Anthropometric characteristics, physical fitness and psychological skills of the elite Icelandic riders

by

Vilfríður Fannberg Sæþórsdóttir

Thesis of 45 ECTS credits

Master of Science in Exercise and Coaching

June 2019

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Vilfríður Fannberg Sæþórsdóttir

Thesis of 45 ECTS credits submitted to the School of Sports Science at Reykjavík University in partial fulfillment of the requirements for the degree of

Master of Science in Exercise Science and Coaching

June 2019

Professor: Jose M. Saavedra

Examiner: Sveinn Þorgeirsson

1 Ágrip

Tilgangur þessarar rannsóknar var (i) að skoða hæð, þyngd og BMI, líkamsgetu og hugræna færni afreks knapa á Íslandi með tilliti til aldurs og kyns, (ii) að skoða fylgni á milli hæðar, þyngdar og BMI, líkamsgetu og hugrænnar færni afreks knapa á Íslandi. Þrjátíu og einn afreksknapi (meðalaldur 27.24 ára) tóku þátt í þessari rannsókn. Þátttakendur voru knapar í A-landsliði og U-21 árs landsliði í hestaíþróttum. Líkamsmælingar sem notast var við voru; hæð, þyngd, og BMI. Til að mæla líkamsgetu knapanna var notast við gripstyrkspróf, armbeygjupróf, kviðkreppupróf, stökkpróf og liðleika og jafnvægispróf. Knaparnir svöruðu þremur spurningarlistum sem skoðuðu hugræna hæfni, kvíða og andlegan styrk (Test of Performance Strategies Questionnaire, The Sport Anxiety Scale 2, The Sports Mental Toughness Questionnaire). Niðurstöður voru settar fram með lýsandi tölfræði og 1-way ANOVA var notað til að greina mun á milli hópanna með tillit til aldurs og kyns. Að lokum var fylgni á milli allra líkamlegra og hugrænna mælinga skoðuð. Niðurstöður sýndu að það er munur á milli A liðsins og U-21 liðsins með tillit til aldurs. A liðið er þyngra, með hærra BMI og betri handgrips styrk í báðum höndum. Í hugrænni færni skoraði A landsliðið hærra í slökunartækni (á æfingum) og sjálfvirkni (í keppni). U-21 landsliðið skoraði betur í kviðkreppum og í hugrænni færni á undirþáttunum markmiðasetningu (á æfingu) og sjónmyndafærni (í keppni). Munur fannst á milli kynja. Karlar voru hærri, þyngri og með meiri handgrips styrk og stökk kraft í neðri hluta líkama. Karlar skoruðu einnig hærra í sjálfvirkni í keppni. Konur skoruðu hærra í markmiðasetningu (á æfingu) og virkjun og sjónmyndafærni (í keppni). Fylgni fannst á milli líkams- og sálfræði mælinga í átta breytum.

Leitarorð: ‘Islenskir knapar, líkamsmælingar, styrkur, jafnvægi, hugræn færni

2 Abstract

The aims of the study were (i) to analyze the anthropometry, physical fitness, and psychological skills in function to age group and sex in elite Icelandic horse-riders (ii) to know the relationship between anthropometry, physical fitness, and psychological skills in elite Icelandic horse-riders. Thirty-one riders (with mean age of 27.24 years) from national team selections participated in the study. They were classified into groups in function to age group (A team/U-21) and sex (male/female). Tests used to evaluate the riders were basic anthropometry (height, weight, BMI), physical fitness tests (grip strength, push-up, sit-up, CMJ, FMS) and psychological tests (TOPS, SAS-2, SMTQ). The basic descriptive statistics (mean, standard deviation) were calculated and a 1-way analysis of variance (ANOVA) was used to establish the difference between teams and sex. Pearson simple correlation coefficients were calculated between each of the tests. Results showed difference between the A team and U-21 team in function to age. The A team were taller, heavier, with higher BMI and grips strength. The A team also scored higher in relaxation technique (in practice) and automaticity (in competition). While the U-21 team scored higher in sit-ups and psychological skills like goalsetting (in practice) and imagery (in competition). Further, results showed difference between sexes. Male riders were taller and heavier, with greater grip strength in hands, and more power in lower body. Male riders also tend to score higher in automaticity in competition. Female riders scored higher in goalsetting (in practice) and activation and imagery (in competition). Finally, correlation was found between anthropometry, physical fitness and psychological parameters, in eight variables.

Keywords: Icelandic horse riders, anthropometry, strength, balance, psychological skills

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Master of Science in Exercise Science and Coaching

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Student:

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Professor:

____

Jose M. Saavedra

Examiner:

____

Sveinn Þorgeirsson

3 Acknowledgements

I would like to thank The Icelandic Equestrian Association (LH) and Reykjavík University for the collaboration and the opportunity to be a sponsored student over the last two years. This has been amazing learning with upcoming opportunities. The following people, whom I am very grateful to, have contributed to this thesis; the staff and board of LH have been amazing and really supportive. Specially, I would like to think Hjörny Snorradóttir for her understanding and motivation. The MSc students, my classmates, who assisted with evaluating the riders; Eyþór Ernir Oddsson, Guðmundur Örn Árnason and Davíð Már Sigurðsson.

Furthermore, I would like to thank the teachers at the department of sport and exercise sciences for their feedback through the master education over the last two years. In addition, I would like to thank Hjalti Rúnar Oddsson and Margrét Lilja Guðmundsdóttir for their involvement and assist in the testing sessions and particularly I want to express my gratitude to Jose M. Saavedra for practical directions and guidance to complete this final master project.

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7 Introduction

In most sports, the benefit of physical and mental training is not just health related but also better physical fit and form for the athlete, which will lead to better outcome in the sport. In general, test of athletes has shown that lower than average fitness levels lead to decreased performance (Douda, Toubekis, Avloniti, & Tokmakidis, 2008). Success is not just about the best physical fitness status. It is also not the least about psychological skills. It is necessary to work on self-esteem, concentration, attention etc. Sport science deals with maximizing athlete´s performance by using a standardized set of tests to measure components like strength, flexibility, coordination, balance, endurance etc. Sport science also helps teams and individuals to fulfill their potential using psychology, like working on focus, confidence, relaxation, controlling emotions, stress, anxiety, self-motivation and self-control. In many sports, the benefit of physical and mental training form of the athlete is clear. Limited information exists concerning equitation as a viable form of physical activity to fulfill minimum and basic referent for base strength and endurance (Douglas, Price, & Peters, 2012; Westerling, 1983). Investigations of rider's fitness related factors and psychological skills that might enhance rider's performance is also limited despite a clearly general agreement that equestrianism requires physical fitness for the maintenance of rider's effectiveness and balance. Further, anxiety management and emotional control because of the human-equine interaction and collaboration to complete a task successfully (Wolframm, 2014). My interest and active participation in horse, horse sport, training and competition spurred me to focus on riders, their physical fitness and psychological skills, in attempt to answer, how these factors impact performance and success in equestrian sports.

8 Review of literature

8.1 About the sport

Horse riding is a popular worldwide as recreational and competitive physical activity and is also an Olympic sport that includes several disciplines like dressage, jumping and event. All these activities require basic training, comprising all the gaits in progression (Sainas et al., 2016). Equestrianism is the only sport that involves two athletes, equine and human. It is the successful partnership between these two components; the relationship of confidence and respect that is builds up between them, makes the sport so incomparable to other sports and therefore unique. It is also one of the few sports where males and females compete equals. There are no woman's groups or men's groups in equine sports. In equestrian competitions (dressage, jumping, event), the rider and a horse perform periods of walking, trotting and/or galloping. In competitions in Iceland, the rider and a horse perform periods of walk, trot, canter but also tölt and/or pace. The walk is a four-beat gait at the slowest speed without leg suspension. The trot is a gait faster than walking, with the horse moving with two legs suspended (in diagonal). The canter, with increase in speed, is a three beat gait with a phase of a complete suspension of the horse´s legs (Sainas et al., 2016). The Icelandic horse has these three gaits and extra two gaits, tölt and pace. Tölt is a four-beat gait with ipsilateral sequence of footfalls. Pace (often called the very fast flying pace) is two-beat gait with a moment of suspension, where ipsilateral legs move almost synchronously back and forth and requires high metabolic demands for the horse (Stefánsdóttir, Gunnarsson, Ragnarsson, & Jansson, 2017). Equestrian sports competitions are different between disciplines. Jumping is an equestrian event where the horse must jump over many obstacles of all heights and sizes on the road within set time limit. The rider is always or mostly all the time galloping and usually with many turns and changes of direction, with the rider in "forward" position, holding the body out of the seat and weight bearing through the legs (Wipper, 2000). Dressage is an equestrian event which last about 5-8 minutes. The rider and a horse perform walk, rising trot, sitting trot, and sitting canter, with the rider in vertical position (ear, shoulder, hip, ankle) and seated contact with the horse (Viry et al., 2013). Event is another equestrian event where horse and rider combine and compete against other combinations across three disciplines. It is like the equestrian version of the modern triathlon. It consists of three competitions, dressage, cross country gallop and show jumping and requires mastery of several type of riding. It can be one-day event, were all three tests take place on one day event, beginning with dressage then jumping and ends on the cross-country or it can be a three-day event, starting with dressage following with cross-country and ending with jumping (Wipper, 2000). Endurance event is based on long distance races that occur over distances from 200m to more than 160km. The winner is the one who maintains the highest average speed over the distance of the race with the rider both in seated and light seated contact with the horse and can push both the rider and the horse to their limits (Gondim, Zoppi, dos Reis Silveira, Pereira-da-Silva, & Vaz de Macedo, 2009). Icelandic horse competitions are events where rider and a horse are supposed to show the different gaits of the horse at different speed with softness but energy, lasting over period of time between 3 to 5 min on average in sport class competitions, like 4gait, 5gait or tölt competition. The rider is in vertical (ear, shoulder, hip, ankle) mostly in seated contact with the horse. Pace race (100,150,250m) is a competition in speed (in the gait pace) and the sprint last from ca. 6.80-26sec.

Available studies from the published literature suggest that horse riding requires a metabolic engagement like that of activities such as aerobics or gymnastics (Devienne and Guez-ennec 2000; Gutiérrez Rincón et al. 1992; Westerling 1983). Few researches have measured the heart rate (Devienne & Guezennec, 2000; Roberts, Shearman, & Marlin, 2009; Trowbridge, Cotterill, & Crofts, 1995), concentration of blood lactate (Gutiérrez Rincón, Vives Turcó, Muro Martinez, & Casas Vaqué, 1992; Roberts et al., 2009), oxygen uptake and pulmonary ventilation (Devienne & Guezennec, 2000; Roberts et al., 2009). The results show that as the horse and rider progress through the equine gaits, the rider will have increased heart rate and oxygen consumption, (like from walk to trot to canter) supporting that riding is mainly aerobic activity (Douglas et al., 2012; Terada, Mullineaux, Lanovaz, Kato, & Clayton, 2004). On the other hand, the physical response is different within various discipline. A dressage rider perform a competition test that last about 5 to 8 minutes, in seated contact with the horse but with limited movements and high isometric contraction (Terada et al., 2004). Discipline that requires faster speed and jumping with the rider in “forward” position, holding the body out of the seat and weight bearing through the legs (Roberts et al., 2009) cost more metabolic efforts and rise in blood lactate assuming some anaerobic demands because of this un-seated position of the rider (Gutiérrez Rincón et al., 1992; Roberts et al., 2009). The same can be said about long races, suggesting by high HR and peak lactate results, that requires the rider to be both aerobically and anaerobically fit (Trowbridge et al., 1995), and even Polo (Wright & Peters, 2008). Summarized, the demanding of different discipline seems least in dressage followed by showjumping, with eventing and then races and polo requiring the most from the rider (Wolframm, 2014). Yet in Iceland, nothing has been reported about rider´s metabolic requirements in different gaits, (walk, trot, canter, tölt, pace).

8.1.1 The horse-rider partnership

The horse-rider partnership in equestrian sports is a complex partnership to explain. Training an equine is based on learning theory, the horse learns to associate certain “aids” from the rider with different movements through principles of negative reinforcement. Thus, riders need to be in control of themselves, both physically and emotionally, and to be able to consistently apply relevant aids. Equestrian is defined as open skill sport, which means that riders need continuously to adapt their motor behavior to the reaction of their horses and the environment, the horse-rider dyad performs in. Most riders understand the importance of sensory feedback on their own motor performance, hence that helps them to evaluate better the gait they are riding in. Based on how they feel their horse movement underneath them, they will decide what to do next, i.e. if they want to continue in a present gait or shift to another gate. Such feedback from the horse will determine the next aids, i.e. specific movements of their seat, hands or leg (Wolframm, 2014). The riders communicate with their horses through the seat, contact from the legs and through the reins and their discipline requires a high level of locomotor control through exercising and collecting the horse gaits (walk, tölt, canter, trot). To achieve optimal performance, the goal of the rider has to be in harmony with the horse via the movements but at the same time at various speeds and gaits (Swift & Harris, 2002). To perform this harmony with the horse, the rider needs to sit balanced in the saddle and be able to influence the way of movements of the horse speed, gait, the right form of the horse and thereby influence the final outcome (improve the efficiency of the horse). A rider who is not in balance nor with the right posture has a negative impact on the horse balance and the way the horse moves and therefore the final outcome (of the horse and rider, the harmony) (Meyners, 2004). It has been presumed, but not many studies exist on the matter, that a rider who exercises regularly and trains his physique should be more qualified to find the balance and the right posture, with ear, shoulder, hip and ankle all aligned, in the saddle when riding, thus better controlling the horse, better able to give accurate aids to the horse for instructions, than a rider in worse physical shape or form (Douglas et al., 2012). How physical strength or form impacts achievements of rider and results in competition is rather unclear, due to lack of studies. Nevertheless, the studies that do exist show that a rider needs a certain amount of muscular endurance to be able to hold the right posture for a longer period. Also it is considered important to have strong core muscles, abdominal muscles and get the main muscle groups to work together for stability and upright position of the body (Hampson & Randle, 2015). The result is a rider who can feel the connection between the top of the head down to the end of his toes and is effective, strong, soft, balanced all at the same time (Champion, Bouvier, & Chadwick, 2005). Bompa and Haff (2009) submit that the dominant motor abilities riders athletes should place emphasis on are strength, reaction time endurance and balance. Others, like Meyners (2011) suggest that riding requires range of motion, good reaction time, motor control, flexibility, balance and muscle memory.

8.1.2 Riders positions

The rider´s position and his physical influence on the horse must be considered when viewing elements in relation with physical fitness of the rider. To be successful and efficient in the chosen competition discipline (e.g. in dressage, jumping) the riders are required of “correct” position on the horse and it is in consistent with the idea, that a good performance riding is mainly based on a correct rider sitting position. This basic position is also thought to be necessary to prevent falls and injuries as consequence (Williams & Tabor, 2017). Xenephon describes the importance of well balanced and supple upright seat of the rider. Today, these rules are still acknowledged across all equestrian discipline (Eckardt, Münz, & Witte, 2014). The ideal and “correct” position is reported in a sagittal view with vertical line through ear-shoulder-hip and heel and the rider needs to have the ability to adapt the motion patterns of the horse of each gait to maintain the harmony with the horse and ride effective. However, it has not been explored why this position is beneficial nor if there are any link between this position and performance of the horse. Interestingly, in the competition discipline in Iceland, it has become more common to see riders on all levels, ride with stooped shoulders with good performance of the horse and result which lead to the final or even winning. Why this is becoming more common is not known but necessary to be aware of by riders, teachers, and judges. This could be an indicator of the importance of strength, posture, and endurance in Icelandic equestrian sport.

In equestrian sports, the require for strength is uncertain and it is suggested that the rider´s muscular activity is more important for stabilization and coordination in patterns to control position, like for balance and rein-contact rather than production of power (Terada, 2000; Terada et al., 2004). The muscular activity and co-ordination patterns in rider´s position have been studied by using electromyography (EMG) for further understanding the physical effects of the riders on performance. When it comes to the role of muscles in maintaining posture, there is a difference between inexperienced and experienced riders. Studies show that muscular activity in novice or inexperienced riders is more uncoordinated, like in sitting trot, they rather use their adductor magnus to maintain their posture, which leads to less stability and a lack of ability to be in harmony with the horse´s movements. While experienced riders use coordination between rectus abdominis and erector spinea muscles which enables the rider to ride a horse in a more effective way. More chance of successful show of gaits and technique (Terada, 2000). As Williams et al. (2017) has reviewed, similar to the findings of Byström et al.(2009), Lovett et al.(2005) and Schils et al.(1993), experienced riders have more vertical position of the trunk while the beginner riders wants to tilt the upper body more forward. Experienced rider´s ability is linked to co-ordination and muscular activity to control posture with still hand not distracting the horse and can give aids to the horse without effecting their position.

8.2 Definitions

Physical activity, physical exercise and physical fitness are concepts used in the area of sport and performance (Budde et al., 2016). Physical activity is any body movement created by muscle action that increases energy expenditure. Individuals achieve physical fitness through physical exercise which are cited to structured, systematic, planned and determined physical activity (Ortega, Ruiz, Castillo, & Sjöström, 2007). Definition for physical fitness is, the ability to perform daily tasks with strength and awareness, without undue fatigue, be able to engage in leisure pursuit and meet above average physical stresses met in emergency situations. Physical fitness has been classified as *health-related physical fitness* (refers to components like muscle strength, cardiorespiratory endurance, body composition and flexibility) or *performance-related fitness* (refers to components like isometric strength, power, speed-agility, balance and co-ordination) (Vanhees et al., 2005). Furthermore, basic anthropometric parameters including height, weight, BMI and body fat percentage has been used widely to characterize physical fitness in specific population like sport performance in athlete population, in function to age and gender (Santos et al., 2014). For example in taekwondo, the following parameters, height, weight, BMI, and body fat percentage, correlate directly with sport performance in the sport (define the winners from the non-winners) (Nikolaidis, Buśko, Clemente, Tasiopoulos, & Knechtle, 2016).

These basic characteristics and physical fitness parameters (like strength, flexibility, power and endurance) are considered important determinants of successful performance in elite athletes (Douda et al., 2008) and have been tested within athletes population in various ways and sport specifics (Suni et al., 1996). Handgrip strength with hand dynamometry (maximal isometric force) has been measured in both normal population (Massy-Westropp, Gill, Taylor, Bohannon, & Hill, 2011) and athletes around the world (Paz, Maia, dos Santos Santiago, & Lima, 2012), within various sports, and often in function to age, gender and occupation (Innes, 1999). Field tests in related to health and physical fitness, such as various sit-up tests and push-up tests are used to evaluate muscular strength and endurance in athletes at all levels in sports populations. These tests show advantage to predict performance on more elaborate measures of muscular strength and endurance. For example, it is noted that performing well in push-ups have correlation to good performance in criterion strength tests, like 1-RM bench press and sit-ups test are considered to indicate strength and muscular endurance in the abdominals. The lower body is carrying the whole trunk through all movements. Strength and power in lower body can play a big role in performance, injury and improvement. Common test used to evaluate strength/power in lower body is the vertical jump test (CMJ). It can either be vertical or standing broad test and have been used to assessing both explosive strength and endurance strength (Ortega et al., 2007).

In equestrianism, the primary method of daily activity/ strength training and chores (which accompanies it) is through riding horses, cleaning stables, carrying feed or hey or riding equipment. It is not recommended a highly (aerobic) competitive sport environment (Meyers & Sterling, 2000) and there are questions about how physically demanding the sport is. Nevertheless, there are clues about some physical profits from competition environment, at least in some disciplines (Douglas et al., 2012). Few equestrian researches have investigated physiological and biomechanical parameters in equestrian sport by testing riders and have reported anthropometric- and physical parameters in relation to rider´s physical fitness, mostly in disciplines including dressage, jumping and event (Douglas et al., 2012), so far no study has been made or published regarding the disciplines in Icelandic horsemanship.

In following sections, I will review anthropometry, physical fitness and psychological parameters and tests used in previous equestrian available studies.

8.3 Anthropometry

An athlete's anthropometric and physical characteristics may represent important assumption for successful participation in any given sport and at the same time helping to determine a suitable physique for a certain sport (Duncan, Woodfield, & al-Nakeeb, 2006). Anthropometric profiles of riders might present some initial indications as to the effect of regular riding related exercise (Wolframm, 2014). Anthropometric parameters including height, weight, body mass index (BMI=weight/height^2) and percentage body fat have been reported in available equestrian studies, but mostly in female riders. These parameters has been examined via dual X–ray absorptiometry (Alfredson, Hedberg, Bergström, Nordström, & Lorentzon, 1998), hydrodensytometry (Meyers & Sterling, 2000) and skin fold techniques (Roberts et al., 2009). Table 1 shows the available studies in equestrian and reported data for anthropometric parameters in riders.

Table 1. Anthropometry values in previous studies for riders

Study	N	Sex	Type of riders	Height (m) (M±SD)	Weight (kg) (M±SD)	BMI (kg/m^{2}) (M±SD)

Alfredson et al; (1998)	20	Females	Jump/dressage	165.1±4.5	61.8±7.0	-
Devienne et al; (2000)	3 2	Females Males	Show jump riders	172±1	54.2±1.1	-
Hobbs et al; (2014)	132 2	Females Males	Dressage	166±12.8	67.1±12.8	24.4±4.1
Meyers; (2006)	15	Females	Amateur Collegiate	164.3±1.3	63.5±2.6	-
Meyers et al; (2000)	24	Females	Collegiate	161.8±5.0	64.9±9.3	24.8±1.7
Roberts et al; (2009)	16	Females	Novice event	166.6±3.8	60.3±5.8	21.7±1.9
Sainas et al; (2016)	10 9	Females Males	Advanced riders	166.7±8.1	53.3±11.7	-
Wilson et al; (2014)	20	Males	Professional (USA)	1.58±0.51	51±1.5	20±1.0

Equestrian participants have been reported in the upper limit of a BMI and body fat percentage (Douglas et al., 2012). Exception of that are riders in race disciplines, were lighter weight has clear evidence to be necessary for successful performance (Wilson et al., 2014). It makes sense that horse of any discipline can perform better carrying lightweight and reduced bodyweight is more favorable to successful equestrian performance. In Iceland, researchers have focused on the horse, his physiological response, gait quality and with attention to the weight of the rider and the effect on performance. Suggesting that increased bodyweight of the rider, has impacts in physiological responses (increased heart rate, lactate, rectal temperature and breathing frequency response) (Stefánsdóttir, Gunnarsson, Roepstorff, Ragnarsson, & Jansson, 2017) and stride parameters and gait quality in horses, to the point of the breeding goals in Icelandic horses (Gunnarsson, Stefánsdóttir, Jansson, & Roepstorff, 2017). Furthermore, suggestions are that rider´s weight, riding style, or both has impact in the pace race, which is very demanding for the horse with anaerobic expenditure efforts (Stefánsdóttir, Gunnarsson, Ragnarsson, et al., 2017).

8.4 Physical fitness

There is need of research related to the importance of human fitness within equestrianism, both leisure riding or training or competition riding. It is complicated to quantify the metabolic demands of equestrianism because of the natural variability in physical responses within various discipline (Douglas et al., 2012) different riding style (e.g. English style, American style, western style or Icelandic style) (Sainas et al., 2016; Schils et al., 1993) and the horse being ridden, different gaits which are ridden and different personalities (some are lazy and have to be urged on while other must be restrained). Few studies available investigated the physiological demands of riding during live competitions (Roberts et al., 2009). Most of them have focused on amateurs and where experienced rider groups are used, the riders are only from dressage and show jumping discipline. Many of these limited studies have also rather focused to date on simulation rather than actual competitive situation, with the majority of the subjects as women with small sample size (Douglas et al., 2012). However there is an apparent consensus from current literature that equestrianism requires physical fitness for the maintenance of rider balance, upper right posture and general effectiveness (Alfredson et al., 1998; Meyers, 2006; Meyers & Sterling, 2000; Roberts et al., 2009; Westerling, 1983). Equestrian sport as skill-based sport requires many hours in the saddle to develop complex skills essential to perform. When training horses the riders focus is on the horse, collecting them, asking to be balanced and be as symmetrically as possible. The attention is on the horse and the skill of horse riding but not on the rider´s physical components. Therefore, the rider can´t develop his physical elements. An off horse program can help the rider to concentrate on improving muscular fitness, cardiovascular fitness, asymmetry, balance, mobility, flexibility and coordination for his physical fitness (Seo, Jung, Song, & Kim, 2015), and can possibly be prevention for injuries (Hitchens, Blizzard, Jones, Day, & Fell, 2011). Comparing riders with others sport athletes, physical fitness of the rider is lower in parameters like to endurance, muscle strength and power. Fat percentage is higher than in other sport athletes but very similar to general population (Halliday, Willmott, & Randle, 2011; Meyers & Sterling, 2000). Earlier literature has claimed that additional unmounted training may benefit for riders and their ridden performance (Devienne & Guezennec, 2000; Meyers & Sterling, 2000; Roberts et al., 2009).

8.4.1 Strength

Main muscular fitness components are maximal strength (isokinetic and dynamic), endurance strength, explosive strength and isokinetic strength (Vanhees et al., 2005). Core stability is also considered a key component for athletes to improve fitness and poor core strength is considered a risk factor for back and lower extremity injury in athletes (Kibler, Press, & Sciascia, 2006). Equestrian researches have indicated that strength and muscular fitness like isometric muscular endurance may together with core stability play a role during horse riding (Terada et al., 2004). Tests used in equestrian disciplines have varied from isokinetic dynamometer for lower body (Alfredson et al., 1998; Westerling, 1983) to push-ups, sits-ups and hand-held dynamometry for grip strength (Meyers, 2006; Meyers & Sterling, 2000). Meyers and Sterling (2000) used a curl-up test, reverse sit-ups test, and push-ups (60sec) and handgrip strength to assess the strength of abdominals, back and arms in 24 female collegiate riders. They concluded that young female riders were on average mean or above average mean values for curl-up, push-up and reverse sit-up compared with normative values for females at specific age, but handgrip strength was lower than established normative values. Similar, Meyers (2006) used a curl-ups, reverse sit-ups or back extensions and push-ups (60sec) to asses muscular endurance in 15 females amateur collegiate riders. At baseline mean values for curl-up were 58.9±4.2/min, for the reverse sit-up 40.1±2.6/min and for the push-up 29.7±2/min. After 14 weeks of equitation intervention no significant improvements were found. However, female riders showed in post-test 11.4% increase in abdominals (curl-up) after the intervention. Alfredson et al (1998), investigated isokinetic concentric and eccentric thigh strength in female riders by using isokinetic dynamometer. This study reported female riders to be stronger than non-actives in quadriceps and hamstring (for eccentric muscle strength). In sports, is the vertical jump test used a lot to evaluate strength/power in the hip, knee and ankle extensors (Ortega et al., 2007). This test also evaluates strength in the gluteal muscles and other muscles in lower body. These muscles play important role in pelvic stability and in “forward” moving, (when the horse and a rider are going forward) (Meyners, 2011), With better pelvic and position stability the rider can have more steady hand while riding, not distracting the horse at different gaits and speed with shaky hands on the rein.

8.4.2 Flexibility and balance

Important physical fitness components necessary for athletic performance and everyday physical activities are flexibility and balance. Flexibility is the ability to move joint through its complete range of motion. Balance is the ability to maintain the whole-body equilibrium with both motor and sensory systems over a period of time (Vanhees et al., 2005). These variables are less investigated within published literature. Thought Hobbs et al. (2014) investigated flexibility in dressage riders using 3-D motion capture technology and a horse model.

Asymmetries, including mobility, range of motion and strength differences in right and left sides, have been recognized as possible factors for injury and correlated with poor performance (Bardenett et al., 2015). It has been reported that riders have tendency to develop asymmetrical postural alignment, which is a negative trait and can lead to injury (Kraft et al., 2009). With increased years of riding or/and at high competitive level many riders increase these asymmetrical posture (Hobbs et al., 2014). All asymmetry and imbalances in the rider´s effects not just himself but also the horses they ride. Symes et al (2009) explored asymmetry in riders position (with large range of riders at competitive level) and found that riders sit with their thoracic spine rotated most commonly to the left, with greater right shoulder displacement in all gaits (walk, trot, canter) showing asymmetry in riders position. In the right canter were chaotic movement patterns in both shoulders whereas in left canter the right shoulder displays significantly more displacement. This axial rotation asymmetry can increase muscle stress and lead to injury and can be explanation for the high percentage of lower back pain of riders (Kraft et al., 2009). Asymmetry in rider´s position and motion patterns may have a significant effect in equestrian sports that require equal ability of the horse and rider to move at the same time in specific movement in both direction, for example in dressage and jumping (Williams & Tabor, 2017). It is suggested that building core stability and flexibility through an exercise program may reduce asymmetry in riders movement and have a positive effect on rider´s health and lead to better and clearer communication to the horse via physical aids in the horse-rider dyad, which leads to better overall performance (Symes & Ellis, 2009). Functional performance tests have not been reported yet for these factors in equitation, but can possibly be made with fundamental movement patterns test like Functional movement screen (FMS) (Cook, Burton, & Hoogenboom, 2006b, 2006a). FMS analyze individual´s set of fundamental movements, in order to determine who possesses or lacks the ability to perform certain essential movements necessary for the engagement in more complex functions. It is comprised of seven tests that require balance, mobility and stability. These tests are deep squat, hurdle step, in line lunge, shoulder mobility, active straight leg raise, trunk stability push-up and rotary stability.

8.5 Psychology of the equestrian sport

Success in sport does not just depends on the physical fitness of the athlete, but rather and not least the psychological characteristics and mental skills. Standardized measurements of the elite´s athlete attitude is used widely over the world to earn statistical information about characteristics and ability. Using statistics to gain competitive advantage has proven to be a great success. It is important to have answers to questions about athlete´s reactions dealing with pressure, his weakness and strength, and if or/and how stress and pressure affect his performance in competition. The results and comparison, provide information about e.g. concentration, self-esteem, stress, self-control, anxiety, motivation, team cohesion and more on of the elite athletes (Wolframm & Micklewright, 2011b). As a result of these tests, it is possible to implement mental skills training program, which is a training on psychological skills and cognition to maximize the effect in performance and success in competition (Blakeslee & Goff, 2007).

Early research evidence suggests an association between psychological skills and sport performance (Morgan & Pollock, 1977; Ogilvie, 1968). Psychological skills includes management in anxiety, emotions, motivation, confidence, team emphases, self-control concentration, abilities to perform under pressure, problem-solving skills and preparation for these mental elements For example these elements are called characteristics of mental toughness, which may be a decisive factor in coping with demands of sport (Madrigal, Gill, & Willse, 2017). Meyers at al. (1996) recognize, the difficulty of matching psychological variables with physiological response. The results have often been controversial since the level of competitive stress and the individual´s ability to cope were found to be directly related to the sport´s type, the position played, as well as the physical/mental ability of the athlete. Now more emphases are placed on identifying psychological skills relevant to the sport. In most traditional sports, both mental and physical ability are dependent only on human decision and response, while equestrian sport disciplines are dependent to large degree on human-equine interaction and collaboration to complete a task successfully (Wolframm, 2014). Previous studies suggest that riders already employ some psychological strategies, which are either inherently possessed or have developed via their personal growth and success in sport (Meyers, Bourgeois, LeUnes, & Murray, 1999; Meyers et al., 1996). It is suggested that riders adopt some psychological skill responses such as anxiety management, concentration, and self-confidence, without any formal mental training program (MST) beforehand, which may be a function of cognitive skills required for human vs animal competition unique to this sport (Blakeslee & Goff, 2007).

Frequently, research in sports has in an attempt to quantify the differences between successful and unsuccessful competitors, tried to distinguish between skill position, event, or gender, to ascertain the effects of training, or to develop a model of the psychological profile supposed necessary for beneficial performance (Raglin, 2001; Taylor, Gould, & Rolo, 2008). Researches in equestrian sport have mostly focused on personality characteristics (Williams & Tabor, 2017), mood and psychological skills in elite and sub elite riders (Meyers et al., 1999) psychological skills in rodeo riders (Meyers et al., 1996), anxiety for competition and sensation seeking (Rainey, Amunategui, Agocs, & Larick, 1992), pre-competitive arousal and riding performance, demonstrating that riders self-confidence and perception of their horse temperament are important factors in the relationship between arousal and performance (Wolframm & Micklewright, 2008). Further two research investigated mental training program (MST) in equestrian riders, employing relaxation, imagery, goal setting, and self-talk (strategies for improving performance and perceptions through cognitive techniques). Results showed more positive effects for non-elite athletes from MST program (Wolframm & Micklewright, 2011) rather than elite effects (Blakeslee & Goff, 2007). Psychological characteristics, such as perseverance, commitment and determination along with mental skills such as imagery, goal setting, arousal, self-talk, self-regulation and thought control have shown to be key factor in performance in sport. These findings seem also to be mirrored in equestrian sports where successful riders also shows greater psychological skills (Wolframm, 2014). Because of the established link between key psychological characteristics and performance outcomes, several self-report instruments have been developed to quantify the fundamental psychological attributes of peak sport performance, like mental toughness, anxiety and mental skills (Sheard, Golby, & van Wersch, 2009; Smith, Smoll, Cumming, & Grossbard, 2006; Thomas, Murphy, & Hardy, 1999). At this time, nothing has been documented in Icelandic equestrian discipline about the psychological skills of Icelandic riders and their relationship to skill performance. Some researchers suggest that psychological skills, like relaxation, self-talk, goal setting and imagery for example, are so crucial that it can predict some outcome in performance but are skills that require practice for proficiency, like other skills (Hall & Martin, 1997). These skills also have significantly correlation with motor skill performance (Annett, 1995), which is efficient in performance for riders and maybe explain the earlier suggestion that riders already employ some psychological characteristics by developing the personality traits needed to succeed in the sport. In conclusion, in many successful training programs you can find measurements of skills like strength, speed, endurance, flexibility and body composition but nothing about assessments of mental skills, even though psychological skills are considered fit to enhance predictions of athletic potential in sports.

9 Objectives

For any teams to be successful, many things need to fall into place. The same goes for national teams and elite groups – how to be successful and improve performance? There is no sure winning formula, but there are factors that contribute, clearly, to the success in sports. Athletes, including riders need some physical fitness and mentality to excel in competition and training. Now more emphasis is also being placed on the importance of rider’s fitness in order to improve athletic performance at the international level. Important knowledge about elite rider’s physical fitness and psychological skills in Iceland is necessary, to find out where they stand in physical health and fitness and to gain data for comparison going forward. Equestrian sports are very different from other sports with regards to physical fitness, physical emphasis and kinetic and motion patterns of the athlete, not least because of the horse-rider dyad, and is therefore not ease to compare with other sports. No research has been done here in Iceland on rider's physical fitness nor on psychological skills. It is essential to know more and quantify the physical condition and cognitive skills of top riders in equestrian sports in Iceland, and maybe later compare that to other sports for reference.

In this context the objectives of this master thesis were:

- i) To analyze the anthropometry, physical fitness, and psychological skills in function to age group and sex in elite Icelandic horse-riders.
- ii) To know the relationship between anthropometry, physical fitness, and psychological skills in elite Icelandic horse-riders.

10 Methods

10.1 Study design

This is a descriptive cross-sectional analysis in a collaboration with The Icelandic Equestrian Association over a two years period. In this study the dependent variables were, the age group (A team/U-21) and sex (male/female). The independent variables were anthropometry parameters, physical fitness parameters and psychological parameters, they are outlined in table 2.

Table 2. The tests used in this study for anthropometry-, physicals- and psychological parameters

1. Anthropometry
   a) Height
   b) Weight
   c) Body max index (BMI)
2. Physical fitness
   a) Muscular strength
      I. Hand dynamometry
      II. Push-up (30s)
      III. Sit-up (30s)
   b) Power
      I. Counter movement jump (CMJ)
   c) Mobility and stability during functional movement
      I. Functional movement screen (FMS)
3. Psychological skills
   I. Test pf performance strategies (TOPS)
   II. Sport anxiety scale-2 (SAS-2)
   III. Sport mental toughness (SMTQ)

10.2 Participants

Thirty-one horse riders participated in this study. The participants were distributed in two groups the A team (adults) and the U-21 team (youth) in function to age and sex.

Table 3. Number of males, females and total participants and their year of birth

Team	Total (n)	Male (n)	Female (n)	Year of birth	(M±SD) (years)
A	17	15	2	1971-1998	35.8±10.24
U-21	14	5	9	1998-2002	18.7±1.67

A = A national team; U-21 = under 21 years old

Written informed consent was obtained from all riders or their parents or legal guardians if they were under 18 years. The participants are all very active in their sport. In the A team all the riders are professional riders, they all make a living from riding, training and competing. In the group of U-21 team, they either work with horses, or are attending school and train horses together with it.

10.3 Procedures

10.3.1 Location and testing frequency

The data for physical components was collected in the period from February 2018 to November 2018. Overall the group of U-21 team performed three testing session, with 3-4 months between each session. The measurements were a part of a weekend long training camp, were they all met and took lessons with the coach on their horses. Session one was during the pre-season in February and took a place in a gymnasium in Valshúsinu. Session two was during the high-season in June and took a place in the gymnasium in Kórinn. Session three was in November during the post-season and took a place in a gymnasium at Sauðárkrókur. The A national team performed one testing session. These participants live in various places around Iceland, no special training camp or meetings are with this group so specific meeting was arranged to have them measured in July, in the middle of highly competitive season. The measurement took a place in a saloon in the equestrian club named Sprettur.

The riders completed a battery of three questionnaires, collected in July 2017 and in November 2018. The questionnaires were presented in Icelandic version. The questionnaires were available on the internet in closed group for the participants where they were encouraged to answer all questions to the best of their ability.

Results from the first testing session was used as independent variable for analysis. After each testing session the coach got general report for each team, with results from each test for each rider and mean and standard deviation for the group. The riders were also able to have report with results from their own performance. Table two shows the measurements date sessions.

Table 4. Dates of testing sessions.

Team	Physicals-Session 1	Physicals-Session 2	Physicals-Session 3	Psychological-
A	02/07/2018			19/07/2017

U-21	09/02/2018	23/06/2018	03/11/2018	03/11/2018

A= The A team; U-21=Under 21 years old

10.3.2 Sessions procedure

In the beginning of session all participants received a number, with instruction to maintain or remember their numerical order throughout the measurement session. The group assistants were informed how to perform and explain each measurement for participants. Motivation for all measurement was allowed for all sessions. In the beginning was the basic anthropometry (height/weight) and grip strength measured. When all participants had finished they warmed up for 7-10 min. The warm-up was the same in each measurement session, comprised off ten physical practice which were considered practical, rise the heartbeat enough and prepare the participants for the following tests. After the warm-up the participants were divided into four groups starting on strength tests (push-up, sit-up), power test (CMJ) and FMS tests. Each session took around 2.5-3h. In the next section are all measurements reviewed and each measurement described and detailed.

10.4 Anthropometry

10.4.1 Height (m), Weight (kg)

Reference: ISAK (2001)

Objective: To evaluate anthropometry values of all riders. For the physical health status.

Test Procedure: Height were measured of all riders using the height and weight scale. The rider wears light clothing and takes the shoes off before stepping up on the scale.

Equipment: Seca scale 220

Score: Meter^2/kilogram

10.4.2 Body max index (BMI)

Reference: Keys and Brozek (1953).

Objective: To evaluate body max index for all riders. To evaluate the relationship between height and weight, for the physical health status.

Test Procedure: Body max index (BMI) was then calculated for each rider in excel file based on the formula: BMI = weight in kilograms (kg) / height in meters^2 (m^2).

Equipment: Computer and excel file

Score: BMI (kg/m^2)

10.5 Physical fitness

10.5.1 Muscular strength

10.5.1.1 Hand dynamometry

Reference: Mathiowetz (2002).

Objective: To evaluate maximal voluntary isometric force of dominant and non-dominant handgrip muscle. Handgrip strength test is simple, quick to assess and the reliability and validity of this method have been confirmed (Mathiowetz, 2002).

Test Procedure: The rider is sitting on a chair, back against the backrest, elbow 90°flexed. The rider holds the dynamometer first with dominant hand and then with the other one. In this position, the rider is asked to exert maximal grip strength without arm or wrist movement.

Equipment: A laptop connected with hand-dynamometer is used to measure the strength with a program named logger lite.

*Score: N*ewton (best try)

10.5.1.2 Push up in 30s

Reference: Baumgartner et al. (2002)

Objective: To evaluate arm, shoulder strength and core stability. It´s easily learned exercise, quick to assess and to perform and can be done everywhere, and it requires minimal equipment and is adaptable depending on the population of athletes.

Test Procedure: When performing the push-up test, the rider starts in the “up” position with the arm straight and only the hands and the toes touching the floor. Hands on either side of the chest and the back is straight. Then the rider lowers the body down towards the floor, until his/her elbows are in 90°, then raises it to an up position. Throughout the performing the body is supposed to be kept straight. If the rider can’t do it on toes, then he/she can “bent knee” and kneel on the floor. For the push up to count, the rider´s chest must touch the fists of the partner. The test starts when the stopwatch is on, the rider does as many as possible in 30s.

Equipment: stopwatch and mattress

Score: Repetitions

10.5.1.3 Sits up in 30s

Reference: Thompson et al. (2013)

Objective: To evaluate strength and endurance in abdominal muscles and flexibility in hips. Evaluated because of the importance of core stability, back support, upper body position and hip flexor muscles. It´s easy to learn and quick to assess and to perform and can be done everywhere with no requirement for equipment.

Test Procedure: Were the rider lies on the floor with the knees bent at approximately right angles, with feet flat on the ground. Arms are folded over chest. A partner may assist by putting hands light on rider’s knees. The rider performs trunk flexion until the rider’s elbows touch the partners´ hand on his/her knee. The test starts when the stopwatch is on, the rider performs as many as possible in 30s

Equipment: stopwatch and mattress

Score: Repetitions

10.5.2 Power

10.5.2.1 Counter movement jump (CMJ) (without arm movement)

Reference: Bosco et al. (1983)

Objective: To evaluate power in the hip, knee and ankle extensors. The countermovement jump (CMJ) is a simple, practical, valid, and very reliable measure of lower body power.

Test Procedure: The rider starts with the shoulder-width between their feet and their hands on the hips, standing on a vertical jump mat. From a stationary position, the rider bends down to 90°flexion in the knees and then jump as high as possible with countermovement, two times in a row. Hands should remain on the hips the entire jump and the knees can't be flexed at any time when the player is in the air.

Equipment: Vertical jumping mat.

Score: Centimeters (best try)

10.5.3 Flexibility and balance during functional movement

10.5.3.1 Functional movement screen (FMS)

Reference: (Cook et al., 2006a, 2006b)

Objective: To evaluate rider´s set of fundamental movements, in order to determine individuals possesses or lack of ability to perform certain essential movements. The FMS aims to identify imbalances in mobility and stability during functional movements.

Test Procedure: The FMS is composed of 7 different tests of fundamental movement: All 7 tests are described in next sections.

Equipment: Functional movement screen equipment.

Score: (I - II – II) (III being the best score and I lowest).

10.5.3.2 Deep squat:

Objective: to evaluate bilateral, symmetrical functional mobility of the hips, knees and ankles. The dowel is places overhead evaluates the bilateral, symmetrical functional mobility of the shoulders as well as thoracic spine.

Test procedure: The starting position is with the feet placed approximately at shoulder width apart with feet aligned in sagittal plan. The hands are holding the dowel placed overhead in a 90degree angle, then pressed up with shoulder extended. The rider is asked to descent slowly into a squat position like seen in anterior view in figure 1and lateral view in figure 2. It criteria of score of III is not achieved, the rider is asked to perform the test with a 2x6 block under their heels, like seen in anterior view in figure 3 (Cook et al., 2006a).

Figure 1. Anterior view (III)

Figure 2. Lateral view (III)

Figure 3. Anterior view (II*)*

Figure 4. Anterior view (I)

Score of III

- Upper torso is parallel with tibia or toward vertical.
- Femur below horizontal
- Knees are aligned over feet
- Dowel aligned over feet

Score of II

- Upper torso is parallel with tibia or toward vertical
- Femur is below horizontal
- Knees are aligned over feet
- Dowel are aligned over feet
  2x6 board is required

Score of I

- Tibia and upper torso are not parallel
- Femur is not below horizontal
- Knees are not aligned over feet
- Lumbar flexion is noted
  2x6 board required

Figures 1,2,3 and 4 from Cook et al. (2006a)

10.5.3.3 Hurdle step

Objective: To evaluate bilateral, symmetrical functional mobility of the hips, knees and ankles. The dowel is places overhead evaluates the bilateral, symmetrical functional mobility of the shoulders as well as thoracic spine.

Test procedure: The rider´s starting position is with his/her feet together. The toes touch the base of the hurdle and the high of rider´s tibial tuberosity is adjusted to it. The dowel is placed across the shoulders. The rider is asked to step over the hurdle and touch the floor with the heel, while maintaining the stance and the balance. Then returning the moving leg to starting position. The rider has up to three times to perform it bilaterally (Cook, Burton, & Hoogenboom, 2006a).


Figure 5. Anterior view (III)


Figure 6. Lateral view (III)


Figure 7. Anterior view (II)


Figure 8. Anterior view (I)

Score of III
- Hip knee and ankles remain in the sagittal plan
- Minimal to no movements in lumbar spine
- Dowel and string remain parallel

Score of III
- Alignment is lost between the hips, knees and ankles
- Movement is noted in lumbar spine
- Dowel and string do not remain parallel

Score of III
- Contact between foot and string occurs
- Loss of balance is noted

Figures 5,6,7 and 8 from Cook et al. (2006a)

10.5.3.4 Inline lunge

Objective: to evaluate hip and ankle mobility and stability, quadriceps flexibility, and knee stability.

Test procedure: The tibia tuberosity length of the rider is measured (like in hurdle step test). The tibia length is marking the line, the line is between the top of the toes to end of the heels. The riders are stepping on the board and locates the toes of the behind foot at mark line. The opposite foot (end of the heel) is located at the earlier indicated mark. The dowel is place behind the back, touching the head, thoracic spine, and sacrum. The hand opposite to the front foot is grasping the dowel at the cervical spine. The other hand is grasping the dowel at the lumbar spine the position is seen in picture 9 and 10. The rider lowers the back knee enough to touch the surface behind the heel of the front foot and then returns to the starting position. The rider has up to three times to perform it bilaterally (Cook et al., 2006a).

Figure 9. Anterior view (III)

Figure 10. Lateral view (III)

Figure 11. Lateral view (II)

Figure 12. Anterior view (I)

Score of III

- Dowel contacts remain with lumbar spine extension
- No torso movement is noted
- Dowel and feet remain in sagittal plane
- Knee touches board behind heel of front foot.

Score of II

- Dowel contacts remain with lumbar spine
- Movements is noted in torso
- Dowel and feet remain in sagittal plane
- Knee touches board behind heel of front foot

Score of I

- Loss of balance is noted

Figures 9,10,11 and 12 from Cook et al. (2006a)

10.5.3.5 Shoulder mobility

Objective: To evaluate bilateral shoulder range of motion, combining internal rotation with adduction and external rotation with abduction. There are also require for normal scapular mobility and thoracic spine extension.

Test procedure: The hand length is measured, the distance from the wrist crease to the tip of the third digit using the dowel. The riders make a fist with each hand and place the thumb inside the fist. Then he/she assume a maximal adducted, extended, and internal rotated position with one shoulder and a greatly abducted, flexed, and externally rotated position with the other. The distance between the closest bony distance prominences, like seen in figure 13 and 14. The rider has up to three times to perform it bilaterally. The shoulder clearing test is shown in table 16. This test is done after the shoulder mobility test. The hand is placed on the opposite shoulder and then attempts to point the elbow upward. If the rider feels any pain the score of zero is given to the shoulder mobility test (Cook, Burton, & Hoogenboom, 2006b).

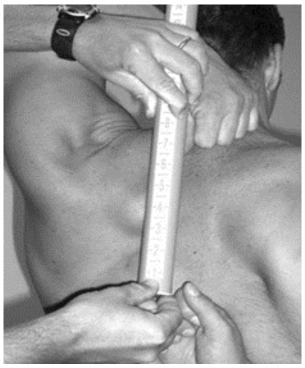

Figure 13. Backward view (III)

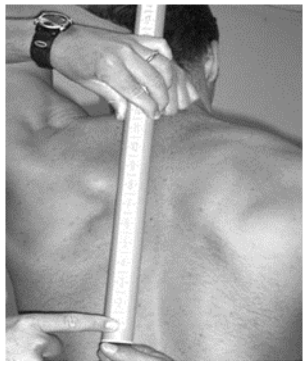

Figure 14. Backward view (II)

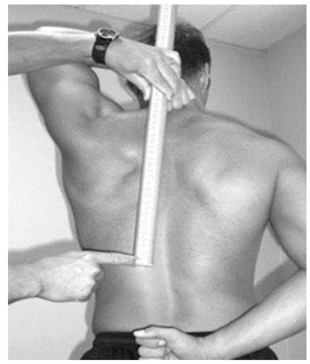

Figure 15. Backward view (I)

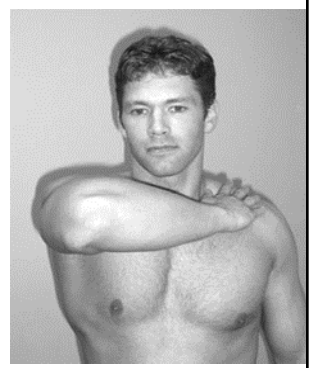

Figure 16. Shoulder clearing test

Score III
- Fists are within one hand length (Assume one hand length)

Score II
- Fists are within one and a half hand lengths (Assume one and half hand lengths)

Score I
- Fists are not within one and half hand lengths.

Figures 13,14,15 and 16 from Cook et al. (2006b)

10.5.3.6 Active straight leg raises

Objective: To evaluate active hamstring and Gastroc-Soleus flexibility of the opposite leg.

Test procedure: The rider lies in starting position with arms in an anatomical position and head flat on the floor. The dowel is located between the rider´s anterior superior iliac spine and patella, at mid-point. Then he/she lift the test leg with dorsi-flexed ankle and extended knee. The rider has up to three times to perform it bilaterally. The opposite side is flat on the ground while performing (Cook et al., 2006b). (Figures 17-19).

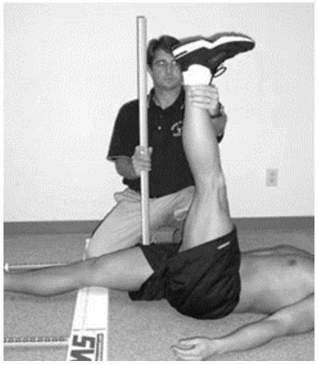

Figure 17.Lateral view (III)

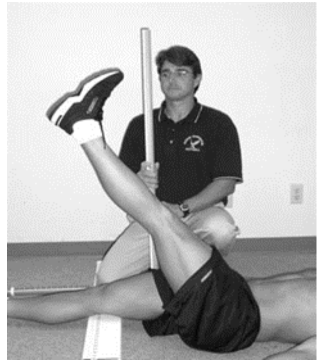

Figure 18. Lateral view (II)

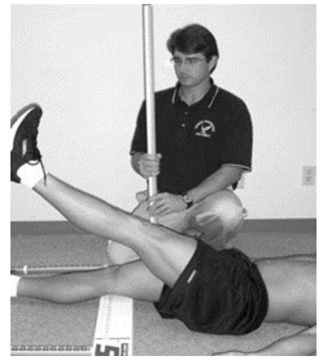

Figure 19.Lateral view (I)

- Ankle/Dowel resides between mid-thigh and ASIS
- Ankle/Dowel resides between mid-thigh and mid-patella/joint line
- Ankle/Dowel resides below mid-thigh and mid-patella/joint line

Figures 17,18,19 and 20 from Cook et al. (2006b)

10.5.3.7 Trunk stability

Objective: To evaluate the trunk stability in the sagittal plane while a symmetrical upper-extremity motion is performed.

Test procedure: The rider undertakes a prone position with feet together. The hands are located shoulder width apart. The knees are extended while the ankle is dorsi-flexed. The rider performs one push up in this position. The body should be lifted as one unit. The spinal extension test is shown in figure 23. This test is done after the trunk stability test. The rider performs a press up in the push up position. If pain is noted with this position a zero is given to trunk stability test. The rider has up to three times to perform it bilaterally (Cook et al., 2006b).

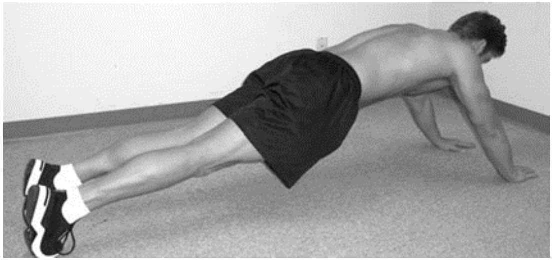

Figure 20.Backward view (III) (male)

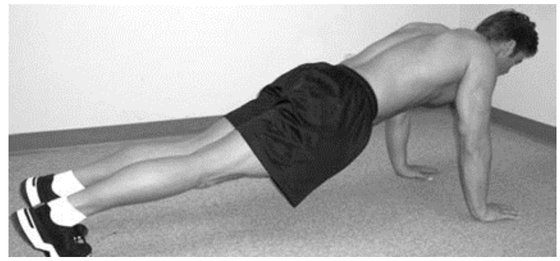

Figure 21.Backward view (II) (male)

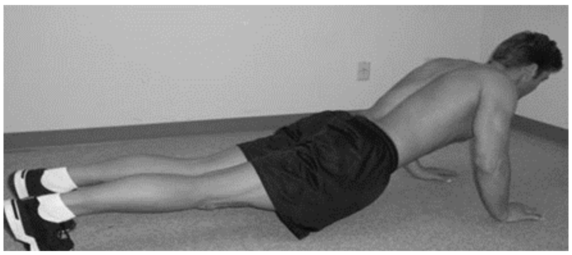

Figure 22. Backward view (I) (male)

Figure 23. Spinal extension clearing test

Score III

- Males perform one repetition with thumbs aligned with the top of the forehead
- Females perform one repetition with thumbs aligned with chin

Score II

- Males perform one repetition with thumbs aligned with chin
- Females perform one repetition with thumbs aligned with clavicle

Score I

- Males are unable to perform one repetition with hands aligned with chin
- Females are unable to perform one repetition with thumbs aligned with clavicle

Figures 20, 21, 22 and 23 from Cook et al. (2006b)

10.5.3.8 Rotary stability

Objective: To evaluate multi plane trunk stability during upper and lower extremity motion.

Test procedure: The rider starts in quadruped position with shoulders and hips at 90 degrees relative to the torso. Knees are at 90 degrees and the ankle are dorsi-flexed. The riders flex the shoulder and extend the same hip and knee. Then the leg and hand raise enough to clear the floor, like figure 25 shows. The same shoulder is then extended while the knee is flexed, the knee and elbow should touch like seen in figure 24. The rider has up to three times to perform it bilaterally. If this is not achieved then the rider performs a diagonal pattern using the opposite hip and shoulder in the same manner, like seen in figure 26 and 27 (Cook et al., 2006b). Figure 29 shows the spinal flexion clearing test. If the rider feel pain in that test the score of zero is given in rotary stab test.

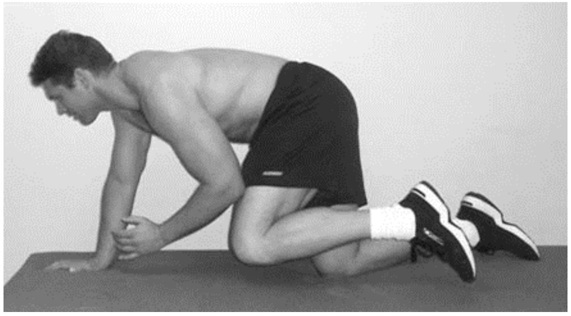

Figure 24. Rotary stab start (III)

Figure 25. Rotary stab finish (III)

Score of III

- Performs one correct unilateral repetition while keeping spine parallel to surface
- Knee and elbow touch

Figures 24 and 25 from Cook et al. (2006b)

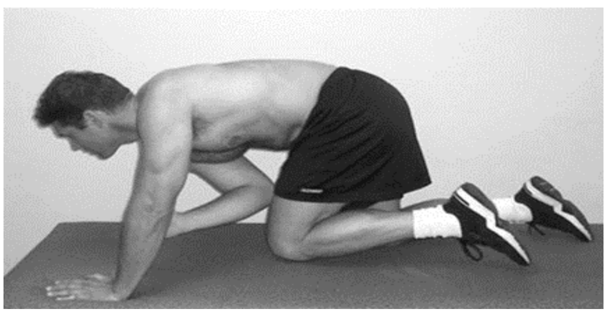

Figure 26.rotary stab start (II)

Figure 27. Rotary stab (II)

Figure 28. Rotary stab start (I)

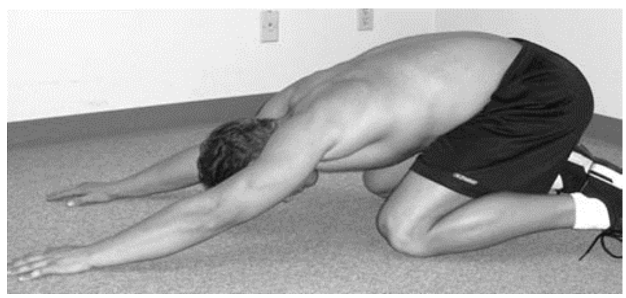

Figure 29. Spinal flexion clearing test

Score of II

- Performs one correct diagonal repetition while keeping spine parallel to surface
- Knee and elbow touch

Score of I

- Inability to performe diagonal repetions

Figures 26, 27,28 and 29 from Cook et al. (2006b)

10.6 Psychological skills

10.6.1 Test of performance strategies (TOPS)

Reference: Thomas et al. (1999)

*Objective: T*o evaluate psychological skills Test of performance strategies was implemented. It´s a self-report which evaluate rider´s use of psychological skills at practice and in competition. The list contains 64 items, divided in to seven subscales that belong to both the competition and the training environment. These skills are goalsetting, relaxation, self-talk, imagery, activation, attentional control, emotional control and automaticity measured at practice but negative thinking is measured rather than attentional control in competition (Hardy, Roberts, Thomas, & Murphy, 2010). When responding to the list, the athlete answers how often certain situations occur during training or in a competition (never, rarely, sometimes, often, always).

Test Procedure: Online, through computer or smartphone.

Equipment: Computer or smartphone.

Score: The total score for each subscale is calculated for both practice and competition environment. The score can be in range of 1-5 for each scale. Higher score means better use of psychological skills either at practice or in competition.

10.6.2 Sport anxiety Scale-2 (SAS-2)

Reference: Smith et al. (2006)

Objective: To evaluate competition anxiety in athletes was the Sport Anxiety Scale-2 implemented. It´s a self-report which evaluate cognitive and somatic trait anxiety before or during the competition. When responding to the list, the athlete evaluates how well certain statements apply to him; not at all, a little bit, pretty much, very much. The list distinguishes between three anxiety factors such as somatic anxiety, worries, and concentration disruption, subscales of SAS. Performance trait anxiety is considered as a tendency to experience high anxiety states under conditions of threat. Thus, an athlete who is high in trait anxiety would probable experience high levels of somatic arousal, worry, and/or concentration disruption when it comes in stressful competitive sport situations. SAS-2 has been proven to be useful to researchers in a variety of sport contexts and appears to be a reliable and valid measure of cognitive and somatic sport performance anxiety (Smith et al., 2006).

Test Procedure: Online, through computer or smartphone.

Equipment: Computer or smartphone.

Score: Total score can range from 15-60 and from 5-20 for subscales. Higher score means more anxiety and worries.

10.6.3 Sports Mental Toughness Questionnaire (SMTQ)

Reference: Sheard et al. (2009)

Objective: To evaluate mental toughness Sports Mental Toughness Questionnaire (SMTQ) was implemented. It´s a self-report which evaluate three factors, confidence, constancy and control in competitions, the 14 item-model for the SMTQ. Scores is on a five-point Likert scale ranging from strongly agree to strongly disagree, with an average completion time of 10 to 15 min. Studies has recognized “mental toughness” as a crucial attribute for success in competitive sport and the development of really successful sport performers, champions performance. (Sheard et al., 2009).

Test Procedure: Online, through computer or smartphone.

Equipment: Computer or smartphone.

Score: The total score is 24 in confidence and 16 in constancy and control.

10.7 Statistical analysis

The basic descriptive statistics (mean and standard deviation) were calculated. A 1-way analysis of variance (ANOVA) was used to examine difference between teams (A team/U-21) and sex (male/female). Subjects were classified into two groups according to their performance level (A team/U-21) and sex (female/male). Finally, Pearson simple correlation coefficients were calculated between each of the variables. The values of this statistics were assigned linguistic labels: >0.1 small, >0.3 moderate, >0.5 large, >0.7 very large, and > 0.9 nearly perfect (Hopkins, Marshall, Batterham, & Hanin, 2009). The level of significant for all statistical tests was set at $p \leq 0.05$. All calculations were performed using SPSS version 25.

11 Results

11.1 Age difference

Table 5 shows the mean and standard deviation of anthropometry, physical fitness and psychological parameters in function of age group. Also, the F, p-values and ES is shown. There were differences in the following variables; weight, BMI, handgrip strength right, handgrip strength left and sit up.

Table 5. Basic descriptors (mean and standard deviation) of anthropometric and physical fitness parameters (one-way analysis of variance), p-value, and the effect sizes (ES) of the differences (Cohen's d) between age group

Variable	Adults/A team (n=13)	Youth/ U21 (n=14)			
	M±SD	M±SD	F	p	ES
Anthropometry					
Height (cm)	177.3±5.9	173.7±6.1	0.028	0.139	0.60
Weight (kg)	80.0±10.0	70.0±10.0	0.186	**0.016**	1.00
BMI (kg/m^2)	25.3±2.2	23.1±3.3	1.797	**0.048**	0.79
Physical fitness					
Handgrip right (N)	424.6±74.5	270.3±54.7	1.016	**<0.001**	2.36
Handgrip left (N)	404.5±75.2	254.2±56.2	1.202	**<0.001**	2.26
Push up (repetition)	21.8±6.4	21.5±7.2	0.008	0.909	0.04
Sit up (repetition)	12.2±4.2	18.7±3.4	0.322	**<0.001**	1.70
CMJ (cm)	29.0±5.5	24.9±4.9	1.154	0.058	0.79
FMS	14.3±2.7	15.6±2.3	0.381	0.225	0.51

BMI= Body max Index; CMJ= Counter movement jump; FMS= Functional movement screen;

Table 6 shows the mean and standard deviation of psychological parameters in function of age group. Also, the F, p-values and ES is shown. There were differences in the following variables; goal setting and relaxation (practice scale), automaticity, imagery (competition scale).

Table 6. Basic descriptors (mean and standard deviation) of psychological skills parameters (one-way analysis of variance), p-value, and the effect sizes (ES) of the differences (Cohen's d) between age group

Psychological skills	Adults/A team (n=17)	Youth/ U21 (n=13)	F	p	ES
	M±SD	M±SD			
Tops Practice					
Goal setting	2.29±0.87	4.17±0.52	6.711	**<0.001**	2.62
Relaxation	3.59±0.43	2.71±0.68	5.034	**<0.001**	2.62
Automaticity	3.22±0.75	3.33±0.47	2.375	0.135	0.18
Activation	3.31±0.87	3.36±0.63	0.737	0.398	0.06
Imagery	3.80±0.77	3.78±0.80	0.068	0.796	0.02
Self-talk	3.85±0.49	3.61±0.75	4.119	0.052	0.38
Emotional control	3.79±0.76	3.42±0.64	0.534	0.471	0.53
Attentional control	3.85±0.49	3.71±0.65	1.161	0.291	0.24
Total score	27.17±4.35	26.48±8.07	0.555	0.462	0.11
Tops Competition					
Goal setting	3.85±.0.72	4.34±0.55	0.479	0.495	0.76
Relaxation	4.16±0.56	3.57±0.42	0.845	0.366	1.19
Automaticity	4.28±0.62	2.70±0.41	2.602	**<0.001**	3.00
Activation	3.71±0.58	4.36±0.62	0.051	0.823	1.08
Imagery	2.96±1.04	4.00±0.65	5.780	**0.004**	1.19
Self-talk	4.00±0.68	3.44±0.81	0.263	0.612	0.74
Emotional control	3.31±0.67	3.56±0.53	0.384	0.541	0.41
Negative thinking	3.37±0.65	4.11±0.54	0.853	0.364	1.24
Total score	28.81±4.61	28.48±8.02	0.275	0.604	0.05

TOPS= Test and performance strategies

Table 7 shows the mean and standard deviation of psychological parameters in function of age group. Also, the F, p-values and ES is shown. No differences were found between the two teams in mental toughness nor anxiety.

Table 7. Basic descriptors (mean and standard deviation) of psychological skills parameters (one-way analysis of variance), p-value, and the effect sizes (ES) of the differences (Cohen's d) between age group

Psychological skills	Adults/A team (n=17)	Youth/ U21 (n=13)			
	M±SD	M±SD	F	p	ES
SMTQ					
Confidence	15.53±3.24	12.61±5.45	3.883	0.059	0.65
Constancy	14.29±1.36	13.58±3.50	1.117	0.300	0.27
Control	13.71±1.76	12.00±3.74	3.573	0.070	0.58
Total	43.53±4.45	38.5±12.36	3.968	0.057	0.54
SAS-2					
Somatic anxiety	8.11±2.15	9.07±1.32	0.909	0.348	0.54
Worry	6.59±2.06	9.69±3.45	0.205	0.654	1.09
Concentration disruption	6.29±1.83	6.31±1.97	0.014	0.908	0.01
Total	20.53±5.19	25.07±5.83	0.023	0.881	0.82

SMTQ= Sports mental toughness Questionnaire; SAS-2= Sport anxiety scale-2

11.2 Sex difference

Table 8 shows the mean and standard deviation of anthropometry, physical fitness and psychological parameters in function of sex. Also, the F, p-values and ES is shown. There were differences in the following variables; height, weight, handgrip strength right, handgrip strength left, CMJ.

Table 8. Basic descriptors (mean and standard deviation) of anthropometric parameters, physical fitness parameters and psychological skills (one-way analysis of variance), p-value, and the effect sizes (ES) of the differences (Cohen's d) between sexes.

Variable	Males (n=18)	Females (n=12)			
	M±SD	M±SD	F	p	ES
Anthropometry					
Height (cm)	178.5±4.8	171.0±5.1	0.047	**0.001**	1.52
Weight (kg)	80.0±10.5	67.3±7.0	2.802	**0.002**	1.42
BMI (kg/m^2)	25.0±3.01	23.0±2.7	0.962	0.103	0.70
Physical fitness					
Handgrip R (N)	402.6±79.2	260.2±63.2	1.766	**<0.001**	1.98
Handgrip L (N)	386.5±77.6	239.4±55.0	2.996	**<0.001**	2.18
Push up (repetition)	22.5±7.6	20.6±5.3	1.838	0.465	0.30
Sit up (repetition)	13.9±5.2	17.7±3.9	0.230	0.056	0.82
CMJ (cm)	29.5±5.2	23.5±3.9	1.708	**0.004**	1.29
FMS	14.5±2.4	15.7±2.64	0.556	0.219	0.48

BMI= Body max Index; CMJ= Counter movement jump; FMS= Functional movement screen.

Table 9 shows the mean and standard deviation of psychological parameters in function of sex. Also, the F, p-values and ES is shown. There were differences in the following variable; goal setting (practice scale), automaticity, activation, imagery (competition scale).

Table 9. Basic descriptors (mean and standard deviation) of psychological skills (one-way analysis of variance), p-value, and the effect sizes (ES) of the differences (Cohen's d) between sexes.

Psychological skills	Males (n=18)	Females (n=12)			
	M±SD	M±SD	F	p	ES
Tops Practice					
Goal setting	2.61±.1.02	3.85±1.07	0.218	**0.003**	1.19
Relaxation	3.31±0.70	3.06±0.70	0.002	0.963	0.36
Automaticity	3.33±0.66	3.16±0.62	0.001	0.972	0.26
Activation	3.43±0.72	3.19±0.83	0.104	0.749	0.30
Imagery	3.67±0.70	3.98±0.86	0.792	0.381	0.39
Self-talk	3.75±0.49	3.75±0.79	5.670	1.000	0.06
Emotional control	3.64±.0.74	3.62±0.75	0.043	0.838	0.02
Attentional control	3.65±0.57	4.00±.0.50	0.289	0.595	0.65
Total score	25.70±7.31	28.63±3.28	1.021	0.321	0.52
Tops Competition					
Goal setting	3.82±.0.67	4.44±0.56	0.123	0.729	1.00
Relaxation	4.01±0.59	3.75±0.54	0.471	0.498	0.46
Automaticity	4.13±0.71	2.80±0.66	1.124	**<0.001**	1.94
Activation	3.72±.0.64	4.40±0.53	0.601	**0.005**	1.15
Imagery	3.10±0.97	3.88±0.96	0.647	**0.039**	0.80
Self-talk	3.81±0.63	3.68±0.99	5.584	1.000	0.22
Emotional control	3.36±0.57	3.51±0.71	0.722	0.403	0.23
Negative thinking	3.44±0.53	4.08±0.78	0.220	0.642	0.96
Total score	27.71±7.53	30.11±3.12	1.316	0.261	0.42

TOPS= Test and performance strategies

Table 10 shows the mean and standard deviation of psychological parameters in function of sex. Also, the F, p-values and ES is shown. No differences were found between the sexes in mental toughness nor anxiety

Table 10. Basic descriptors (mean and standard deviation) of psychological skills parameters (one-way analysis of variance), p-value, and the effect sizes (ES) of the differences (Cohen's d) between age group

Psychological skills	Males (n=18)	Females (n=12)			
	M±SD	M±SD	F	p	ES
SMTQ					
Confidence	15.50±3.31	14.50±3.63	0.024	0.878	0.28
Constancy	14.13±1.31	14.75±1.14	0.726	0.402	0.50
Control	13.94±1.69	12.58±2.43	2.708	0.112	0.65
Total	43.56±4.58	41.83±5.28	0.501	0.485	0.35
SAS-2					
Somatic anxiety	8.5±1.69	8.58±2.19	0.562	0.460	0.04
Worry	7.22±2.16	9.00±4.04	1.060	0.312	0.55
Concentration disruption	6.55±1.94	5.91±1.73	2.178	0.151	0.35
Total	21.83±4.86	23.50±6.91	0.174	0.680	0.29

SMTQ= Sports mental toughness Questionnaire; SAS-2= Sport anxiety scale-2

11.3 Relationship between variables

Table 7 shows the correlation between variables. The pair of variables with the biggest correlation (r = 0.600; p<0.01) are; Weight and handgrip right; weight and handgrip left; weight and sit ups; BMI and sit ups; handgrip right and handgrip left; handgrip right and sit up; handgrip left and sit up; FMS and SAS-2.

Table 11. Pearson linear correlation for each variable

	1	2	3	4	5	6	7	8	9	10	11	12	13
Height (1)	1												
Weight (2)	**0.554****	1											
BMI (3)	0.118	**0.88****	1										
Handgrip R (4)	**0.551****	**0.698****	**0.553****	1									
Handgrip L (5)	**0.564****	**0.674****	**0.491****	**0.931****	1								
CMJ (6)	0.213	0.078	-0.057	0.322	**0.402***	1							
Push up (7)	-0.022	-0.027	-0.018	0.051	0.113	**0.474***	1						
Sit up (8)	-0.178	**-0.617****	**-0.620****	**-0.723****	**-0.641****	-0.024	0.115	1					
FMS (9)	**-0.390***	**-0.460***	-0.365	-0.358	-0.329	0.209	0.233	0.250	1				
TOPS com (10)	-0.163	-0.56	0.018	0.145	0.091	-0.274	0.585**	-0.243	-0.117	1			
TOPS prac (11)	-0.192	-458*	-0.430*	-0.382	-0.427*	-0.180	-0.146	0.561**	0.044	0.055	1		
SAS-2 (12)	-.0.155	-0.288	-0.306	-0.382	-0.292	0.330	0.246	0.377	**0.618****	-0.52	-0.259	1	
SMTQ (13)	-0.021	-0.187	-0.236	-0.237	-0.187	-0.258	-0.548**	-0.312	-0.248	0.146	0.735**	**-0.492****	1

*p< 0.05
**p< 0.01

12 Discussion

This study has analyzed the anthropometry, physical fitness and the psychological skills of both elite groups of Icelandic riders in function to age and sex difference and the relationship between the variables in attempt to explain the characteristics of the equestrian sport.

12.1 Differences in function to age

In this study a difference was found for basic anthropometry parameters between riders in the A team and U-21 team. The riders in the A team were heavier than the riders in U-21 team (ES:1.00; p = 0.016), seen in table 5. No direct comparison has been done between riders in other studies however previous studies have reported values for height, weight and BMI. For example, Hobbs et al (2014) reported (67.1±12.8kg) in 134 dressage riders, Meyers et al (2000) reported (64.9±9.3kg) in 24 female collegiate riders while Sainas et al (2016) reported (53.3±11.7kg) in advanced riders (combined of both males and females) and Wilson et al (2014) reported (51±1.5kg) in 20 professional male riders in race competition. It seems that Icelandic riders are heavier than riders in other disciplines. Body max index (BMI) was also greater in the A team than in U-21 team (ES: 0.79; p = 0.048), seen in table 5. Previous studies have shown similar BMI in dressage and female collegiate riders (Hobbs et al., 2014; Meyers & Sterling, 2000) while others have report lower BMI (21.7±1.9 kg/m^2) in novice female riders (Roberts et al., 2009) and male race riders (20±1.0 kg/m^2) (Wilson et al., 2014). In conclusion, Icelandic riders seem to be heavier than riders in other disciplines but with similar BMI values except from race jockeys. Some earlier studies have reported that riders are average or over average for BMI value, but compared to athletes in e.g. tennis, triathlon or volleyball, the average BMI values are similar (ranging from 20-24 kg/m^2) (Santos et al., 2014).

With regards to physical fitness, a difference was found in three out of six variables. The A team were stronger in the right hand than U-21 (ES: 0.60; p = < 0.001), seen in table 5. The A team were also stronger in the left hand (404.5±75.2N) than U21 (254.2±56.2N), seen in table 5. Generally, this results are in line with previous studies that show increases in grip strength with higher age and the peak will be around 30-40 years old (Massy-Westropp et al., 2011). In equestrian studies, Westerling (1983) did a comparison in static muscle strength between riders (403N) and a control group (411N) but with no significant difference between groups reported. Studies have done comparison between right and left hand in riders to quantify physical response, reporting right grips strength (283.4N) and the left grip strength (261.8N) in 24 collegiate female riders (Meyers & Sterling, 2000). Other have done a comparison between right and left hand in riders when searching for dynamical asymmetry at different competition level, reporting the dominant hand stronger than the left one (Hobbs et al., 2014). Further, Meyers et al (2006) investigated grip strength in amateur collegiate riders and control group, with a baseline test, intervention as equitation program for the riders group (mean average 39.07 min/sec/day) and then a follow up test. No significant difference was found between the riders and the control group, but strength increased in riders from (264.8N-289.2N) after the program. In conclusion, horse-riding or equestrian sport, seems influence grip strength in riders. Another difference was found in physical fitness between the two groups. The U-21 team did more sit-ups (ES: 1.70; p = <0.001), seen in table 5. Meyers et al (2000) reported (56.5±15.8 reps) in 60sec curl-up test and (36.6±13.2reps) in 60 sec reverse sit-up test by 24 female collegiate riders. Similar, Meyers et al (2006) reported in baseline test (58.9±4.2reps) and for follow up test (66.5±3.3reps) with a 11.4% increase in curl-up test in riders after 14 weeks of equitation program. Interestingly, this result seems lower by both teams than reported from previous studies. This difference between the two teams (adult and youth) could be explained solely by age difference or by the unequal sex distribution in the two teams, or both.

A comparison was done between the A team and U-21 in psychological skills (PS) mental toughness (MT) and anxiety. Differences were found in practice scale on goalsetting sub scale (ES: 2.62; p = <0.001) and relaxation sub scale (ES: 2.62; p = <0.001), seen in table 6. On competition scale, difference was found on automaticity subscale (ES: 3.00; *p* = <0.001) in favor of A team and imagery sub scale (ES: 1.19; *p* = <0.004), in favor of U-21. Results seem to show that riders in the U-21 team scored higher in goal setting during practice and imagery strategies during competitions while riders in A team scored higher in relaxation strategies in practice and automaticity in competition. In equestrian studies, nothing has been explored with the same test battery questionnaires as in this one. Researchers have used different questionnaires when evaluating PS and anxiety and have focused on personality characteristics questionnaires. Generally in sports, researches have shown that difference in PS, MT and anxiety are more between elite and none elite athletes (Gould, Dieffenbach, & Moffett, 2002; Gould, Greenleaf, Guinan, & Chung, 2002; Meyers et al., 1996) rather than between elite athletes in different age groups (Kristjánsdóttir, Erlingsdóttir, Sveinsson, & Saavedra, 2018). One study evaluated psychological skills (PS), mental toughness (MT) and anxiety in 174 elite Icelandic handball players in function to age group (A team and U21, U19, U17, U15), and found in general, only slight differences between elite teams in PS and MT and none in anxiety. One of these two slight differences was found on the practice sub scale in TOPS where the U-17 team scored higher in self talk than the A team (Kristjánsdóttir et al., 2018).

12.2 Differences in function to sex

Differences were found for basic anthropometry parameters between genders. Males were taller than females (ES: 1.52; *p* = 0.001) and heavier than females (ES:1.42; *p* = 0.002), like seen in table 8. A comparison with other equestrian studies is difficult as in their analysis, a difference between sexes is not conducted in anthropometry and physicals fitness parameters. In comparison with other athletes, Santos et al. (2014) reported reference values for anthropometric measurements in females and male athletes in different sports. Reported height (m) average values for female athletes in tennis were (168.5m), triathlon (168.4m), volleyball (174.5m), and for male in tennis (177.4m), triathlon (175.8), volleyball (195m), reporting males taller than females. Further this research reported weight values for females, in tennis as (64.2kg), triathlon as (57.9kg), volleyball as (67.7kg) and for males in tennis as (71.3kg), triathlon as (65.9kg) and volleyball as (90.1kg) (Santos et al., 2014). This suggest that male riders are in average taller and heavier than female riders like in other sports.

With regards to physical fitness of the riders, a difference was found between sexes in strength for both right hand (ES: 1.98; <1; p = 0.001) and left hand (ES: 2.18; p = <0.001, seen in table 6). Male riders were stronger than female riders in right and left hand. Handgrip strength have been reported higher in males than females in normal population at all ages (Massy-Westropp et al., 2011) and in male athletes in other sports (Leyk et al., 2007). A difference was found for Counter movement jump (CMJ) were male riders jumped higher than female riders (ES: 1.29; p =0.004), as shown in table 8, suggesting that male riders have more power in the lower limbs than female riders. In different sports (primarily football, basketball, baseball, and volleyball), studies have showed that elite male athletes jump higher than elite female athletes. (Laffaye, Wagner, & Tombleson, 2014). These are sports that requires strong power in the lower limbs, either for sprinting or jumping. The CMJ test has not been reported in equestrian studies before, earlier studies have used isokinetic concentric and eccentric thigh strength in female riders by using isokinetic dynamometer and reported female riders to be stronger than non-actives in quadriceps and hamstring (for eccentric muscle strength). The CMJ test also evaluates the gluteal muscles (and other muscles) that play an important role in pelvic stability. With better pelvic and positional stability, the rider can have more steady hand not distracting the horse at different gaits and speed with unnecessary and confusing suggestions caused by a shaky hand. More research is needed, to compare the CMJ results of elite riders to elite athletes in other sport, both on CMJ results and positional stability overall.

Comparison was done between sexes in psychological skills (PS) mental toughness (MT) and anxiety. Differences were found on practice scale were females riders scored higher in goal setting (ES: 1.19; p = 0.003). On competition scale, were differences found in automaticity (ES: 1.94; p = 0.001), activation (ES: 1.15; p = 0.005) and imagery (ES: 0.80; p = 0.039), seen in table 9. Results seem to show that female riders scored higher in goal setting strategies on practice and activation and imagery in competition. While male riders scored higher in automaticity in competition. Previous equestrian studies have found the trend for male to score higher in anxiety management, concentration and confidence, coping with competition stress and greater cognitive skills while female riders are more dealing with mood disturbance and emotional states (Meyers et al., 1999, 1996). Difference between sexes in PS skill have been evaluated in 174 elite Icelandic handball players. This study showed that men scored higher on automaticity, relaxation and emotional control in competition but females in self talk and relaxation in practice (Kristjánsdóttir et al., 2018).

12.3 Relationship between variables

Positive relationship was found with weight (kg) and handgrip strength in right hand (r = 0.698; p<0.001), handgrip strength in left hand (0.674; *p*<0.001) and sit-ups (r = - 0.617; p<0.001). Relationship was also found with sit up and BMI (r = -0.620; *p*<0.001). Heavier riders tend to be stronger in right and left hand. It seems that riders are strong in the upper body while the abdominal strength and hip flexibility are poorer. These riders also seem to have higher BMI.

Strong positive relationship was found between grip strength in right and left hand (r = 0.931; *p*<0.001), suggesting that riders who are strong in the right hand tend to be also strong in the left hand. Negative relationship was found with sit-up and grip strength in right hand (r = -0.723; *p*<0.001) and grip strength in left hand (r = -0.641; *p*<0.001). In summary, those riders with greater grip strength have poorer abdominal strength and hip flexibility and are also heavier and with higher BMI. Riders daily activity/exercise are training horses, both on and off the horse, carrying hey or riding equipment, cleaning the stable using a lot their hand and upper body in all activities. However, as earlier studies have suggested the key point in riding is to be core-stabilized, the posture needs to be stabilized with the abdominal and to work with the lower body for upright stability position. This can probably be explained by the vertical (aligned ear, shoulder, hips, ankle) seated contact in the sitting position while riding the horse. The upper and lower body seems to be working, but the core is more relaxed than expected. This is not supported by other equestrian studies, which showed considerably higher abdominal strength (Meyers, 2006; Meyers & Sterling, 2000). This study tested the abdominal strength with sit-up test, where the body is flexing and extending the trunk therefore the test is affected by hip flexibility. The vertical sitting position (ear, shoulder, hip, ankle) of the rider is probably more working in static isometric contraction, at all gaits not flexing nor extending the trunk. Possible explanation could be stiffness in the hip decreasing the ability to perform many fast sit-ups. However, researches have indicated that sit-up test can indicate the strength and muscular endurance in the abdominal (Esco, Olson, & Williford, 2008).

On the other hand studies have found a relationship with sit-ups and anthropometric parameters, like weight and BMI and indicate that sit-ups test can be predicted from these variables (Esco et al., 2008), which means that greater weight, BMI and body circumference or abdominal fat can affect the performance in maximal exercise tests like these ones (Wong et al., 2004).

Relationship was found between physical fitness and psychological parameters. Positive relationship was found with FMS and SAS-2 ($r = 0.633$; $p < 0.002$). Riders who scored higher in mobility and stability in functional movement also scored higher in anxiety. This needs more research.

No relationship was found between psychological skills variables. Earlier equestrian research has suggest that elite riders employ some psychological strategies, such as anxiety management, concentration and self-confidence and developed the personality traits needed to success in the sport without any formal PS training (Meyers et al., 1999, 1996; Wolframm & Micklewright, 2010b). Results seems to show that elite riders employ some PS strategies to cope with anxiety and develop the personality traits needed to qualify in performance but there were no great differences between these two elite teams in function to age or gender.

13 Limitations

This study has several limitations, first this is a cross sectional study, second the age of the U-21 is maturation. Third, no cardiorespiratory fitness was done and compared by teams which could have provide insight into the rider´s fitness while equestrian studies have measured oxygen uptake, HR, peak power e.g. to find out required physical demand of the sport in different disciplines. Fourth, the sample is small, contains men and women in each team but with unequal sex distribution in both teams.

14 Conclusion

The conclusion of this study was:

i) Differences were found in anthropometric and physicals fitness parameters in function to age group. The A team were heavier with higher BMI and greater grip strength in hands than the U-21 team. The U-21 team have greater abdominal strength than the A team. These results seem logical because of the difference between the two teams in age and sex distribution. Differences was found between the teams on PS. Results showed that riders in the U-21 team scored higher in goal setting during practice and imagery strategies during competitions while riders in A team scored higher in relaxation strategies in practice and automaticity in competition. No difference was found in MT nor anxiety between adults and youth. It seems that age does not influence elite rider´s MT, or anxiety in a great way.

ii) This study also showed differences between sexes in anthropometric and physical fitness parameters. Males were taller and heavier than women. Male were also with greater grips strength in hands and with more power in the lower body. This is, in agreement with previous research that have investigated the differences in anthropometry and strength parameters between genders in athletes (Leyk et al., 2007; Santos et al., 2014). Differences was found between the teams on PS. Results seem to show that female riders scored higher in goal setting strategies on practice and activation and imagery in competition. While male riders scored higher in automaticity in competition. Further, it seems that sex does not influence elite rider´s MT or anxiety in a great way.

iii) Relationship was found between eight variables. Result seem to suggest that riders who were heavier with higher BMI and strong grip strength, tend to be with poorer abdominal strength. This can probably be explained by the vertical (aligned ear, shoulder, hips, ankle) seated contact in the sitting position while riding the horse. The upper and lower body seems to be working, but the core is more relaxed than expected. No relationship was found between variables for psychological skills. However, results seem to show that elite riders employ some PS strategies to cope with anxiety and develop the personality traits needed to qualify in performance but overall there was no great difference between the two elite teams in function to age or gender.

15 Future research

The results of this study may have purposeful practical information regarding and for the Icelandic equestrian community. Both when it comes to riders and trainers of competition riders. It can give a clue were elite riders stand in anthropometry, physical fitness and psychological skills in comparison with other equestrian disciplines and/or other athletes. Evaluating and monitoring the elite rider and maybe later, both rider and the horse, can provide information on how these factors effect rider performance. Clearly much is left to be gained, how the objective, direct measurements of rider´s parameter can assist in providing more appropriate feedback. Study with greater sample size can give more power in the statistical analysis, in function to both age and sex, and with ensure that there is equal distribution of sex in all groups. How these factors, effect the rider´s performance in competition is very interesting and can give practical information for coaches and riders. Study with performance parameter score in competition could be practical or/and can give more information about these factors and how it impacts in success in this sport. Furthermore, physical or/and psychological intervention together with performance related factor could be of interest to view.

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