discussion and many were shocked about specific aspects. Here are some comments clients mentioned:

"Oh wow, I felt really tired that morning. It is crazy to see that during that night I actually recovered the best from the 3 days!"

"No wonder I love food so much, since apparently that's the time of the day I recover the best"

11 RESULTS

The results of the 18 successful measurements shows that students stress levels are within normal limits. In the Firstbeat preliminary questionnaire 61% of the 18 students felt stressed.

The results of the measurement showed that average amount of stress reactions during one measurement day among the group was 55%, meaning that the value was within normal limits. Firstbeat states that a value of under 60% of stress reactions per day is normal.

In the Firstbeat preliminary questionnaire 83% reported that their days include recovering moments and breaks. The results of the Firstbeat measurement showed only an average of 5 minutes (Figure 2) of recovery during work which is below normal values. Normal values for recovery during work is over 10 minutes an excellent amount of time of recovery is 30 minutes and above.

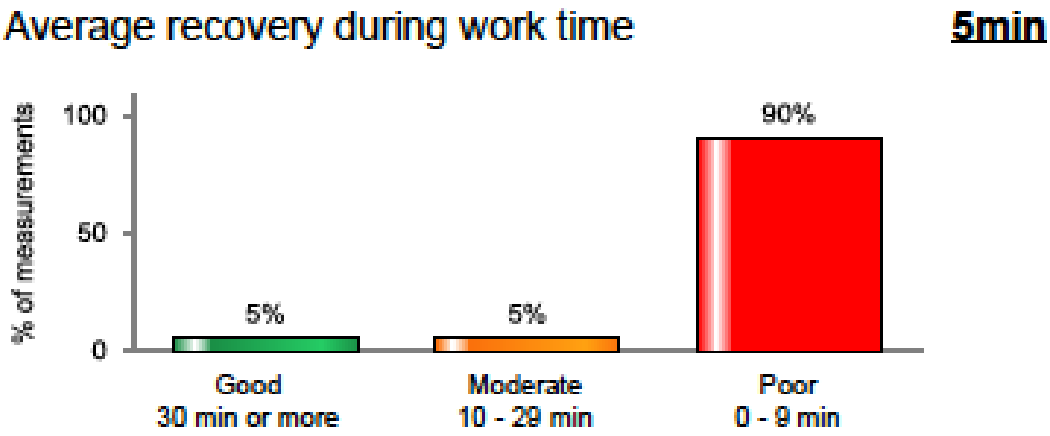


Figure 2. Recovery during worktime (Firstbeat Technologies Oy)

The average amount of leisure time the students had in one day was 12,9 hours. The group average for recovery during leisure time was 47 minutes which is within normal values (Figure 3). Only 25% of students recovered 60 minutes or more very well during leisure time. The majority of students (41%) recovered poorly during leisure time.

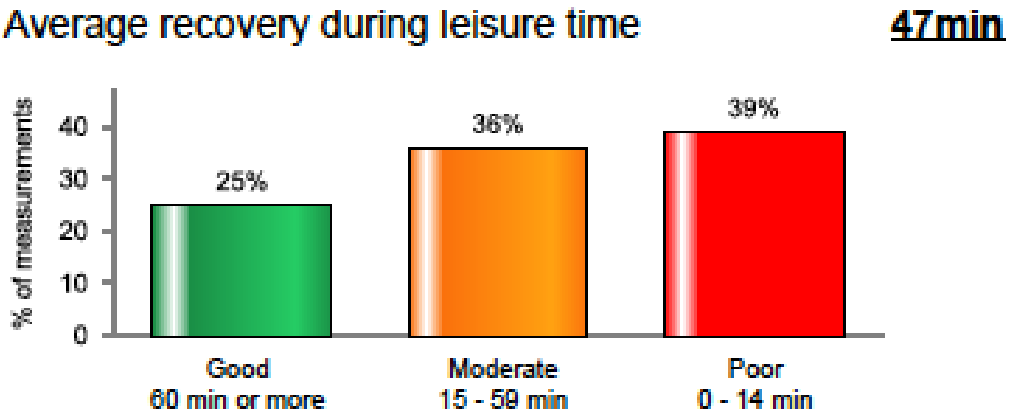


Figure 3. Recovery during leisure time (Firstbeat Technologies Oy)

The average amount of sleep within the group was 8 hours and 19 minutes. 81% of the students slept more than 7 hours a night. Which is within recommendations for a healthy adult. The measurement shows that 36% of students recovered remarkably during their sleep, while in the other hand another 36% of the student's recovery

during sleep was poor, the rest 28% were within normal values. The average recovery percentage during sleep was 58% which is within normal values (Figure 4).

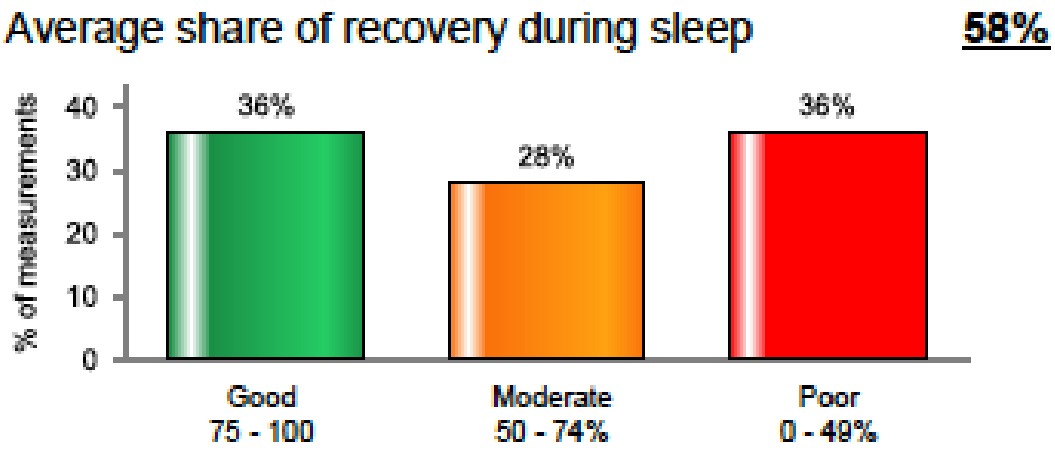


Figure 4. Recovery during sleep (Firstbeat Technologies Oy).

The average quality of recovery during sleep (RMSSD) was 57ms which is on the higher end of normal values. Only 4% was below normal values (Figure 5).
The measurement results show that the balance between stress and recovery are well balanced in 39%, fairly balanced in 33% and poorly balanced in 28% of students.

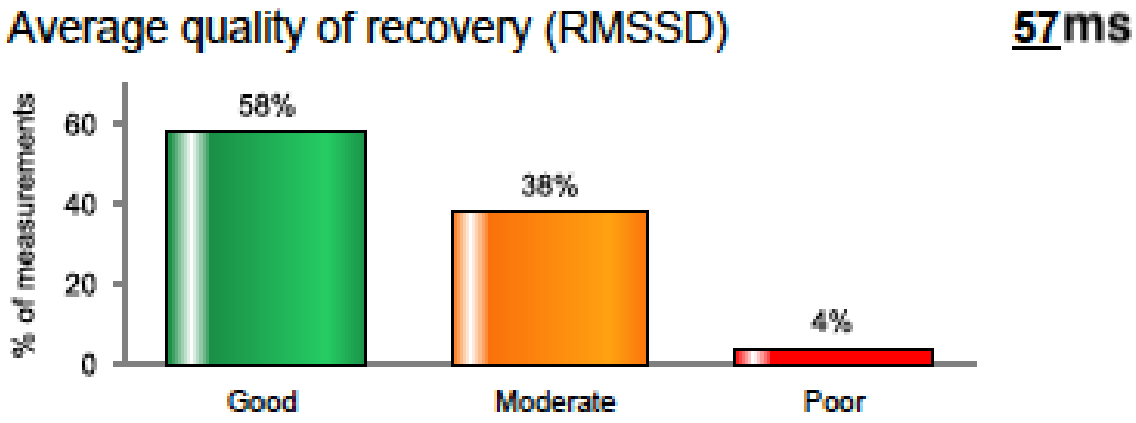


Figure 5. Quality of recovery during sleep (Firstbeat Technologies Oy)

Firstbeats recommendation for recovery in 24 hours is over 30%, the group average was 23% which is below the recommendation value.

12 CONCLUSION

The study does show university students have poor balance with stress and recovery even though stress reactions were within normal limits.
The balance between stress and recovery were well balanced in 39%, fairly balanced in 33% and poorly balanced in 28% of the students. This indicates that there are still factors that affect students over all wellbeing and recovery that should be considered in the future.
Recovery during leisure time was very poor compared to the actual average amount of leisure time students had per day. Recovery during work was below normal values.
When comparing results, students found moments of recovery. Due to marking the journal, we could together figure out the activity they were doing at the specific moments. Some had moments of recovery when reading, watching tv or meditation.

Even though students slept as per normal recommendations the results showed that 36% of students recovered poorly during sleep time. When analyzing results, it was clearly seen that if a student had consumed alcohol the recovery during sleep was poor.
While comparing results it was very clear that ones who were more physically active, younger and did not have any children recovered remarkably better during their sleep time.

This is a great step to improve student's recovery and wellbeing. Even though a certain percentage of the students recover well, there is still as many recovering poorly.

13 DISCUSSION

The implementation and measurements were the most enjoyable part of this thesis process. Which is not a huge surprise due to studying physiotherapy. Making a PowerPoint, handout about information for the students and feedback sessions were very pleasant. Analysing results was very interesting especially when being so interested in physiology, stress and recovery.

This thesis process had a lot of challenges. As mentioned in the thesis the main aim was to have 20 measurements for the thesis but unfortunately there were technical issues in some of the devices. It was quite embarrassing to get back some of the students' devices and find out in some there was measurements from less than a day and missing too much data to even give proper if any feedback. There was alot of frustration and stress during measurements and thoughts of regretting the choosing of the topic just because the issues with the devices.

In total 27 students had measurements done but only 18 were completely successful and had enough data to be used in the study. Nearly 9 students were left empty handed, but luckily the students were very understanding and weren't upset.
When the three measurement periods were over it was already time for my three month clinical practice placement. There was no more time to implement another two measurements that were missing. Another reason was COVID-19 pandemic, the university was closed from all students meaning there was no way to finish the measurements even if clinical practice had not started. Together with OLL we decided that the measurements would be done in the autumn. It was a quite stressful time not knowing if there was any way to finish the two measurements with the COVID-19 pandemic going on. In Autumn 2020, OLL decided that the two measurements were not needed anymore which was a huge relief.

Another challenge was booking of devices. There were plenty of other students during the time also using Firstbeat for their thesis so there were only a limited number of devices available having to divide the work into many separate weeks to get the complete number of measurements.

Was also quite challenging having long days at clinical practice and afterwards having to write the thesis. Even having a proper writing schedule did not help. Some

days would be so exhausting that there was no energy whatsoever to have a clear and concentrated mind to write the thesis. This could have been avoided by actually start writing early on in the summer.
Finding proper and relevant theory was quite difficult due to many articles and books not being available in the library or some relevant references had a fee, which obviously a student can't afford due to limited budget. The search for references took so much time from the writing process that it actually took a lot of time to get proper content on the thesis.

There are many factors that can affect the results. One being that the third measurement group had winter break during their measurement week so there was no study or workdays during the measurement period. The average leisure time with the measured students in the group was nearly 13 hours a day which is quite a lot. University students' schedules vary a lot depending on time of the year and degree programme. If this study was made at a time when everyone would have had almost equal amount of university hours and maybe also work hours the results could have been a lot different.
The three day measurement period is quite short and would be very interesting to do a similar study again.

Even though this thesis process and writing were quite demanding it was very eye-opening experience. I feel like I learned a lot about stress and recovery, and I hope in the future as a physiotherapist I get to do more studies and measurements for different client groups. I feel very confident using the device and with analysing results. I feel like I have enough knowledge now to educate others about stress and proper recovery and their mechanisms.

REFERENCES

Cherry Kendra ‘What is the autonomic nervous system?‘. Verywellmind. 18.04.2020 Referred 7.10.2020 https://www.verywellmind.com/what-is-the-autonomic-nervous-system-2794823

Colten, H. & Altevogt, B. 2006. Sleep Disorders and Sleep Deprivation. Institute of medicine of nationional academies. Referred 14.10.2020 https://www.ncbi.nlm.nih.gov/books/NBK19956/?report=reader

Costa, M. Brookes, S. Hennig, G. 2000. Anatomy and physiology of the enteric nervous system. BMJ Journals 47, 15. https://gut.bmj.com/content/gutjnl/47/suppl_4/iv15.full.pdf

Health Engine. 2010. ‘Sleep Physiology ‘. Referred 27.10.2020 https://healthengine.com.au/info/sleep-physiology

Heikkilä, P. Tikkamäki, K. Rytövuori, S. Ainasoja, M. Oksman, V. 2016. Älä tule paha stressi tule hyvä stressi, 10. Referred 19.10.2020. https://www.vttresearch.com/sites/default/files/julkaisut/muut/2016/Eustress-Ala_tule_paha_stressi.pdf

Hoffman, T. 2020. ‘What is heart rate variability and why does it matter? ‘. Firstbeat Technologies Oy. https://www.firstbeat.com/en/blog/what-is-heart-rate-variability-hrv/

Hye-Geum, K. Cheon, E-J. Bai, D-S. Lee, Y. Koo, B-H. 2018. Stress and heart rate variability: A meta-analysis and review of the literature. Psychiatry Investigation, 235. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5900369/pdf/pi-2017-08-17.pdf

Jaakkola, K. 2018. Palaudu ja vahvistu. Helsinki: Tammi.

Kunttu, K. Pesonen, T & Saari, J. Korkeakouluopiskelijoiden terveystutkimus 2016. Ylioppilaiden terveydenhoitosäätiön tutkimuksia 48. 2016. 35, 83–86. Referred 01.11.2020 https://www.yths.fi/app/uploads/2020/01/KOTT_2016-1.pdf

Liao, Y., Xie, L., Chen, X., Kelly, B. C., Qi, C., Pan, C., Yang, M., Hao, W., Liu, T., & Tang, J. 2019. Sleep quality in cigarette smokers and nonsmokers: findings from the general population in central China. BMC public health 19, 2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6591832/

Liuska, H. 1998. Jaksaako opiskelija?: opiskelijan stressitekijät ja voimavarojen hankinta. Oulun yliopisto. Opintotoimisto.

Mesquita, M. Ferreira, S. Rossini, S. Evelise, A. Reimao R. 2010 Effects of tobacco and alcohol consumption on sleep quality of university students. Neurobiology J. 74, 20. Referred https://www.researchgate.net/publication/236586720_Effects_of_tobacco_and_alcohol_consumption_on_sleep_quality_of_university_students

Oberiri Destiny Apuke. 2017. Quantitive research methods a synopsis approach. Arabian Journal of Business and Management Review 10, 1. https://www.researchgate.net/publication/320346875_Quantitative_Research_Methods_A_Synopsis_Approach

Peltomaa, H. 2015. Stressi, Palautuminen ja Hyvinvointi: Ihmisen mahdollisuudet vaikuttaa kehon- ja mielentilaan. Vaasa: Opintoverkko

Ruokavirasto. 2020. Hyvinvointia ja opiskelukykyä ruokailusta – korkekouluopiskelijoiden ruokailusuositus. Referred 03.11.2020 https://www.ruokavirasto.fi/globalassets/teemat/terveytta-edistava-ruokavalio/ravitsemus--ja-ruokasuositukset/vrn-ja-kela_korkeakouluopiskelijoiden-ruokailusuositus_kasikirjoitusluonnos_19.10.2020_f.pdf

Tuominen, S. 'Miksi muka alkoholi ei sovi kuntoilijalle?'. Firstbeat Technologies Oy. 2020. Referred 29.10.2020 https://www.firstbeat.com/fi/blogi/miksi-muka-alkoholi-ei-sovi-kuntoilijalle/

Tuominen, S. 'Sympaattinen ja parasympaattinen hermosto – kehon kaasu ja jarru'. Firstbeat Technologies Oy. 2020. Referred 29.10.2020 https://www.firstbeat.com/fi/blogi/sympaattinen-ja-parasympaattinen-hermosto-kehon-kaasu-ja-jarru/

Tuppurainen, J. 2020, Hyvinvoinnin ammattilaisen opas. Firstbeat Technologies Oy. Referred 5.11.2020 https://www.content.firstbeat.com/hyvinvoinnin-ammattilaisen-opas?_ga=2.193152045.1081886840.1605476758-1341463711.1605211017

Vartiovaara, I. 2004. Voimaa eustressistä. Kustannus Oy: Duodecim

Website of CampusMowe. 2020. Referred 01.11.2020 https://campusmowe.fi/en-gb/services/70/

Website of CampusMowe. 2020. Referred 01.11.2020 https://campusmowe.fi/en-gb/article/front-page/what-is-campusmowe/4/

Website of CampusMowe. 2020. Referred 01.11.2020 https://campusmowe.fi/en-gb/to-whom/campusmowe/74/

Website of Finnish Student Sports Federation. 2020. Referred 01.11.2020 https://www.oll.fi/en/oll/history/

Website of Firstbeat Technologies Oy. 2020. Referred 28.10.2020 https://www.firstbeat.com/fi/fysiologia/tieteellinen-tausta/

Website of Firstbeat Technologies Oy. 2020. Referred 29.10.2020 https://www.firstbeat.com/fi/yritys/

Website of Firstbeat Technologies Oy. 2020. Referred 29.10.2020 https://www.firstbeat.com/fi/yritys/tarina/

Website of Firstbeat Technologies Oy. 2020. Referred 29.10.2020 https://www.firstbeat.com/fi/fysiologia/sykevaihtelu/

Website of Firstbeat Technologies Oy. 2020. Referred 26.10.2020 https://www.firstbeat.com/fi/fysiologia/stressi-palautuminen/

Website of Hardvard Health Publishing. 2020. Referred 26.10.2020 https://www.health.harvard.edu/staying-healthy/understanding-the-stress-response

Website of National Institute of General Medical Sciences. 2020. Referred 25.10.2020 https://www.nigms.nih.gov/education/fact-sheets/Pages/circadian-rhythms.aspx

Website of NHS. 2020. Referred 02.11.2020. Referred 06.11.2020 https://www.nhs.uk/live-well/quit-smoking/stopping-smoking-mental-health-benefits/

Website of Satakunta University of Applied Sciences. 2020. Referred 01.11.2020 https://www.samk.fi/en/about-samk-2/

Website of Satakunta University of Applied Sciences. 2020. Referred 01.11.2020 https://www.samk.fi/en/study/choose-satakunta-university-of-applied-sciences/

APPENDIX 1

Suostumus tutkimukseen osallistumisesta

Tutkimuksen nimi: Korkeakouluopiskelijoiden palautuminen – Firstbeat mittaus

Tutkimuksen hankkija: Opiskelijoiden liikuntaliitto ry

Tutkimuksen tekijä: Saara Benlamine

Tässä tutkimuksessa tehdään Firstbeat mittaus 20 opiskelijalle. Tutkimuksessa selvitetään korkeakouluopiskelijoiden stressin määrästä, palautumisesta ja aktiivisuudesta. Tutkijana toimii Satakunnan ammattikorkeakoulun (SAMK) kolmannen vuoden fysioterapia opiskelija Saara Benlamine ja tutkimus on osa hänen opinnäytetyötänsä.

Opiskelija käyttää Firstbeat-laitetta 2+1 päivää ja aktiivisesti päivittää päiväkirjaa. Opiskelija palauttaa Firstbeat-mittarin SAMK Porin kampuksen infoon nimellä Saara Benlamine (muista mainita myös oma nimesi) viimeistään maanantai iltana **(xx.xx.2020).**

Minulle on selvitetty yllä mainitun tutkimuksen tarkoitus ja tutkimuksessa käytettävät tutkimusmenetelmät. Olen tietoinen siitä, että tutkimukseen osallistuminen on vapaaehtoista. Olen myös tietoinen siitä, että tutkimukseen osallistuminen ei aiheuta minulle minkäänlaisia kustannuksia, henkilöllisyyteni jää vain tutkijan tietoon, minua koskevaa aineistoa käytetään vain kyseiseen tutkimukseen ja aineisto hävitetään tutkimuksen valmistuttua.

Voin halutessani keskeyttää tutkimukseen osallistumisen, milloin tahansa ilman, että minun täytyy perustella keskeyttämistäni.

Päiväys _____

Tutkittavan allekirjoitus ja nimenselvennys _____