2024

Driftline validation projects

SUMMARY

AGNAR STEINARSSON

Contents

The IAK study (RU 2019)

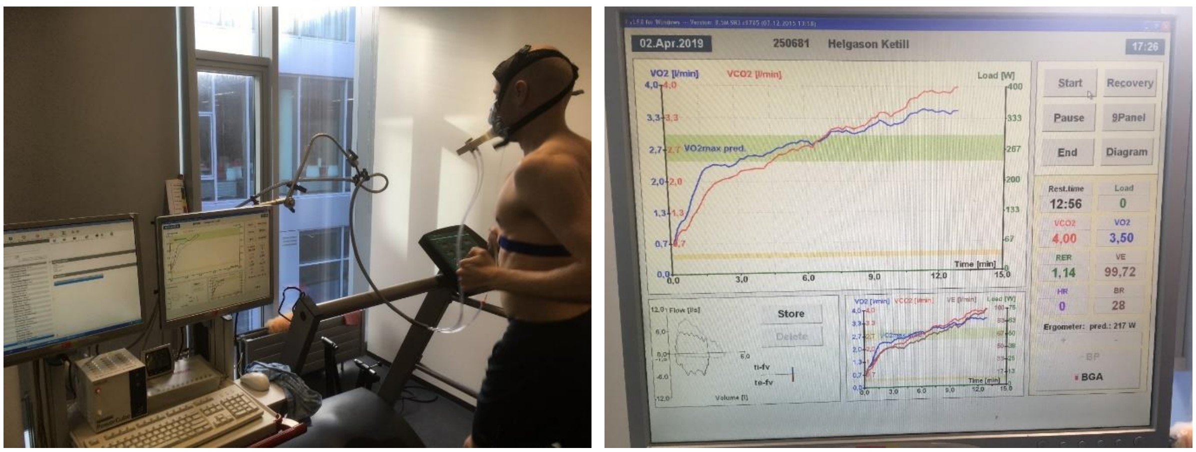
Co-operation: Driftline, Keilir Sports Academy (IAK), Reykjavík University (RU).

Aim: Validation of Runmaker fitness analytics.

Time of testing: April 2019.

Methods: Eight students performed submaximal treadmill running tests. Four of the students performed cardiopulmonary exercise tests (CPET) at the RU sports laboratory. Measured parameters; VO2, VCO2, VO2max, VE, RER, HR, LT and vVO2max. Protocol: 2-min step protocol, 1 kph increment, 1% incline/1% increment after 16 kph.

CPET test supervision: Ingi Þór Einarsson professor, Eyþór Oddsson, RU Masters student.



CPET test in the IAK study (April 2nd, 2019).

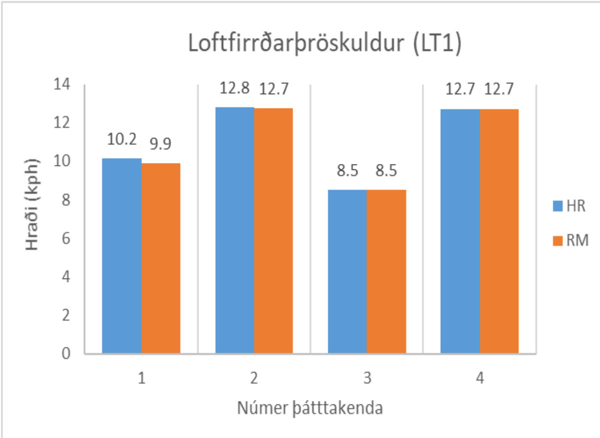
Example CPET measurements:

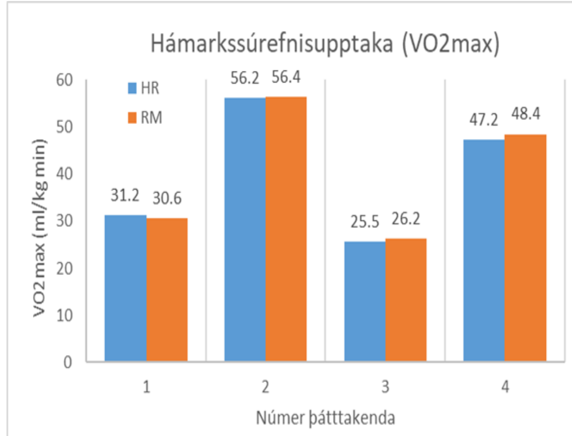
Time	Speed	VO2 (l/min)	VO2 (ml/kg/min)	VCO2 (l/min)	RER (VCO_2/VO_2)
0:00-2:00	10 kph	1.68	24.73 (44.02%)	1.33	0.80
2:00-4:00	11 kph	2.44	35.93 (63.96%)	2.17	0.89
4:00-6:00	12 kph	2.74	40.31 (71.75%)	2.58	0.94
6:00-8:00	13 kph	2.96	43.56 (77.55%)	2.98	1.01
8:00-10:00	14 kph	3.17	46.58 (82.92%)	3.32	1.05
10:00-12:00	15 kph	3.43	50.49 (89.88%)	3.77	1.10
12:00-14:00	16 kph	3.56	52.29 (93.08%)	4.07	1.15
14:00-16:00	16 kph 2%	3.71	54.53 (97.08%)	4.60	1.24

VO2max: 56.2 ml/kg/min
vVO_2max: 16.4 kph
VT-2: 12.8 kph

Results.

Driftline vs CPET validation:





Driftline vs CPET validation. Graph 1 shows the agreement for the LT threshold. Graph 2 shows the agreement for VO2max.

The two graphs show the excellent agreement between Driftline (Runmaker) and gold standard CPET testing for both LT and VO2max.

Conclusion.

This was a small pilot study with the aim to provide some initial validation for the Driftline analytics. The Driftline app was called Runmaker at the time.

The main conclusion from this study was that the Driftline submaximal running test was able to accurately estimate fitness parameters with excellent agreement with gold standard CPET testing. These results paved the way for continued validation studies at the RU Sports Science Department.

The Runmaker Masters study (RU 2021)

Title: Validation and reliability of the Runmaker fitness app.

Author: Ingibjörg Þóra Þórarinsdóttir.

Thesis: Thesis of 45 ECTS credits submitted to the Sports Science Department, School of Social Sciences at Reykjavík University in partial fulfillment of the requirements for the degree of Master of Sports Science and Coaching (June 2021).

Main supervisor: Dr. Ingi Þór Einarsson.

Co-supervisor: Dr. Sigurbjörn Árni Arngrímsson.

Examiner: Dr. Elvar Smári Sævarsson.

Abstract.

Introduction: The maximal oxygen uptake test (VO2max) is considered to be the most accurate test to assess aerobic capacity. It is one of the most commonly used measurements despite being both complex and demanding. Many different submaximal testing protocols have been developed to make it easier to estimate aerobic endurance and VO2max. The main objective of this single-blinded laboratory setting research was to test the reliability and validation of the Runmaker fitness app.

Method: Participants were 35, between16-52 years old, and both male ($n=21$) and female ($n=14$). They performed various endurance and anaerobic power tests on separate days: VO2max, 10-meter sprint and a submaximal endurance test. Six participants aged 16-24 years were asked to perform a submaximal test a second time.

Results: The repeated submaximal measurements in the reliability study showed no statistical difference between variables between tests 1 and 2 ($p > 0.05$). The effect size between the same variables was small to medium (ranging 0.02-0.55). The validity study showed a significant correlation between the measured variables and the predicted variables. The strongest correlation was found between the measured and predicted VO2max ($r=0.675$) and the measured and predicted HRmax ($r=0.709$).

Conclusion: This study shows that The Runmaker fitness testing app can be considered a reliable and valid test to measure physical parameters by measuring heart rate from a submaximal exercise.

Key words: Aerobic endurance, maximal oxygen uptake, submaximal, heart rate, correlation.

The Run and recovery BSc study (RU 2022)

Title: Assessment of fitness parameters with a submaximal treadmill running test.

Author: Þórey Hákonardóttir and Jón Oddur Guðmundsson.

Report: Report submitted to the Sports Science Department, School of Social Sciences at Reykjavík University in partial fulfillment of the requirements for the degree of Bachelor of Sports Science and Coaching (June 2022).

Supervisor: Dr. Ingi Þór Einarsson.

Abstract.

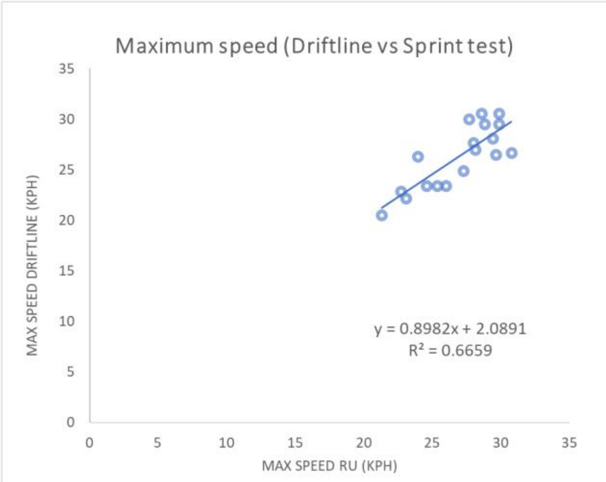
Introduction: Cardiopulmonary exercise testing (CPET) is widely recognized as the gold standard test for measuring aerobic capacity. However, the laboratory-based CPET is very physically demanding and not easily accessible to the general public. The main aim of this single-blind laboratory setting research was to validate the Driftline submaximal assessment of fitness parameters.

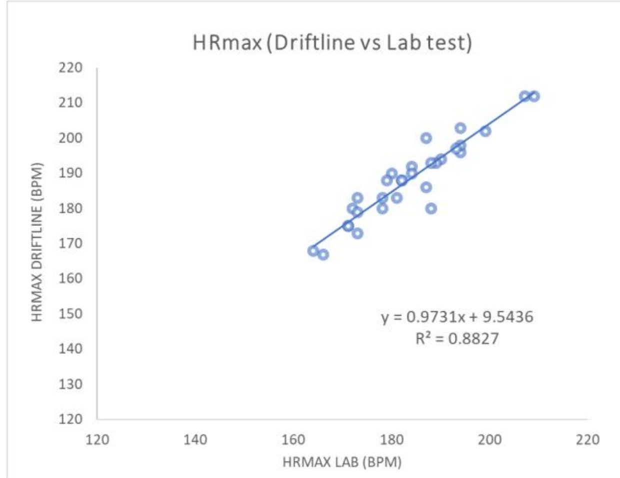
Method: Participants were 30, between 21-48 years old, and both male (n=19) and female (n=11). They performed various tests on separate days: walking treadmill test, CPET, 10-meter sprint and a 20-min submaximal endurance test. A lactate blood sample was taken after 15 minutes of the submaximal test with 15-min passive recovery.

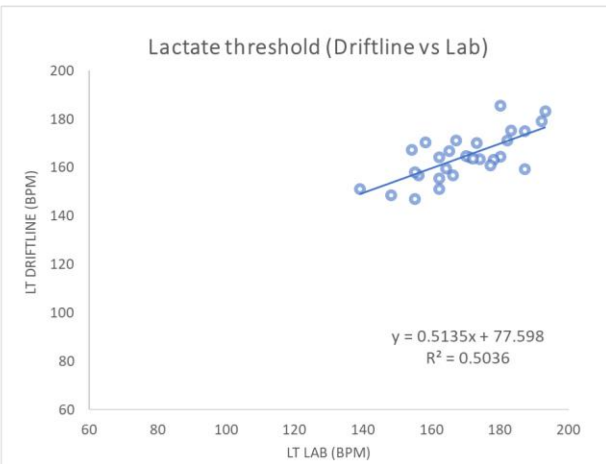
Results: The study showed a significant correlation between measured and predicted variables. The strongest correlation was found between the measured and predicted HRmax (r=0.883) and the measured and predicted VO2max (r=0.737). The average, measured and predicted VO2max values were 51.2±10.4 and 52.6±9.7 ml/kg/min, respectively. The average, measured and predicted HRmax values were 184.1±8.4 and 188.3±8.7 bpm, respectively. The average, measured and predicted Vmax values (max sprinting speed) were 26.4±3.1 and 25.9±2.9 bpm, respectively. The average, measured and predicted LT-1 threshold speeds were 9.9±1.8 and 9.9±1.7 km/hour, respectively. The average, measured and predicted LT-2 threshold speeds were 14.3±2.8 and 13.9±2.6 km/hour, respectively.

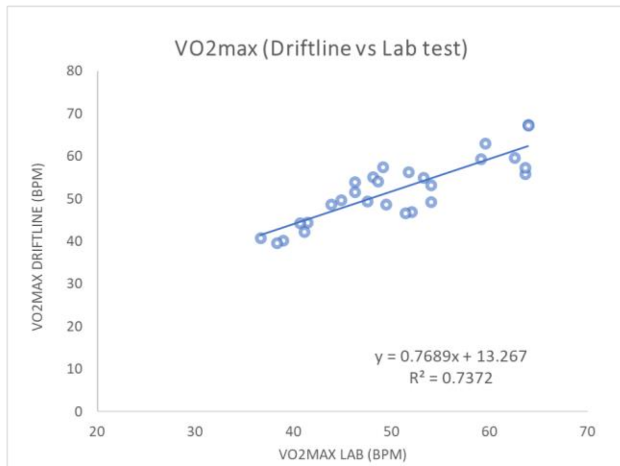
Figures.

A highly significant correlation was found between measured and predicted fitness parameters, as shown on the graphs on the next page.









Conclusion: This study shows that Driftline submaximal fitness test can be considered a reliable and valid test to assess fitness parameters from heart rate analysis.

Key words: Aerobic endurance, maximal oxygen uptake, submaximal, heart rate, correlation.

The Elderly Fitness Masters study (RU 2024)

Title: Different sub-maximal tests to evaluate aerobic endurance among older adults.

Author: Þórey Hákonardóttir.

Thesis: Thesis of 45 ECTS credits submitted to the Sports Science Department, School of Social Sciences at Reykjavík University in partial fulfillment of the requirements for the degree of Master of Sports Science and Coaching (June 2024).

Supervisor: Ingi Þór Einarsson.

Key words: Exercise science and coaching, Aging, Health, Exercise.

Abstract

Introduction: Exercise is well-known for improving quality of life and health. As longevity increases, paying attention to well-being becomes more crucial. Driftline is an Icelandic start-up company introducing HR monitoring that measures aerobic endurance from 0-100%.

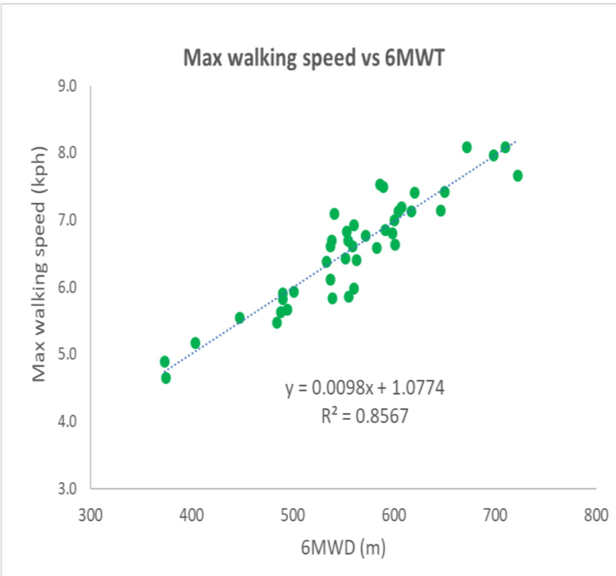
Objective: If 6- and 12-minute treadmill walking tests are valid and reliable measurements compared to the 6-minute walking test on the floor (6MWT) and if Driftline's analytics can assess aerobic endurance among older adults using sub-maximal testing protocols.

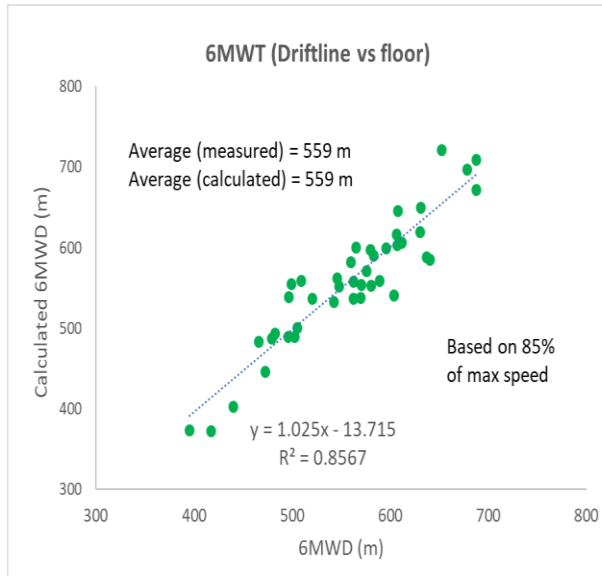
Methods: 42 older adults (60% female, mean age 71.93±4.68) participated in four submaximal endurance tests: 6MWT on the floor, 6MWT on a treadmill, 12MWT on a treadmill, and 6MWT at a self-selected speed on a treadmill. A total of 28 participants completed all tests. Heart rate (bpm) was monitored throughout the tests, with a ten-minute seated rest period after the tests. A repeated measures ANOVA was conducted along with Pearson correlation.

Results: There was a significant correlation between the 6MWD on the floor and the treadmill in all tests (r=0.955-0.874). There were significant differences ($p<0.001$) between treadmills and 6MWT on the floor, with an 83.36 ± 31.77 m difference in distance walked, a 14% lower HR response, and a reduced step frequency of 5.46±0.82-9.37±0.44 steps/min. Driftline Analytics' endurance scale significantly correlated with walking distances in all tests (r=0.350-0.469).

Six-minute-walking-test (6MWT). Agreement between test and estimation:

Among the parameters calculated by Driftline was the estimated maximum walking speed for each of the participants, based on a novel method of gait analysis. The calculated maximum speed (from a submaximal treadmill test) showed excellent agreement with the measured 6MWT floor distance (6MWD), as shown in the two graphs below:





The first graph shows a highly significant correlation between 6MWD and the calculated max walking speed. The second graph shows a highly significant correlation between measured and calculated 6MWD.

Conclusions: The 6MWT and 12MWT on a treadmill are valid alternatives to the 6MWT on the floor for assessing aerobic endurance in older adults, and the U-turns in the 6MWT have an effect. Driftline's heart rate analysis can be used at sub-maximal effort.

The results show that the six-minute walking distance only shows a weak correlation with aerobic endurance, as defined and measured by Driftline, but on the other hand a very strong correlation with the estimated maximum walking speed. Apparently, maximum power and speed are more important for performance than endurance in such a short walking test.

The main conclusion is that with the Driftline analytics it is possible to use a submaximal treadmill walking test to approximate performance in a six-minute walking test with high accuracy.

The METFIT PhD study (UI 2024)

The METFIT study (*Metabolic effect of Feeding and Exercise*) is Agnar Steinarson‘s PhD study at the University of Iceland. METFIT is divided into three parts, METFIT-1 (*Fitness study*), METFIT-2 (*Metabolic study*) and METFIT-3 (*Energy study*). All three studies are planned to be completed before the end of the year 2024.

The METFIT-1 study is designed to validate the novel heart rate analytics developed by the Icelandic analytics company Driftline. The study is divided into four parts:

1. Easy running test.
    a. A 20-minute treadmill running test at 1% incline with a 10-min lying, passive recovery. Heart rate recording with three heart rate monitors.
2. Sprinting test.
    a. Several 60-meter all-out sprints on an indoor running track. Four Witty speed gates mounted at 0, 20, 40 and 60 meters.
3. Cardiopulmonary exercise test (CPET).
    a. A graded maximal exertion treadmill test for the detection of VO2max, exercise thresholds, running economy and fuel oxidation. Gas exchange measured with a Vyaire metabolic mask.
4. Slow component test (a sub-set of participants).
    a. A 30-minute treadmill running test at 1% incline with 15-min lying, passive recovery. Heart rate monitoring and metabolic mask for the whole duration.

A total of 40 participants, 22 men and 18 women aged were recruited for the study. The participants ranged from 25 – 55 years in age and from 18.6 – 39.1 in BMI index. The first part (the easy running test) was completed in March and part two (the sprinting test) was completed in April. The third part (CPET) is currently in action at the University lab and when this report is written, 22 participants have completed their test. Part 4 will be performed in late May and early June.

This report briefly describes the methodology used in the study and the preliminary results at this stage of the study, when approximately half of the participants have completed the CPET testing. The main aim of the study design is to validate the Driftline heart rate analytics through the so-called gold standard cardiopulmonary exercise testing (CPET).

CPET testing and parameters

Cardiopulmonary exercise testing (CPET) is the determination of a person‘s performance during physical exercise by measuring the metabolic gas exchange. The aim of a standard

CPET protocol is to expose the individual to an incrementally increasing workload for about 8 - 12 minutes (incremental ramp protocol) to a volitional maximum. During the test, the patient is connected via mask giving minute ventilation, breathing frequency, oxygen uptake, carbon dioxide production, exercise thresholds and endurance capacity, as well as other parameters.

An important aspect of CPET is the determination of ventilatory exercise thresholds, usually displayed as break points in the CPET graphical displays. Two, and sometimes three, ventilatory thresholds (VT1, VT2 and VT3) can be detected through standard CPET testing. In sports science, however, blood lactate using step protocols is often used for threshold determination. A multitude of threshold concepts exists in the literature, such as Lactate thresholds (LT1, LT2), the Anaerobic threshold (AT), the Respiratory compensation point (RPC) or the Maximal Lactate Steady State (MLSS) (Poole et al., 2021).

Unfortunately, ambiguous threshold terms exist in the scientific literature which can lead to confusion, misunderstanding or even an incorrect interpretation (Binder, 2008). In 2012, a major CPET working group (Westhoff, 2013) decided to refer to the LT and MLSS thresholds as VT1 and VT2, respectively, to avoid this confusion in the future. These terms seem to have gained international acceptance and are now widely implemented in CPET software. Figure 1 shows a simple comparison between *ventilatory and lactate thresholds*.

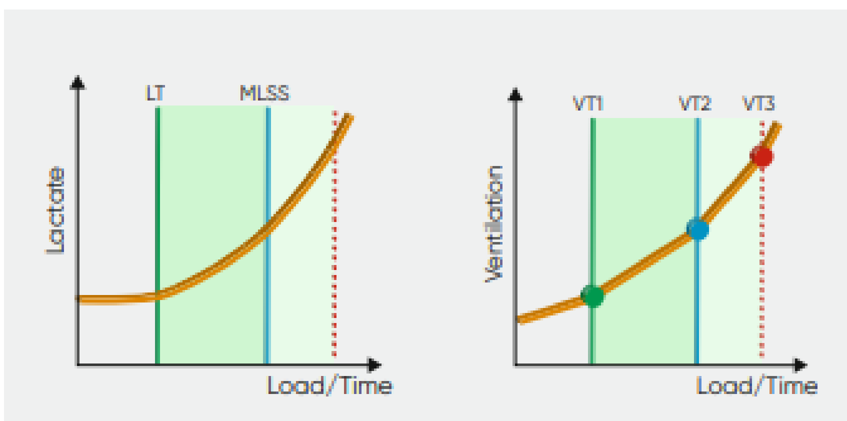


Figure 1. *The connection between lactate and ventilatory thresholds (from Vyaire Medical brochure).*

The first graph in figure 1 show that the lactate curve is usually exponential in nature with no clear break points and thus, neither the second nor the third (if reached) ventilatory break points can be recognized directly in the lactate curve. Usually the MLSS (often called LT2) is defined as the intensity where blood lactate exceeds 4 mMol/L. As mentioned above, the VT1 and VT2 thresholds correspond to the LT and MLSS thresholds, provided that the measurements were performed under identical conditions. The mandatory interruptions while collecting blood samples for lactate measurements may unduly increase the lactate production and thus interfere with the threshold determination (Vyaire Medical, 2019).

Methods

A total of 38 participants, 21 men and 17 women aged were recruited for the study. The participants ranged from 25 – 55 years in age and from 18.6 – 39.1 in BMI index. The easy running test and the CPET tests were carried out in the Sports Science Laboratory of the University of Iceland. Both tests were performed on a Woodway treadmill. A Vyaire Medical metabolic cart was used for the CPET testing. Both these tests included an easy warm-up phase and a passive recovery phase post exercise. The participants were equipped with three heart rate monitors: a Polar H7 chest strap monitor, a Polar Verity Sense armband (right upper arm) and a Scosche armband (left forearm). The easy running test had a 20-min duration and a 10-min recovery phase. During CPET testing they wore a metabolic mask for measurement of gas exchange for the entire duration of the test. The stepwise CPET protocol used a 1% incline and 1-minute step-durations, designed to exhaust the participant after 10-14 minutes of running. The sprinting test was performed on an indoor running track, using Witty speed gates. Each participant warmed up and performed 3-4 all-out 50 meter sprints from a standing start. The fourth part of the study is yet to be performed. Figure 2 shows some example photos from the study tests.

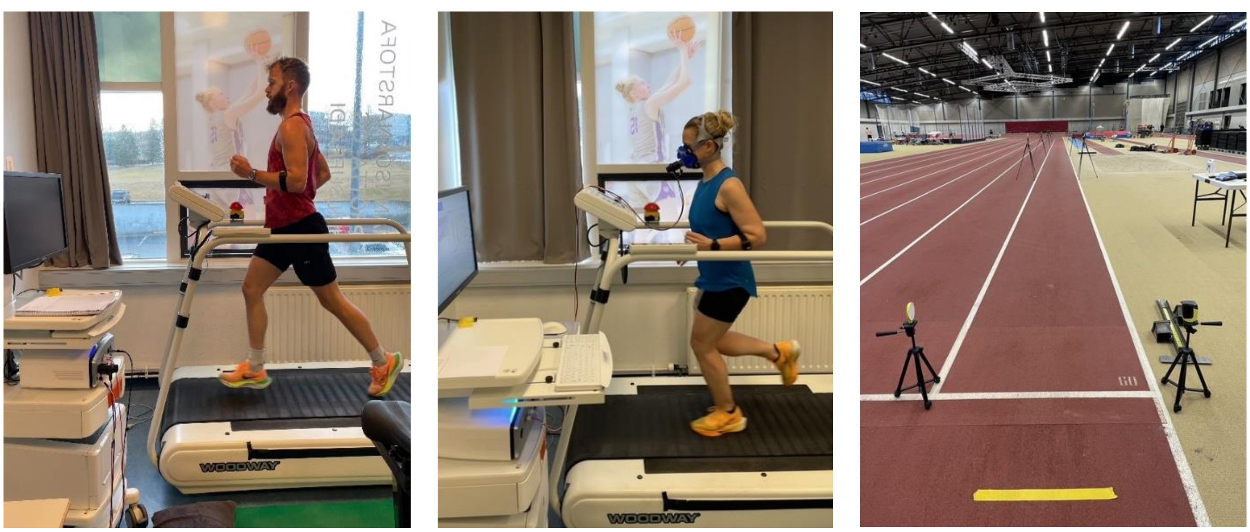


Figure 2. *Participants performing the easy running test and the CPET test. A photo of the 50-m running track.*

Analysis and results (preliminary)

Figure 3 on the next page shows an example heart rate model fit to the heart rate data from the easy running test and CPET gas exchange results for one of the participants.

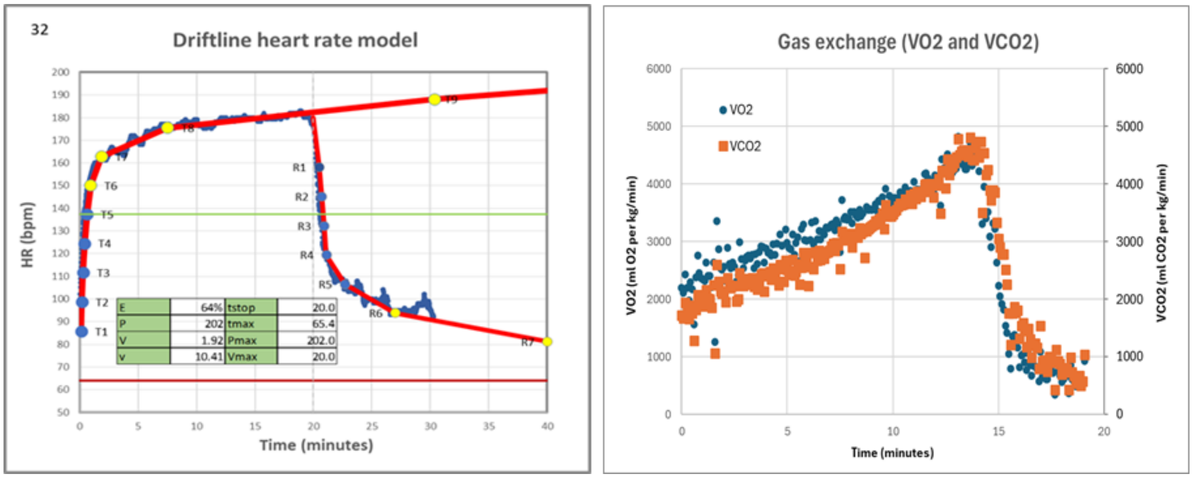


Figure 3. *Example heart rate model fit to the heart rate data from the easy running test and CPET gas exchange results for one of the participants.*

Selected fitness parameters, such as VO2max, ventilatory threshold 2 (VT-2) and HRmax, were calculated independently through each methodology (Driftline and CPET) and subsequently compared. The Driftline-predicted max speed was compared directly to the measured max speed on the running track. Figure 4 shows some preliminary results.

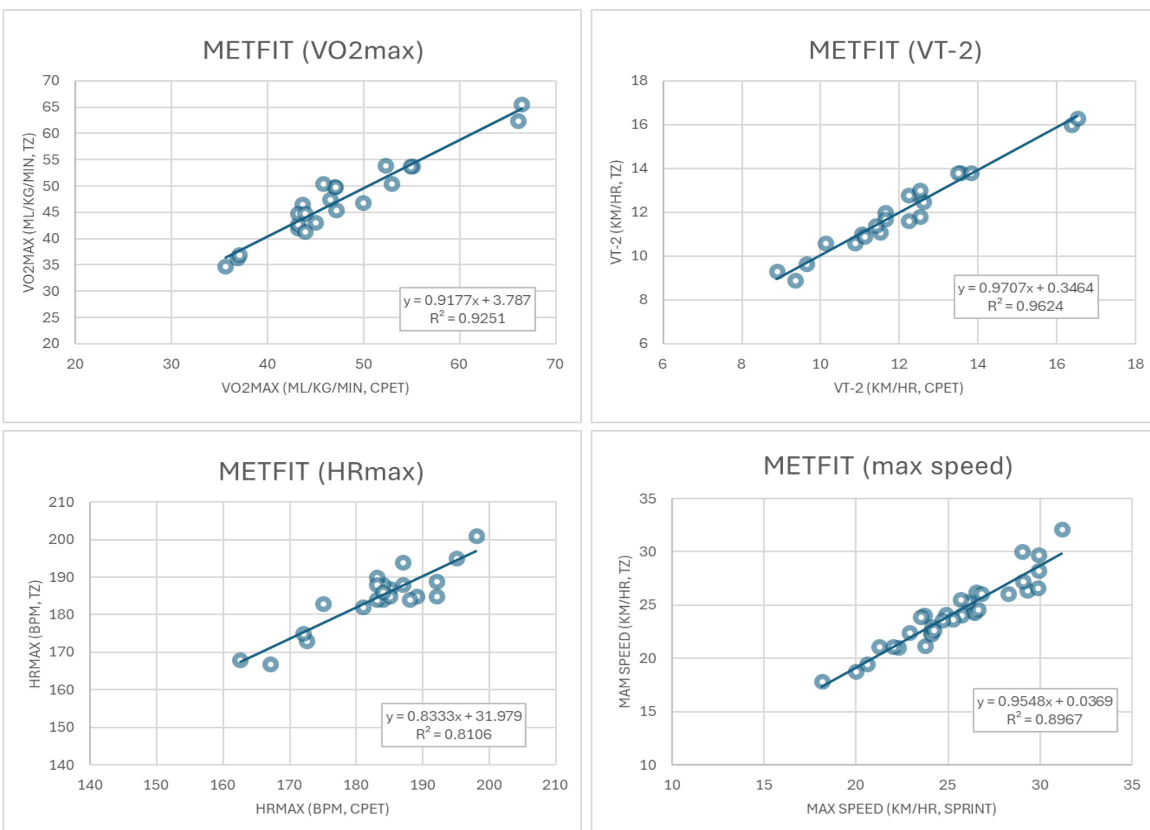


Figure 4. *Preliminary results from the METFIT fitness study. X-axis shows CPET calculations or direct speed measurements, while the Y-axis shows the Driftline calculations (alternatively TrueZone, TZ).*

Discussion

It must be noted that these are still preliminary results as only about half of the participants have completed the CPET test at this stage. Nevertheless, it is noteworthy that these preliminary results show a convincing validation for the Driftline analytics, as presented by Steinarsson and Agnarsson (2020).

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