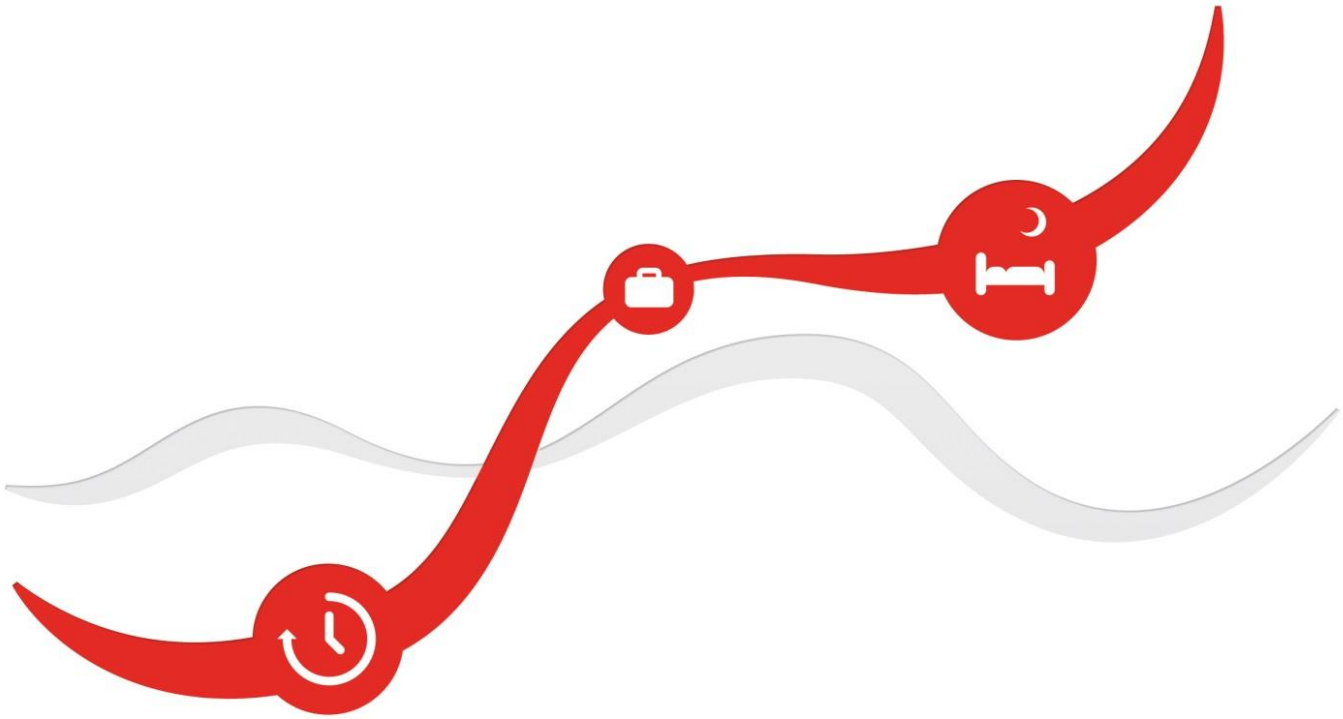


Firstbeat Lifestyle Assessment

Guide for professionals

June 2016

Contents

Editing
Firstbeat Technologies Oy

The Lifestyle Assessment's Guide for professionals is intended for wellness and health professionals, utilizing the Firstbeat Lifestyle Assessment in instructing how to use the Lifestyle Assessment for promoting the client's well-being. Instructions for the technical use of the Lifestyle Assessment can be found in the Lifestyle Assessment's Guide for users under Learning Center, and for the interpretation of reports in the Report interpretation guide.

1. Lifestyle Assessment – a tool for wellness and fitness professionals

The Lifestyle Assessment is a tool designed for wellness and fitness professionals for the evaluation of stress, physical activity and recovery. The Lifestyle Assessment tool assists in finding the best individual methods for stress management, better recovery and correct methods of exercise. A 24-hour analysis provides a profile on lifestyle issues that support or exhaust well-being and assists in finding the reasons behind stress or weak recovery.

The Lifestyle Assessment is based on a computer program which analyses heart rate data and recognizes physiological states in the heart rate variability (Figure 1).

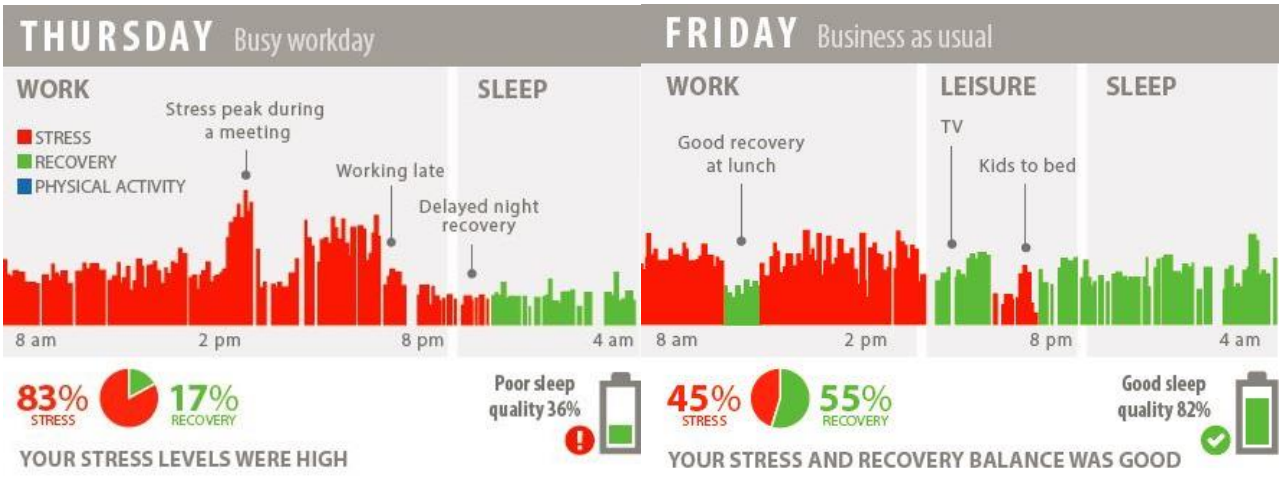


Figure 1. An example of the results of a Lifestyle Assessment.

1.1 Benefits and applications

Lifestyle Assessment assists in verifying stress factors, the sufficiency of daily recovery and sleep, and the health and fitness effects of physical activity. On the basis of the results, the client is provided with recommendations for actions to be taken and, if necessary, referred to further examinations.

The aim of the Lifestyle Assessment is the early detection of signs of stress, more effective allocation of actions, motivation of the client to making lifestyle changes, and a decreasing of costs incurred by stress and illness.

Benefits of the Lifestyle Assessment:

Person being assessed:
- Indicates the factors affecting well-being, both during work and leisure time.
- Assists in finding a balance between being active and resting.
- Helps in managing stress, improving recovery and in exercising correctly.

Employer:
- Decreases costs incurred by stress and being ill.
- Indicates the company's development targets and assists in allocating well-being investments correctly.
- Offers the employees tips on coping at work and managing stress.

Service provider:
- Offers in-depth and comprehensible information on the client's daily life and motivates them to make changes.
- Assists in finding the best individual methods for stress management, sufficient recovery and correct methods of exercise.
- Aids in making the provider stand out and produce good well-being coaching.

1.2 Stages of the Lifestyle Assessment

The Lifestyle Assessment typically includes three-day heart rate measurements, feedback and recommendations for action, and possible follow-up (Figure 2).

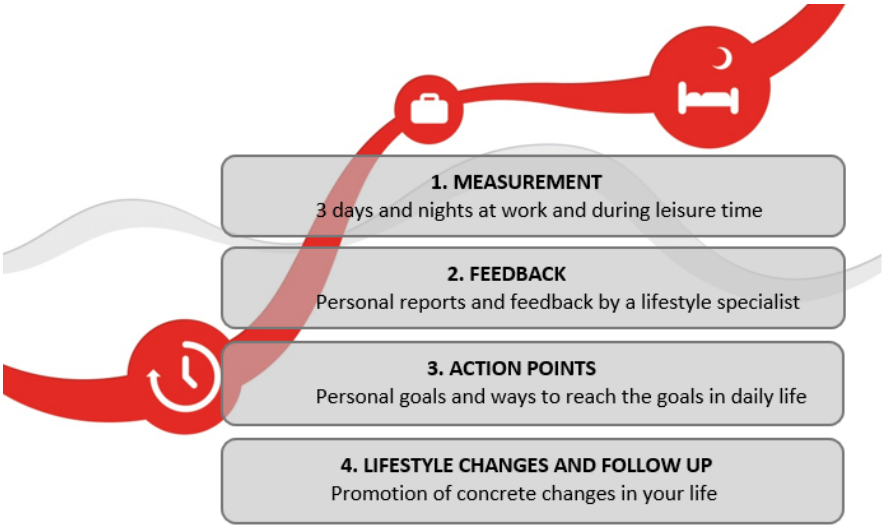


Figure 2. Stages of the Lifestyle Assessment.

The client implements the measurements independently, according to instructions. The specialist analyses the heart rate data and creates reports, using the Lifestyle Assessment online application. The client receives a Lifestyle Assessment report and a specialist's feedback on the results. Finally, the personal goals are set and the recommendations for actions to be taken are examined. A follow-up can be used for verifying that goals are reached and that actions are effective.

1.3 Ethical guidelines for the Lifestyle Assessment

- Lifestyle Assessment reports are not handed over to the person being assessed without the specialist's feedback. The Specialist report should not be given to the client at all, as it is only intended for the specialist.
- The feedback on the results can only be given by a specialist who has participated in the Firstbeat training.
- The person providing the feedback must treat all client results and mutual conversations as confidential.
- The results will not be disclosed to any third parties.
- The specialist aims to maintain his or her competence by utilizing the Lifestyle Assessment support material (the Learning Environment, webinars and user guides) and to attend training sessions and seminars organized by Firstbeat, whenever possible.

2 Implementation of measurements

2.1 Planning of a measurement project

Before starting the Lifestyle Assessment measurements, it is good to plan beforehand:

- On which days will the measurements be implemented?
  - A typical measurement evaluation period is three days, including two working days and one leisure day (for example, from Thursday to Sunday or from Sunday to Wednesday). The measurement began directly after waking up and ended three days later after waking up.
  - Longer measurement periods are also possible. For example, measurement periods in excess of three-days are recommended for shift workers, so that the evaluation would include different shift types.
- How will the measurement devices be delivered to the persons to be evaluated or will an initial information session be arranged jointly for them?
  - In group evaluations, an initial information session is a good way of distributing the devices and going through the measurement instructions and schedule.
  - In the evaluation of individuals, the measurement device can be mailed to the person being assessed or the person can pick-up the device from the service provider.
- When and how will the person being assessed return the measurement device?
  - The measurement devices must be returned to the service provider in good time before the feedback session, and in group evaluations at the latest a few days in advance.
  - For example, the person being assessed can return the device to the service provider, either in person or in a return envelope with prepaid postage.
- Will the feedback be given as individual or group feedback, and when will the feedback session be organized?
  - Individual feedback is recommended when there are only a few people being evaluated.
  - In larger group assessments, group feedback will save time and money, and will also enable a more versatile discussion.
- What types of potential further actions are recommended with regard to poor or divergent results?
  - Based on the results, a person can be referred, for example, to stress-management, weight-management or exercise groups, to occupational health care or a health examination.
  - If necessary, the client must be referred to more specific tests with a physician, for example.

2.2 Bodyguard 2 measurement tool

Bodyguard 2 is a measurement tool developed by Firstbeat for performing the Lifestyle Assessment measurements (Figure 3). The device is attached to the skin with two electrodes and starts recording automatically when attached. Bodyguard 2 enables a continuous assessment of up to six days. Bodyguard 2 records R-R interval and movement data.

Figure 3. The Bodyguard 2 measurement device is an easy-to-use R-R interval recording device designed for the Lifestyle Assessment measurements.

Technical specifications of the Bodyguard 2 measurement device:

- Rechargeable battery with a battery life of approximately six days
- Storage capacity of more than 20 days
- IP class IP52
- Weight 24 g
- Measurement accuracy for heartbeat recording 1 ms (1,000 Hz)
- Data uploading and battery charging is done via the computer's USB port.
- The device is **not** waterproof!

2.3 Whose data can be measured?

A Lifestyle Assessment can be performed on nearly all those interested in their health, well-being and in enhancing their level of fitness. However, there are cases where the rationality of measurements needs to be considered in order to reach correct results and conclusions.

Illnesses

Measurement is not recommended for persons who have a cardiac pacemaker, have undergone a heart transplant, or suffer from severe cardiac disease, continuous atrial fibrillation or flutter, or an unmanaged thyroid disorder, because the results of the Lifestyle Assessment can then be unreliable. If you have a fever, it is best to postpone the measurement.

The Lifestyle Assessment is used for the purpose of promoting well-being; it is not intended for the diagnosis of illnesses.

Medication

Some medications, such as beta blockers, affect the heart rate and might thus misrepresent

the results of the Lifestyle Assessment. Asthma and allergy medication, long-acting sleep medicines and strong painkillers can also affect the heart rate and, thus, also the analysis results. The more illnesses and medication the client has, the more difficult it is to obtain reliable result interpretations. It is for the specialist to decide whether he or she would recommend a Lifestyle Assessment for a client with several illnesses and medication.

Pregnancy

Pregnancy does not prevent performing a Lifestyle Assessment, but comparison of the results with the reference values is not sensible. After the first trimester, measurements are not recommended as the physiological changes related to pregnancy (such as increased heart rate level, weight gain, and hormonal changes) can have a significant effect on the results. The changes and possible nausea of early pregnancy can also affect the results. The foetal heart rate does not affect the mother's heart rate signal, so in this respect the pregnancy does not interfere with the R-R interval measurement.

Children

A Lifestyle Assessment can be performed on a child, but in the development phase of this assessment method, the test persons were of 15 to 70 years of age, so the reference values in the reports have been created with this age group in mind. The method is best suited for use within the relevant group, but measurements have been carried out successfully for younger and older people as well.

Contraindications for measurement

In the following cases, measurements are forbidden or they are not recommended:

- When swimming or going to the sauna, because the Bodyguard measurement devices are not waterproof.
- In certain industrial areas requiring an ATEX approval, heart rate monitoring devices are not allowed unless they are also ATEX approved.
- During air travel, measurements are not recommended due to tightened security regulations. If measurements still need to be performed, it is recommended that the Bodyguard is removed from the body for the duration of the security check.
- In some sports, regulations do not allow the use of heart rate monitoring devices (such as self-defense sports and team sports). Use of a measurement device in a competition situation needs to checked with the referee.
- If the client has a cardiac pacemaker or has undergone a heart transplant, the results of a Lifestyle Assessment can be considered unreliable.

2.4 Individual or group measurements?

A Lifestyle Assessment can be performed, either as an individual assessment or as a group assessment. A group assessment saves time in all stages of implementation of measurements. Group-reporting requires at a minimum a group of five, but technically, just three persons can form a group for a Lifestyle Assessment. Preparation and analysis of the measurements in the Lifestyle Assessment software is faster to implement as a group assessment than an individual

assessment. With groups of less than five persons, it is best to consider whether the feedback session will be organized as a group or individual feedback session.

Things to consider in group assessments:

- Creation of a group report requires a minimum of five persons (15 measurement days) in order for the results of a group report to be presented publically (Figure 4). The rule is that you should not be able to differentiate an individual person from the results!
- The group reporting will only include successful measurements (less than 15% of measurement errors, recommended measurement duration 24 hrs +/- 4 hrs).
- In addition to the group feedback, the client must also have the possibility to ask personal questions regarding his or her results.

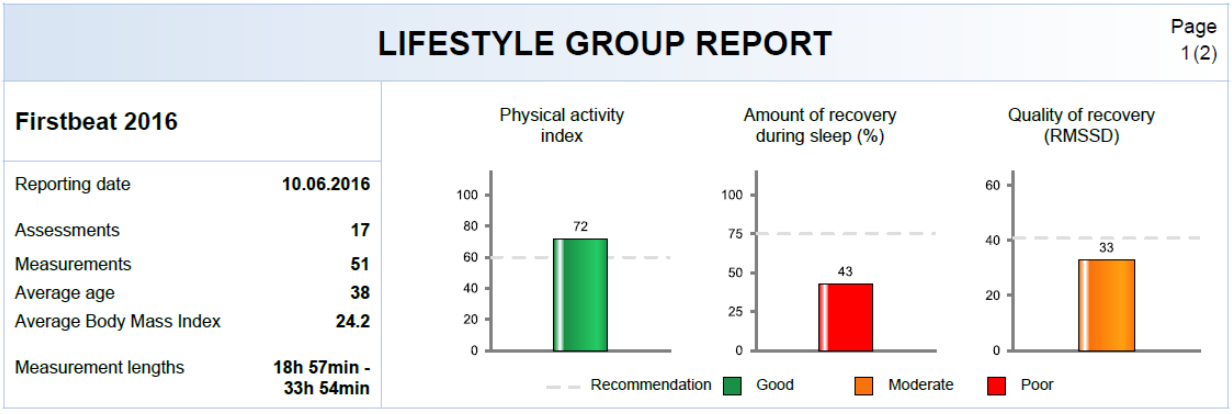


Figure 4. There are several different group reports available in the Lifestyle Assessment.

2.5 Implementation of measurements

<u>The specialist's tasks before starting measurements:</u>

- Gather the names and e-mail addresses of persons to be assessed (if necessary, mailing addresses to where measurement devices will be sent).
- Create (group) and profiles for those to be assessed in the Lifestyle Assessment.
- Charge and prepare the measurement devices. Read the instructions from the Guide for users.
- Deliver to the client a Bodyguard 2 measurement device, electrodes (at least 8) and a cover letter with instructions for the measurement process. The cover letter can be downloaded in the Learning environment under Implementation of measurements.
- Deliver the measurement devices to the persons being assessed, either during the initial information session or by mail. You can utilize the Initial information video and the Initial information presentation during the initial information session by downloading them from the Learning environment.

Tasks of the person being assessed (performing the measurement)

- The person being assessed starts the measurements at the scheduled time directly after waking up.
- At the beginning of the measurement period the client receives an e-mail message with a link for completing obligatory personal information and a journal.
- The measurement device is not waterproof, so the device must be taken off during bathing and swimming.
- The person being assessed stops the measurement on the scheduled date in the morning after waking up and returns the measurement device to the service provider by the agreed upon date. Refer to the How to start the measurement video.
- After the measurement, the person being assessed receives a personal report and the specialist's feedback.

The specialist's tasks after the measurements

- Make sure that the measurement devices are returned by the agreed upon return date and, if necessary, remind the persons being assessed to return the devices.
- Analyze the heart rate data and create the reports. Read further information from the Guide for users.
- If, for some reason, the measurement fails, agree with the person being assessed on a new measurement period. Example: Send an e-mail to the client on the failing of the measurement
- Provide the feedback and agree on possible further actions.

2.6 Actions when measurements have failed

The failure of heart-rate measurements can be due to various different reasons, such as the measurement device itself or problems related to its use or other external interference. If measurements fail or there are more than 15% of incorrect measurements on several days, please act as follows:

- Try to find out what has caused the measurement to fail (e.g., is there a technical fault in the measurement device, has the device been operated incorrectly or is the failure due to the abnormal functioning of the client's heart).
- The operation of the measurement device can be tested by performing a test measurement on yourself for a few hours. If the measurements succeed without failure, the measurements that failed previously were most likely not caused by a technical fault of the device.
- New measurements will be performed for the client (if he or she so wishes), but the measurements will be performed by using another device than before.
- If the measurements fail for a second time and no cause is detected for, e.g., the client's large measurement error rate, an ECG examination can be recommended for the client to exclude the possibility of an abnormal heart function.
- If two sets of measurements have failed, a third measurement is not recommended.

3 Interpretation of results

The reports will assist in stating the central conclusions on stress, recovery and physical activity, and establishing the daily choices which will support or consume recovery resources. The aim is to identify individual stress factors and resource factors which will then be used for planning suitable actions for the client's situation in life.

The Lifestyle Assessment reports will, for example, answer the following questions:

- Is the sleep period sufficiently long and restorative?
- Is the balance between stress and recovery optimal?
- Are there moments of recovery during the day?
- Is there enough exercise for the purpose of a) health b) improving the person's fitness?
- Can an increase in resources be seen?

3.1 Is the sleep period sufficiently long and restorative?

Sleep is the day's most important period of recovery. Too little sleep or sleep that does not provide sufficient recovery exposes a person to illnesses and weakens his or her performance. The body can withstand individual nights of sleep that do not provide sufficient recovery, but if the situation drags on, the risk of overload increases (Figure 5).

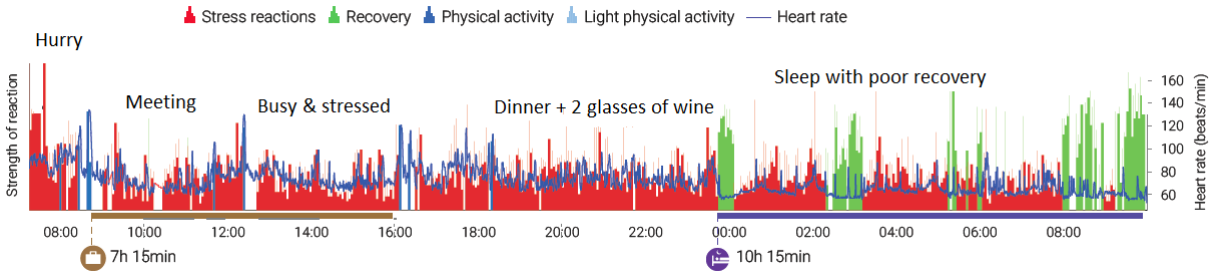


Figure 5. The Lifestyle Assessment will establish whether the body recovers during sleep.

The sleep periods will be examined in the Lifestyle Assessment from four different viewpoints: the quality of sleep reported by the person being assessed, the length of the sleep period, the amount of recovery, and the quality of recovery during the sleep period.

<u>The length of the sleep period</u>

According to recommendations, a sufficient length of a sleep period is seven hours, but the need for sleep is individual and varies on the basis of the stress level (Figure 6). As the stress increases, the need for sleep usually increases rather than decreases, but we still tend to go short of sleep during hectic times. During the feedback discussion, it is good to ask the client what his or her personal need for sleep is and to evaluate the length of the sleep period in comparison to the normal need and the current stress level.

Figure 6. The Lifestyle Assessment will establish whether the length of the sleep period is sufficient with regard to recommendations. The length of the sleep period means the time marked in the measurement journal between going to sleep and waking up.

Amount of recovery from the sleep period

The amount of recovery from the sleep period should be more than 75% (Figure 7). If the amount of recovery is less than 75%, it is important to establish the factor(s) weakening recovery. It is also important to evaluate whether it is a question of an acute or a chronic stress factor. The most common factors weakening recovery are:

- Alcohol
- Stress
- Illnesses
- Pain and infection
- Chronic sleep deprivation
- Overweight and poor physical condition
- Physical overload (such as strenuous exercise in the evening)
- Menopause

Figure 7. At least 75% of the sleep period should consist of recovery. If the amount of the recovery is less than 75%, it is important to establish the stress factors behind this.

Quality of recovery

The quality of recovery is based on the RMSSD value calculated on the basis of heart rate variability (Figure 8). Lower values during sleep indicate poor recovery, higher values better recovery. In addition to stress factors, age and genome affect heart rate variability. The reference values for the quality of recovery decrease as a person ages. The limit which is still considered good equals the heart rate variability average of people who are of the same age and gender.

Figure 8. The quality of recovery during a sleep period is based on the RMSSD value calculated on the basis of heart rate variability. A good result is a value which is higher than the average of people your own age.

Criteria of a sleep providing recovery:

- The amount of recovery from the sleep period is more than 75%.
- Recovery already starts before going to bed or soon after it (Figure 9).
- The quality of recovery is good in relation to that of people the same age.
- The length of the sleep period is sufficient with regard to the individual need (recommendation > 7 hrs).

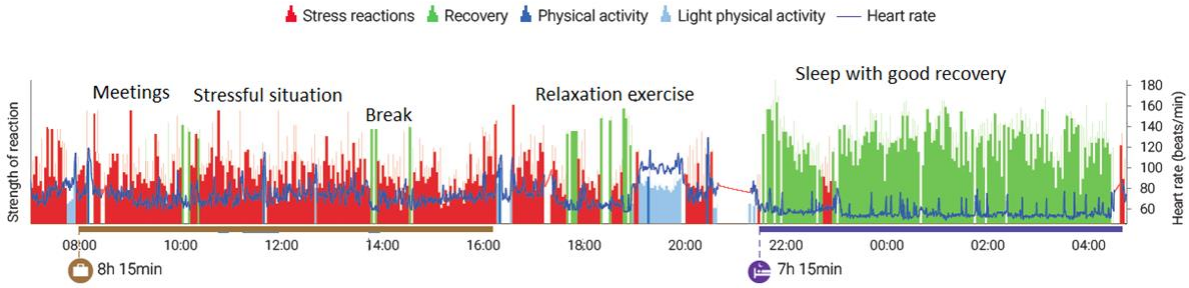


Figure 9. Recovery already starts before going to bed and continues for the entire night.

3.2 Are the stress and recovery in balance?

A good amount of recovery per day is more than 30% (Figure 10). If the length of a sleep period is more than seven hours and the sleep provides recovery, the daily recommendation of recovery is usually fulfilled. In a period of three days, there should be at least 30% of recovery on at least one day. The average amount of recovery is 26% per day (Firstbeat 2016).

A normal amount of stress reactions in a day is 40–60%. A stress reaction means an increased state of alertness which does not need to be eliminated, but there should be enough recovery to counterbalance this. On average, the share of stress reactions per day is 50% (Firstbeat 2016).

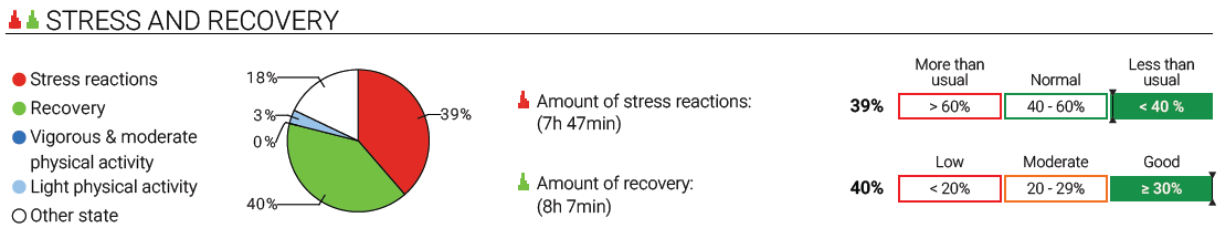


Figure 10. A good amount of recovery per day is at least 30%. A normal amount of stress is 40–60% per day.

3.3 Are there moments of recovery during the day?

There should be at least short moments of recovery during the day (Figure 11). Even a short moment of recovery during a work day is a positive thing. Relaxing brings pleasure and improves your alertness and work efficiency. It is essential to examine a day, and see whether there is recovery whenever it is possible. Before going to sleep, it is important to prefer methods that lower your alertness, such as relaxation exercises or reading.

Good methods for inducing calmness and relaxation include:

- relaxation exercises, breathing techniques, meditation, mindfulness
- reading, listening to music, watching television
- sudokus, crossword puzzles, knitting, handicrafts
- naps

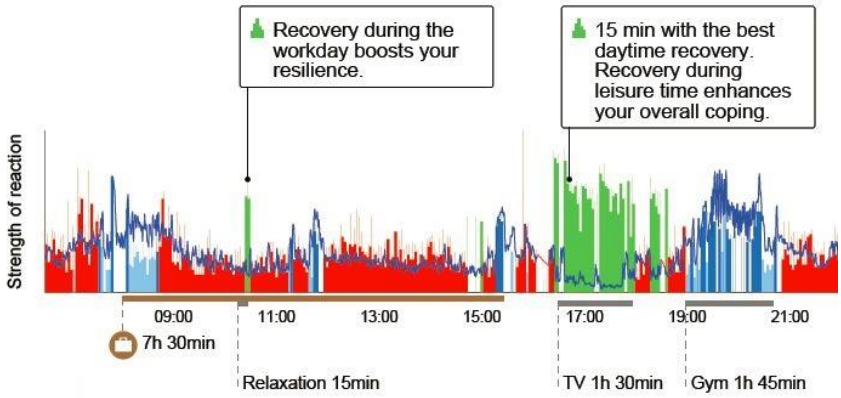


Figure 11. The moments of recovery during a day do not need to be long, but it is important that there are such moments both during and after the work day.

3.4 Is there enough exercise for the purpose of health and improving a person's fitness?

According to exercise recommendations, there should be at least 30 minutes of brisk endurance exercise at least five times a week or, alternatively, 75 minutes of strenuous exercise, for example, divided into shorter periods. In addition, muscular strength and mobility should be trained at least twice a week. This amount is the minimum in order to maintain your health. The benefits will increase, if the amount of exercise is doubled.

The **exercise points** in the Lifestyle Assessment sum up the effects of exercise on your health during a day. The points accumulate on the basis of exercise duration and effectiveness, such that lighter (low impact) exercise needs to be longer in duration than harder exercise (high impact) (Figure 12).

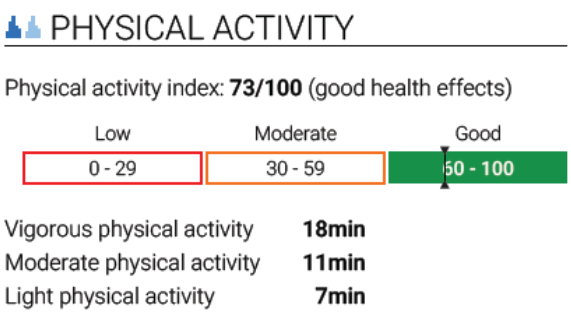


Figure 12. The exercise points sum up the exercise practiced during the day and indicate what kinds of health effects were attained with the exercise.

In order to reach a good result (60 points), one should do moderate physical activity for, e.g., 30 minutes. (Figure 13). The Lifestyle Assessment is best suited for analyzing effects targeted at the cardiovascular system. The Lifestyle Assessment does not consider, for example, the effects of power or mobility training.

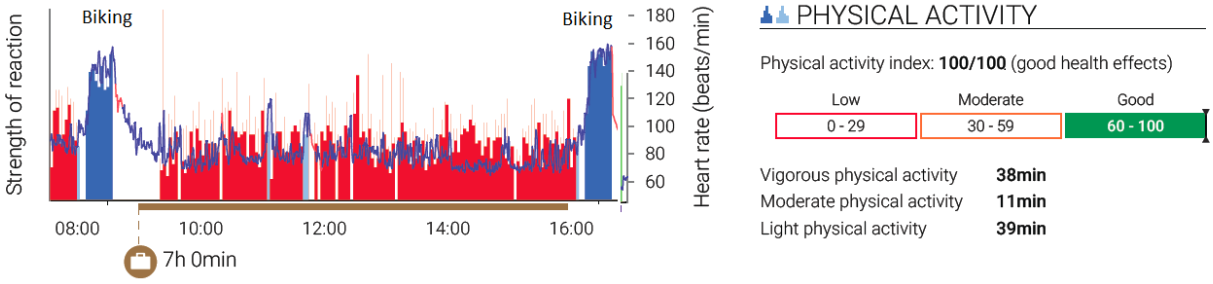


Figure 13. A 30-minute bicycle ride to work and back accumulated a total of 100 physical activity points and produced significant health effects.

Light physical activity means a low-intensity physical load during which the intensity is under 40% of the estimated maximal capacity. It is good to have some light physical activity each day, because it improves your metabolism and acts as an excellent recovery exercise. On its own, however, it is not sufficient to improve your fitness. Excellent light physical activities include, e.g., household activities, brisk walking, heavy household and gardening work, picking berries in the forest, and hunting.

Moderate physical activity means physical loading during which the intensity is 40-60% of the estimated maximal capacity. This type of physical activity provides health effects for the respiratory and cardiovascular system, the musculoskeletal system, and the lipid and glucose balance of the blood.

Vigorous physical activity means very strenuous physical exercise which causes breathlessness and during which the intensity is more than 60% of the maximal capacity. This type of physical activity has significant effects on the health of the heart, vascular system and the lungs. Improvement of physical fitness also improves the ability to recover (Figure 14).

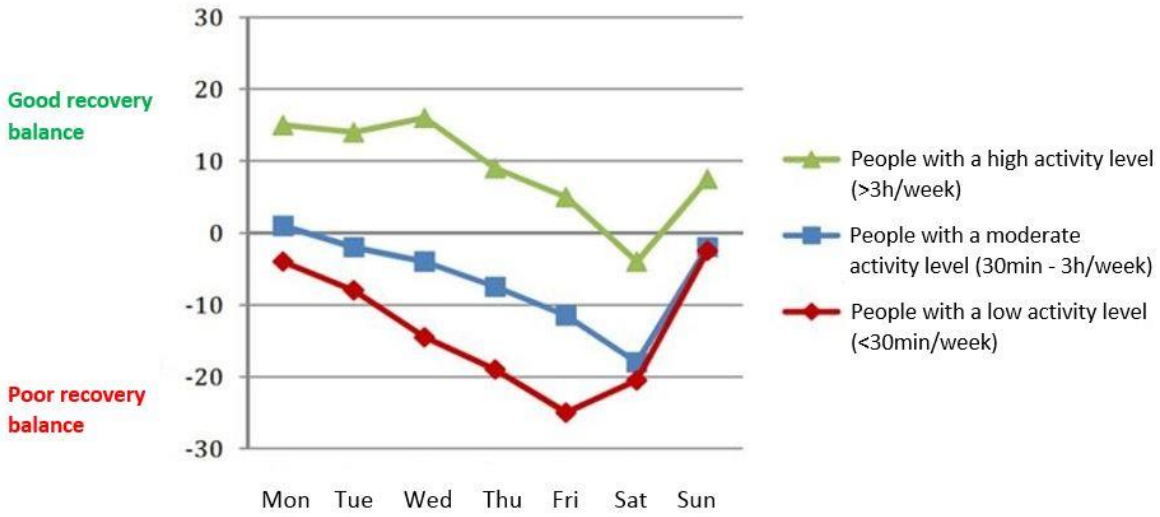


Figure 14. Those who exercise actively, also recover better each day than those who exercise less. Source: Firstbeat

The **training effect** indicates the effect of the exercise on the improvement of fitness. The scale of the training effect is 1–5, such that 1 indicates light exercise and 5 indicates a temporarily overloading form of exercise (Figure 15).

Figure 15. The five-step scale of training effects.

The training effect is determined according to an EPOC value calculated on the basis of oxygen consumption. EPOC (Excess post-exercise Oxygen Consumption, indicated as ml/kg) is a measurement unit for describing the capacity of a physical activity performance. The harder and longer you exercise, the higher the EPOC value and the greater the attained training effect.

In addition to the EPOC value, the activity class also influences the training effect (Figure 16). The higher the activity class (i.e., better fitness condition), the higher the EPOC value needs to be in order to receive the same training effect from the same exercise as a person in weaker condition.

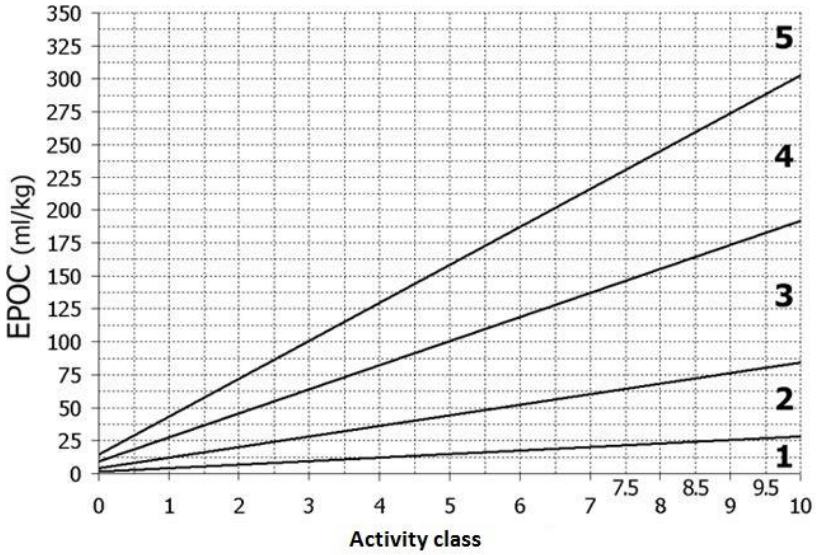


Figure 16. The higher the activity class, the higher the EPOC value needs to be in order to receive the same training effect. For example, in order to obtain a training effect (2) which maintains fitness in activity class 1, an EPOC value of approx. 10 ml/kg is sufficient, and with an activity class of 10 (top-condition athlete), the same training effect requires approx. 90 ml/kg.

The Lifestyle Assessment guides you in exercising correctly in relation to your fitness and recovery status. Some people exercise repetitively too lightly, some exercise with excessive capacity (Figure 17). Exercising should be scheduled in a versatile manner, such that at times you do lighter exercise which maintain fitness and at times you do more vigorous exercise which improve fitness. Vigorous exercise will weaken recovery acutely, but in the long term, it will improve your fitness and ability to recover. Vigorous exercise performed too often will cause a state of overload.

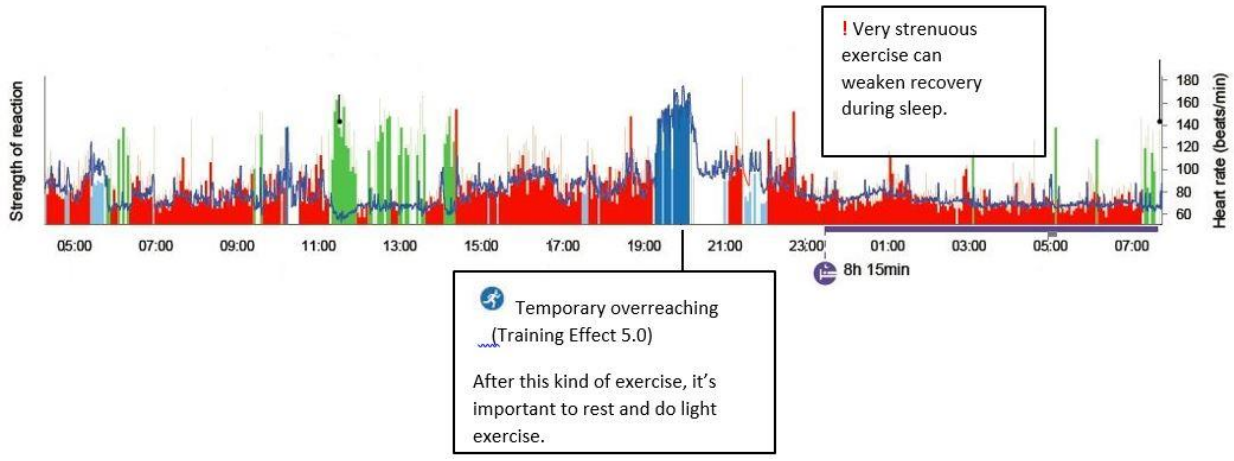


Figure 17. A 44-year old overweight male in poor condition started to exercise again after many years. His exercises were too stressful in relation to his fitness, which significantly weakened his ability to recover. In order to avoid a state of overload, the capacity of his exercises was decreased and the training was scheduled better.

If the results of the Lifestyle Assessment differ from the exercise capacity experienced by the client, the following matters should be checked:

- On what level has the heart rate been during the physical activity? Unless the heart rate is clearly above 110, the capacity of the physical activity has not been sufficient.
- Does the client have medication that affects the heart rate? Beta blockers lower the maximum heart rate and tend to underestimate the amount of exercise considerably, unless the maximum heart rate is decreased lower than estimated for the client's age.
- Is a person's maximum heart rate correct? If the maximum heart rate evaluated based on age significantly differs from the person's actual maximum heart rate, the intensity of the exercise will be distorted. A higher maximum heart rate than the rate evaluated based on age will overestimate the amount and intensity of the exercise, and a lower maximum heart rate than the rate evaluated based on age will underestimate them.
- Does the physical activity consist of endurance exercise or power or mobility training? If a client has completed, for example, an exercise that improves maximum force, the report will only indicate the effect on the respiratory and cardiovascular system, not any strength characteristics. The same also applies to yoga and Pilates which do not significantly load the respiratory and cardiovascular system, but are excellent exercise methods for improving muscular balance, body control and mobility.

It is important to ask the client about his or her typical weekly amounts of physical activity. The client can exercise enough and in versatile ways, even if there has been no physical activity during the measurement days. The guidance in exercise-related issues will then focus on other things than the guidance for those who only exercise irregularly.

3.5 Can an increase in resources be detected?

The body's ability to respond to external and internal stress factors is called **resources**. Resources increase during recovery, and stress decreases the resources.
The resource diagram indicates the effects of the measurement period on the resources (Figure 18).

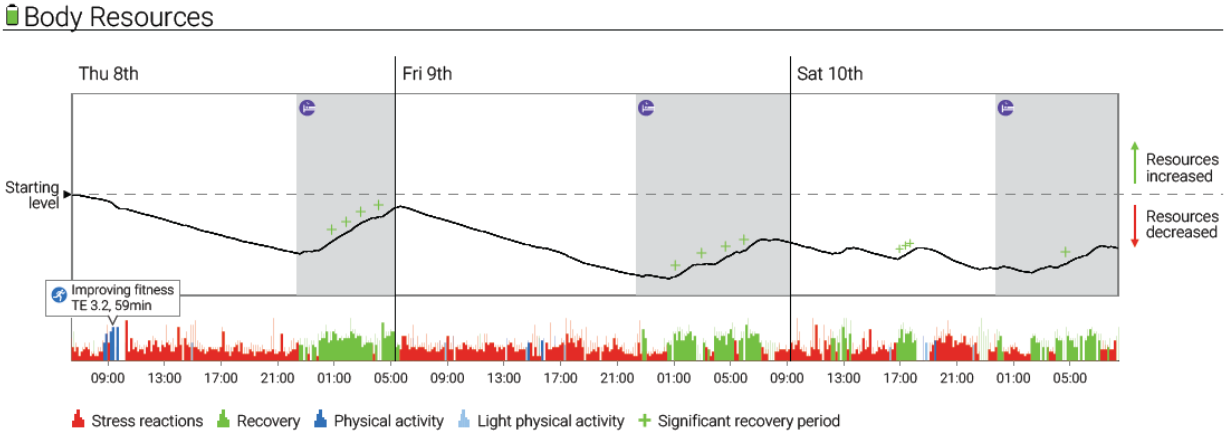


Figure 18. An ascending graph indicates an increase in resources and a descending graph indicates a decrease. The purpose of sleep is to accumulate resources. In an ideal situation, resources increase during the measurement period (the resource graph ends above the centre line in the right edge of the diagram).

A temporary decrease in resources, for example, due to nights of poor sleep, hard training or short-term stress does not need to be eliminated. When you take care that you are able to recover sufficiently after an unusually stressful period, the stress and rest will remain in balance.

If the measurement days depict typical days in your life and the resources decrease continuously, the risk of falling ill increases. In a stressful situation in life, identifying individual stress factors and affecting them helps in attaining a better resource balance again. Regular recovery, healthy nutrition, good physical condition and efficient stress management support good health and the increasing of resources.

3.6 When will the client be referred for further tests?

The Lifestyle Assessment does not provide assistance in diagnosing illnesses. If recovery is especially poor or the results are abnormal, the client is referred for further studies, as needed. A more specific account, such as a health examination, is recommended in cases where the result is abnormal, even when no known chronic illness or an acute stress factor exists (such as fever or use of alcohol) and the client feels tired or unwell.

Based on the results of the Lifestyle Assessment, the client can be recommended to undergo a health examination in, e.g., the following cases:

- The amount and quality of recovery during sleep are especially low in relation to reference values without any known cause (for example, a chronic illness or an acute stress factor such as alcohol).
- The results exhibit an exceptionally high heart rate level throughout the entire measurement period, especially during the night, when the heart rate at rest should decrease to a rate of under 65 beats/minute.
- The results exhibit an exceptionally low heart rate variability throughout the entire measurement (especially during sleep) without any known cause (for example, a chronic illness or an acute stress factor such as alcohol).
- The analysis recognized extra beats or extrasystole in the measurement. The criteria for the identification of extrasystole is that there is more than 800 extrasystole/day on several days.
- The client has felt abnormally tired, stressed or fatigued for a longer period (weeks and/or months) or the client has experienced a stabbing feeling, pain or a feeling of pressure in his or her chest during physical exercise and/or mental stress.

The Learning environment (Interpretation of results) provides a prepared document on referral to more specific tests.

4 Reliability of results

The evaluation of the reliability of results is an important part of the Lifestyle Assessment. The reliability of results is affected by:

- Resting heart rate
- Maximum heart rate
- Personal information
- Use of alcohol
- Illnesses
- Medication
- Missing heart rate data
- Duration of measurement

4.1 Resting heart rate

The resting heart rate is a central variable in the Lifestyle Assessment. The resting heart rate is most reliably measured when:

- The resting heart rate is measured during the sleep period.
- The client is healthy during the measurement.
- The client has not used intoxicants, such as alcohol, during the measurement
- During the measurements, the client has not used medication which affect the heart rate.
- The client is feeling well and does not suffer, for example, from exhaustion or an overload.
- The measurement period has not been unusually stressful, either mentally or physically.

Such a standard situation cannot always be reached in the measurements as the client is intended to be leading a normal life. This is why the Lifestyle Assessment tool evaluates the reliability of the measured resting heart rate and, if necessary, decreases the rate on the basis of experienced stress and well-being reported in the pre-questionnaire, consumption of alcohol or exercise performed late at night (Figure 19).

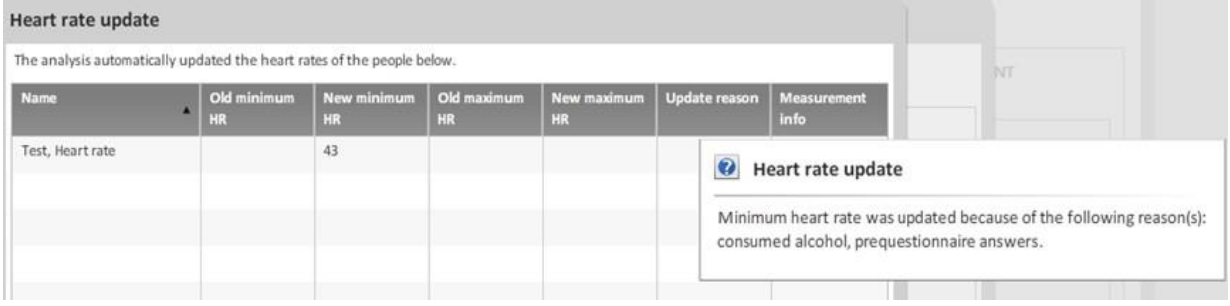


Figure 19. The Lifestyle Assessment tool evaluates the reliability of the resting heart rate and, if necessary, automatically decreases the rate by 1–6 beats.

4.2 Maximum heart rate

The Lifestyle Assessment uses a calculatory estimated maximum heart rate based on age (210 – (0.65 x age)). If necessary, this estimate can be changed, if the measured maximum heart rate is known. In most cases, the maximum heart rate estimate based on age is reliable, but with some people, the actual maximum heart rate can deviate from the estimated maximum heart rate by as much as 10 beats. This will cause distorted Lifestyle Assessment results. The maximum heart rate mainly affects the exercise analysis, but it can also affect the identification of stress and recovery.

If the client has exercised and the Lifestyle Assessment does not seem to be correct, the reliability of the maximum heart rate can be evaluated by:

- Interviewing the client on the intensity level and subjective experience of the exercise performance.
- Inquiring if the client has access to a heart rate monitor and can measure how high the heart rate increases at its highest, for example, during a ball game or another maximum performance.

If necessary, the maximum heart rate can be updated in the personal information. This will require the reports to be recreated. If the person being assessed is using beta blocker medication, it is recommendable to decrease the maximum heart rate by 15 beats.

4.3 Personal information

Personal information will have an effect on the results, so they must be entered correctly. During potential follow-up measurements, information may have changed, such as a person's weight or activity class, so they may need to be updated. If several measurements have been conducted for a client within a short time span, such as within six months, it needs to be checked that the assessments have used the same resting and maximum heart rates. In particular, the resting heart rate may have decreased if you detect a lower resting heart rate in later measurements. In such situations, the previous measurements should be analyzed with the detected lower resting heart rate, so that the results would be comparable.

4.4 Alcohol

Even a few units of alcohol increase the heart rates and weakens recovery (Figure 20). The larger the amount of consumed alcohol, the greater the effect on the body. If the client has consumed alcohol on every evening, the detected resting heart rate is most likely not reliable. In such a case, the Lifestyle Assessment tool decreases the resting heart rate by a few beats depending on the number of consumed units. If a large amount of alcohol has been consumed on each measurement day, the reliability of results is significantly weaker.

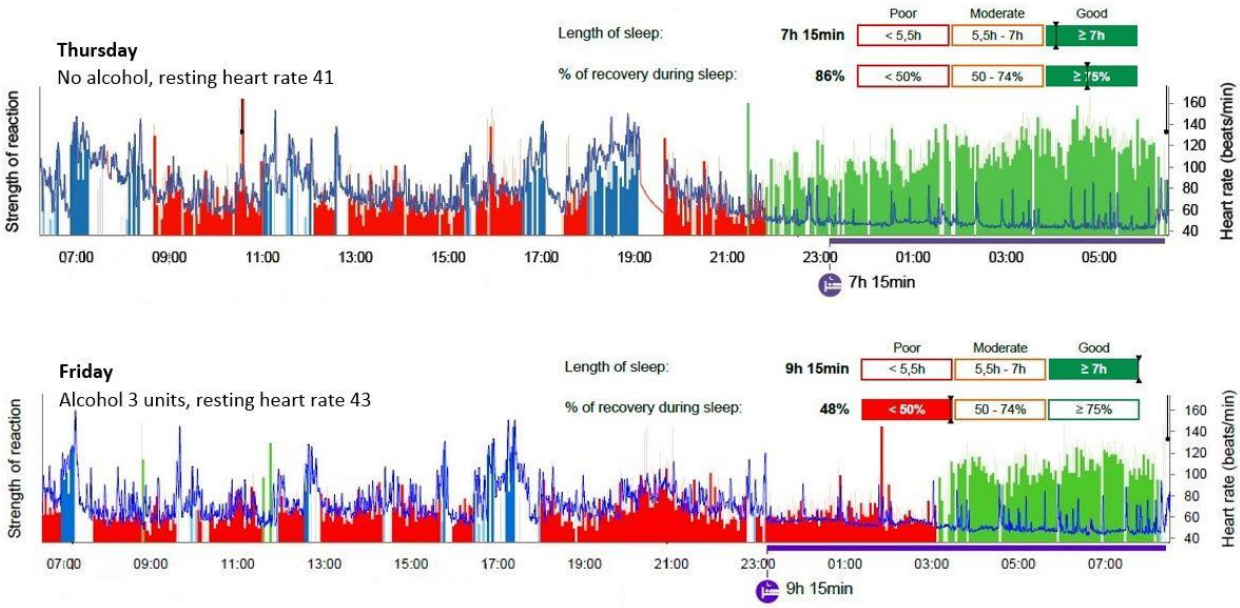


Figure 20. The result of a 44-year old healthy woman of normal weight without any consumed alcohol (the upper diagram) and after three units of alcohol (the lower diagram). On the first night without alcohol, the amount of recovery from the sleep period was 79% and after three units of alcohol, it was 48%.

4.5 Illnesses

Acute illnesses, especially a fever, stresses the body and weakens recovery. Sometimes the onset of an acute illness can be detected in the body already before any identifiable symptoms have appeared. Similarly, the body can still show signs of being ill a few days after an illness. If the client has a fever, it is recommended that the measurement be postponed.

With chronic illnesses, the possible effect of the illness on the autonomic nervous system should be considered when interpreting the results and especially when comparing them with the reference values. The results of the Lifestyle Assessment can be unreliable and the measurement is not recommended, if the client has:

- A cardiac pacemaker
- A heart transplant
- Chronic atrial fibrillation or flutter
- An unmanaged thyroid disorder
- A chronic neurological disease (MS, Alzheimer's, Parkinson's)

The measurement can be performed, for example, with the following illnesses, but the results can be unreliable:

- Bundle branch block
- Coronary artery diseases treated with a balloon dilatation or a bypass operation
- A diagnosed severe exhaustion

Despite many illnesses, you can perform the Lifestyle Assessment, but it might not be worthwhile to compare the results with the reference values.

4.6 Medication

Some medications affect the heart rate and weaken the reliability of the results. Medication which decrease or increase the heart rate can provide a false representation of the body's recovery. In particular, the following groups of pharmaceuticals can cause a challenge in the interpretation of results:

- Thyroid medication
- Beta blockers (large doses of diuretic drugs and ACE inhibitors)
- Tricyclic and other activating antidepressants
- Long-acting sleep medicines
- Pain medication affecting the central nervous system
- Strong medication for psychosis and arrhythmia, and neurological medication

If necessary, the effect of the medication will be considered in the analysis. For example, if the client is using beta blockers, it is recommendable to decrease the maximum heart rate by 15 beats to the personal information and recreate the reports.

4.7 Missing heart rate data

Measurement device problems, abnormal cardiac rhythm (Figure 21) and, for example, measurement breaks during bathing or swimming (Figure 22) will cause missing heart rate data in the measurement. If the share of missing data in the measurement is great (more than 15%), the analysis results must be evaluated critically. If the share of missing heart rate data is more than 15% on two days during a three-day measurement, a new measurement is recommended. Missing heart rate data is indicated in the summary diagram.

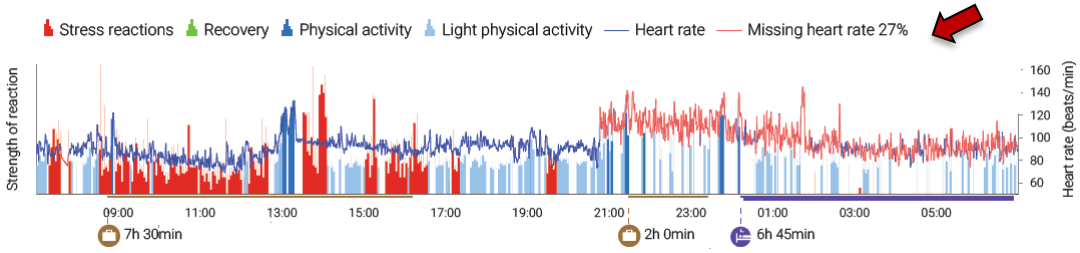


Figure 21. The share of missing heart rate data was 27%, which was caused by the client experiencing an atrial fibrillation attack that started in the evening at 9 pm. The reliability of the result is poor during the evening and night.

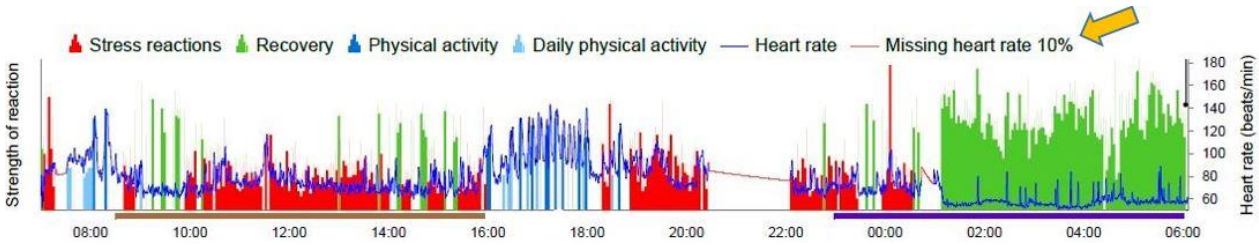


Figure 22. The share of measurement errors was 9%, which was caused by a measurement break (sauna bathing) between 10 and 11 pm. Missing heart rate data caused by this type of *measurement break does not weaken the reliability of the result, if the break is not long.*

4.8 Duration of measurement

When comparing the results with the reference values, it must be considered that most of the reference values have been provided for days, that is for 24-hour measurements. If the measurement lasts well under 24 hours, or there is a missing sleep period, the day's recovery rate might be considerably low, as the most important period of recovery is missing from the measurement period. In order to ensure the reliability of measurements, they should be conducted from the time one wakes up to the time when one wakes up again, which will provide a measurement length of approx. 24 hours (give or take 4 hours) that also includes a sleep period.

5 Provision of feedback

The goal of the feedback session is to examine the report results and, on the basis of the central conclusions and the discussion, to set goals and actions to support the client's well-being. Feedback provided on an individual level enables an interactive feedback discussion and the planning of individual actions to be taken. Feedback given to a group of people enables the cost-effective implementation of even larger projects, as the interpretation of results can be examined on a general level simultaneously for an entire group.

5.1 Individual feedback

Individual feedback can be provided in a personal meeting, on the phone or via the Internet (Figure 23). The ideal duration of an individual feedback session is 45–60 minutes, but a shorter feedback is also possible. A longer feedback session enables more mutual interaction, but a shorter session is more focused on the specialist's information. In multi-professional groups, it is good to utilize professionals from different fields. A psychologist can examine the stress-related matters and a physiotherapist can discuss the issues related to exercise and weight management.

Figure 23. Individual feedback enables a personal discussion on the results and the actions to be taken.

Main points regarding individual feedback:

- Explain the goal of the Lifestyle Assessment
- Assess your client's situation in life
- Examine the reports in an interactive manner with your client
- Ask your client to set concrete goals for well-being (1–3 goals)

- Summarize the conclusions and the actions to be taken

5.2 Group feedback

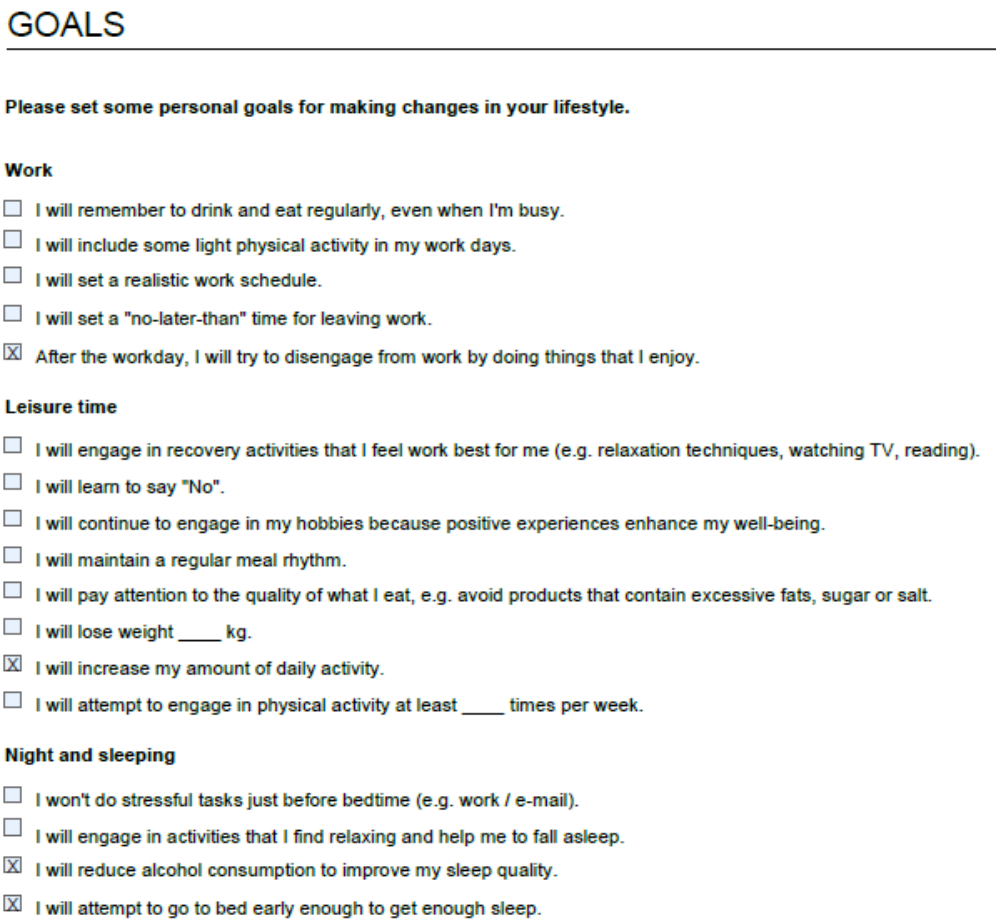
The duration of a group feedback session is usually 1–1.5 hours. The persons being assessed are handed their reports which are then examined with the help of group-feedback slides and sample reports. No personal results will be presented to a group. Finally, the group can have a discussion on potential actions to be taken and common methods of operation, especially if the group consists of persons who usually work as a group. In addition to the group feedback, the persons being assessed can also be arranged to have a shorter, personal discussion, if needed.

Main points regarding group feedback:

- Explain the goal of the Lifestyle Assessment
- Examine the interpretation of the report by utilizing sample reports and group-feedback slide presentations
- Examine the group's results, using the group reports
- For the implementation of group reports, it is recommended that the group size is a minimum of five persons (a total of 15 measurement days).
- There are different types of group reports, so select the suitable reports according to the purpose of use.
- Provide recommendations for actions to be taken and encourage the group members to set themselves personal goals to support well-being.
- Summarize the conclusions and agree upon actions to be taken.

5.3 Setting a goal

Setting a goal is an important part of the Lifestyle Assessment (Figure 24). The goals set in the journal during the measurement are printed on the Lifestyle Assessment report, but they can also be set during the feedback discussion.



GOALS

Please set some personal goals for making changes in your lifestyle.

Work

- ☐ I will remember to drink and eat regularly, even when I'm busy.
- ☐ I will include some light physical activity in my work days.
- ☐ I will set a realistic work schedule.
- ☐ I will set a "no-later-than" time for leaving work.
- ☒ After the workday, I will try to disengage from work by doing things that I enjoy.

Leisure time

- ☐ I will engage in recovery activities that I feel work best for me (e.g. relaxation techniques, watching TV, reading).
- ☐ I will learn to say "No".
- ☐ I will continue to engage in my hobbies because positive experiences enhance my well-being.
- ☐ I will maintain a regular meal rhythm.
- ☐ I will pay attention to the quality of what I eat, e.g. avoid products that contain excessive fats, sugar or salt.
- ☐ I will lose weight ____ kg.
- ☒ I will increase my amount of daily activity.
- ☐ I will attempt to engage in physical activity at least ____ times per week.

Night and sleeping

- ☐ I won't do stressful tasks just before bedtime (e.g. work / e-mail).
- ☐ I will engage in activities that I find relaxing and help me to fall asleep.
- ☒ I will reduce alcohol consumption to improve my sleep quality.
- ☒ I will attempt to go to bed early enough to get enough sleep.

Figure 24. Setting a goal is an important part of the Lifestyle Assessment. The goals set are printed on the Lifestyle Assessment report, or the goals can be set later.

A suitable number of goals is between one and three. If there are too many goals, they are more easily left unimplemented. A good goal is realistic and concrete. A realistic goal means that the client believes in reaching the goal and finds the effort to strive toward the goal. Goals that are too large or ambitious can take away the motivation. A concrete goal can be measured. Instead of aiming at weight loss, a more concrete goal would be to plan on losing five kilos, or instead of increasing exercise, a more concrete goal is to be physically active three times a week, instead of just the one.

6 Physiological background

6.1 The basis for heart rate analysis

Firstbeat Technologies Oy has developed a revolutionary heart rate analysis method which allows the production of precise and versatile information on the functions of the body by analyzing the heart rate variability. The heart rate and its variability contains a great deal of information on human physiology, as a large number of body functions are directly or indirectly related to the regulation of cardiac function. The body's adaption to various situations is visible in the heart rate as microscopic and macroscopic reactions and variability.

The heart rate analysis method developed by us is based on the fact that it is possible to identify and computationally differentiate the effects that different functions of the body have on the heart rate. By using this data, it is possible to simulate a digital model of the body functions of the person being assessed.

There is more than 20 years of research work on the functioning of the autonomic nervous system and on the fields of exercise physiology, psychophysiology and psychology behind the Lifestyle Assessment tool. The databases utilized in the Lifestyle Assessment contain thousands of laboratory results on physiological body functions, such as respiration, energy expenditure, and maximal oxygen uptake. In addition, more than a 100,000 measurements based on heart rate variability have been conducted in normal daily life using the Firstbeat methods.

6.2 Heart rate variability

The heart rate is not fully regular. The fluctuation in the time interval between consecutive heartbeats is called heart rate variability HRV) (Figure 25). The R spikes observed in an ECG tracing represent the contraction of the ventricles of the heart, and the interval between consecutive R spikes is called a heart rate.

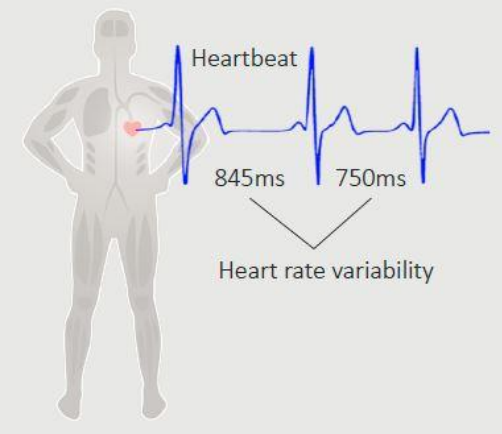


Figure 25. The time between two heartbeats is measured in milliseconds. The duration in time of consecutive heart rate intervals fluctuates, and this natural fluctuation is called heart rate variability.

The heart rate variability increases during recovery and relaxation and decreases during load situations, such as stress. Typically, heart rate variability and heart rate have an inverse relationship. When the heart rate is low, the heart rate variability is typically greater than when the heart rate is elevated.

The amount of heart rate variability is very individual. It also fluctuates from one day to the next, for example, depending on the load status of the day, exertion caused by exercise, and work-related stress. In addition to these external stress factors, there are also internal stress factors, such as an unbalanced diet, consumption of alcohol and illnesses which cause fluctuation in the amount of daily heart rate variability. Numerous studies have shown that negative feelings, such as anger, anxiety, grief and everyday concerns decrease the heart rate variability. Respectively, positive feelings, such as joy, gratitude and love can increase the heart rate variability.

Generally, persons in good condition have greater heart rate variability than those in poorer physical condition. A high heart rate variability is normally considered an indicator of a healthy and well-functioning heart.

6.3 The autonomic nervous system

Heart rate variability is mainly caused by the regulative function of the autonomic nervous system, and heart rate variability does provide a means to analyse the balance between the sympathetic nervous system which accelerates the body and the parasympathetic nervous system which calms the body.

The autonomic nervous system is divided into the sympathetic and parasympathetic nervous systems. The sympathetic and parasympathetic nerves start from the central nervous system and lead to target organs located in various parts of the body. Usually the sympathetic and parasympathetic parts operate simultaneously, having an opposite effect on their target organs (Figure 26).

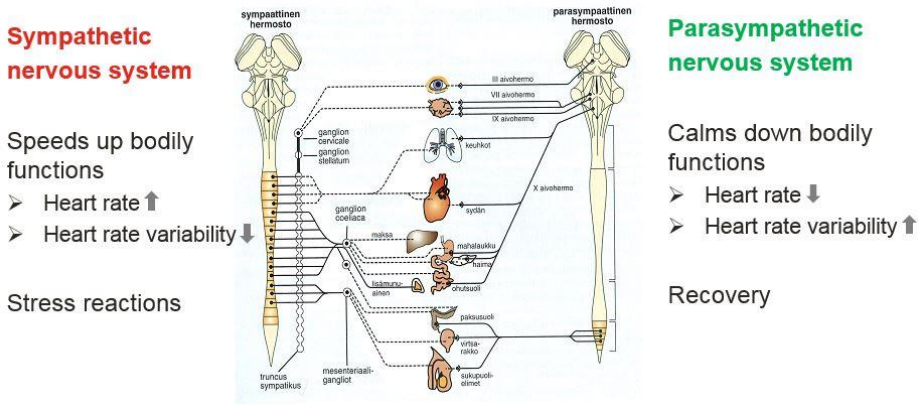


Figure 26. The autonomic nervous system is divided into the sympathetic and parasympathetic parts which have the opposite effect on their target organs. (Source: Sovijärvi, A. et al. 2003.)

Sympathetic nervous system

The sympathetic nervous system prepares an individual for action by elevating their blood pressure, heart rate and respiration rate. These changes improve the supply of energy and performance by assisting the body in adapting to the demands of the situation and the environment. If the elevated sympathetic activeness continues for an extended time without sufficient recovery, a hazardous stress response can develop in the body. Rest and moderate exercise are important methods of calming the hyperactivity of the sympathetic nervous system.

Parasympathetic nervous system

The parasympathetic nervous system calms the body's functions for the purpose of recovery and the restocking of energy stores. An increase in the parasympathetic activeness decreases the heart rate and increases heart rate variability. With the help of parasympathetic regulation, the psychophysiological functioning can also be quickly changed. The vagus nerve is the tenth cranial nerve and it is the most important parasympathetic nerve.

6.4 The physiology of stress

Stress is the body's normal response to, for example, a demanding work task, a relationship crisis, fear, strenuous physical activity or illness. The effect of stress can be both useful and detrimental. When it lasts for a short time, it makes us function more efficiently, but when it drags on, it can make us ill.

In a short-term stress reaction, the sympathetic nervous system and the hypothalamus-pituitary gland-adrenal gland (HPA) axle activates quickly to defend the body. The activation of the HPA axle secretes catecholamines, adrenaline and noradrenaline into the blood stream initiating a "fight or run" reaction which leads to the energy intake and physical performance of the body becoming more efficient. The effects of this can be observed, for example, as an elevation in the heart rate and respiration rate. Also the secretion of pain-alleviating endorphins increases during a stress response. These changes help a person to cope with short-term stress.

When stress drags on, it can start to affect us via several different mechanisms, and it can harm the body's immune response. The pituitary gland secretes corticotrophin (ACTH) into the blood stream which causes glucocorticoid secretion from the cortex of the adrenal gland.
Long-term stress weakens the functioning of the parasympathetic nervous system and decreases the heart rate variability during rest (Figure 27). Strong, long-term stress also has a negative effect on cognitive performance, thoughts and emotions.

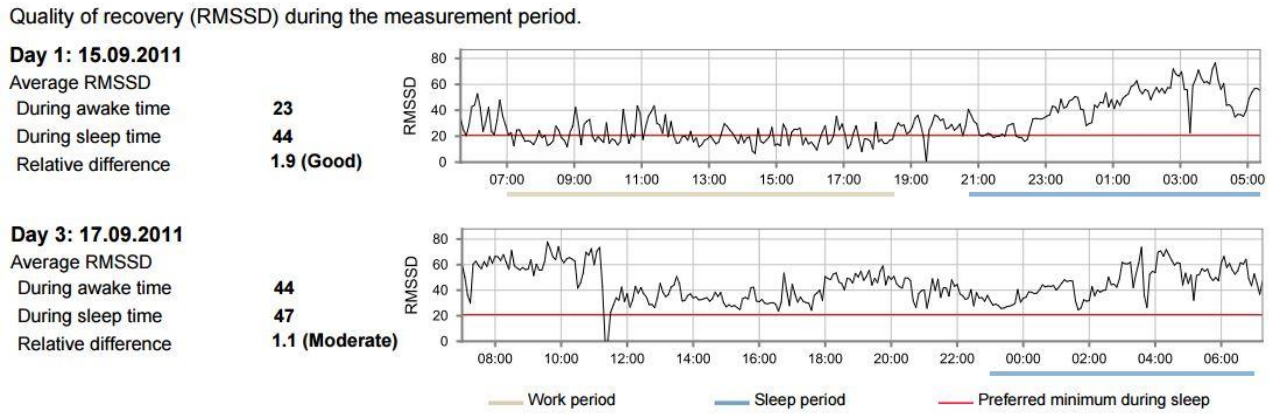


Figure 27. Long-term stress decreases the heart rate variability.

Typical stress factors

A factor inducing a stress reaction is called a stress factor. A stress factor can be either physical or mental, it can have a beneficial or a detrimental effect, and it can be either short or long in duration. Usually when a stress factor is removed, the stress reaction subsides and the body calms down. The most common reasons behind stress reactions are listed in the following table (Table 1).

Table 1. Stress factors which initiate a stress reaction.

Physiological (external)	Physiological (internal)	Psychological	Social
Alcohol and other intoxicants	Acute infection	Work stress	Presentation, speech etc.
Medication	Chronic illnesses	Anxiety	Fear of social occasions
Stimulants e.g., coffee	Pain	Mental stress	Pressure
Hangover	Exhaustion	Negative feelings such as hate and bitterness	Lack of social support
Strenuous exercise	An athlete's overload situation	Fear	
Physically demanding work	Fatigue	Grief	
Sauna	Pregnancy	Relationship problems	
Sleep deprivation	Digestion	Depression	
Jetlag	Dehydration	Psychological disorders	
High altitudes		Traumatic events	
Temperature		Excitement	
Noise			

6.5 How is stress measured in the heart rate?

When measuring stress, it is essential to differentiate the factors affecting the autonomic regulation and to exclude, for example, the elevations of activity caused by exercising. The Lifestyle Assessment differentiates physiological states by combining data on the heart rate, oxygen consumption and respiration rate. This will allow access to information on when the body's activation level is elevated due to exercise and when due to psychologically stressful factors.

When evaluating the function of the autonomic nervous system, the connection of the heart rate with other physiological variables should be taken into consideration. The heart rate is affected by, e.g.:

- Metabolic processes
- Posture and changes in posture
- Respiration rhythm
- Physical activity
- Emotions and thoughts
- Stress and recovery

Calculatory stages of stress measurement

Firstbeat's stress measurement includes several different stages: processing of the heart rate signal, formation of the physiological variables, division of the heart rate data, exclusion of physical activity, identification of stress states and recovery states, formulation of information, and generation of a graphic presentation (Figure 28).

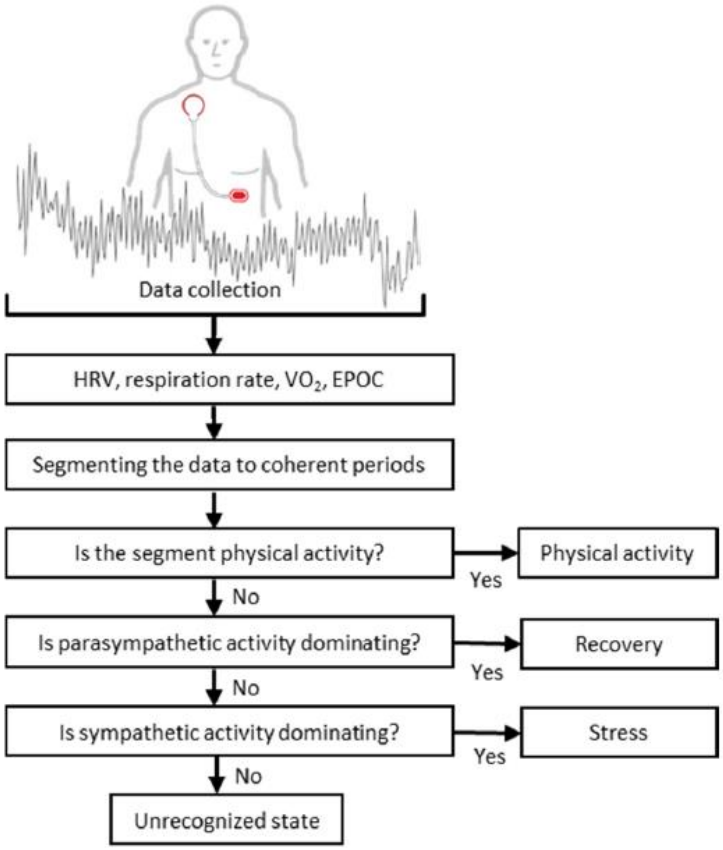


Figure 28. Simplified illustration of the analysis procedure.

In the first stage of the calculation, the various variables are formulated for the purpose of describing the function of the autonomic nervous system and the physical activity level of the body. The errors caused by measurement are corrected from the R-R interval signal and the signal is preprocessed with various digital filters in order to improve the quality and interpretation of the signal. Respiratory variables are calculated from the heart rate (such as respiration rate, ventilation and oxygen consumption). In addition, various heart rate variability variables and key figures of the autonomic nervous system are determined on the basis of the R-R interval data for the purpose of determining the functional status of the sympathetic and parasympathetic nervous system.

In the second stage of calculation, the data calculated in the first stage are combined to determine the stress reactions and recovery states. Oxygen consumption is an indicator of the body's physical activity, and when identifying the stress states, one can use oxygen consumption data to exclude the time points where the autonomic nervous system state has been elevated due to physical strain or due to recovery after exercise. After having excluded the acceleration of the autonomic nervous system states caused by physical activity from the analysis, one can evaluate the load caused by other factors.

Stress levels and the moments of recovery are determined for the remaining time points by utilizing the respiratory variable and the model created on the basis of the heart rate variability and the heart rate to describe the functional level of the autonomic nervous system. The stress

level can be separately scaled for each person which will provide an improved discrimination level in the monitoring of an individual. The stress level can be determined separately for each point in time.

Read more on the scientific background and on the White Papers and publications at www.firstbeat.fi