The Talk Test and nasal breathing when running below and above the first lactate turnpoint

TOR EMIL HANSEN

SUPERVISOR
Stephen Seiler

University of Agder, 2021
Faculty of Health- and Sport Science
Department of Sport Science and Physical Education

CONTENTS

ABBREVIATIONS

MCT	Mouth Closed Test
TT	Talk Test
HRR	Heart Rate Reserve
VO_2	Oxygen uptake ($ml \cdot kg^{-1} \cdot min^{-1}$)
$VO_{2\,max}$	Maximal oxygen uptake ($ml \cdot kg^{-1} \cdot min^{-1}$)
$VO_{2\,peak}$	Peak oxygen uptake ($ml \cdot kg^{-1} \cdot min^{-1}$)
$[la^{-1}]$	Blood lactate concentration
RPE	Rate of perceived exertion (Borg scale, 6-20)
LT_1	First lactate turnpoint
LT_2	Second lactate turnpoint
LR90	Long run 90%
LR100	Long run 100%

ABSTRACT

Objective: The use of lactate and heart rate as intensity control tools may be expensive for certain populations and may lead athletes to be excessively 'numbers fixated'. The aim of this study was to investigate if the Talk Test and/or a mouth closed 'nose breathing' test could serve as an effective intensity control tool and differentiate between running below and above the first lactate turnpoint.

Methods: 16 male and 6 female recreational and well-trained runners (37 ± 9 yrs, 68 ± 27 km/week, mean ± SD) were recruited and performed a lactate profile and $VO_{2\,max}$ test, one 30-minutes running session at the speed midway between the first (LT_1) and second (LT_2) lactate turn point, and two low-intensity long-duration tests at 90- and 100% of LT_1 speed. Mouth Closed Test (MCT) and the Talk Test (TT) was performed at three different intensities: Below, At and Above LT_1.

Results: A small but significant change in frequency distribution for perceived comfort when performing both MCT and TT ($p \leq 0.05$) was observed comparing running below and above LT_1. There were significant differences in physiological and RPE responses associated with responding "yes or "no" to both the MCT and the TT ($p \leq 0.05$).

Conclusion: At the group level, both MCT and TT responses demarcate statistically significant and practically meaningful differences in physiological intensity and perceived exertion. However, neither the MCT nor the TT consistently differentiate between running just below and just above LT_1 at the individual level. They should therefore be viewed as supplementary but not sufficient tools to identify delineation in the field.

Keywords: Talk Test, nasal breathing, intensity control, running

SAMMENDRAG

Introduksjon: Bruk av hjertefrekvens og laktat som intensitetsstyring kan for noen populasjoner være kostbart og føre til at utøvere blir 'tallfikserte'. Derfor var hensikten med denne studien å undersøke hvorvidt Talk Test (TT) og Mouth Closed Test (MCT) kan fungere som intensitetsverktøy og skille mellom å løpe under og over den første laktatterskelen.

Metode: 22 godt trente løpere (37 ± 9 år, 68 ± 27 km/uke, gj.snitt ± SD) ble rekruttert og gjennomførte en laktatprofil og $VO_{2\ max}$ test, samt en 30 minutter økt på median farten av den første (LT_1) og andre (LT_2) "laktatterskelen", i tillegg til to 120 minutters økter på 90- og 100% av LT_1 fart. Mouth Closed Test og Talk Test ble gjennomført på tre intensiteter: under, på og over den første laktatterskelen.

Resultater: Det var en signifikant forskjell i distribusjonen av frekvens relatert til opplevd anstrengelse under og over den første laktatterskelen ved både MCT og TT ($p \leq 0.05$). Det var en signifikant forskjell i fysiologiske- og selvopplevd anstrengelse (RPE) variabler assosiert med svarene "ja" og "nei" for både MCT og TT ($p \leq 0.05$).

Konklusjon: På gruppenivå, for både MCT og TT, er det en statistisk signifikant forskjell mellom grad av komfort. Samtidig, på individnivå, klarer hverken MCT eller TT å konsekvent skille mellom å løpe rett under eller rett over LT_1. Det er ikke et klart skille i frekvensen av opplevd anstrengelse ved under og over den første laktatterskelen.

Nøkkelord: Talk Test, nesepusting, intensitetskontroll, løping

STRUCTURE OF THE THESIS

This thesis is divided into two parts:

Part 1 presents an in-depth description of methods, theoretical background for the research, and a methodological discussion of strength and limitations for the research project.

Part 2 presents the findings of the research, written in accordance with the standards of "Frontiers in Sports and Active Living".

PART 1

THEORETICAL BACKGROUND AND METHODS

Tor Emil Hansen

University of Agder

May 2021

TABLE OF CONTENTS

1. INTRODUCTION

An effective way to increase aerobic performance is to combine and distribute low-intensity training and high-intensity training over days, weeks, months, and years. High-level endurance athletes perform ~80 % of their training at low intensity (LIT~60-65 % VO_{2max}) below the first lactate turnpoint (LT_1) and ~20 % of their training is performed at high intensity, above the first lactate turnpoint (LT_1) (Bangsbo, 2015; Jonathan Esteve-Lanao, Foster, Seiler, & Lucia, 2007; K. S. Seiler & Kjerland, 2006; S. Seiler & Tønnessen, 2009). Among others, high-level rowers, swimmers, runners, cyclists, and cross-country skiers practice this regime (K. S. Seiler & Kjerland, 2006). This form of "polarized" training that we see in elite runners is also observed amongst recreational athletes (J. Esteve-Lanao, San Juan, Earnest, Foster, & Lucia, 2005; Manzi et al., 2015) and is beneficial for improving endurance performance (Jonathan Esteve-Lanao et al., 2007; Munoz et al., 2014).

Training and intensity can be monitored from two fundamental points of view. First, there is an *external workload* that can be measured precisely with the velocity or pace in running (although inclines and declines complicate this measurement in running). This is the actual pace or power generated during each training session. The *internal workload* associated with maintaining this power or pace produced can be measured in different ways. However, heart rate and blood lactate responses are the most accessible and practical physiological measurements in daily training practice. Additionally, we can measure athletes' rate of perceived exertion (RPE) throughout an endurance session. The RPE scale ranges from 6-20, where 6 defines as "rest" and 20 being "maximal effort" (Borg, 1982).

Several studies (Jonathan Esteve-Lanao et al., 2007; K. S. Seiler & Kjerland, 2006; S. Seiler & Tønnessen, 2009; Tønnessen et al., 2014; Zapico et al., 2007) have employed the first and second lactate turnpoints to describe three aerobic endurance training intensity zones. Zone 1 (low-intensity zone) is prescribed below LT_1 (typically <2 mM). Zone 3 (high-intensity zone) is prescribed blood-lactate measurements above LT_2 (typically >4 mM) and zone 2 emerges between these two zones. Esteve-Lanao et al., 2007 describes heart rate ranges for the intensity distribution; Zone 1 (50-80 % HR_{max}), zone 2 (65-90 % HR_{max}) and zone 3 (80-100 % HR_{max}). Both the substantial range in intensity associated with Zone 1 and the overlapping seen in physiological measures across the 3 zones are noteworthy. When coaches instruct their athletes to perform an easy training session in zone 1 (50-80 % HR_{max}) this represents a large potential for differing interpretations and execution of the training prescription, based on $\%HR_{max}$.

Physiological thresholds determined by laboratory testing and measurement of ventilation, gas exchange, and blood lactate concentration concerning exercise intensity serve the purpose of prescribing training intensities (Rodríguez-Marroyo, Villa, García-López, & Foster, 2013). Unfortunately, laboratory methods are either unavailable or unaffordable for many athletes. Therefore, simple indirect methods for measuring exercise intensity, such as the ratings of perceived exertion (RPE) and the Talk Test (TT) (Reed & Pipe, 2014; Woltmann et al., 2015) can be welcome alternatives. The TT measures the ability to 'speak comfortably' while exercising at different intensities and responding to a number of different speech-provoking strategies. The strategies include, among others, responding to questions, reciting a standard paragraph, counting out loud and, hearing yourself breathe. Investigators of the TT consider this to be a practical alternative to standard laboratory methods for prescribing training intensity and identifying the ventilatory threshold (Rodríguez-Marroyo et al., 2013; Woltmann et al., 2015).

Within recent years, methodologies utilizing restricted nasal breathing while running has received growing attention (Bourdin, Sallet, Dufour, & Lacour, 2002; Dallam, McClaran, Cox, Foust, & Science, 2018; LaComb, Tandy, Lee, Young, & Navalta, 2017; Recinto, Efthemeou, Boffelli, & Navalta, 2017). This nasal only breathing approach has been suggested to have beneficial effects during submaximal exercise intensities (LaComb et al., 2017) including a significantly lower VO_2 at steady state (Dallam et al., 2018) and lower respiratory exchange ratio (Recinto et al., 2017). To the author's knowledge, no studies have systematically investigated whether nasal breathing can be used as an intensity control tool. Therefore, we have developed a simple and practical test, inspired by the Talk Test, which measures the perceived comfort of nasal breathing during exercise. The test will be referred to as Mouth Closed Test (MCT) throughout this study. The test involves subjects running with the mouth closed for two minutes, before responding whether it felt "comfortable", "equivocal" or "not comfortable".

Regular blood lactate and heart rate measurements may be expensive for certain populations and may lead athletes to be excessively “numbers fixated”. Identifying a cost-effective and simpler tool for intensity control during low-intensity training would be beneficial. Therefore, this study will investigate the Talk Test’s and Mouth Closed Test’s ability and practicality for controlling exercise intensity among endurance trained runners. The aim of this study is two-fold. First, it seeks 1) to quantify perceived comfort during the Talk Test and Mouth Closed Test in experienced runners performing long-duration low-intensity running sessions. Second, it aims 2) to investigate whether the Talk Test or Mouth Closed Test can consistently distinguish running at an intensity of below and above the first lactate turnpoint.

Research Question & Hypothesis

The purpose of this research is to quantify physiological responses and perceived comfort during the Talk Test and Mouth Closed Test in experienced runners performing long-duration low-intensity running sessions. Therefore, this study employs a descriptive approach to answer the following research question:

Can the Talk Test or Mouth Closed Test consistently distinguish between the intensity of below and above the first lactate turnpoint and be a used as a tool for intensity control during prolonged easy runs?

Hypothesis: The Talk Test is a valid instrument for controlling intensity in runs prescribed at or below LT_1-speed and contain a high degree of practicality. The Mouth Closed Test has a high degree of practicality but is not a useful tool for intensity control due to large individual variation.

2. THEORETICAL BACKGROUND

2.1 Physiological Factors Influencing Running Performance

It is essential to clarify that in this context, 'running performance' is related to distance running, involving all distances from 5 km to ultramarathon. Jones & Carter (2000) defines endurance as *"the capacity to sustain a given velocity or power output for the longest possible time".* Various factors influence running performance, most of which are physiological. High aerobic capacity forms the foundation of endurance performance, but well-developed fractional utilization of $VO_{2\ max}$ and work economy is essential for optimal running performance. Endurance exercise results in cardiorespiratory, pulmonary, and neuromuscular adaptions (Jones & Carter, 2000). This results in greater oxygen delivery and oxygen consumption to the working muscles, causing the body to tackle the external workload more efficiently (Joyner & Coyle, 2008). The most important physiological parameters related to running performance are maximal oxygen uptake ($VO_{2\ max}$), running economy, and fractional utilization of $VO_{2\ max}$ (Bassett & Howley, 2000; Jones & Carter, 2000; Joyner & Coyle, 2008; M. A. Thompson, 2017).

2.1.1 Performance VO_2

Hill et al. (1923) first coined the term 'maximal oxygen uptake', defined as the highest rate at which the body can utilize oxygen during high-intensity exercise (Bassett & Howley, 2000; Hill & Lupton, 1923). Furthermore, high $VO_{2\ max}$ values have commonly been considered good indicators of success in endurance sports like running, cycling, and rowing (Jones & Carter, 2000). Such studies suggest that it is not the muscles' ability to exploit oxygen but rather the rate at which oxygen can be supplied to the muscles that limit $VO_{2\ max}$ (Saltin & Strange, 1992). Two main factors lead to increased $VO_{2\ max}$. The first one is rising blood flow to the working muscles, caused by the heart producing a higher stroke- and minute volume due to endurance exercise (Jones & Carter, 2000). Moreover, the increased arterio-venous oxygen difference (A-V O_2) contributes to higher $VO_{2\ max}$ values (Paterson, Shephard, Cunningham, Jones, & Andrew, 1979). However, $VO_{2\ max}$ is relatively homogeneous in elite runners. Therefore, the variance in performance of athletes with similar $VO_{2\ max}$ is highly relevant. Utilization of $VO_{2\ max}$ and VO_2 at lactate threshold has developed as the physiological explanation for this phenomenon (Costill, Thomason, & Roberts, 1973; M. A. Thompson, 2017). Utilization of $VO_{2\ max}$ is expressed as a percentage of maximal oxygen uptake at a certain speed, and a higher percentage can often differentiate good athletes from elite ones with similar $VO_{2\,max}$ values (Costill et al., 1973; M. A. Thompson, 2017). In addition, VO_2 at LT is a superior indicator of running performance (Bird, Theakston, Owen, & Nevill, 2003; Farrell, Wilmore, Coyle, Billing, & Costill, 1979; McLaughlin, Howley, Bassett, Thompson, & Fitzhugh, 2010).

2.1.3 Running Economy

Running economy is defined as the steady-state oxygen consumption at a given running velocity. (Barnes & Kilding, 2015b; Bassett & Howley, 2000; M. A. Thompson, 2017). The lower the VO_2 at submaximal speed, the better the running economy. Over the last decade, running economy has earned more attention and has proven to be one of the most critical determinants of running performance (Barnes & Kilding, 2015a, 2015b; M. A. Thompson, 2017). Running economy is a complex concept that is determined by environmental, physiological, biomechanical, and anthropometric factors (Saunders, Pyne, Telford, & Hawley, 2004). Moreover, running economy is influenced by training history and training volume (Barnes & Kilding, 2015a, 2015b; Saunders et al., 2004). For instance, when adjusted for body mass, the oxygen cost of running at a given speed is lower for Kenyan elite runners than for other elite runners (Saltin et al., 1995). Even when not normalizing for body mass, the best Kenyan runners are still more efficient compared to top Swedish runners (Saltin et al., 1995). A study of Weston et al., 2000 comparing running economy in African and Caucasian runners, found that the two groups had similar 10km race performance. However, this study also found the African runners had a 13% lower $VO_{2\,max}$. The similarity in race performance was explained by an 8% better running economy when adjusted for body mass. The Kenyan runners also worked at a higher percentage of their $VO_{2\,max}$ but with similar lactate [la^{-1}] as the Caucasian runners (Weston, Mbambo, & Myburgh, 2000). While the physiological markers of high-level running performance are quite clear, the physiological responses during prolonged runs at low intensity are not adequately investigated.

2.2 Physiological Responses During Prolonged Running

Several physiological changes occur during prolonged exercise. Among them are changes in hydration status (Baker & Jeukendrup, 2011), increases in core and muscle temperatures (Febbraio et al., 1994), increases in circulating catecholamines (Zouhal, Jacob, Delamarche,

& Gratas-Delamarche, 2008) and depletion of endogenous fuel stores (Watt, Heigenhauser, Dyck, & Spriet, 2002). Additionally, work economy may decrease during prolonged exercise (Passfield & Doust, 2000; Scheer, Vieluf, Cramer, Jakobsmeyer, & Heitkamp, 2018). Moreover, oxygen consumption gradually increases during prolonged running at a submaximal, constant speed (Kalis et al., 1988). This phenomenon is referred to as cardiovascular drift (CV) and is characterized by a rise in heart rate and fall in stroke volume (Wingo, Ganio, & Cureton, 2012) . Conventionally, the hypothesized cause of CV is a progressive increase in cutaneous blood flow, as body temperature rises and reduces stroke volume during exercise (Nixon, 1988). However, little empirical evidence supports this connection between a progressive decline in stroke volume and cutaneous circulation (Coyle & González-Alonso, 2001). In fact, the same stroke volume has been observed during moderately intense exercise in the heat (35°C) and cold (8°C) within trained subjects, despite a large difference in cutaneous blood flow (González-Alonso, Mora-Rodríguez, & Coyle, 2000). Hyperthermia and hypovolemia are proposed as the main mechanisms of CV (Coyle & González-Alonso, 2001). Mean core- and skin temperatures increase when exercising both in 22°C-25°C) and 30°C-35°C environmental conditions (Gliner, Raven, Horvath, Drinkwater, & Sutton, 1975; Lafrenz, Wingo, Ganio, & Cureton, 2008).

Whereas the aforementioned explanations for cardiovascular drift occur during uncontrolled conditions, Maunder, Seiler, Mildenhall, Kilding, and Plews (2021) have discussed cardiovascular drift when factors like hydration and temperature are controlled for. Moreover, they propose a new term ‘durability’, which they defines as “*the time of onset and magnitude of deterioration in physiological-profiling characteristics over time during prolonged exercise*” (Maunder et al., 2021). They suggest it is likely ‘durability’ characteristics vary between individuals and exemplifies this with crowd-sourced data (in controlled conditions), where HR responses varied substantially between athletes. Finally, the physiological mechanisms behind these effects, could be muscle fibre-type recruitment, substrate metabolism, and thermoregulatory capabilities (Maunder et al., 2021).

2.3 Training Organization

The daily training of elite and well-trained runners mostly consists of prolonged easy runs, and only a fraction of all the training is performed at high intensity (Jonathan Esteve-Lanao, 2007; Bangsbo, 2015; Seiler & Kjerland, 2006; Seiler & Tønnessen, 2009). In particular, easy training refers to an intensity at or below the first lactate turnpoint (<2 mmol, <13 RPE units, 55 – 82 % HR_{max}) (Olympiatoppen). This polarized training is well established and has thus far been proven as the best recipe for developing high level running performance (Tønnessen et al.,2014; Jonathan Esteve-Lanao, 2007; Munoz et al., 2014). This intensity distribution is illustrated in Figure 1. Overtraining is a common problem among endurance athletes and can cause a high risk of injury (Foster, 1998). The causes of overtraining may be diverse, but a recently discovered issue is that athletes often do not execute the intensity prescription applied by the coach (Brink, Frencken, Jordet, & Lemmink, 2014; Judge et al., 2020; Wallace, Slattery, & Coutts, 2009). The easy runs are perceived as harder than prescribed, and high-intensity interval sessions are perceived as easier than prescribed (Judge et al., 2020). Therefore, it is crucial for runners striving to perform better to control and understand what intensity they are working at during prolonged runs prescribed at low intensity.

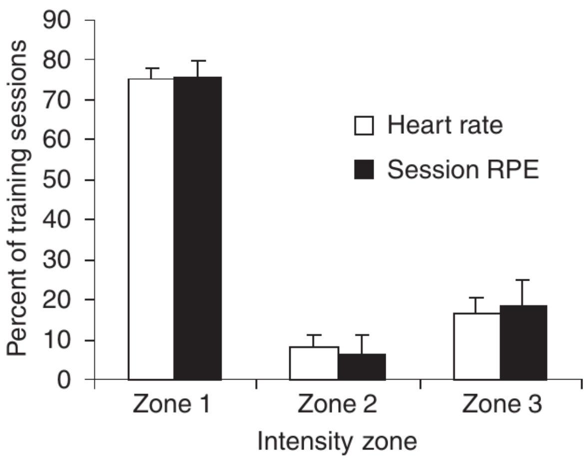


Figure 1: Training intensity distribution in 318 training bouts. Taken from Seiler & Kjerland (2006).

2.4 Intensity Control

There are several tools for measuring intensity, which are differentiated between external, internal, and subjective tools. This chapter seeks to elucidate strengths and limitations of existing intensity control tools in terms of practicality, cost-effectiveness, and validity.

2.4.1 Blood Lactate

To this day, blood lactate measurements are considered the gold standard for determining lactate threshold. Over the years, the various methods for establishing lactate thresholds have been heavily debated both in research and practice. Several terminologies across countries have been used to express a metabolic rate where the increase of blood lactate is maximal and equal to the rate of diffusion of lactate from the exercising muscle (Billat, 1996). Among them are maximal lactate steady state (MLSS), the onset of blood lactate accumulation (OBLA), aerobic threshold, anaerobic threshold, and lactate threshold (Billat, 1996; Jacobs, 1986). These various terminologies have somewhat confused the understanding of the concept, but researchers are still convinced that blood lactate measurements are the best existing tool for determining a threshold speed. Furthermore, studies have found that lactate variables are highly correlated with performance (Allen, Seals, Hurley, Ehsani, & Hagberg, 1985; Iwaoka, Hatta, Atomi, & Miyashita, 1988). Iwaoka et al. (1988) found that 92% of the variance in performance was related to the VO_2 expressed at the lactate threshold. Moreover, performance in within 10k and marathon running was predicted using speed at lactate threshold in the study of Allen et al. (1985). Nevertheless, Wiswell et al. (2000) concluded that $VO_{2\,max}$ is a better predictor of performance in master runners.

When executing a lactate profile, two lactate turnpoints will occur. This “aerobic-anaerobic transition” was first described by (Kindermann, Simon, & Keul, 1979). The “aerobic threshold” is the first increase in blood lactate and the “anaerobic threshold” is the second increase in blood lactate. These two turnpoints were introduced by Kindermann and his colleagues as the first and second lactate threshold (LT_1 and LT_2). Based on this, in addition to the studies of Lucía, Sánchez, Carvajal, and Chicharro (1999) and Lucia, Pardo, Durantez, Hoyos, and Chicharro (1998), K. S. Seiler and Kjerland (2006) developed three lactate intensity zones: zone 1) <2 mmol/L, zone 2) >2 and <4 mmol/L, zone 3) >4 mmol/L. Several studies (Bangsbo, 2015; Jonathan Esteve-Lanao et al., 2007; K. S. Seiler & Kjerland, 2006; Tønnessen et al., 2014; Zapico et al., 2007) have quantified training intensity distribution in elite and recreational athletes and have found that training is predominantly performed below the first lactate threshold.

In daily practice and training, lactate measurements are commonly used by high-level athletes to control exercise intensity during threshold intervals or high-intensity bouts to ensure they are not exceeding intensities and physiological stress that will postpone recovery time. However, the limitations to blood lactate measurements are that they can be expensive and do not serve as a practical tool for intensity control for the common recreational athlete during low-intensity running.

2.4.2 Heart Rate

Heart rate (HR) is presumably the most common intensity control tool among runners and a popular method to express heart rate is percentage relative to the maximal HR (%HR_{max}). The Norwegian Olympic Federation (Olympiatoppen) describes heart rate ranges in five zones with the method of %HR_{max}: 1) 55-72%, 2) 72-82%, 3) 82-87%, 4) 87-92% and 5) >92% (Olympiatoppen). However, this method does not account for individual differences in resting HR. Therefore, heart rate reserve (%HRR), which allows for individual variation in both maximal and resting HR, is a preferred method (Karvonen & Vuorimaa, 1988).

The rapid development of technology has made heart rate monitors more accessible and can today be found in smartwatches, detecting heart rate from the wrist. This implies that you can constantly be aware of your heart rate. In addition, the smartwatches and training apps automatically provide scores of sleeping patterns, recovery, training effects, and so on. This may be beneficial and useful information to some athletes but may confuse others even more. If one does not have an education related to physical activity and can sift out what is important, one can easily become overwhelmed and disorientated by the information. This phenomenon of information overload has not been thoroughly researched, but a few studies have mentioned and described it (Billinghurst & Starner, 1999; Halson, Peake, & Sullivan, 2016). With this in mind, a simpler and more practical tool for controlling intensity could be beneficial.

2.4.3 Rating of Perceived Exertion

To express and monitor an individual's rating of perceived exertion and effort during and after exercise, Borg's rating of perceived exertion (RPE) has been widely used in both research and practice. The scale ranges from 6 to 20, where 6 is defined as rest and 20 being maximal effort. The scale is presented in Table 1. Studies have investigated the validity and reliability and it has been proven to be a precise tool for measuring perceived exertion (Chen, Fan, & Moe, 2002; Scherr et al., 2013). Perceived exertion is strongly correlated with both heart rate (r = 0.74) and blood lactate (r = 0.83) (Scherr et al., 2013). Conversely, neither gender, age, coronary artery disease, physical activity status nor exercise testing modality appears to influence the correlation significantly (Scherr et al., 2013). Further on, the study of Scherr et al., 2013 reported RPE values of 10.8 ± 1.8 at the first lactate threshold and 13.6 ± 1.8 at the second lactate threshold. While at fixed lactate thresholds (3 and 4 mmol/L) corresponding RPE values were 12.8 ± 2.1 and 14.1 ± 2.0 (Scherr et al., 2013). These data were collected from 1,612 healthy individuals. Borg's rating of perceived exertion has the validity and reliability to serve as a tool for intensity control during exercise. The strongest properties of the scale, are arguably its practicality and cost-effectiveness.

Table 1: The 15-grade scale for ratings of perceived exertion. Modified from Borg (1982). Copyright Gunnar Borg.

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

2.4.4 Talk Test

The Talk Test was developed hypothesizing that if exercisers are 'just capable of talking' they are close to their threshold. The theory originated from climbers in the 1930's and their unspoken rule to not climb faster than a speed at which they are able to speak (Goode, 2008). The rationale for this approach was to reduce the effects of altitude hypoxia (Goode, 2008). Fatigue combined with light-headedness is two particularly unfavourable conditions when climbing a mountain. Over the years, the Talk Test has been scrutinized in exercise laboratories. The TT measures the ability to 'speak comfortably' while exercising at different intensities and responding to several different speech-provoking strategies, including responding to questions, reciting a standard paragraph, counting out loud, and hearing yourself breathe. Existing literature suggests that the Talk Test is a valid and inexpensive tool for guiding exercise intensity across populations, including healthy adults, individuals with cardiovascular diseases, and athletes (Persinger, Foster, Gibson, Fater, & Porcari, 2004; Reed & Pipe, 2014; Rodríguez-Marroyo et al., 2013; Zanettini et al., 2013). According to the previous literature, comfortable speech is not possible when an individual is exercising at an intensity close to or at the second lactate threshold (Persinger et al., 2004; Quinn & Coons, 2011; Recalde & Porcari, 2002), and has therefore been suggested to be a good tool for determining ventilatory threshold and lactate threshold.

2.4.5 Restricted Nasal Breathing During Exercise

Nasal breathing when running is observed in the field among athletes and coaches and is mentioned in many running magazines and blogs (Beck; Halse, 2019). Restricted nasal breathing compared to oral breathing is documented to have different physiological characteristics during submaximal exercise, such as lower VO_2, expiratory exchange ratio, respiratory rate, and ventilation (Dallam et al., 2018; LaComb et al., 2017; Recinto et al., 2017). The study of LaComb et al. (2017) revealed 8-10% lower VO_2 during nasal breathing compared to oral breathing. However, heart rate seems to increase when performing restricted nasal breathing (Dallam et al., 2018; LaComb et al., 2017; Recinto et al., 2017). Niinimaa, Cole, Mintz, and Shephard (1980) determined a switching point from nasal to oral breathing during an incremental exercise test performed on a cycle ergometer. They found that the switching point was characterized by means of 13.2 ± 2.2 RPE and 36.3 ± 10 V_E (Niinimaa et al., 1980). Unfortunately, only absolute values of heart rate (125.1 ± 19.7) were reported. Niinimaa and his colleagues suggest that nasal resistance influences the switching point, which is supported by Saketkhoo, Kaplan, and Sackner (1979), but Saibene, Mognoni, Lafortuna, and Mostardi (1978) showed no correlation of the relationship.

3. METHODS

3.1 Study Design

This research was part of a wider research project conducted with a fellow master student at the University of Agder, Faculty of Health- and Sport Science for the Department of Sport Science and Physical Education. Prior to the study, the authors conducted pilot testing to test various protocols. This descriptive study consisted of four tests performed on four different days. Test day 1 consisted of the $VO_{2\ max}$- and lactate profile test (Figure 3) and was considered preliminary testing. The $VO_{2\ max}$ test validated the participant's fitness level, while LT_1-speed (used in threshold test and two-hour low-intensity running tests) was derived from the lactate profile test. Test day 2 was the 30-minute threshold test (Figure 4) and was performed after the preliminary testing. Test days 3 and 4 consisted of two low-intensity long-duration tests (LR90 and LR100) (Figure 5). All participants performed the testing protocol in an identical manner. Data collection and testing were performed from December 2020 to February 2021.

3.2 Participants

Recruitment occurred through contact with local running clubs on social media and via personal interactions. A total of 61 runners announced their interest in participating and were asked to fill out a questionnaire about their training level. Data collected from this questionnaire (appendix 7) provided useful information and allowed the authors to select the desired intervention group. We ensured a varied sample group including a range of ages, sex, and level of training. The questionnaire was also used to indicate whether participants could perform a low-intensity two-hour running session. Within the limited timeframe and with the available resources, we were able to recruit 22 subjects. These participants were then screened for study inclusion.

A total of 22 runners (16 male, 6 female; aged 37 ± 9) participated in the study. The target group included experienced runners averaging at least 30 km per week for the last eight weeks and which were able to perform a low-intensity indoor running session for two hours. The selection criteria used for this study required participants to be 1) aged 18-55 years, 2) healthy and not injured, 3) able to perform a two-hour low-intensity running session on a treadmill and 4) running >30 km per week for the last eight weeks. The exclusion criteria used to eliminate potential participants for this research required participants not to have any illness or injury that could potentially influence their running performance. Furthermore, the upper age limit of 55 and the lower age limit of 18 were set in order to match the desired population. During the data collection period, subjects were instructed to continue their regular training routines. The participants were arranged into either high volume (HV) or low volume (LV) groups, based on their reported training volume and typical long run duration throughout the last eight weeks. The cut-off for being selected to either HV- or LV group was: HV group = >70 km/week and >90 min typical long run duration; LV group = <70 km/week and <75 min typical long run duration. This cut-off was not decided on forehand, but based on the looks of the questionnaire data. The physiological characteristics of the two groups are presented in Table 2.

One dropout from the HV group was registered before preliminary testing due to injury. Moreover, two male participants from the HV group did not complete test 4 (LR100) due to injury or illness. The two subjects were therefore excluded from the final analyses of test 4.

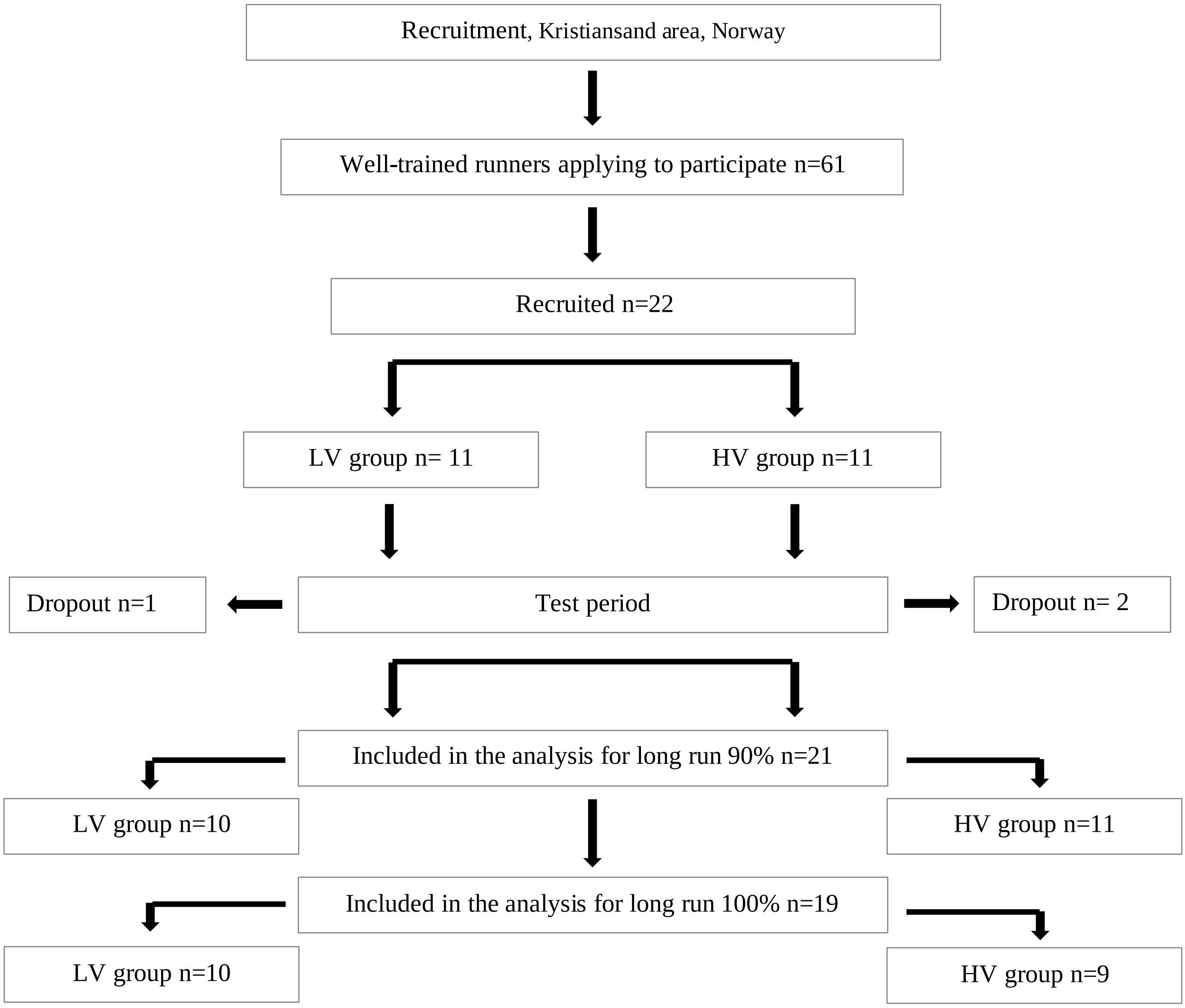


Figure 2: Flowchart. N= number of participants; HV = High-volume; LV = Low-volume.

Table 2: Training characteristics.

	Total (n=21)	HV(n=11)	LV(n=10)
Age	37 ± 9	39 ± 9	35 ± 9
Sex (female/male)	6/15	2/9	4/6
Weight	69 ± 10	68 ± 10	70 ± 11
Height	176 ± 9	175 ± 9	177 ± 9
Training characteristics			
Years of running experience	11 ± 8	11 ± 7	10 ± 9
Training volume (km/week)	68 ± 27	88 ± 22*	47 ± 11*
Typical duration of long runs (minutes)	99 ± 43	125 ± 46*	71 ± 6*
Personal bests			
10 000 metres (min:sec)	38:11 ± 4:26	36:40 ± 3:39*	40:02 ± 4:46*
Half marathon (hr:min:sec)	1:27:52 ± 00:11:43	1:22:42 ± 00:08:36*	1:33:02 ± 00:12:31*
Marathon (hr:min:sec)	03:11:35 ± 00:46:23	02:58:20 ± 00:15:35	03:55:46 ± 01:29:29

Results are presented as mean ± standard deviation (SD). HV = High volume; LV = Low volume; km/week = Kilometres per week; hr:min:sec = Hours:minutes:seconds; N = Number of runners. *Significant differences between groups ($p \leq 0.05$).

3.3 Ethical Considerations

Prior to conducting the research, all selected participants received a written letter containing necessary information. This included the purpose of the research, the potential risks involved, the potential benefits of participating, and a statement explaining that at any point during the research period they would be able to withdraw their participation without any reason.

The participants were not to subjected to unnecessary risks, and their well-being remained a priority throughout the research. The level of physiological stress to which participants were exposed was similar to the level they would have experienced during their daily training. The study was performed in accordance with the Declaration of Helsinki and approved by the

Faculty´s ethics committee (FEK) (appendix 4), where any data was stored safely according to the guidelines provided by the Norwegian Centre for Research Data (appendix 3).

3.4 Testing Procedures

The test protocol consisted of four tests performed on four different days. The first test (preliminary testing) was the $VO_{2\ max}$ and lactate profile test (Figure 3). The second test was a 30-minute threshold test (Figure 4). The third (LR90) and fourth tests (LR100) (Figure 5) were long-duration (120 minutes) low-intensity (90 and 100 % LT_1 speed) sessions. All participants had to complete preliminary testing before performing tests 2, 3, and 4. At least 48 hours of recovery time between each test day were considered sufficient for recovery and optimal performance. The participants were not allowed to perform any intense exercise 24 hours before the test days and were instructed to wear the same shoes for all tests. Additionally, the participants were instructed to consume the same meal type and avoid consuming caffeine three hours preceding testing. Furthermore, during the $VO_{2\text{-}max}$ test, verbal encouragement was given to stimulate maximal exercise effort. The same test leaders supervised and executed all tests and measurements. In addition, we strived to perform testing for women in the follicular phase of the menstrual cycle (Appendix 5). If a subject reported amenorrhea, were using oral contraceptives, or were in menopause, the menstrual cycle was not accounted for.

3.4.1 Test Day 1: Preliminary Testing

Lactate Profile Test

The first test day started with a submaximal incremental lactate profile test. The test started with a 10-minute warm-up, including familiarizing the participants with the treadmill and information about the test protocol. Testing proceeded with 5 minutes submaximal bouts with increasing workloads to identify speed, heart rate, and lactate values at both LT_1 and LT_2. Between five and seven running stages were completed by all subjects. Starting speed was individualized and based on the discussion between test leaders and runners. The incline was set at 1%, and the workload increased by 1 $km \cdot h^{-1}$ every five minutes. Athletes stood with legs straddling the treadmill for 30s during each finger blood draw before continuing running at the next treadmill speed. When blood lactate exceeded LT_2 values, the test was stopped to prevent fatigue prior to the $VO_{2\ max}$ test. LT_1 values were calculated as 0,5 $mMol \cdot L^{-1}$ + the mean of the first two blood [la^{-1}] measurements, while LT_2 was calculated as 2,1 $mMol \cdot L^{-1}$ + the mean of the first two blood [la^{-1}] measurements.

$VO_{2\ max}$ Test

Subjects rested for 10 minutes between the lactate profile and $VO_{2\ max}$ test, which began at 1 $km \cdot h^{-1}$ below the calculated LT_2 speed. During the $VO_{2\ max}$ test treadmill speed was initially increased by 1 $km \cdot h^{-1}$. In the last stages of the test, runners had the option of either keeping the same speed or increase with 1- or 0.5 $km \cdot h^{-1}$. A total duration of 6-8 minutes was desirable.

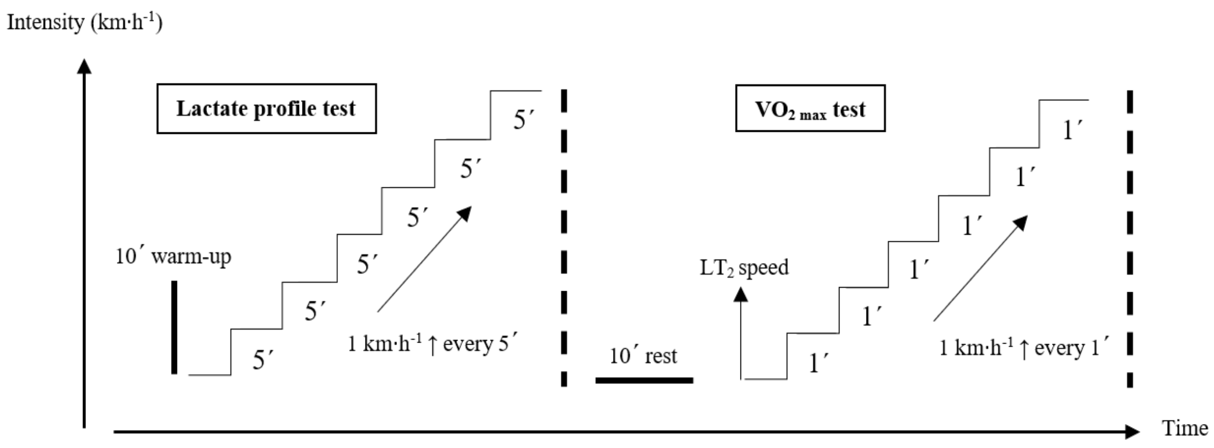


Figure 3: Preliminary testing.

3.4.2 Test Day 2: Threshold Test

Test day 2 consisted of one threshold test with the purpose of running 30 minutes at the median of LT_1- and LT_2 speed record responses to the Talk Test and Moth Closed Test when runners were clearly above their LT_1-speed. The test started with a 10-minute warm-up, with an incline set at 1%. Athletes performed the Mouth Closed Test from 9-11 minutes and 24-26 minutes. Immediately they were asked: "Did running with your mouth closed feel comfortable?" Three possible answers were recorded: 1) "yes", 2) "equivocal" and 3) "no". From 12-15 and 27-30 minutes, Talk Test, VO_2, HR, Borg Scale, and blood lactate were measured. Conducting the Talk Test, athletes were instructed to recite a standard paragraph that required 10-15 seconds of speaking during the last 30 seconds of every bout. The standard paragraph used in this test was the first verse of the Norwegian national anthem. After reciting the paragraph, he or she was asked “can you speak comfortably?”. The three possible answers were recorded: 1) “yes”, 2) “equivocal” and 3) “no”. For both tests, the participants were obligated to continue the tests regardless of the answers to the questions.

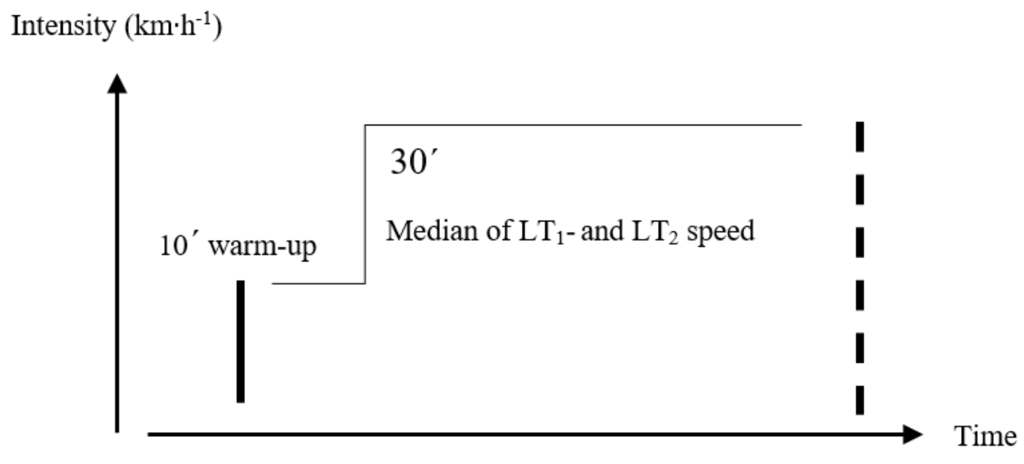


Figure 4: Threshold test.

3.4.3 Test Day 3 and 4: 2-Hour Low-intensity Running Tests

Test day 3 and 4 consisted of a 120 min, low-intensity treadmill run performed at 90% (LR90)- and 100% (LR100) of identified LT_1-speed, respectively. To simulate a normal easy running session, runners could listen to music or watch television during the two-hour run. Measurements were performed in the following order: Mouth Closed Test, Talk Test, Stryd™, heart rate, electromyography (EMG), VO_2, Borg Scale, lactate, skin temperature, core temperature. Each bout of lactate, skin- and core temperature measurements resulted in one minute off the treadmill. Additionally, participants were weighed before and after each test to control and calculate weight loss due to dehydration. Before attaching EMG sensors to M. vastus medialis and M. biceps femoris, both areas were shaved and disinfected with an alcohol swab to prevent any signal disturbances. The timeline for measurements is presented in Figure 6.

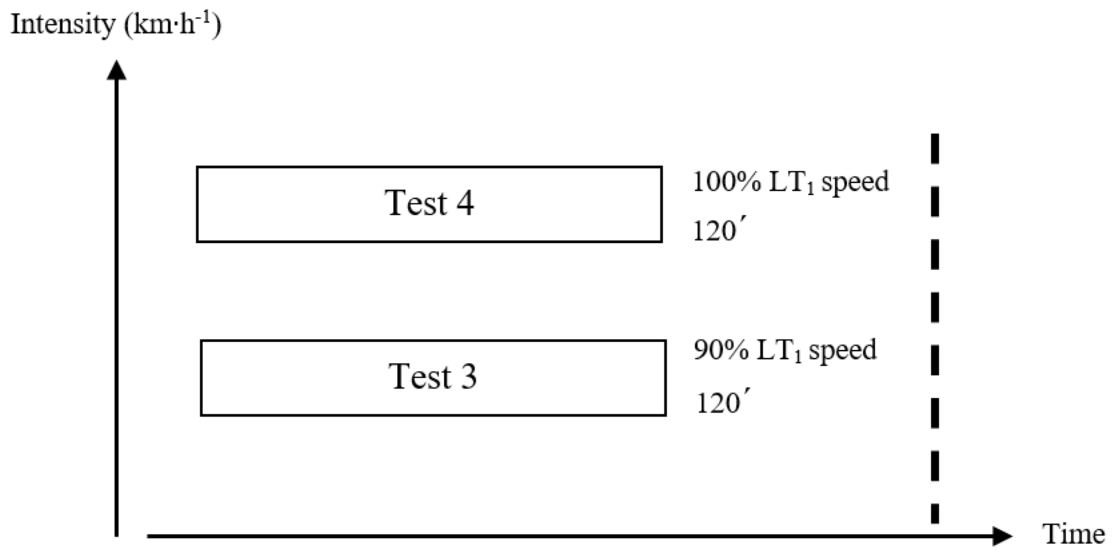


Figure 5*:* 2-hour low-intensity running tests.

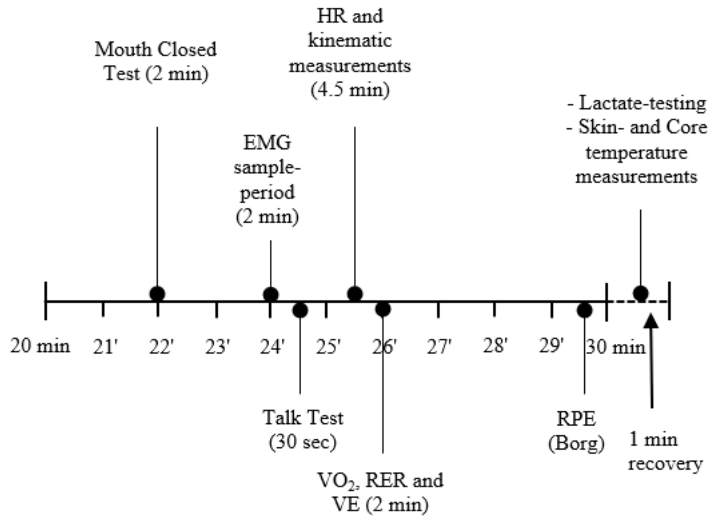


Figure 6: Timeline of measurements during the LR90- and LR100 test. EMG = Electromyography; Min = Minutes; Sec = Seconds; RPE = Rate of perceived exertion; VO_2 = Oxygen uptake; RER = Respiratory exchange ratio; VE = Minute ventilation.

3.5 Instruments

The same treadmill (Lode Katana Sport, Lode B. V., Groningen, Netherlands) was used for all tests. The treadmill was calibrated on a regular basis. Moreover, all tests were performed under similar environmental conditions (18-21°C) and at the same time of day (± 2h). Metabolic and ventilatory measurements were made using Oxycon Pro™ with a mixing chamber and 30 seconds sampling time (Oxycon, Jaeger GmbH, Hoechberg, Germany). The metabolic cart was calibrated before every test and again midway through the LR90 and LR100 tests. During all tests, blood [la^{-1}] measurements were analyzed using a stationary lactate analyzer (EKF BIOSEN, EKF diagnostic, Cardiff, UK), which was automatically calibrated every 60 minutes. HR was measured using Polar V800 (Polar Elektro Oy, Kempele, Finland). Core temperature measurements were made using Braun IRT6520 ThermoScan® 7 Age precision® (Braun, Kronberg im Taunus, Germany) and participants were instructed to perform them by themselves for improved standardization. Skin temperature was measured using Flir TG267 Thermal Camera® (Flir Systems, Inc. Wilsonville, Oregon, US). Kinematic variables were measured using a Stryd™ foot pod (Stryd, Boulder, Colorado, US). EMG was measured using Delsys Trigno Wireless EMG System (Delsys, Natick, Massachusetts, US). Before and after each test, runners were weighed using a Seca model 713 (Seca, Hamburg, Germany).

Table 3: Testing equipment

Testing equipment	**Test**
Treadmill: Lode Katana Sport (Groningen, The Netherlands)	1, 2, 3 & 4
Lactate analyser: Biosen 5030 (EKF BIOSEN, EKF Diagnostic, Cardiff, UK)	1, 2, 3 & 4
Oxygen analyser: Oxicon Pro (Jaeger GmbH, Hoechberg, Germany)	1, 2, 3 & 4
Heart rate monitor: Polar V800 (Polar Elektro Oy, Kempele, Finland)	1, 2, 3 & 4
Weight: Seca 713 (Hamburg, Germany)	1, 3 & 4
Talk Test: First verse of the Norwegian national anthem song	2, 3 & 4
Thermal meter: Braun IRT6520 ThermoScan 7 Age Precision	3 & 4
Electromyography: Delsys Trigno Wireless System (Boston, USA, 2010)	3 & 4
Thermography camera: FLIR TG267 (Flir Systems, Inc., Wilsonville, Oregon, USA)	3 & 4
Stryd™ foot pod: Stryd Wind v3 (Boulder, Colorado, USA)	1, 2, 3 & 4

3.6 Statistics

Data were analyzed using IBM SPSS Statistics 25 (SPSS Inc., Chicago, IL, USA) and results are presented as mean ± *SD*. Ordinal data are presented as frequencies. Tables and figures were made using Microsoft Word and Microsoft Excel 2019 (Microsoft Corporation, Redmond, Washington, USA). Differences in training- and physiological characteristics within the HV and LV groups were analyzed using an independent samples *t*-test. A one-way repeated measures ANOVA with a Greenhouse Geisser correction was conducted to compare lactate values at all intensities. A Bonferroni post hoc test was then used to examine where differences lied. To investigate differences in TT and MCT responses below, at, and above LT_1, non-parametric K Related Sample tests were used. To compare means in physiological and RPE markers related to MCT and TT, a one-way ANOVA was used. Values of $p \leq 0.05$ were considered statistically significant.

4. METHODOLOGICAL DISCUSSION

This chapter seeks to discuss and describe the methodological perspectives and challenges which occurred when designing and carrying out this research project.

4.1 Design

In the current study, a desciptive approach was used, and the research question was the decisive factor for the choice of study design. For eliminating potential biases, randomization is the optimal method when conducting an experiment (Concato, Shah, & Horwitz, 2000). The initial plan was to first execute preliminary testing, and then to follow up with the 30-minute threshold test, LR90- and LR100 test in a randomized order. However, we considered the Covid-19 situation to be unpredictable and could potentially end up with a closed laboratory due to an infection outbreak. Therefore, we decided to perform testing in chronological order. All participants executed the preliminary testing, then the 30minute threshold test, and finally the LR90- and LR100 test. This way, in a scenario with an infection outbreak and a closed laboratory, the possibility for achieving data for all participants for at least one test, would be higher.

4.2 Establishing the First and Second Lactate Turnpoint

The method of establishing the first and second lactate threshold was undoubtedly a crucial part of this project. It was important because the intensity of the 30-minute threshold test and LR90 and LR100 was based on the lactate value and threshold speeds derived from the preliminary testing. The multiple methods of determining the first and second lactate threshold were described in the chapter THEORETICAL BACKGROUND. Further on, because blood lactate concentrations can vary greatly among endurance-trained individuals (Cheng et al., 1992; Stegmann, Kindermann, & Schnabel, 1981), we, therefore, considered an individualized lactate threshold method to be preferable. To determine the first lactate threshold, we used the calculation of 0,5 mMol·L^{-1} + the mean of the first two blood [la^{-1}] measurements and for the second lactate threshold, we used 2,1 mMol·L^{-1} + the mean of the first two blood [la^{-1}] measurements. This is a valid method for establishing the first and second lactate threshold according to Tanner and Gore (2012) and Hughson and Green (1982). Besides, this method for establishing the second lactate turnpoint is according to The

Norwegian Olympic Federation’s (OLT) standardized testing protocol for runners. Finally, during pilot testing prior to the study, several volunteers performed lactate profiles, which provided the authors assurance that the method was operating sufficiently.

4.3 Test Protocol

The preliminary testing (lactate profile- and $VO_{2\ max}$ test) was performed according to The Norwegian Olympic Federation’s standardized testing protocol. Treadmill incline during the $VO_{2\ max}$ test and the method for determining lactate LT_2 was the only deviations to the OLT’s protocol. During pilot testing, the authors experienced a 1% incline to be sufficient for runners to achieve their $VO_{2\ peak}$. We also tested a 5,3% incline (which is according to OLT’s protocol). However, we observed that muscular fatigue in the lower extremities hindered respiratory exhaustion, and therefore, runners were not able to achieve their $VO_{2\ peak}$.

For the LR90- and LR100 tests, two aspects were considered when deciding to perform measurements every 30 minutes, resulting in four measurement bouts for each test. First, we strived to make the test protocol equivalent to each participant's normal easy run. This involved minimizing the disturbance of the runners while they ran. Second, we considered that the four data points: 30-, 60-, 90- and 120 minutes would correspond to the participant's physiological and perceptual state.

4.4 Intervention Period

In the laboratory, we can control for numerous factors which are important for running performance, such as test protocol, temperature, fluid intake, weight loss/weight gain, and shoes. However, there are aspects you cannot control for, which involve the participant's everyday life and their preparation for the testing. For instance, we instructed participants to not perform any intense exercise 24 hours before the test days and to consume the same meal-type and avoid consuming caffeine three hours preceding testing. Moreover, because blood lactate measurements are influenced by bicarbonate (Davies, Iber, Keene, McArthur, & Path, 1986; Kowalchuk, Heigenhauser, & Jones, 1984) and caffeine (Gaesser & Rich, 1985), the degree to whether participants followed these instructions became a methodological challenge. Besides, we were only in the position to communicate the importance of following these directions. Therefore, we acknowledge the possibility that some participants might not have followed the guidelines, and that this may have influenced blood lactate concentration. On the other hand, we recognize that participants may have jobs and family to consider, and therefore optimization prior to testing could be challenging.

4.5 Prescribed Intensities During the Long Duration Runs

The overall goal of the LR90- and LR100 test was to simulate a normal easy running session. The decision to employ the percentages of 90% and 100% was made on the assumption that this speed would be in line with what the participants normally use during their long runs. However, during testing, several participants expressed a concern that the speed was perceived as harder than their long runs in daily training. Based on this assumption, there is reason to believe we should have prescribed a lower intensity for these two-hour runs. The authors believe this may have influenced the results, but do not account for it as a variable to affect the conclusion of the study.

4.6 Strengths and Limitations

Participants executed two separate two-hour low intensity runs. The first one was 90% of their calculated LT_1 speed (LR90). The second one was 100% of their calculated LT_1 speed (LR100). The typical difference in running speed between these two conditions was 1-1.5 km/h. Participants also performed a 30min running session where they ran at an intensity which was clearly above their LT_1 speed (midpoint of LT_1 - and LT_2 speed). A key strength of the current study, as the results demonstrate, is that the participants were running at the prescribed and intended intensities during all tests (Figure 3 - Article). In addition, heart rate and RPE were consistent with lactate measurements. Another strength of the current study is that we were able to recruit the desired intervention group. The variation of sex (16 male and 6 female), age (37 ± 9) and training level (68 ± 27 km/week) were representative of recreational to serious runners. Finally, a strength of this study is that we accounted for the menstrual cycle for the female subjects as the menstrual cycle can influence exercise performance in a negative way (de Jonge, 2003; Lebrun, 1994; Belinda Thompson, Almarjawi, Sculley, & de Jonge, 2020; B Thompson & Han, 2019).

Although participants on average were exercising at the prescribed intensity after 30 min, the LR100 test (at LT_1 speed) may have felt too hard towards the 90min and 120min timepoint for some of the participants. Therefore, the muscular fatigue may have influenced their perceived comfort of performing the MCT or TT. This is interesting because it links perceptions of comfort executing the TT and MCT to acute fatigue mechanisms. Furthermore, the goal of the 30-minute running session, where participants were running in the middle of their "threshold zone", was to provoke a negative response both the Talk Test and the Mouth Closed Test. This way, we could compare physiological and RPE responses when execution of the MCT and TT was both comfortable and uncomfortable. Partially, we succeeded in doing so, but one could argue that the speed should be closer to participant's LT_2 speed. Finally, probably the most crucial limitation to this study, is that we did not collect MCT and TT data when the participants conducted the preliminary testing and lactate profile test. In retrospect, we should have included the MCT and TT to the preliminary test battery. That way, we could achieve reference points for responses to the MCT and TT at the first and second lactate threshold.

5. REFERENCES

Allen, W. K., Seals, D. R., Hurley, B. F., Ehsani, A. A., & Hagberg, J. M. (1985). Lactate threshold and distance-running performance in young and older endurance athletes. *J Appl Physiol, 58*(4), 1281-1284.

Baker, L. B., & Jeukendrup, A. E. (2011). Optimal composition of fluid-replacement beverages. *Comprehensive Physiology, 4*(2), 575-620.

Bangsbo, J. (2015). Performance in sports–With specific emphasis on the effect of intensified training. *Scandinavian journal of medicine and science in sports, 25*, 88-99.

Barnes, K. R., & Kilding, A. E. (2015a). Running economy: measurement, norms, and determining factors. *Sports Medicine - Open, 1*(1), 8. doi:10.1186/s40798-015-0007-y

Barnes, K. R., & Kilding, A. E. (2015b). Strategies to Improve Running Economy. *Sports Medicine, 45*(1), 37-56. doi:10.1007/s40279-014-0246-y

Bassett, D. R., & Howley, E. T. (2000). Limiting factors for maximum oxygen uptake and determinants of endurance performance. *Medicine & Science in Sports & Exercise*.

Beck, K. (14. September, 2020). Can Nasal Breathing Improve Your Running Performance? Retrieved from https://www.runnersworld.com/training/a33993505/nasal-breathing/

Billat, L. V. (1996). Use of blood lactate measurements for prediction of exercise performance and for control of training. *Sports Medicine, 22*(3), 157-175.

Billinghurst, M., & Starner, T. (1999). Wearable devices: new ways to manage information. *Computer, 32*(1), 57-64.

Bird, S., Theakston, S., Owen, A., & Nevill, A. (2003). Characteristics Associated with 10-km Running Performance among a Group of Highly Trained Male Endurance Runners Age 21–63 Years. *Journal of Aging and Physical Activity, 11*. doi:10.1123/japa.11.3.333

Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Medicine & Science in Sports & Exercise*.

Bourdin, M., Sallet, P., Dufour, A., & Lacour, J. (2002). Influence of changes in nasal ventilation on estimated workload during submaximal field running. *Journal of sports medicine and physical fitness*. *42*(3), 295.

Brink, M. S., Frencken, W. G., Jordet, G., & Lemmink, K. A. (2014). Coaches' and players' perceptions of training dose: not a perfect match. *International journal of sports physiology performance*. *9*(3), 497-502.

Chen, M. J., Fan, X., & Moe, S. T. (2002). Criterion-related validity of the Borg ratings of perceived exertion scale in healthy individuals: a meta-analysis. *Journal of Sports Sciences, 20*(11), 873-899. doi:10.1080/026404102320761787

Cheng, B., Kuipers, H., Snyder, A., Keizer, H., Jeukendrup, A., & Hesselink, M. (1992). A new approach for the determination of ventilatory and lactate thresholds. *International journal of sports medicine, 13*(07), 518-522.

Concato, J., Shah, N., & Horwitz, R. I. (2000). Randomized, controlled trials, observational studies, and the hierarchy of research designs. *New England journal of medicine, 342*(25), 1887-1892.

Costill, D., Thomason, H., & Roberts, E. (1973). Fractional utilization of the aerobic capacity during distance running. *J Medicine science in sports*. *5*(4), 248-252.

Coyle, E. F., & González-Alonso, J. (2001). Cardiovascular Drift During Prolonged Exercise: New Perspectives. *29*(2), 88-92.

Dallam, G. M., McClaran, S. R., Cox, D. G., Foust, C. P., & Science, S. (2018). Effect of nasal versus oral breathing on Vo2max and physiological economy in recreational runners following an extended period spent using nasally restricted breathing. *International Journal of Kinesiology and Sports Science, 6*(2), 22-29.

Davies, S. F., Iber, C., Keene, S. A., McArthur, C., & Path, M. (1986). Effect of respiratory alkalosis during exercise on blood lactate. *J Appl Physiol, 61*(3), 948-952.

de Jonge, X. A. J. (2003). Effects of the menstrual cycle on exercise performance. *Sports Medicine, 33*(11), 833-851.

Esteve-Lanao, J., Foster, C., Seiler, S., & Lucia, A. (2007). Impact of training intensity distribution on performance in endurance athletes. *The Journal of Strength and Conditioning Research, 21*(3), 943-949.

Esteve-Lanao, J., San Juan, A. F., Earnest, C. P., Foster, C., & Lucia, A. (2005). How do endurance runners actually train? Relationship with competition performance. *Med Sci Sports Exerc, 37*(3), 496-504. doi:10.1249/01.mss.0000155393.78744.86

Farrell, P. A., Wilmore, J. H., Coyle, E. F., Billing, J. E., & Costill, D. L. (1979). Plasma lactate accumulation and distance running performance. *Med Sci Sports, 11*(4), 338-344.

Febbraio, M. A., Snow, R. J., Hargreaves, M., Stathis, C. G., Martin, I. K., & Carey, M. F. (1994). Muscle metabolism during exercise and heat stress in trained men: effect of acclimation. *J Appl Physiol, 76*(2), 589-597.

Foster, C. (1998). Monitoring training in athletes with reference to overtraining syndrome. *Medicine science in sports exercise*. *30*(7), 1164-1168.

Gaesser, G., & Rich, R. (1985). Influence of caffeine on blood lactate response during incremental exercise. *International journal of sports medicine, 6*(04), 207-211.

Gliner, J. A., Raven, P. B., Horvath, S. M., Drinkwater, B. L., & Sutton, J. C. (1975). Man's physiologic response to long-term work during thermal and pollutant stress. *J Appl Physiol, 39*(4), 628-632. doi:10.1152/jappl.1975.39.4.628

González-Alonso, J., Mora-Rodríguez, R., & Coyle, E. F. (2000). Stroke volume during exercise: interaction of environment and hydration. *Am J Physiol Heart Circ Physiol, 278*(2), H321-330. doi:10.1152/ajpheart.2000.278.2.H321

Goode, R. (2008). Historical perspectives: A personal insight into the origin of the “Talk Test”. *Health Fitness Journal of Canada*. *1*(1), 5-8.

Halse, H. (2019, 18. September, 2019). How Nose Breathing Can Make You a Faster Runner. Retrieved from https://blog.mapmyrun.com/how-nose-breathing-can-make-you-a-faster-runner/

Halson, S., Peake, J., & Sullivan, J. (2016). Wearable technology for athletes: information overload and pseudoscience? *International journal of sports physiology and performance, 11*(6), 705-706.

Hill, A. V., & Lupton, H. (1923). Muscular exercise, lactic acid, and the supply and utilization of oxygen. *QJM: An International Journal of Medicine, os-16*(62), 135–171. doi:https://doi.org/10.1093/qjmed/os-16.62.135

Hughson, R. L., & Green, H. J. (1982). Blood acid-base and lactate relationships studied by ramp work tests. *Medicine and science in sports and exercise, 14*(4), 297-302.

Iwaoka, K., Hatta, H., Atomi, Y., & Miyashita, M. (1988). Lactate, respiratory compensation thresholds, and distance running performance in runners of both sexes. *International journal of sports medicine, 9*(05), 306-309.

Jacobs, I. (1986). Blood lactate. *Sports Medicine, 3*(1), 10-25.

Jones, A. M., & Carter, H. (2000). The Effect of Endurance Training on Parameters of Aerobic Fitness. *Sports Med*.

Joyner, M. J., & Coyle, E. F. (2008). Endurance exercise performance: the physiology of champions. *J Physiol, 586*(1), 35-44. doi:10.1113/jphysiol.2007.143834

Judge, L. W., Bellar, D., Links, B., Mullally, A., King, M., Waterson, Z., . . . Wang, H. (2020). Comparing Training Load and Intensity Perceptions Between Female Distance Runners and Their Coach. *Journal of Orthopedics and Orthopedic Surgery*. *1*(2).

Kalis, J., Freund, B. J., Joyner, M. J., Jilka, S. M., Nittolo, J., & Wilmore, J. H. (1988). Effect of beta-blockade on the drift in O2 consumption during prolonged exercise. *J Journal of Applied Physiology, 64*(2), 753-758.

Karvonen, J., & Vuorimaa, T. (1988). Heart rate and exercise intensity during sports activities. *Sports Medicine, 5*(5), 303-311.

Kindermann, W., Simon, G., & Keul, J. (1979). The significance of the aerobic-anaerobic transition for the determination of work load intensities during endurance training. *European journal of applied physiology and occupational physiology, 42*(1), 25-34.

Kowalchuk, J. M., Heigenhauser, G., & Jones, N. L. (1984). Effect of pH on metabolic and cardiorespiratory responses during progressive exercise. *J Appl Physiol, 57*(5), 1558-1563.

LaComb, C. O., Tandy, R. D., Lee, S. P., Young, J. C., & Navalta, J. W. (2017). Oral versus nasal breathing during moderate to high intensity submaximal aerobic exercise. *International Journal of Kinesiology and Sports Science, 5*(1), 8-16.

Lafrenz, A. J., Wingo, J. E., Ganio, M. S., & Cureton, K. J. (2008). Effect of ambient temperature on cardiovascular drift and maximal oxygen uptake. *Med Sci Sports Exerc, 40*(6), 1065-1071. doi:10.1249/MSS.0b013e3181666ed7

Lebrun, C. M. (1994). The effect of the phase of the menstrual cycle and the birth control pill on athletic performance. *Clinics in sports medicine, 13*(2), 419-441.

Lucia, A., Pardo, J., Durantez, A., Hoyos, J., & Chicharro, J. (1998). Physiological differences between professional and elite road cyclists. *International journal of sports medicine, 19*(05), 342-348.

Lucía, A., Sánchez, O., Carvajal, A., & Chicharro, J. L. (1999). Analysis of the aerobic-anaerobic transition in elite cyclists during incremental exercise with the use of electromyography. *British journal of sports medicine, 33*(3), 178-185.

Manzi, V., Bovenzi, A., Castagna, C., Sinibaldi Salimei, P., Volterrani, M., & Iellamo, F. (2015). Training-Load Distribution in Endurance Runners: Objective Versus Subjective Assessment. *IInternational journal of sports physiology and performance, 10*(8), 1023-1028. doi:10.1123/ijspp.2014-0557

Maunder, E., Seiler, S., Mildenhall, M. J., Kilding, A. E., & Plews, D. J. (2021). The Importance of 'Durability'in the Physiological Profiling of Endurance Athletes. *Sports Medicine*, 1-10.

McLaughlin, J. E., Howley, E. T., Bassett, D. R., Jr., Thompson, D. L., & Fitzhugh, E. C. (2010). Test of the classic model for predicting endurance running performance. *Med Sci Sports Exerc, 42*(5), 991-997. doi:10.1249/MSS.0b013e3181c0669d

Munoz, I., Seiler, S., Bautista, J., Espana, J., Larumbe, E., & Esteve-Lanao, J. (2014). Does polarized training improve performance in recreational runners? *International journal of sports physiology and performance, 9*(2), 265-272. doi:10.1123/ijspp.2012-0350

Niinimaa, V., Cole, P., Mintz, S., & Shephard, R. (1980). The switching point from nasal to oronasal breathing. *Respiration physiology, 42*(1), 61-71.

Nixon, P. J. S. M. (1988). Human circulation regulation during physical stress. LB Rowell. Oxford University Press, London, 1986. No. of pages: 416. Price:£ 35.00. *4*(2), 124-125.

Olympiatoppen. (05. June 2021). OLT I-SKALA. Retrieved from https://olt-skala.nif.no/

Passfield, L., & Doust, J. H. (2000). Changes in cycling efficiency and performance after endurance exercise. *Medicine and science in sports and exercise, 32*(11), 1935-1941.

Paterson, D., Shephard, R., Cunningham, D., Jones, N., & Andrew, G. J. J. o. A. P. (1979). Effects of physical training on cardiovascular function following myocardial infarction. *47*(3), 482-489.

Persinger, R., Foster, C., Gibson, M., Fater, D. C., & Porcari, J. P. (2004). Consistency of the talk test for exercise prescription. *Medicine and science in sports and exercise*. *36*(9), 1632-1636.

Quinn, T. J., & Coons, B. A. (2011). The Talk Test and its relationship with the ventilatory and lactate thresholds. *Journal of Sports Sciences*, *29*(11), 1175-1182.

Recalde, P. T., Foster, Carl, Skemp-Arlt, Karen M., Fater, Dennis CW, Neese, Christine A., Dodge, Christopher, & Porcari, J. P. (2002). The talk test as a simple marker of ventilatory threshold. *South African Journal of Sports Medicine, 9*(2), 5-8.

Recinto, C., Efthemeou, T., Boffelli, P. T., & Navalta, J. W. (2017). Effects of nasal or oral breathing on anaerobic power output and metabolic responses. *International journal of exercise science*, *10*(4), 506.

Reed, J. L., & Pipe, A. L. (2014). The talk test: a useful tool for prescribing and monitoring exercise intensity. *Current opinion in cardiology, 29*(5), 475-480. doi:10.1097/HCO.0000000000000097

Rodríguez-Marroyo, J. A., Villa, J. G., García-López, J., & Foster, C. (2013). Relationship between the talk test and ventilatory thresholds in well-trained cyclists. *The Journal of Strength Conditioning Research*, *27*(7), 1942-1949.

Saibene, F., Mognoni, P., Lafortuna, C. L., & Mostardi, R. (1978). Oronasal breathing during exercise. *Pflügers Archiv, 378*(1), 65-69.

Saketkhoo, K., Kaplan, I., & Sackner, M. A. (1979). Effect of exercise on nasal mucous velocity and nasal airflow resistance in normal subjects. *J Appl Physiol, 46*(2), 369-371.

Saltin, B., Larsen, H., Terrados, N., Bangsbo, J., Bak, T., Kim, C. K., . . . Rolf, C. J. (1995). Aerobic exercise capacity at sea level and at altitude in Kenyan boys, junior and senior runners compared with Scandinavian runners. *Scand J Med Sci Sports, 5*(4), 209-221. doi:10.1111/j.1600-0838.1995.tb00037.x

Saltin, B., & Strange, S. (1992). Maximal oxygen uptake: "old" and "new" arguments for a cardiovascular limitation. *Medicine and science in sports and exercise, 24*(1), 30-37.

Saunders, P. U., Pyne, D. B., Telford, R. D., & Hawley, J. A. (2004). Factors Affecting Running Economy in Trained Distance Runners. *Sports Medicine, 34*(7), 465-485. doi:10.2165/00007256-200434070-00005

Scheer, V., Vieluf, S., Cramer, L., Jakobsmeyer, R., & Heitkamp, H.-C. (2018). Changes in running economy during a 65-km ultramarathon. *Frontiers in physiology, 9*, 1809.

Scherr, J., Wolfarth, B., Christle, J. W., Pressler, A., Wagenpfeil, S., & Halle, M. (2013). Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. *Eur J Appl Physiol*, *113*(1), 147-155.

Seiler, K. S., & Kjerland, G. Ø. (2006). Quantifying training intensity distribution in elite endurance athletes: is there evidence for an "optimal" distribution? *Scandinavian Journal of Medicine & Science in Sports, 16*(1), 49-56.

Seiler, S., & Tønnessen, E. (2009). Intervals, thresholds, and long slow distance: the role of intensity and duration in endurance training. *Sportscience, 13*.

Stegmann, H., Kindermann, W., & Schnabel, A. (1981). Lactate kinetics and individual anaerobic threshold. *International journal of sports medicine, 2*(03), 160-165.

Tanner, R., & Gore, C. (2012). *Physiological tests for elite athletes*: Human kinetics.

Thompson, B., Almarjawi, A., Sculley, D., & de Jonge, X. J. (2020). The effect of the menstrual cycle and oral contraceptives on acute responses and chronic adaptations to resistance training: A systematic review of the literature. *Sports Medicine, 50*(1), 171-185.

Thompson, B., & Han, A. (2019). Methodological Recommendations for Menstrual Cycle Research in Sports and Exercise. *Medicine and science in sports and exercise*. *51*(12), 2610-2617.

Thompson, M. A. (2017). Physiological and Biomechanical Mechanisms of Distance Specific Human Running Performance. *Integrative and Comparative Biology, 57*(2), 293-300. doi:10.1093/icb/icx069

Tønnessen, E., Sylta, Ø., Haugen, T. A., Hem, E., Svendsen, I. S., & Seiler, S. (2014). The road to gold: training and peaking characteristics in the year prior to a gold medal endurance performance. *PLoS One, 9*(7).

Wallace, L. K., Slattery, K. M., & Coutts, A. J. (2009). The ecological validity and application of the session-RPE method for quantifying training loads in swimming. *The Journal of Strength and Conditioning Research*. *23*(1), 33-38.

Watt, M. J., Heigenhauser, G. J., Dyck, D. J., & Spriet, L. L. (2002). Intramuscular triacylglycerol, glycogen and acetyl group metabolism during 4 h of moderate exercise in man. *The Journal of physiology, 541*(3), 969-978.

Weston, A. R., Mbambo, Z., & Myburgh, K. H. (2000). Running economy of African and Caucasian distance runners. *Med Sci Sports Exerc, 32*(6), 1130-1134. doi:10.1097/00005768-200006000-00015

Wingo, J. E., Ganio, M. S., & Cureton, K. J. (2012). Cardiovascular drift during heat stress: implications for exercise prescription. *J Exercise sport sciences reviews*. *40*(2), 88-94.

Wiswell, R. A., Jaque, S. V., Marcell, T. J., Hawkins, S. A., Tarpenning, K. M., Constantino, N., & Hyslop, D. (2000). Maximal aerobic power, lactate threshold, and running performance in master athletes. *Medicine science in sports and exercise*. *32*(6), 1165-1170.

Woltmann, M. L., Foster, C., Porcari, J. P., Camic, C. L., Dodge, C., Haible, S., & Mikat, R. P. (2015). Evidence that the talk test can be used to regulate exercise intensity. *The Journal of Strength Conditioning Research*. *29*(5), 1248-1254.

Zanettini, R., Centeleghe, P., Franzelli, C., Mori, I., Benna, S., Penati, C., & Sorlini, N. (2013). Validity of the Talk Test for exercise prescription after myocardial revascularization. *European journal of preventive cardiology, 20*(2), 376-382.

Zapico, A., Calderon, F., Benito, P., Gonzalez, C., Paris, A., Pigozzp, F., & SALVO, V. (2007). Evolution of physiological and haematological parameters with training load in elite male road cyclists: a longitudinal study. *J Sports Med Phys Fitness, 20*(1.9), 20-21.29.

Zouhal, H., Jacob, C., Delamarche, P., & Gratas-Delamarche, A. (2008). Catecholamines and the effects of exercise, training and gender. *Sports Medicine, 38*(5), 401-423.

PART 2

RESEARCH PAPER

The Talk Test and nasal breathing when running below and above the first lactate turnpoint

This research paper is written according to the standards of the following journal:

“Frontiers in active sports and living”

https://www.frontiersin.org/journals/sports-and-active-living#

Tor Emil Hansen

University of Agder

May 2021

The Talk Test and nasal breathing when running below and above the first lactate turnpoint

Tor Emil Hansen[1], Kristian Tjørnhom[2], Stephen Seiler[3]

[1,2,3]Faculty of Health- and Sport Science, Department of Sport Science and Physical Education, University of Agder, Kristiansand, Norway.

Correspondence:
Tor Emil Hansen
University of Agder, Faculty of Health and Sport Sciences
Telephone: +47 974 81 860
Email: toremil96@gmail.com
PO. Box 442, 4604 Kristiansand, Norway

Keywords: Talk Test, Mouth Closed Test, nasal breathing, intensity control, running

Wordcount: 5099

Figures: 7

Tables: 2

Abstract

Objective: The use of lactate and heart rate as intensity control tools may be expensive for certain populations and may lead athletes to be excessively ‘numbers fixated’. The aim of this study was to investigate if the Talk Test and/or a mouth closed ‘nose breathing’ test could serve as an effective intensity control tool and differentiate between running below and above the first lactate turnpoint.

Methods: 16 male and 6 female recreational and well-trained runners (37 ± 9 yrs, 68 ± 27 km/week, mean ± SD) were recruited and performed a lactate profile and $VO_{2\ max}$ test, one 30-minutes running session at the speed midway between the first (LT_1) and second (LT_2) lactate turn point, and two low-intensity long-duration tests at 90- and 100% of LT_1 speed. Mouth Closed Test (MCT) and the Talk Test (TT) was performed at three different intensities: Below, At and Above LT_1.

Results: A small but significant change in frequency distribution for perceived comfort when performing both MCT and TT ($p \leq 0.05$) was observed comparing running below and above LT_1. There were significant differences in physiological and RPE responses associated with responding “yes or “no” to both the MCT and the TT ($p \leq 0.05$). Mean differences between answering NO and YES respectively for MCT were: % Heart Rate Reserve (%HRR: 8 ± 1 % higher); blood lactate ([la^{-1}]: 0.9 ± 0.1 $mmol \cdot L^{-1}$ higher); RPE (MD: 1.9 ± 0.2 RPE units higher). For the Talk Test, mean differences between uncomfortable and comfortable speech were: %HRR (9.0 ± 2.0 % higher); blood lactate [la^{-1}] (0.8 ± 0.2 $mmol \cdot L^{-1}$ higher); RPE (1.8 ± 0.4 RPE units higher).

Conclusion: At the group level, both MCT and TT responses demarcate statistically significant and practically meaningful differences in physiological intensity and perceived exertion. However, neither the MCT nor the TT consistently differentiate between running just below and just above LT_1 at the individual level. They should therefore be viewed as supplementary but not sufficient tools to identify delineation in the field.

INTRODUCTION

Combining and distributing low-intensity training and high-intensity training over days, weeks, months and years is a commonly used recipe for increasing aerobic performance. High-level endurance athletes perform ~80 % of their training at low intensity (LIT, ~60-65 % VO_{2max}) below the first lactate turnpoint (LT_1) and ~20 % of their training is performed at high intensity, above the first lactate turnpoint (LT_1) (1-4). Among others, high-level rowers, swimmers, runners, cyclists, and cross-country skiers practice this regime (1). Training intensity distribution has also been evaluated among recreational athletes (5, 6) and a "polarized" approach with substantial relative volumes of LIT has also been found to be beneficial for improving endurance performance in recreational athletes training fewer hours per week (4, 7).

Training and intensity can be monitored from two points of view. First, there is an *external workload* that can be measured precisely with the velocity or pace in running (although inclines and declines complicate this measurement in running). This is the actual pace or power generated during each training session. The *internal workload* associated with maintaining this power or pace produced can be measured in different ways. However, heart rate and blood lactate responses are the most accessible and practical physiological measurements in daily training practice. Additionally, we can measure athletes' rate of perceived exertion (RPE) throughout an endurance session. The RPE scale ranges from 6-20, where 6 defines as "rest" and 20 being "maximal effort" (8).

Several studies (1, 2, 4, 9, 10) have employed the first and second lactate turnpoints to describe three aerobic endurance training intensity zones. Zone 1 (low-intensity zone) is prescribed below LT_1 (typically <2 mM). Zone 3 (high-intensity zone) is prescribed from individual lactate profiles as above LT_2 (typically >4 mM) and zone 2 emerges between these two zones. Esteve-Lanao et al., 2007 (4) describes heart rate ranges for this 3-zone intensity distribution as: Zone 1 (50-80 % HR_{max}), zone 2 (65-90 % HR_{max}) and zone 3 (80-100 % HR_{max}). Both the substantial range in intensity associated with Zone 1 and the overlapping seen in physiological measures across the 3 zones are noteworthy. When coaches instruct their athletes to perform an easy training session in zone 1 (50-80 % HR_{max}) this represents a large potential for differing interpretations and execution of the training prescription, based on $\%HR_{max}$.

Physiological thresholds determined by laboratory testing and measurement of ventilation, gas exchange, and blood lactate concentration can help improve the communication and precision of exercise intensity prescription (10). Unfortunately, laboratory methods are either unavailable or unaffordable for many athletes. Therefore, simple indirect methods for measuring exercise intensity, such as the rating of perceived exertion (RPE) and the Talk Test (TT) (11, 12) can be welcome alternatives. The TT measures the perception of 'being able to speak comfortably' while exercising at different intensities and responding to several different speech-provoking strategies. The strategies include, among others, responding to questions, reciting a standard paragraph, counting out loud and, hearing yourself breathe. Investigators of the TT consider this to be a practical alternative to standard laboratory methods for prescribing training intensity and identifying the ventilatory threshold (11, 13).

Recently, methodologies utilizing nasal only breathing (breathing with the mouth closed) while running have received growing attention (14-17). This restricted breathing approach has been suggested to have beneficial effects during submaximal exercise intensities (18), including a significantly lower VO_2 at steady state (14) and lower respiratory exchange ratio (15). To the author's knowledge, no studies have systematically investigated whether nasal breathing can be used as an intensity control tool during endurance training. Therefore, we have developed a simple and practical test, inspired by the Talk Test, which measures the perceived comfort of nasal only breathing during exercise. The test will be referred to as Mouth Closed Test (MCT) throughout this study. The test involves subjects running with the mouth closed for two minutes, before responding with either "comfortable", "equivocal" or "not comfortable" ratings to their breathing perception.

Regular blood lactate and heart rate measurements may be expensive for certain populations or may lead athletes to be excessively 'numbers fixated'. Identifying a cost-effective and simpler tool for intensity control during low-intensity training would be beneficial. Therefore, this study will investigate the validity and practicality of the MCT and TT for controlling exercise intensity among endurance trained runners. The aim of this study is two-fold. We seek to 1) quantify perceived comfort during the TT and MCT in experienced runners performing long-duration low-intensity running sessions and 2) investigate whether the TT or MCT can consistently distinguish running at an intensity below or above the first lactate turnpoint.

MATERIALS AND METHODS

This was a descriptive investigation where experienced runners performed two, 120 min low intensity indoor running sessions with speed derived from a preliminary lactate profile test. The two 120 minutes running sessions were nominally prescribed and performed at and below their LT_1-pace. In addition, runners performed a 30 min running session nominally prescribed at a running speed significantly above their LT_1 pace. TT and MCT responses were recorded under all 3 conditions. Finally, all participants performed the testing protocol in an identical manner.

Subjects

A total of 22 runners (16 male, 6 female) were recruited through contact with the local running clubs on social media and via personal interactions. Participants were experienced runners at recreational (including two former elite runners) and elite level. Inclusion criteria used to select participants for this study included 1) aged 18-55 years, 2) healthy and currently injury free, 3) able to perform a two-hour low-intensity running session on a treadmill and 4) running >30 km per week for the last eight weeks. Participants were allocated to high-volume (HV) or low-volume (LV) groups, based on their reported training volume and typical long run duration over the preceding weeks. The cut-off for being selected to either HV- or LV group was: HV group = >70 km/week and >90 minutes typical long run duration; LV group = <70 km/week and <75 minutes typical long run duration. During the data collection period, subjects were instructed to continue their regular training routines. The training characteristics of the participants are presented in Table 1.

One dropout from the HV group was registered before preliminary testing due to injury. Two male participants from the HV group did not complete the second 120 min run (LR100) due to injury or illness. The two subjects were therefore excluded from the final analyses of test 4.

Testing procedures

The test protocol consisted of four tests performed on four different days. Due to the risks of cancelled testing because of the national and local Covid-19 restrictions, we performed all tests in chronological order. Preliminary testing began with a lactate profile test followed by a $VO_{2\ max}$ test on a motorized treadmill. The second day of testing involved a 30-minute threshold intensity treadmill run, executed at the median of LT_1 and LT_2 speed. The third (LR90) and fourth (LR100) tests were long-duration (120 min) low-intensity (90 and 100 % LT_1 speed) sessions. All participants had to complete preliminary testing before performing tests 2, 3, and 4. At least 48 hours of recovery time was required between each test day. The participants were not allowed to perform any intense exercise 24 hours before the test days. Additionally, they were instructed to wear the same shoes during all tests, consume the same meal type and avoid consuming caffeine three hours preceding testing. Furthermore, during the $VO_{2\text{-}max}$ test, verbal encouragement was given to stimulate maximal exercise effort. The same test leaders supervised and executed all tests and measurements. In addition, we strived to perform testing for women in the follicular phase of the menstrual cycle (Appendix 5). If a subject reported amenorrhea, using oral contraceptives, or being in menopause, the menstrual cycle was not accounted for.

Test day 1: Preliminary testing

Lactate profile test

The lactate profile test started with a 10-minute warm-up, including familiarizing the participants with the treadmill and information about the test protocol. Testing proceeded with 5 min submaximal bouts at increasing treadmill speed to identify speed, heart rate, and lactate values at both LT_1 and LT_2. Between five and seven running stages were completed by all subjects. Starting speed was individualized and based on the discussion between test leaders and runners. The incline was set at 1%, and the workload increased by 1 $km \cdot h^{-1}$ every five minutes. Athletes stood with legs straddling the treadmill for 30s during each finger blood draw before continuing running at the next treadmill speed. When blood lactate exceeded LT_2 values, the test was stopped to prevent fatigue prior to the $VO_{2\ max}$ test. LT_1 values were calculated as 0,5 $mMol{\cdot}L^{-1}$ + the mean of the first two blood [la^{-1}] measurements, while LT_2 was calculated as 2,1 $mMol{\cdot}L^{-1}$ + the mean of the first two blood [la^{-1}] measurements.

$VO_{2\ max}$ test

Subjects rested for 10 minutes between the lactate profile and $VO_{2\ max}$ test, which began at 1 $km{\cdot}h^{-1}$ below the calculated LT_2 speed. During the $VO_{2\ max}$ test treadmill speed was initially increased by 1 $km{\cdot}h^{-1}$. In the last stages of the test, runners had the option of either keeping the same speed or increasing with 1.0 or 0.5 $km{\cdot}h^{-1}$. A total test duration of 6-8 minutes was targeted.

Test day 2: Threshold test

Test day 2 consisted of a 30 min threshold run performed at a treadmill speed identified as the median of LT_1- and LT_2 speed from preliminary testing. During this run, responses to the TT and MCT were assessed when runners were clearly running above their LT_1-speed. The test was preceded by a 10-minute warm-up and performed at a constant incline of 1%. Athletes performed the Mout Closed Test from 9-11 minutes and 24-26 minutes. Immediately they were asked: “Did running with your mouth closed feel comfortable?” Three possible answers were recorded: 1) “yes”, 2) “equivocal” and 3) “no”. From 12-15 and 27-30 minutes, Talk Test, VO_2, HR, Borg Scale, and blood lactate were recorded. When conducting the Talk Test, athletes were instructed to recite a standard paragraph requiring 10-15s of speaking. The standard paragraph used in this test was the first verse of the Norwegian national anthem. After reciting the paragraph, each subject was asked “can you speak comfortably?” and responded with “yes”, “equivocal” or “no”. For both tests, the participants were obligated to continue the tests regardless of the answers to the questions.

Test day 3 and 4: Two-hour low intensity running tests

Test day 3 and 4 consisted of a 120 min, low-intensity treadmill run performed at 90% (LR90)- and 100% (LR100) of identified LT_1-speed, respectively. To simulate a normal easy running session, runners could listen to music or watch television during the two-hour run. Every 30min, measurements were performed in the following order: Mouth Closed Test, Talk Test, Stryd™, heart rate, electromyography (EMG), metabolic measurements, Borg Scale, lactate, skin temperature and core temperature. Each series of lactate, skin- and core temperature measurements resulted in 60s off the treadmill. Additionally, participants were weighed before and after each treadmill run to control for and calculate dehydration. Before attaching EMG sensors to M. vastus medialis and M. biceps femoris, both areas were shaved and disinfected with an alcohol swab to minimize any signal disturbances.

Instruments

The same treadmill (Lode Katana Sport, Lode B. V., Groningen, Netherlands) was used for all tests. The treadmill was calibrated on a regular basis. Moreover, all tests were performed under similar environmental conditions (18-21°C) and at the same time of day (± 2h). Metabolic and ventilatory measurements were made using Oxycon Pro™ with a mixing chamber and 30 seconds sampling time (Oxycon, Jaeger GmbH, Hoechberg, Germany). The metabolic cart was calibrated before every test and again midway through LR90 and LR100 tests. During all tests, blood [la^{-1}] measurements were analyzed using a stationary lactate analyzer (EKF BIOSEN, EKF diagnostic, Cardiff, UK), which was automatically calibrated every 60 minutes. HR was measured using Polar V800 (Polar Elektro Oy, Kempele, Finland). Core temperature measurements were made using Braun IRT6520 ThermoScan® 7 Age precision® (Braun, Kronberg im Taunus, Germany) and participants were instructed to perform them by themselves for better standardization. Skin temperature was measured using Flir TG267 Thermal Camera® (Flir Systems, Inc. Wilsonville, Oregon, US). Kinematic variables were measured using a Stryd™ foot pod (Stryd, Boulder, Colorado, US). EMG was measured using Delsys Trigno Wireless EMG System (Delsys, Natick, Massachusetts, US). Before and after each test, runners were weighed using a Seca model 713 (Seca, Hamburg, Germany).

Statistical analyses

Data were analyzed using IBM SPSS Statistics 25 (SPSS Inc., Chicago, IL, USA) and results are presented as mean ± *SD*. Ordinal data are presented as frequencies. Differences in training- and physiological characteristics within the HV and LV groups were analyzed using an independent samples *t*-test. A one-way repeated measures ANOVA with a Greenhouse Geisser correction was conducted to compare lactate values at all intensities. A Bonferroni post hoc test was then used to examine where differences lied. A one-way ANOVA was also used to compare differences in cardiac drift between groups. To investigate differences in TT and MCT responses below, at, and above LT_1, non-parametric K Related Sample tests were used. To compare means in physiological and RPE markers related to MCT and TT, a one-way ANOVA was used. Values of $p \leq 0.05$ were considered statistically significant.

RESULTS

Physiological characteristics for the groups

Physiological characteristics for the two groups are presented in Table 2. As intended, there were significant group differences in training volume and long run duration, as well as for personal bests for the 10 k and half marathon ($p \leq 0.05$). However, age, weight, height, and years of running experience were not significantly different between groups. Preliminary testing showed that the high-volume group had a significantly higher running velocity at both LT_1 and LT_2 ($p \leq 0.05$). They also achieved a slightly higher $VO_{2\ peak}$ and treadmill velocity at $VO_{2\ peak}$ compared to the low-volume group, but this difference was not significant (Table 2).

Change in cardiac drift for high-volume and low-volume group

For both LR90 (HV: 6.3 ± 4.2 % versus LV: 7 ± 2.8 %) and LR100 (HV: 6.7 ± 2.9 % versus LV: 7.5 ± 3.4 %), there was no significant difference in relative magnitude of cardiac drift between the two groups ($p > 0.05$).

Physiological and perceptual responses at 4 intensities

Physiological and perceptual responses during runs prescribed at LT_1 speed, at LT_1/LT_2 median speed and 90% LT_1 speed are presented in Figure 3. There were significant differences in blood lactate values across test-conditions ($F(2.52, 45) = 65.38$, $p \leq 0.05$, $\eta_p^2 = .78$). Blood lactate when running at $LT_{1\text{-}2}$ was significantly elevated vs blood lactate values during the other 3 tests: **90% LT_1** (+1.7± 0.12 $mmol \cdot L^{-1}$ vs $LT_{1\text{-}2}$), **at** LT_1 (+1.4± 0.1 $mmol \cdot L^{-1}$) and **above LT_1** (+ 0.6 ± 0.15 $mmol \cdot L^{-1}$ all $p \leq 0.05$). Blood lactate when running at LT_1 was significantly lower vs the **above** LT_1-speed condition (-0.99 ± 0.15 $mmol \cdot L^{-1}$,

$p \leq 0.05$). As Figure 3 demonstrates, responses in other physiological and perceptual markers (%HRR and RPE) were consistent with lactate measurements.

Mouth Closed Test and Talk Test responses

Frequency distributions of responses to the MCT are presented in Figure 4, where a response of "yes" indicated that the subject could run comfortably with their mouth closed while a response of "no" indicated that doing so was uncomfortable. During the MCT, 12 of 21 participants responded "yes" when running below their LT_1 speed, versus 5 of 21 answering "yes" when running above their LT_1 speed. This difference was significant ($p \leq 0.01$). No other significant differences in the MCT response distribution were identified.

Frequencies of responses to the TT are presented in Figure 4. Based on the same perception of ease, or comfort, during the TT 16 of 21 participants answered "yes" while running below their LT_1 speed, while 10 of 21 still answered "yes" while running above their LT_1 speed. This difference was significant ($p \leq 0.05$). However, only 3 of 21 answered "no" to the question of TT comfort when running moderately above LT_1-speed.

Physiology and RPE related to Mouth Closed Test responses

To further investigate potential explanations for the ambiguity of perceived comfort when executing the MCT, answers of "yes, equivocal, or no" were used as grouping variables to compare physiological and RPE responses associated with the three verbal responses. These results are presented in Figure 6. Discomfort ("no" response) during the MCT was associated with higher HR (+8 ± 1 % HRR), blood lactate [la^{-1}] (+ 0.85 ± 0.1 $mmol \cdot L^{-1}$), RPE (+1.9 ± 0.2 RPE units) and $\%VO_2$ (+ 5.3 ± 0.9 %) when compared to responses when subjects were comfortable running with their mouth closed ("yes" response), all $p \leq 0.05$. Surprisingly, there was not a significant difference in respiration frequency between those who answered "yes" and "no" to the MCT.

Physiology and RPE related to Talk Test responses

Similarly, responses of “yes”, “equivocal”, and “no” to the Talk Test from all treadmill speed conditions and timepoints were merged and used as grouping variables to further investigate the physiology and perceptual responses associated with different qualitative perceptions when executing the Talk Test. These results are presented in Figure 7. Discomfort (“no” response) during the TT was associated with higher HR (+9.0 ± 2.0 % HRR), blood lactate [la^{-1}] (+ 0.77 ± 0.18 $mmol \cdot L^{-1}$), RPE (+1.8 ± 0.4 RPE units) and $\%VO_2$ (+ 3.7 ± 1.5 %) when compared to responses when subjects were comfortable performing the TT (“yes” response), all $p \leq 0.05$. Surprisingly, there was not a significant difference in respiration frequency between those who answered “yes” and “no” to the MCT. There was a small but significant difference in % maximal respiration frequency when responding “equivocal” vs “yes” on the TT (+7 ± 3 %) ($p \leq 0.05$).

DISCUSSION

Main aim and findings

Controlling and adjusting exercise intensity is an important part of the daily endurance training process. Several methods for gauging intensity are well established and widely used. Among them are measurements of blood lactate concentration, heart rate, and RPE. However, lactate and heart rate may be expensive for certain populations and may lead athletes to be excessively “numbers fixated”. In addition, athletes perform most of their training (~80 %) at a relatively low work intensity, below the first lactate turnpoint. Identifying a cost-effective and simpler tool for intensity control during low-intensity training would be beneficial. This need motivated us to investigate the Talk Test and Mouth Closed Test as potential replacements for or supplements to existing monitoring tools.

Our results demonstrate that the execution of the MCT and TT are both generally perceived as comfortable when performed at a running intensity below the first lactate turnpoint. However, the frequency distribution of perceived comfort when exercising at below, at and above the first lactate turnpoint is ambiguous. Therefore, the conclusion is that the TT and MCT are not able to consistently differentiate conditions when running speeds slightly above and moderately below the LT_1 speed determined from laboratory testing are compared. To our knowledge, this is the first systematic investigation of mouth closed breathing as a gauge of exercise intensity. Our findings suggest that the MCT does have potential as an intensity control tool, but preferably if used in combination with other methods such as heart rate and RPE.

The Talk Test and Mouth Closed Test' ability as intensity control tools

When participants were running at a treadmill speed clearly above that identified as their LT_1 speed, 10 of 21 still reported comfortably performing the Talk Test versus 16 of 21 when running speed clearly below that corresponding to LT_1 (Figure 5). In addition, only 3 answers of "no" (i.e., talking was distinctly uncomfortable) were recorded at the intensity above the first lactate turnpoint. Although the overall response distributions moved in the expected direction with increasing running intensity, and were significantly different, our results indicate that the Talk Test does not clearly differentiate between running below and above the first lactate turn point. Our findings differ somewhat from previous research (11-13, 19) where negative or equivocal responses are observed more frequently when runners are close to or at their second lactate turnpoint. The explanation for these different findings may be that Talk Test data are more strongly related to physiological and perceptual variables corresponding to the lactate threshold than to the ventilatory threshold (20).

The Mouth Closed Test and a condition of nasal breathing has not, to our knowledge, been systematically investigated in a manner like the Talk Test. The difference in perceived comfort performing the mouth closed test from below to above the first lactate turn point was significant and seemed to better distinguish this relatively subtle change in intensity than the Talk Test. However, 5 participants managed the MCT comfortably and an additional 5 felt equivocal (Figure 5). This difference suggests that the MCT is better than the Talk Test to differentiate intensities below and above the first lactate turnpoint. However, there was not a clear and consistent shift of perceived comfort from below to above the first lactate turnpoint. The heterogeneous responses to the MCT may be caused by individual differences in nasopharyngeal anatomy, as some individuals might have narrow nasal passages. In addition, day-to-day variation in nasal congestion can potentially influence the perception of comfort while executing the MCT. This theory is also supported by Niinimaa et al., 1980 (20) and Saketkhoo et al., 1978 (21). Dallam et al., 2018 (14) argue that there is an adaptation phase to nasal breathing. They recruited subjects who already had been using restricted nasal breathing while exercising for at least 6 months and found that the participants were able to achieve the same peak work and maximal oxygen consumption while breathing nasally that they achieved breathing nasal-orally(14). In contrast, Morton et al., 1995 (22) which included naive subjects with no experience using restricted nasal only breathing, found a 35% reduction in maximal VE, 10% reduction in VO_2 max and higher heart rate at submaximal intensity when exercising under restricted breathing conditions. In our study, participants experienced an acute improvement in perceived comfort while executing the MCT. Many reported that they felt less comfortable the first minute versus the last minute during the MCT test, suggesting some acute "dilation" of the nasal passages when forcing large ventilatory volumes through the nasopharyngeal cavity. We conclude that there can be both a long-term and a short-term, within-exercise bout adaptation phase to performing nasal breathing while exercising.

Physiological and RPE responses to "yes", "equivocal" and "no"

During the MCT mean blood lactate, %HRR, RPE and %VO_2 were significantly higher when subjects responded positively (yes, comfortable breathing) to the MCT versus when they responded negatively (no, uncomfortable breathing). The mean difference in RPE from the answer "yes" to "no" was 12 versus 14. For comparison, mean RPE for all participants at the second lactate turnpoint from preliminary testing was 15. Similar RPE values at lactate threshold (fixed 4 $mmol \cdot L^{-1}$) were also found in Scherr et al., 2013 (23). These data suggest that when an athlete is close to or at the second lactate turnpoint, the perception of ease or comfort performing the MCT shifts to "not comfortable". For the answer "yes" during MCT mean %HRR was 72.19%, while the mean %HRR at the first lactate turnpoint from preliminary testing was 76.43%. Based on these results, one could argue that when an athlete is exercising at the intensity of 70% of HRR and performs the MCT with an answer of "yes", the athlete is exercising at an intensity below the first lactate turnpoint. If the perceived comfort of executing the MCT is "equivocal" and HRR is 75%, the athlete is likely to be exercising very near the first lactate turnpoint intensity.

The same tendencies of physiological responses related to perceived comfort were observed in the TT as in the MCT. As shown in Figure 7, there is not a distinct shift from the answer "yes" to "no", but rather a gliding and smooth change in physiological responses. During the TT, mean blood lactate, %HRR, RPE, and %VO_2 were significantly higher when the TT result was "no" versus when it was "yes". Mean %VO_2 was 71.3 ± 6.1 % when the TT was perceived as comfortable. This result is similar to what Persinger et al., 2004 (24) (69-78% $VO_{2\ max}$) and Quinn & Coons et al., 2011 (20) (64 ± 5 %) found in their studies. Interestingly, Persinger et al., 2004 (24) found that comfortable speech was not possible when the intensity was 89% $VO_{2\ max}$, while in our study we found that comfortable speech was not possible at 75% $VO_{2\ max}$. Although, it should be taken into consideration that our results included data from all time points, and that these differences may be caused by fatigue during the LR100 test and in that way affected participants perception of comfort. Finally, mean RPE when participants were not able to speak comfortably was 14 in the current study, and Quinn & Coons et al., 2011 (20) observed a mean RPE 16 for negative tests.

Strengths and limitations

Participants executed two separate two-hour low intensity runs. The first one was 90% of their calculated LT_1 speed (LR90). The second one was 100% of their calculated LT_1 speed (LR100). The typical difference in running speed between these two conditions was 1-1.5 km/h. Participants also performed a 30min running session where they ran at an intensity which was clearly above their LT_1 speed (midpoint of LT_1 - and LT_2 speed). A key strength of the current study, as the results demonstrate, is that the participants were running at the prescribed and intended intensities during all tests (Figure 3). In addition, heart rate and RPE were consistent with lactate measurements. However, it is important to state this observation was at the group-level. At the individual level, physiological state varies day-to-day and athletes may therefore have exercised at a lower or higher intensity than the tests prescribed. Another strength of the current study is that we were able to recruit the desired intervention group. The variation of sex (16 male and 6 female), age (37 ± 9) and training level (68 ± 27 km/week) were representative of recreational to serious runners. Finally, a strength of this study is that we accounted for the menstrual cycle for the female subjects as the menstrual cycle can influence exercise performance in a negative way (25-28).

Although participants on average were exercising at the prescribed intensity after 30 min, the LR100 test (at LT_1 speed) may have felt too hard towards the 90min and 120min timepoint for some of the participants. Therefore, the muscular fatigue may have influenced their perceived comfort of performing the MCT or TT. This is interesting because it links perceptions of comfort executing the TT and MCT to acute fatigue mechanisms. Furthermore, the goal of the 30-minute running session, where participants were running in the middle of their “threshold zone”, was to provoke a negative response both the Talk Test and the Mouth Closed Test. This way, we could compare physiological and RPE responses when execution of the MCT and TT was both comfortable and uncomfortable. Partially, we succeeded in doing so, but one could argue that the speed should be closer to participant’s LT_2 speed. Finally, probably the most crucial limitation to this study, is that we did not collect MCT and TT data when the participants conducted the preliminary testing and lactate profile test. In retrospect, we should have included the MCT and TT to the preliminary test battery. That way, we could achieve reference points for responses to the MCT and TT at the first and second lactate turnpoint. Future research needs to be carried out to establish whether the MCT or the TT can be a valid intensity control tool for recreational and elite runners.

Ethics statement

Prior to conducting the research, all selected participants received a written letter containing necessary information. This included the purpose of the research, the potential risks involved, the potential benefits of participating and a statement explaining that at any point during the research period they would be able to withdraw their participation without any reason.

The participants were not to subjected to unnecessary risks, and their well-being remained a priority throughout the research. The level of physiological stress to which participants were exposed was similar to the level they would have experienced during their daily training. The study was performed in accordance with the Declaration of Helsinki, and approved by the Faculty´s ethics committee (FEK) (appendix 4) where any data was stored safely according to the guidelines provided by the Norwegian Centre for Research Data (appendix 3).

Conflict of interest

The authors declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

1. Seiler KS, Kjerland GØ. Quantifying training intensity distribution in elite endurance athletes: is there evidence for an “optimal” distribution? Scandinavian journal of medicine & science in sports. 2006;16(1):49-56.
2. Seiler S, Tønnessen E. Intervals, thresholds, and long slow distance: the role of intensity and duration in endurance training. Sportscience. 2009;13.
3. Bangsbo J. Performance in sports–With specific emphasis on the effect of intensified training. Scandinavian journal of medicine and science in sports. 2015;25:88-99.
4. Esteve-Lanao J, Foster C, Seiler S, Lucia A. Impact of training intensity distribution on performance in endurance athletes. The Journal of Strength and Conditioning Research. 2007;21(3):943-9.
5. Esteve-Lanao J, San Juan AF, Earnest CP, Foster C, Lucia A. How do endurance runners actually train? Relationship with competition performance. Med Sci Sports Exerc. 2005;37(3):496-504.
6. Manzi V, Bovenzi A, Castagna C, Sinibaldi Salimei P, Volterrani M, Iellamo F. Training-Load Distribution in Endurance Runners: Objective Versus Subjective Assessment. IInternational journal of sports physiology and performance. 2015;10(8):1023-8.
7. Munoz I, Seiler S, Bautista J, Espana J, Larumbe E, Esteve-Lanao J. Does polarized training improve performance in recreational runners? International journal of sports physiology and performance. 2014;9(2):265-72.
8. Borg GA. Psychophysical bases of perceived exertion. Medicine & science in sports & exercise. 1982.
9. Zapico A, Calderon F, Benito P, Gonzalez C, Paris A, Pigozzp F, et al. Evolution of physiological and haematological parameters with training load in elite male road cyclists: a longitudinal study. J Sports Med Phys Fitness. 2007;20(1.9):20-1.9.
10. Tønnessen E, Sylta Ø, Haugen TA, Hem E, Svendsen IS, Seiler S. The road to gold: training and peaking characteristics in the year prior to a gold medal endurance performance. PLoS One. 2014;9(7).
11. Rodríguez-Marroyo JA, Villa JG, García-López J, Foster C. Relationship between the talk test and ventilatory thresholds in well-trained cyclists. The Journal of Strength Conditioning Research. 2013;27(7):1942-9.

12. Woltmann ML, Foster C, Porcari JP, Camic CL, Dodge C, Haible S, et al. Evidence that the talk test can be used to regulate exercise intensity. The Journal of Strength Conditioning Research. 2015;29(5):1248-54.

13. Reed JL, Pipe AL. The talk test: a useful tool for prescribing and monitoring exercise intensity. Current opinion in cardiology. 2014;29(5):475-80.

14. Dallam GM, McClaran SR, Cox DG, Foust CP, Science S. Effect of nasal versus oral breathing on Vo2max and physiological economy in recreational runners following an extended period spent using nasally restricted breathing. International Journal of Kinesiology and Sports Science. 2018;6(2):22-9.

15. Recinto C, Efthemeou T, Boffelli PT, Navalta JW. Effects of nasal or oral breathing on anaerobic power output and metabolic responses. International journal of exercise science. 2017;10(4):506.

16. LaComb CO, Tandy RD, Lee SP, Young JC, Navalta JW. Oral versus nasal breathing during moderate to high intensity submaximal aerobic exercise. International Journal of Kinesiology and Sports Science. 2017;5(1):8-16.

17. Bourdin M, Sallet P, Dufour A, Lacour J. Influence of changes in nasal ventilation on estimated workload during submaximal field running. Journal of sports medicine and physical fitness. 2002;42(3):295.

18. LaComb CO, Tandy RD, Lee SP, Young JC, Navalta JWJIJoK, Science S. Oral versus nasal breathing during moderate to high intensity submaximal aerobic exercise. 2017;5(1):816.

19. Recalde PT, Foster, Carl, Skemp-Arlt, Karen M., Fater, Dennis CW, Neese, Christine A., Dodge, Christopher, Porcari JP. The talk test as a simple marker of ventilatory threshold. South African Journal of Sports Medicine. 2002;9(2):5-8.

20. Quinn TJ, Coons BA. The Talk Test and its relationship with the ventilatory and lactate thresholds. Journal of sports sciences. 2011;29(11):1175-82.

21. Saketkhoo K, Kaplan I, Sackner MA. Effect of exercise on nasal mucous velocity and nasal airflow resistance in normal subjects. Journal of applied physiology. 1979;46(2):369-71.

22. Morton A, King K, Papalia S, Goodman C, Turley K, Wilmore J. Comparison of maximal oxygen consumption with oral and nasal breathing. Australian journal of science medicine in sport. 1995;27(3):51-5.

23. Scherr J, Wolfarth B, Christle JW, Pressler A, Wagenpfeil S, Halle M. Associations between Borg's rating of perceived exertion and physiological measures of exercise intensity. European journal of applied physiology. 2013;113(1):147-55.
24. Persinger R, Foster C, Gibson M, Fater DC, Porcari JP. Consistency of the talk test for exercise prescription. Medicine and science in sports and exercise. 2004;36(9):1632-6.
25. Thompson B, Han A. Methodological Recommendations for Menstrual Cycle Research in Sports and Exercise. Medicine and science in sports and exercise. 2019;51(12):2610-7.
26. de Jonge XAJ. Effects of the menstrual cycle on exercise performance. Sports medicine. 2003;33(11):833-51.
27. Lebrun CM. The effect of the phase of the menstrual cycle and the birth control pill on athletic performance. Clinics in sports medicine. 1994;13(2):419-41.
28. Thompson B, Almarjawi A, Sculley D, de Jonge XJ. The effect of the menstrual cycle and oral contraceptives on acute responses and chronic adaptations to resistance training: A systematic review of the literature. Sports Medicine. 2020;50(1):171-85.

Figure legends

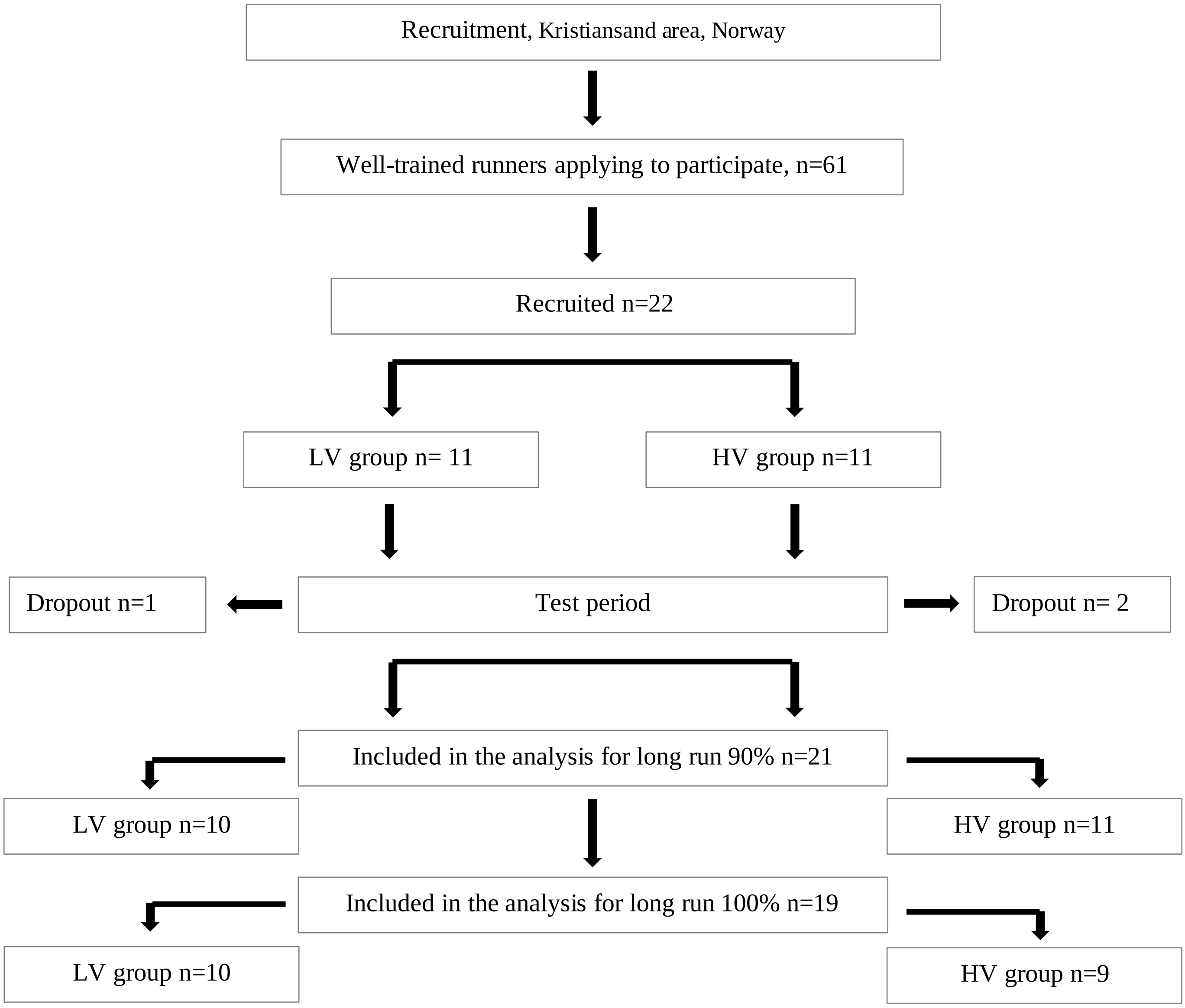


Figure 1: Flowchart. N= number of participants; HV = High-volume; LV = Low-volume.

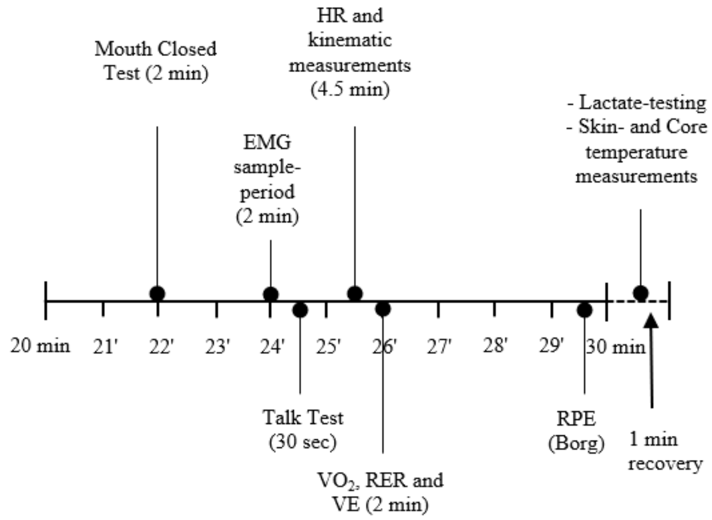


Figure 2: Timeline of measurements during test 3 (LR90) and 4 (LR100). EMG = Electromyography; Min = Minutes; Sec = Seconds; RPE = Rate of perceived exertion; VO_2 = Oxygen uptake; RER = Respiratory exchange ratio; VE = Minute ventilation

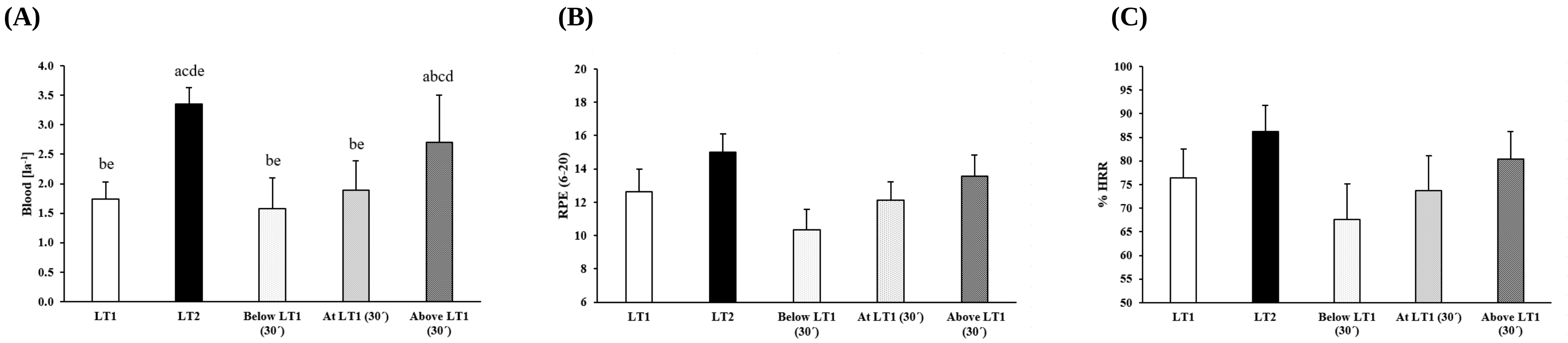


Figure 3: Mean physiological and perceptual responses at all intensities (below, at, and above LT_1) compared to the mean LT_1 and LT_2 value from preliminary testing. Results are presented as mean and SD. A) mean blood lactate B) mean RPE C) mean %HRR. LT_1 = First lactate turnpoint; LT_2 = Second lactate turnpoint; Blood [la^{-1}] = blood lactate; RPE = Rate of perceived exertion; %HRR = % Heart rate reserve; a = Significantly different vs "LT1"; b = Significantly different vs "LT2"; c = Significantly different vs "Below LT1 (30´)"; d = Significantly different vs "At LT1 (30´)"; e = Significantly different vs "Above LT1 (30´)". $p \leq 0.05$.

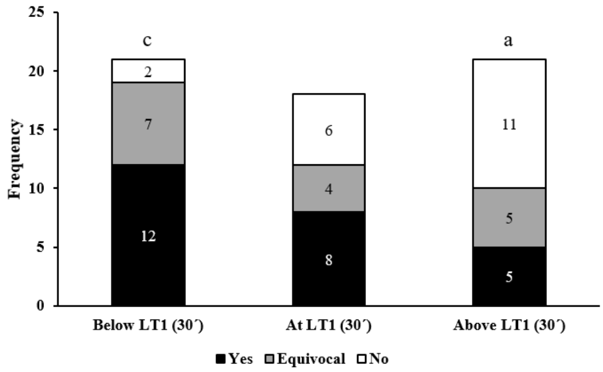


Figure 4: Frequency distribution of perceived ability to run comfortably during Mouth Closed Test. Results are presented as frequencies of the answers "yes", "equivocal" and "no" during running at three intensities (below, at and above LT_1). Black bars = "Yes". Grey bars = "Equivocal". White bars = "No". LT_1 = First lactate turn point; a = Significantly different vs "Below LT1"; b = Significantly different vs "At LT1"; c = Significantly different vs "Above LT1". $p \leq 0.05$.

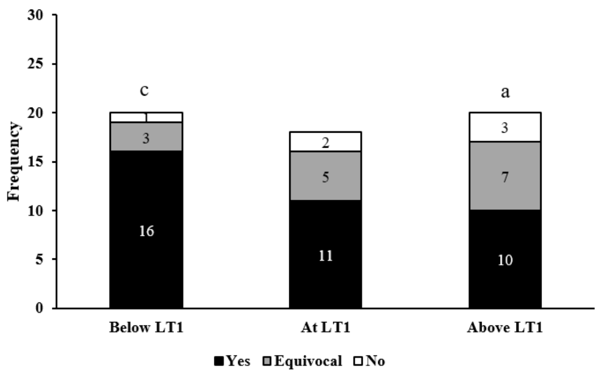


Figure 5: Frequency distribution of perceived ability to run comfortably during the Talk Test. Results are presented as frequencies of the answers "yes", "equivocal" and "no" during running at three intensities (below, at and above LT_1). Black bars = "Yes". Grey bars = "Equivocal". White bars = "No". LT_1 = First lactate turnpoint; a = Significantly different vs "Below LT1"; b = Significantly different vs "At LT1"; c = Significantly different vs "Above LT1". $p \leq 0.05$.

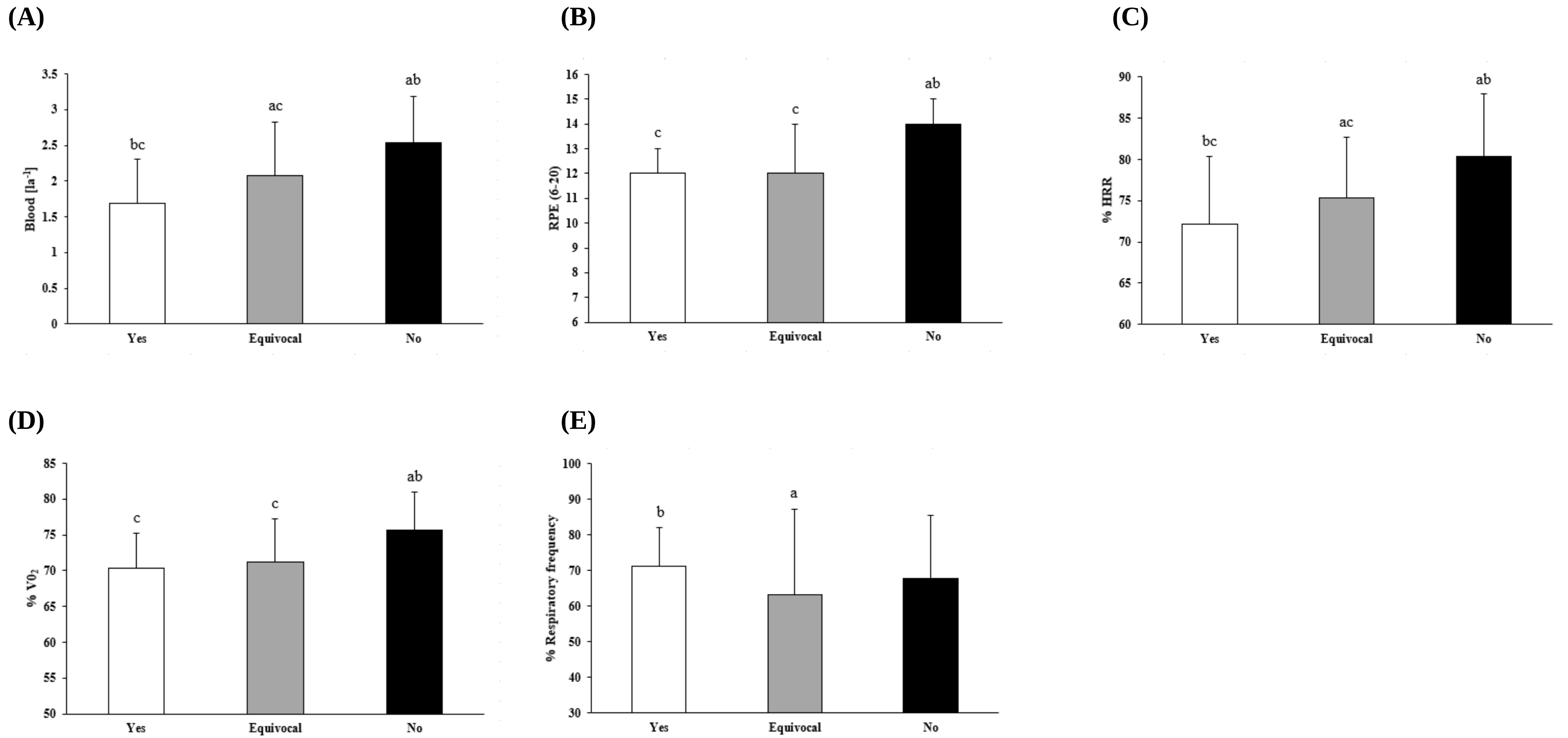


Figure 6: Physiological markers and RPE during treadmill runs, grouped by Mouth Closed Test response. Results are presented as mean and SD. Figures show mean physiological and perceptual values related to the answers “yes, no and equivocal” from all timepoints and tests. White bar = “yes” (90 samples). Grey bar = “equivocal” (48 samples). Black bar = “no” (62 samples). A) mean blood lactate. B) mean RPE. C) mean %HRR. D) mean % $VO_{2\,max}$. E) % maximal respiratory frequency from preliminary testing. Blood $[la^{-1}]$ = blood lactate; %HRR = % Heart rate reserve; % VO_2 = Oxygen uptake; RPE = Rate of perceived exertion; a = significantly different vs “Yes”; b = significantly different vs “Equivocal”; c = significantly different vs “No”. $p \leq 0.05$.

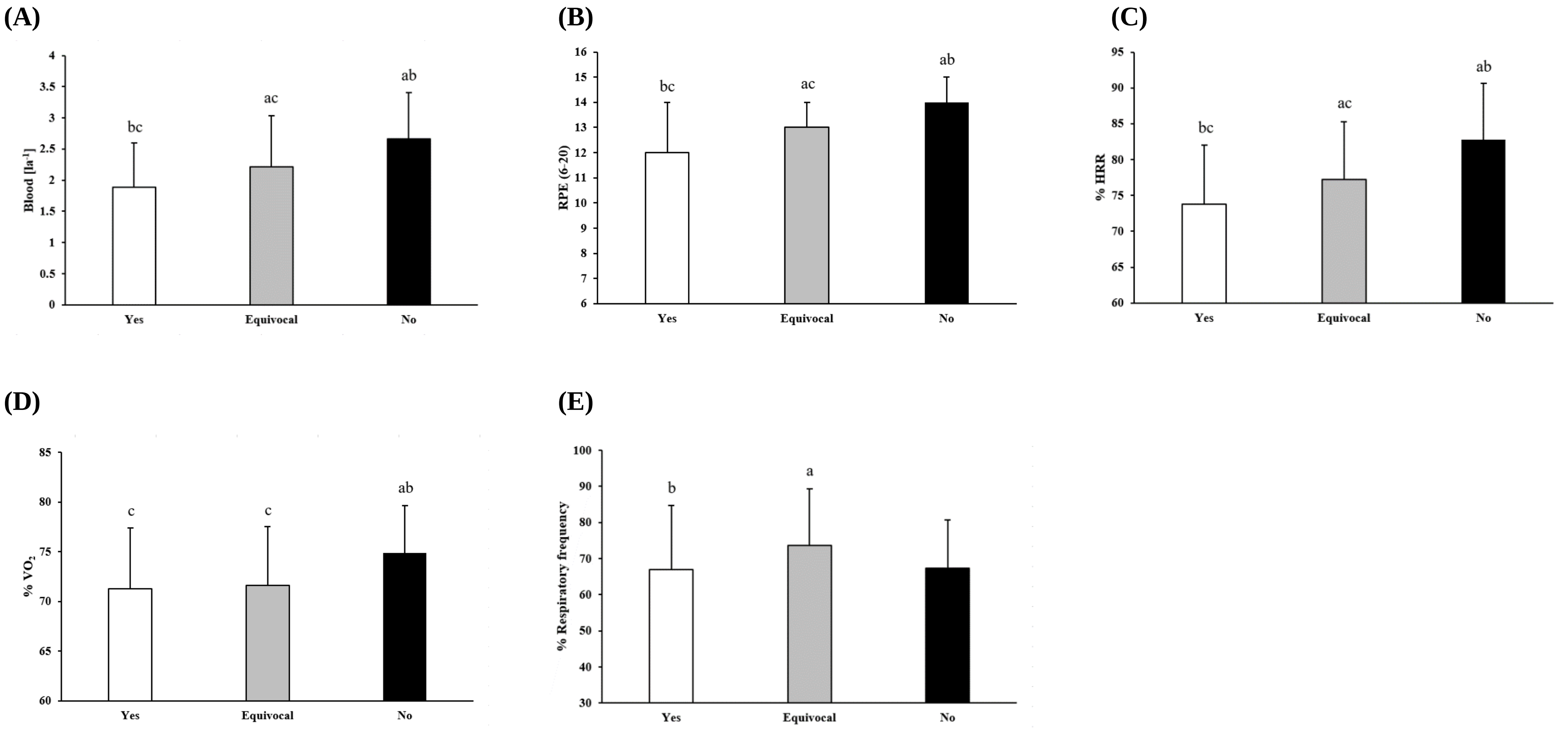


Figure 7: Physiological markers and RPE during treadmill runs, grouped by Talk Test response. Results are presented as mean and SD. Figures show mean physiological and perceptual values related to the answers "yes, no and equivocal" for all timepoints and tests. White bar = "yes" (128 samples). Grey bar = "equivocal" (47 samples). Black bar = "no" (17 samples). A) mean blood lactate. B) mean RPE. C) mean %HRR. D) mean % $VO_{2\,max}$. E) % maximal respiratory frequency from preliminary testing. Blood [la^{-1}] = blood lactate; %HRR = % Heart rate reserve; %VO_2 = Oxygen uptake; RPE = Rate of perceived exertion; a = significantly different vs "Yes"; b = significantly different vs "Equivocal"; c = significantly different vs "No". $p \leq 0.05$.

Table 1: Training characteristics.

	Total (n=21)	HV(n=11)	LV(n=10)
Age	37 ± 9	39 ± 9	35 ± 9
Sex (female/male)	6/15	2/9	4/6
Weight	69 ± 10	68 ± 10	70 ± 11
Height	176 ± 9	175 ± 9	177 ± 9
Training characteristics			
Years of running experience	11 ± 8	11 ± 7	10 ± 9
Training volume (km/week)	68 ± 27	88 ± 22*	47 ± 11*
Typical duration of long runs (minutes)	99 ± 43	125 ± 46*	71 ± 6*
Personal bests			
10 000 metres (min:sec)	38:11 ± 4:26	36:40 ± 3:39*	40:02 ± 4:46*
Half marathon (hr:min:sec)	1:27:52 ± 00:11:43	1:22:42 ± 00:08:36*	1:33:02 ± 00:12:31*
Marathon (hr:min:sec)	03:11:35 ± 00:46:23	02:58:20 ± 00:15:35	03:55:46 ± 01:29:29

Results are presented as mean ± standard deviation (SD). HV = High volume; LV = Low volume; km/week = Kilometres per week; hr:min:sec = Hours:minutes:seconds; N = Number of runners. *Significant differences between groups ($p \leq 0.05$).

Table 2: Physiological characteristics from preliminary testing.

	HV (N=11)	LV (N=10)
$VO_{2\ peak}$ (ml·kg^{-1}·min^{-1})	65.6 ± 7.7	61.5 ± 5.4
HR_{peak} (bpm)	185 ± 8	191 ± 10
HR_{rest} (bpm)	47 ± 5	52 ± 5
Peak Speed (km·h^{-1})	19.0 ± 2.0	18.0 ± 1.5
Peak VE (L·min$^{-1)}$	152 ± 26	145 ± 29
Peak RER	1.05 ± 0.05	1.06 ± 0.05
Peak RPE (Borg)	19.1 ± 0.8	19.6 ± 0.5
Peak Lactate (mMol·L^{-1})	8.1 ± 1.5*	9.9 ± 1.3
LT_1 HR (bpm)	152 ± 12	158 ± 12
LT_1 HR % HR_{peak}	82.2 ± 5.2	83.0 ± 4.2
LT_1 Speed (km·h^{-1})	13.3 ± 1.3*	11.8 ± 1.1
LT_1 Speed % of peak	69.9 ± 2.8*	65.9 ± 3.7
LT_2 HR (bpm)	165 ± 12	172 ± 12
LT_2 HR % HR_{peak}	89.3 ± 4.7	90.2 ± 3.6
LT_2 Speed (km·h^{-1})	14.8 ± 1.5*	13.5 ± 1.2
LT_2 Pace % of peak	78.0 ± 2.4	75.4 ± 3.4

Results are presented as mean ± standard deviation (SD). HV = High volume group; LV = Low volume group; $VO_{2\ peak}$ = Peak oxygen uptake; HR_{peak} = Heart rate peak; bpm = Beats per minute; km·h^{-1} = Kilometres per hour; VE (L·min^{-1}) = Minute ventilation (litres per minute); RER = Respiratory exchange ratio; RPE = Rate of perceived exertion; mmol·L^{-1} = Millimol per liter; LT_1 = Lactate threshold 1; LT_2 = Lactate threshold 2.

PART 3

APPENDICES

Contents:

Appendix 1

INTENSITETSSTYRING OG FYSIOLOGISKE ENDRINGER/MEKANISMER VED LANGVARIGE LAVINTENSITETS LØPEØKTER

UiA Fakultet for helse- og idrettsvitenskap

Informasjon og forespørsel om deltakelse i forskningsprosjekt

«Intensitetsstyring og fysiologiske endringer/mekanismer ved langvarige lavintensitets løpeøkter»

- ***En deskriptiv studie i idrettsvitenskap***

Kontakt: Tor Emil Hansen: tlf.:97481860 / e-mail: toremil96@gmail.com eller Kristian Tjørnhom: tlf.: 91157477/e-mail: kristiantjoernhom@hotmail.no

INTENSITETSSTYRING OG FYSIOLOGISKE ENDRINGER/MEKANISMER VED LANGVARIGE LAVINTENSITETS LØPEØKTER

Kjære løper!

Vi søker løpere til å bli med på en deskriptiv laboratorie studie i forbindelse med to masteroppgaver i idrettsvitenskap ved Universitetet i Agder (UiA). Her følger informasjon om prosjektet og hva det vil innebære for deg å delta. Det var planlagt et informasjonsmøte der vi skulle gått gjennom denne informasjonen muntlig, men på grunn av Covid-19 velger vi å ikke gjennomføre det. Derfor ber vi deg om å lese dette informasjonsskrivet nøye slik at du får med deg all nødvendig informasjon.

Bakgrunn og hensikt med studien

Forskningsprosjektet har to hensikter:

1. En effektiv metode for å utvikle utholdenhet er å benytte både lav- og høyintensitets treningsøkter over dager, uker, måneder og år. Forskning viser at gode utholdenhetsutøvere sin trening består av cirka 80% rolig trening (intensitetssone 1-2) og 20% høyintensitetstrening (intensitetssone 3-5). Denne fordelingen er godt dokumentert i flere utholdenhetsidretter som løping, langrenn, sykling og roing. De rolige langturene er kanskje den viktigste treningsformen for løpere, men det eksisterer et behov for et mer detaljert fysiologisk bilde over de fysiologiske endringene som skjer når en opplever utmattelse ved langvarige lavintensitets løpeøkter. Hensikten er derfor å kvanitifisere fysiologiske responser ved langvarige lavintensitets løpeøkter, og gi en bedre forståelse av hvilke fysiologiske mekanismer som er assosiert med kardiorespiratorisk endring og utmattelse ved langvarige lavintensitetsøkter.

2. Det finnes tre metoder for å måle intensitet; eksternt (km/h, watt), internt (hjertefrekvens, laktat) eller subjektivt (selvopplevd anstrengelse). De vanligste metodene løpere bruker for å styre intensitet på rolige langturer er hjertefrekvens, laktat eller selvopplevd anstrengelse. Disse metodene har dog noen begrensninger, da de er avhengig av dagsform. Vi skal undersøke om det finnes andre mer praktiske og

kostnadseffektive metoder for måle intensitet ved rolig lankjøring. Derfor vil vi validere og sammenligne ulike feltmetoder opp mot standariserte labmetoder for måling av intensitet.

Hvem er ansvarlig for forskningsprosjektet?

Universitetet i Agder, institutt for idrettsvitenskap og kroppsøving er ansvarlig for prosjektet. Tabellen under viser en oversikt over de som er involvert.

Tabell 1: Oversikt over involverte i forskningsprosjektet.

Institusjon	Navn	Rollebeskrivelse
UiA	Stephen Seiler	Veileder og prosjektansvarlig
UiA	Tor Emil Hansen	Masterstudent
UiA	Kristian Tjørnhom	Masterstudent

Hvorfor får du spørsmål om å delta?

Du får spørsmål om å delta fordi vi ønsker å rekruttere 20 erfarne løpere i alderen 18 til 55 år som løper 30 km i uka eller mer og er i stand til å gjennomføre en rolig langkjøring (120 minutter) på tredemølle.

Hva innebærer det for deg å delta?

Å være med i prosjektet innebærer at vi får hentet ut dine treningsdata for de to siste månedene. I tillegg må du gjennomgå et testbatteri som består av totalt 4 fysiske tester utført på fire forskjellige dager med flere dagers mellomrom. Total tid på testing er cirka seks timer (alle dager inkludert). All testingen i laben vil foregå i tidsrommet desember 2020 -februar 2021. Alt er gratis.

Kontakt: Tor Emil Hansen: tlf.:97481860 / e-mail: toremil96@gmail.com eller Kristian Tjørnhom: tlf.: 91157477/e-mail: kristiantjoernhom@hotmail.no

INTENSITETSSTYRING OG FYSIOLOGISKE ENDRINGER/MEKANISMER VED LANGVARIGE LAVINTENSITETS LØPEØKTER

Oversikt over testing

Dag 1:

- Laktatprofiltest (varighet cirka 45 minutter)
- $VO_{2\ max}$ test (varighet 15 minutter)
- Total varighet cirka 1,5 timer

Prosedyre:

- 10min oppvarming
- 5 min drag, 30 sek pause
- Hastigheten økes med 1 km/t for hvert 5 min drag
- Borg-skala etter 4.45 min
- Laktat måles hvert 5. min
- VO_2 måles fra 3-4,5 min på hvert drag
- Testen avsluttes når laktaten er høyere enn 2,1 over hvileverdi

10 min pause før VO_2- maks test

- Kontinuerlig løping (6-10 min)
- Hastighet starter på LT_2-fart
- Hastighet økes med 1 km/h per minutt frem til utmattelse

Dag 2:

- 30 minutter terskeløkt
- Total varighet cirka 1 time
- Her måles: Laktat, VO_2, Hjertefrekvens, Talk Test, Løpe med munnen lukka, Selvopplevd anstrengelse (Borg skala)

Kontakt: Tor Emil Hansen: tlf.:97481860 / e-mail: toremil96@gmail.com eller Kristian Tjørnhom: tlf.: 91157477/e-mail: kristiantjoernhom@hotmail.no

Dag 3 og 4:

- Rolig langtur 120 mintutter
- 4x30min (1 min pause) løping på lav intensitet.
- Test 3 gjennomføres på 90% av LT_1 hastighet
- Test 4 gjennomføres på 100% av LT_1 hastighet

På dag 3 og 4 vil vi i løpet av hver 30 minutts periode måle:

- Laktat
- VO_2
- EMG (elektromyografi)
- Hjertefrekvens
- Talk Test
- Løpe med munnen lukka
- Kjernetemperatur (via øre)
- Hudtemperatur (infrarødt kamera)
- Selvopplevd anstrengelse (Borg skala)
- Kortisol (spyttprøve) (Måles kun før og etter)

Forberedelser

- Ikke gjennomføre intensiv fysisk trening 24 timer før testing.
- Kosthold: Innta samme type måltid/innhold før hver test
- Ikke spise siste 2 timer før test.
- Ikke konsumere koffein 3 timer før testing.
- Bruke samme joggesko for hver test.
- Deltakere må utføre testing i shorts (kortbukse) slik at vi får festet EMG-elektroder på Musculus Vastus Lateralis og Musculus Biceps Femoris.

Kontakt: Tor Emil Hansen: tlf.:97481860 / e-mail: toremil96@gmail.com eller Kristian Tjørnhom: tlf.: 91157477/e-mail: kristiantjoernhom@hotmail.no

Det er frivillig å delta i prosjektet

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke deg fra studien uten å måtte oppgi grunn om hvorfor. Alle opplysninger om deg, vil da bli anonymisert eller slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller velger å trekke deg på et senere tidspunkt.

Personvern – Oppbevaring og behandling av dine opplysninger

Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene dine konfidensielt og i samsvar med personvernregelverket. Navn og kontaktopplysninger om deg vil bli anonymisert og kodet slik at dine data ikke er direkte knyttet direkte til ditt navn. All data- og biologisk materiale (spyttprøvene) vil bli lagret på en sikker måte og utilgjengelig for andre enn de som er involvert i prosjektet. Det innebærer at data oppbevares avidentifisert på insituttets passordbelagte PC. Anonymisert data vil kunne bli brukt i forbindelse med publisering av artikkel i tidsskrift eller i undervisning og kongresser.

Hva skjer med opplysningene dine når prosjektet er avsluttet?

Prosjektet skal etter planen avsluttes innen juni 2020. Ved prosjektslutt skal koblingen mellom anonymiserte datafiler og personinformasjon (navn og email adresse) slettes.

Dine rettigheter:

- innsyn i hvilke personopplysninger som er registrert om deg,
- å få rettet personopplysninger om deg,
- få slettet personopplysninger om deg,
- få utlevert en kopi av dine personopplysninger (dataportabilitet),
- å sende klage til personvernombudet eller Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?

Vi behandler personopplysninger om deg basert på ditt samtykke. Studien har blitt godkjent av Fakultetets Etiske Komitè (FEK). I tillegg har Norsk senter for forskingsdata AS (NSD) vurdert at behandlingen av personopplysninger i dette prosjketet er i samsvar med personvernregelverket.

Hvordan bli med?

Dersom du fortsatt ønsker å være en del av dette prosjektet kan du bekrefte din deltakelse ved å sende en mail til toremil96@gmail.com

Hvor kan jeg finne ut mer?

Hvis du har ytterligere spørsmål til studien eller ønsker å benytte deg av dine rettigheter, vennligst ta kontakt med:

- Masterstudent; Tor Emil Hansen, toremil96@gmail.com, telefon 97481860.
- Masterstudent; Kristian Tjørnhom, kristiantjoernhom@hotmail.com , telefon
- Vårt personvernombud: Ina Danielsen, Universitetet i Agder, ina.danielsen@uia.no, telefon +47 452 54 401
- NSD – Norsk senter for forskningsdata AS, på epost (personverntjenester@nsd.no) eller telefon: 55 58 21 17.

Med vennlig hilsen

Stephen Seiler, Tor Emil Hansen, Kristian Tjørnhom

Appendix 2

Samtykke til deltakelse i forskningsprosjektet «Intensitetsstyring og fysiologiske endringer/mekanismer ved langvarige lavintensitets løpeøkter»

Ved å signere samtykkeerklæringen bekrefter du at du ikke har noen hjertesykdom eller lidelser/sykdom som medfører at din fastlege har frarådet deg å trene intensivt. Du, som deltaker, er for øvrig også forsikret av UiAs egen forsikringsordning for forskningsprosjekter.

- Jeg samtykker at det innhentes biologisk materiale (spyttprøve)
- Jeg bekrefter å ha fått og forstått informasjon om studien og er villig til å delta

Ja ☐

Nei ☐

____

(Signert av prosjektdeltaker, dato)

Appendix 3

NORSK SENTER FOR FORSKNINGSDATA

NSD sin vurdering

Prosjekttittel

Validering av feltmetoder for intensitetsstyring, og fysiologiske responser ved langvarige lavintensitets løpeøkter

Referansenummer

915200

Registrert

19.10.2020 av Kristian Tjørnhom - kritjo15@student.uia.no

Behandlingsansvarlig institusjon

Universitetet i Agder / Fakultet for helse- og idrettsvitenskap / Institutt for folkehelse, idrett og ernæring

Prosjektansvarlig (vitenskapelig ansatt/veileder eller stipendiat)

Kerry Stephen Seiler, Stephen.seiler@uia.no, tlf: 91614587

Type prosjekt

Studentprosjekt, masterstudium

Kontaktinformasjon, student

Kristian Tjørnhom, Tor Emil Hansen, kristiantjoernhom@hotmail.no, tlf: 91157477

Prosjektperiode

01.12.2020 - 30.06.2021

Status

05.03.2021 - Vurdert

Vurdering (1)

05.03.2021 - Vurdert

Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet 05.03.2021 med vedlegg, samt i meldingsdialogen mellom innmelder og NSD. Behandlingen kan starte.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde:
https://nsd.no/personvernombud/meld_prosjekt/meld_endringer.html

Du må vente på svar fra NSD før endringen gjennomføres.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle særlige kategorier av personopplysninger om helseforhold og alminnelige kategorier av personopplysninger frem til 30.06.2021.

LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 nr. 11 og art. 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse, som kan dokumenteres, og som den registrerte kan trekke tilbake.

Lovlig grunnlag for behandlingen vil dermed være den registrertes uttrykkelige samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a, jf. art. 9 nr. 2 bokstav a, jf. personopplysningsloven § 10, jf. § 9 (2).

PERSONVERNPRINSIPPER
NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:

- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20).

NSD vurderer at informasjonen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon.

OPPFØLGING AV PROSJEKTET
NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Lykke til med prosjektet!

Kontaktperson hos NSD: Kajsa Amundsen
Tlf. Personverntjenester: 55 58 21 17 (tast 1)

Appendix 4

Tor Emil Hansen

Besøksadresse:
Universitetsveien 25
Kristiansand

Ref: [object Object]

Tidspunkt for godkjenning: : 17/11/2020

Søknad om etisk godkjenning av forskningsprosjekt - Intensitetsstyring og fysiologiske endringer/mekanismer ved langvarige lavintensitets løpeøkter

Vi informerer om at din søknad er ferdig behandlet og godkjent.

Kommentar fra godkjenner:
Søknaden godkjennes under forutsetning av at prosjektet gjennomføres som beskrevet i søknaden og under forutsetning av godkjenning av NSD. FEK forutsetter at prosjektet er framlagtsvurdert for REK, og ber om at dokumentasjon fra REK og NSD godkjenning sendes på mail til Anne Skisland når dette foreligger.

Hilsen
Forskningsetisk komite
Fakultet for helse - og idrettsvitenskap
Universitetet i Agder

UNIVERSITETET I AGDER
POSTBOKS 422 4604 KRISTIANSAND
TELEFON 38 14 10 00
ORG. NR 970 546 200 MVA - post@uia.no -
www.uia.no

FAKTURAADRESSE:
UNIVERSITETET I AGDER,
FAKTURAMOTTAK
POSTBOKS 383 ALNABRU 0614 OSLO

Appendix 5

Infoskriv for kvinner som skal delta i forskningsprosjektet:

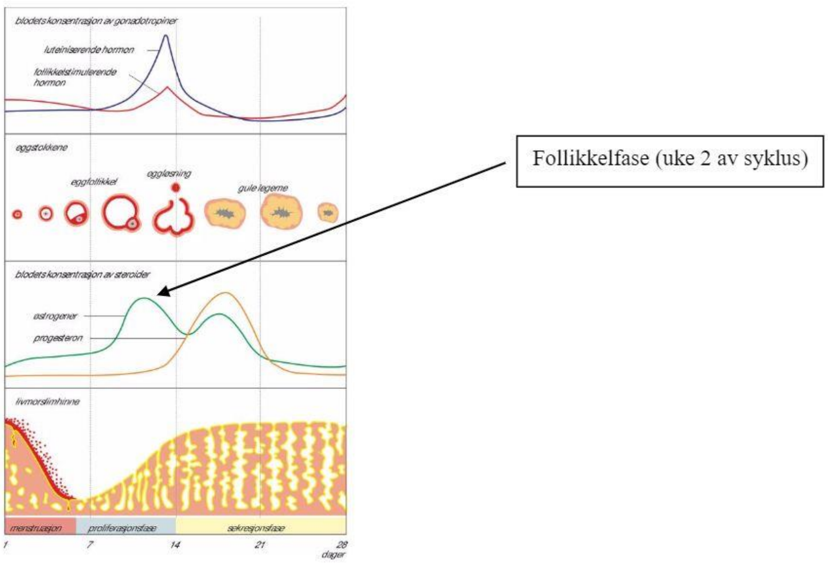
«Intensitetsstyring og fysiologiske endringer/mekanismer ved langvarige lavintensitets løpeøkter»

Kjære løper!

Vi gleder oss til å komme i gang med prosjektet og er glad dere ønsker å være med. Selv om informasjonen som følger i dette skrivet ikke er hovedproblemstillingen i vårt prosjekt, ønsker vi allikevel å ta hensyn til det av metodiske årsaker. Forskning viser nemlig at de hormonelle endringene i menstruasjonssyklus kan påvirke prestasjon og vi ønsker å ta stilling til dette. Fagmiljøet anbefaler at forskere bør kontrollere for menstruasjonsstatus ved fysiologisk testing, og ved repeterte målinger bør det utføres målinger i samme fase av menstruasjonssyklusen. Vi håper at vi kan ha en dialog, hvor dere uttrykker et ønske om når dere vil teste basert på den informasjonen som gis i dette skrivet.

Dersom du går på prevensjonsmidler, eller er i overgangsalderen og ikke har regelmessige blødninger kan du se bort i fra dette infoskrivet, ettersom prevensjonsmidler reduserer de hormonelle endringene.

Vi ønsker så godt det lar seg gjøre, at testene blir utført i follikkelfasen (uke 2 av syklus). Se figur.



Ønsket periode for testing kan sendes på mail til toremil96@gmail.com 😊

Hvis du ønsker mer informasjon om temaet, se kilder under:

Kilder:

- JANSE DE JONGE, XANNE1; THOMPSON, BELINDA1; HAN, AHREUM2. Methodological Recommendations for Menstrual Cycle. Research in Sports and Exercise, Medicine & Science in Sports & Exercise: December 2019 - Volume 51 - Issue 12 - p 2610-2617. Doi: 10.1249/MSS.0000000000002073
- Romance R, Vargas S, Espinar S, Petro JL, Bonilla DA, Schöenfeld BJ, Kreider RB, Benítez-Porres J. Oral Contraceptive Use does not Negatively Affect Body Composition and Strength Adaptations in Trained Women. Int J Sports Med. 2019 Dec;40(13):842-849. doi: 10.1055/a-0985-4373. Epub 2019 Sep 6. PMID: 31491790.
- Thompson B, Almarjawi A, Sculley D, Janse de Jonge X. The Effect of the Menstrual Cycle and Oral Contraceptives on Acute Responses and Chronic Adaptations to Resistance Training: A Systematic Review of the Literature. Sports Med. 2020 Jan;50(1):171-185. doi: 10.1007/s40279-019-01219-1. PMID: 31677121.
- https://sml.snl.no/menstruasjon

Appendix 6

Institutt for idrettsvitenskap og kroppsøving

Olympiatoppen Sør

Covid-19: Egenerklæring

- Er du i karatene per dags dato?
  - ☐ Ja
  - ☐ Nei
- Har du vært i kontakt med noen som har vært smittet av korona i løpet av de siste 14 dagene?
  - ☐ Ja
  - ☐ Nei
- Har du opplevd noen av følgende symptomer de siste 10 dagene (kryss av for eventuelle symptomer)?
  - ☐ Feber
  - ☐ Hoste
  - ☐ Vond/sår hals
  - ☐ Nei
- Har du opplevd tap av smak- eller luktesans i løpet av de siste 10 dagene?
  - ☐ Ja
  - ☐ Nei
- Har du vært i utlandet/områder med høy smitte de siste 10 dagene?
  - ☐ Ja
  - ☐ Nei

Dato:

Utøver/foresatt:

____

Appendix 7

Forskningsprosjekt Løping

Intensitetsstyring og fysiologiske endringer ved langvarig løping på lav intensitet.

E-postadresse *

Gyldig e-postadresse

Dette skjemaet samler inn e-postadresser. Endre innstillingene

Navn *

Kort svartekst

Kjønn *

- Mann
- Kvinne

Alder *

Kort svartekst

Hvor mange år erfaring har du med løping? *

Kort svartekst

Har du tilgang på treningsdata for de siste 8 ukene gjennom treningsapp? For eksempel i Strava, Polar, Training Peaks eller Garmin. *

- Ja
- Nei

Cirka hvor mange kilometer per uke har du løpt de siste 8 ukene? *

Kort svartekst

Hva er typisk varighet (minutter) for din lengste ukentlige langtur de siste 8 ukene? *

Kort svartekst

Har du en personlig rekord på 10 km? *

- Ja
- Nei

Hva er din personlige rekord på 10 km?

Varighet

Har du en personlig rekord på halvmaraton? *

- Ja
- Nei

Hva er din personlige rekord på halvmaraton?

Varighet

Har du en personlig rekord på maraton? *

Ja

Nei

Hva er din personlige rekord på maraton?

Varighet