Freely chosen finger tapping frequency is increased between limbs during repeated bout rate enhancement

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Published in:
Program & Abstracts, 10th Annual Meeting of the Danish Society of Biomechanics, 5 October 2018, Brøndby, Denmark

Publication date:
2018

Document Version
Publisher's PDF, also known as Version of record

Program & Abstracts

10th Annual Meeting of the Danish Society of Biomechanics

Editor: Ernst Albin Hansen

05-10-2018

WELCOME & VENUE

Dear Colleagues

On behalf of the board of the Danish Society of Biomechanics, Team Danmark, as well as the Organising Committee, we invite you to the 10th annual meeting on October 5, 2018 in Brøndby, The House of Sport, Brøndby Stadion 20, 2605 Brøndby. Meeting room: Gunnar Nu.

This year's annual meeting is arranged in collaboration with the Danish elite sport institution Team Danmark. Team Denmark acknowledge that sports biomechanics have received inadequate attention in the quest for medals. Thus, the program around mid-day will focus on sports biomechanics and the way biomechanics interacts with other disciplines to produce performance improvements. Team Danmark has invited Catherine Shin, a sport biomechanist from the English Institute of Sport (EIS), who will be keynote speaker and participate in a subsequent panel discussion focusing on the use of biomechanics in Danish elite sports. The overall purpose is therefore to enlighten Team Danmark, the Danish National Coaches and Sport Directors in the perspectives of sports biomechanics in the quest for medals but also to encourage and motivate the Danish scientist and students in the area of biomechanics to do research in the applied area of sports biomechanics.

Looking forward to be seeing you in The House of Sport

On behalf of the organizers

Thue Kvorning
Team Danmark

MEETING INFORMATION

Keynote lecture

The EIS supports 38 Olympic and Paralympic sports in science, medicine, technology and engineering. The biomechanics team is one of 12 disciplines which all work to support Olympic and Paralympic success. As an applied biomechanics discipline, all athletes are treated as individuals. While much academic literature and teaching is based on finding an optimal movement pattern, once we reach these levels of performance, we are looking for smaller nuances of technique which are specific to a single athlete, to find possible performance gains or interventions to mitigate against injury risk. For our team, one of the most important factors is the ability to measure and understand performance in the athletes' training or competition environment. This can be very challenging, especially in water or ice-based sports however new technologies, such as wearable motion capture, allow us to move closer to this goal. We work closely with the performance innovation team to investigate whether athletes have the optimal equipment set-up to optimise performance, or consult on skill acquisition by evaluating learning environments. We also work closely with other disciplines, such as strength and conditioning coaches and physiotherapists. Here we can use the insight gained from biomechanics testing to inform training programmes, monitor longitudinal change and tailor training to individuals.

Catherine Shin
English Institute of Sport (EIS)

Steno Speaker

The Steno lecture 2018 will be given by Professor Marius Henriksen.

Nedestående er Steno-udvalgets vurdering:

Professor Marius Henriksen (MH) har en stærk faglig, biomekanisk profil med indsigt i metoder til at studere den funktionelle anatomi i såvel det raske, som det syge menneske. MH har inden for sin forskning fokuseret på patienter med knæ artrose samt smertelindring relateret til denne lidelse, og i de senere år er *god klinisk praksis* blevet et centralt udgangspunkt for MHs professionelle virke. MH har stor erfaring og succes inden for undervisning, forskningsformidling, forskningsledelse og fundraising især nationalt, men også internationalt. Desuden har MH en lang ekspertbedømt publikationsliste (jf. SCOPUS d.d. 90 publikationer H-index: 22). Et af de største fingeraftryk MH p.t. har sat på dansk biomekanik er dannelsen af Dansk Biomekanisk Selskab (DBS). Selskabet blev stiftet år 2009 på grundlag af et ambitiøst forarbejde alene drevet af Marius Henriksen. MH besad selv formandsposten 2009 – 2014, og i denne periode blev DBS konsolideret og årsmøderne blev det centrale omdrejningspunkt. Desuden blev DBS affilieret med International Society of Biomechanics (ISB).

Komiteen tilslutter sig følgende karakteristik af MH som blev givet i indstillingen:
'Marius Henriksen har haft, og har fortsat en signifikant indflydelse på dansk biomekanik. Han er et kreativt og generøst menneske, som villigt deler sin viden og sine ideer. Han er på én og samme tid visionær og pragmatisk, men også rastløs og uimponeret - altid på vej mod nye mål og horisonter. Marius har en gadedrengs mod til at udfordre det gængse - bryde med vanetænkningen og sætte nye retninger. Derfor indstilles Marius Henriksen til at modtage Stenoprisen 2018.'

Dansk Biomekanisk Selskab (DBS)
Komiteen for årets Stenopris 2018
v. Prof. Karen Søgaard, Prof. Pascal Madeleine og Prof. Michael Voigt (Formand)

Organizing Committee

Thue Kvorning, Sportsfysiolog, Team Danmark

DBS Board

Scientific Committee

Tine Alkjær, Associate Professor, DBS Board Member
Ernst Albin Hansen, Associate Professor, DBS Board Member
Anders Holsgaard Larsen, Associate Professor, DBS President
Maj Halling Thomsen, Dyrlæge, DBS Board Member

PROGRAM OVERVIEW

10th Annual Meeting of the Danish Society of Biomechanics	
8:30-9:00	**Registration, poster mounting, and coffee**
9:00-9:10	**Welcome**
9:10-10:10	**Steno lecture**
10:10-11:00	**Podium presentations (DBS student award)**
11:00-11:15	**Coffee break**
11:15-12:00	**Keynote lecture**
12.00-13:00	**Lunch (and General assembly for members)**
13:00-14:00	**Panel discussion on the perspectives of sports biomechanics in the quest for medals**
14:00-15:00	**Podium presentations**
15:00-16:00	**Posters and coffee**
16:00-16:10	**DBS Student Award ceremony**
16:10-16:20	**Official closing of the meeting**
16:20-	**Refreshments and networking**

PROGRAM DETAILED

8:30-9:00 **REGISTRATION, POSTER MOUNTING, AND COFFEE**

9:00-9:10 **WELCOME**

By Thue Kvorning

9:10-10:10 **STENO LECTURE**

Myth busting in clinical biomechanics
By Marius Henriksen

Chair: Tine Alkjær

10:10-11:00 **PODIUM PRESENTATIONS (DBS STUDENT AWARD)**

10:10-10:22 ESTIMATION OF SPINAL LOADING DURING MANUAL MATERIALS HANDLING USING ONLY INERTIAL MOTION CAPTURE AND PREDICTED GROUND REACTION FORCES - A VALIDATION STUDY
FG Larsen, FP Svenningsen, MS Andersen, M de Zee, S Skals

10:22-10:34 SCAPULAR MUSCLE ACTIVITY IN HEALTHY INDIVIDUALS DURING SERRATUS PUNCH EXERCISES
SK Magnúsdóttir, T Alkjær, M Henriksen, R Høffner, A Cools

10:34-10:46 THE EFFECT OF NORDIC HAMSTRING EXERCISE AS PREVENTION OF HAMSTRING STRAIN INJURY IN PHYSICALLY ACTIVE - A SYSTEMATIC REVIEW
E Ringtved, M Schuster, M Banck-Petersen, K Nørgaard, H Koblauch

10:46-10:58 EFFECT OF EXPERIMENTAL TIBIALIS POSTERIOR MUSCLE PAIN ON MUSCLE RECRUITMENT: A PARAMETRIC STUDY
MB Simonsen, A Yurtsever, K Næsborg-Andersen, PDC Leutscher, K Hørslev-Petersen, RP Hirata, MS Andersen

Chair: Maj Halling Thomsen

11:00-11:15 **COFFEE BREAK**

11:15-12:00 **KEYNOTE LECTURE**

Biomechanics as part of the multidisciplinary team at the EIS
By Catherine Shin

Chair: Thue Kvorning

12:00-13:00 **LUNCH**

12:00-13:00 **GENERAL ASSEMBLY** (for DBS members)

13:00-14:00 **PANEL DISCUSSION ON THE PRESPECTIVES OF SPORTS BIOMECHANICS IN THE QUEST FOR MEDALS**

Chair: Thue Kvorning

14:00-15:00 **PODIUM PRESENTATIONS**

14:00-14:15 HOW DIFFERENT IS THE NEW BADMINTON SERVE?
J Rasmussen, M de Zee

14:15-14:30 IDENTIFICATION OF HAND EXERCISES USING WEARABLE SURFACE ELECTROMYOGRAPHY
JL Isaksen, JK Kanters, T Alkjær

14:30-14:45 THE INFLUENCE OF ADDED COGNITIVE LOAD ON THE TRANSITION BETWEEN WALKING AND RUNNING
MK Hyttel, LS Jakobsen, MK Jensen, H Balle, EA Hansen, M Voigt

14:45-15:00 VARIABILITY OF FOOT STRIKE CHARACTERISTICS IN RUNNERS WITH DIFFERENT SELF-REPORTED RUNNING RELATED INJURIES
PC Raffalt, M Neutzner, T Neitmann, AN Agres, GN Duda

Chair: Ernst Albin Hansen

15:00-16:00 **POSTERS AND COFFEE**

MAPPING THE LOAD INTENSITY OF JUMPING EXERCISES IN POST-MENUPAUSAL FEMALES: IMPLICATIONS FOR OSTEOGENIC TRAINING
T Alkjaer, KB Smale, LH Hansen, JK Kristensen, MK Zebis, C Andersen, DL Benoit, EW Helge

HABITUAL LOADING LEADS TENDON HYPERTROPHY IN THE ELDERLY AND YOUNG HUMAN PATELLAR TENDON
C Couppé, RB Svensson, SV Skovlund, JD Nybing, JK Jensen, M Kjaer, SP Magnusson

THE ESSENTIALS OF TRAINING DIARIES FOR SPECIFIC PHYSICAL ACTIVITY QUANTIFICATION IN HEALTH PROMOTION – A WORKPLACE CLUSTER RANDOMISED TRIAL
T Dalager, V Johnston, E Boyle, A Welch, J Larkin, S O'Leary, G Sjøgaard

PASSIVE FINGER TAPPING IS SUFFICIENT TO ELICIT REPEATED BOUT RATE ENHANCEMENT
A Emanuelsen, M Voigt, P Madeleine, EA Hansen

STRIDE FREQUENCY AS DETERMINANT FOR THE TRANSITION BETWEEN WALKING AND RUNNUNG
LS Jakobsen, MK Jensen, MK Hyttel, H Balle, EA Hansen, M Voigt

A NEW DEVICE FOR MEASURING FORCES IN THE FOOTREST AND SEAT DURING SPRINT KAYAKING
K Klitgaard, J Hansen, M de Zee

DYNAMICS OF POSTURAL CONTROL IN ELITE SPORT RIFLE SHOOTERS
IF Marker, PC Raffalt, AT Adler, T Alkjaer

BODY DISCOMFORT AND TRUNK MUSCLE ACTIVATION DURING A WRITING-TASK ON A DYNAMOSTOL INCHARGE CHAIR WITH EITHER A STABLE OR UNSTABLE BASE OF SUPPORT
JE Nørgaard, MJ Thomsen, RP Hirata, TS Palsson

ANODAL TRANSCRANIAL DIRECT CURRENT STIMULATION DOES NOT IMPROVE VOLUNTARY ACTIVATION LEVEL OR MAXIMAL VOLUNTARY CONTRACTION IN QUADRICEPS
JE Nørgaard, MJ Thomsen, JS Aaes, D Knudsen, M Voigt, M Kristiansen

DYNAMICS OF POSTURAL CONTROL IN INDIVIDUALS WITH LATERAL ANKLE SPRAIN
PC Raffalt, M Chrysanthou, GN Duda, AN Agres

FREELY CHOSEN FINGER TAPPING FREQUENCY IS INCREASED BETWEEN LIMBS DURING REPEATED BOUT RATE ENHANCEMENT
B Seiferheld, S Bak, L Knudsen, EA Hansen, AJT Stevenson, A Emanuelsen

INCREASE IN CORTICAL EXCITABILITY ELICITED BY ANODAL TRANSCRANIAL DIRECT CURRENT STIMULATION DOES NOT AFFECT SELF-PACED CYCLING PERFORMANCE
MJ Thomsen, JE Nørgaard, D Knudsen, JS Aaes, M Kristiansen, M Voigt

16:00-16:10	**DBS STUDENT AWARD CEREMONY** Chair: Anders Holsgaard Larsen & Maj Halling Thomsen
16:10-16:20	**OFFICIAL CLOSING OF THE MEETING** By Thue Kvorning
16:20-	**REFRESHMENTS AND NETWORKING**

ABSTRACTS

Mapping the load intensity of jumping exercises in post-menopausal females: Implications for osteogenic training

Tine Alkjaer [2,6], Kenneth B. Smale[1], Lisa H. Hansen[2], Julie K. Kristensen[2], Mette K. Zebis[3],

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INTRODUCTION

Osteoporosis is a worldwide and frequent disease that causes serious socio-economic problems. Thus, methods for prevention of this disease are important. Post-menopausal women are more likely to have low bone mineral density and are therefore more prone to osteoporosis than men. To this extent, evidence-based exercises that induce osteogenic loading and mitigate osteoporosis are needed.

The purpose of this study was to investigate the loading intensity of three different jumping exercises: 1) countermovement jump (CMJ), 2) drop jump (DJ), and 3) hard landing (HL) in a group of healthy post-menopausal females. We hypothesized that the HL would produce the highest loads and loading rate among the three jumps.

METHODS

Fourteen healthy post-menopausal women (62.5 ± 5.5 years, 1.68 ± 0.05 m, 64.3 ± 8.9 kg, T-score: -0.99 ± 0.84) participated in this study. The participants completed a series of CMJ, DJ and HL on force platforms. A 30 cm high wooden box was placed in front of the force plates for DJ and HL initiation. Surface markers corresponding to a whole-body model, including lower limb clusters were placed on the participants.

Kinematic and kinetic analyses were performed to estimate the load intensity. Selected outcomes were hip flexion angle, hip flexor and extensor moment, rate of hip moment change (RMC), dynamic hip stiffness, peak vertical ground reaction force (vGRF), vGRF loading rate, and vGRF index (peak vGRF * vGRF loading rate).

RESULTS AND DISCUSSION

Peak hip extensor moment and rate of moment change were significantly greater ($p < 0.05$; $\eta 2 = 0.483 - 0.693$) in the first landing of the drop jump than the CMJ and HL. Hip stiffness approached significance ($p = 0.067$) while peak vGRF, vGRF loading rate, and vGRF index were significantly greater during the HL ($p < 0.01$; $\eta 2 = 0.259 - 0.864$) than the CMJ and DJ (Fig. 1).

The current results supported the hypothesis as HL continuously demonstrated the greatest load intensities, followed by the first landing of the drop jump, while the CMJ appeared to be the exercise with the lowest intensity.

The HL and DJ created the greatest magnitude and rate of loading and they are likely to have greater osteogenic potential than the CMJ. Thus, healthy post-menopausal females may benefit from training that includes jumping exercises such as HL and DJ.

Future research is needed to determine the osteogenic effect of these jumping exercises as well as the dose-response relationships between general training parameters (volume, intensity, intermittence, and rest) in order to design safe and effective osteogenic training programs for post-menopausal females.

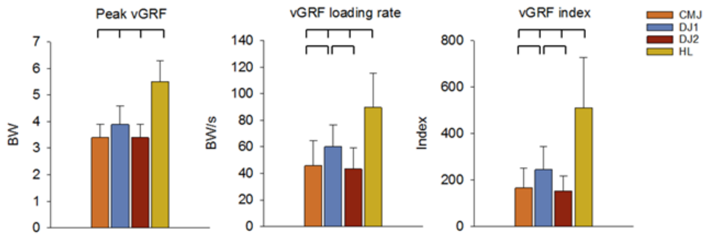

Fig. 1 Left: Peak vGRF, middle: vGRF loading rate, right: vGRF index. Values are means and standard deviations with significances between jump types indicated by horizontal bars.

CONCLUSIONS

The current results supported the hypothesis as HL continuously demonstrated the greatest load intensities, followed by the first landing of the DJ, while the CMJ appeared to be the exercise with the lowest intensity.

ACKNOWLEDGEMENTS

The authors thank Andreas Hedetoft and Ramus Mogensen (BSc) for their assistance in relation to the experiments.

Furthermore, great thanks go to Xlab, Department of Biomedical Sciences, University of Copenhagen for their hospitality and valuable technical advices.

HABITUAL LOADING LEADS TENDON HYPERTROPHY IN THE ELDERLY AND YOUNG HUMAN PATELLAR TENDON

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INTRODUCTION
Habitual loading leads to tendon hypertrophy and greater mechanical properties of the young human patellar tendon (PT) [1]. However, it remains unknown if life-long habitual side-specific loading results in augmented structural and mechanical properties of the older tendon. The purpose was to investigate if life-long side-specific loading leads to greater cross-sectional area (CSA) and mechanical properties of the patellar tendon (PT).

METHODS
Nine elderly (OM) (age: 66±7yrs, BMI: 24.7±2.7, 51±8 playing-yrs) and 6 young (YM) (age 23±5, BMI: 22.0±1.7, 15.8 playing-yrs) knee-injury free elite badminton players and fencers were included.
CSA of the PT, obtained by 3-tesla MRI, and ultrasonography-based measurement of tibial and patellar movement together with PT force during isometric contractions were used to estimate mechanical properties of the PT bilaterally. MRI images and mechanical properties of the PT were evaluated in a blinded fashion. Differences between legs (lead vs. non-lead) were analyzed using paired two-tailed t tests, while differences between the two groups (YM vs OM) were analyzed using unpaired two-tailed t tests with the level of significance set at $p < 0.05$. Data are reported as Mean±SD or Mean±SE.

RESULTS AND DISCUSSION
We found that the CSA of the lead leg was greater than the non-lead at the proximal and distal, but not the mid PT, in both OM and YM (Table 1).
For a given common force, OM had a stress (based on average CSA) that was lower on the lead leg compared with the non-lead (28±4 MPa vs. 32±4 MPa; $p<0.05$).
Again, in the YM, the lead leg demonstrated lower PT stress than the non-lead (55±4 MPa vs. 64±7 MPa; $p<0.05$) and also lower tendon strain on the lead compared to their non-lead leg (3.5±0.3%, vs. 4.6±0.4%; $p<0.05$). The OM PT stiffness did not differ between the lead and non-lead legs (4997±887 N/mm vs. 4800±1016 N/mm). However YM had 29% greater PT stiffness on the lead than on the non-lead leg (7571±749 N/mm vs. 5861±397 N/mm, $p<0.05$). Moreover, there was no side-to-side difference for PT elastic modulus either in OM (lead 1.6±0.3 GPa vs. non-lead 1.8±0.3 GPa) or in YM (lead 3.0±0.2 GPa vs. non-lead 2.6±0.3 GPa) at a common force.

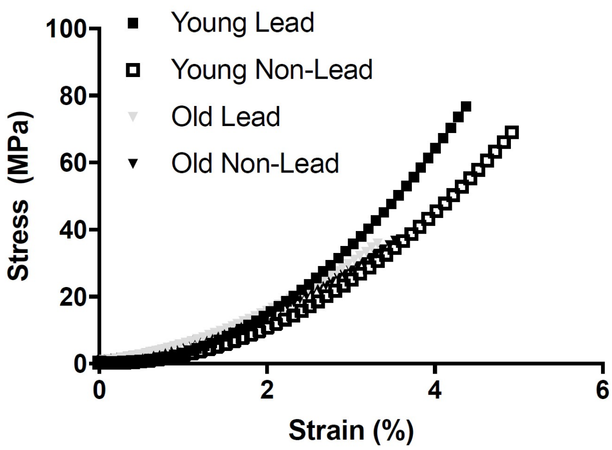

Fig. 1 Stress-strain relationship for the patellar tendon.

CONCLUSIONS
These data confirm previous data that habitual loading leads to tendon hypertrophy and greater mechanical properties of the young human patellar tendon. The data also demonstrate that life-long unilateral habitual loading in elderly elite athletes yields region-specific tendon hypertrophy that may serve to lower the mechanical stress and thereby reduce the risk of injury.

ACKNOWLEDGEMENTS
The present study was supported by RegionH, Center for Healthy Aging (Nordea Foundation), University of Copenhagen, Lundbeck Foundation and the Danish Medical Research Council.

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	Proximal		Mid		Distal	
	Lead	**Non-lead**	**Lead**	**Non-lead**	**Lead**	**Non-lead**
Old PT CSA (mm^2)	154±12*	126±8	130±10	113±4	128±9*	112±5
Young PT CSA (mm^2)	114±6*	97±6	99±4	93±6	108±28*	102±12

Table 1 Patellar tendon (PT) cross-sectional area (CSA) in the lead and non-lead legs of old and young athletes. * $p<0.05$ versus non-lead.

The essentials of training diaries for specific physical activity quantification in health promotion – A workplace cluster randomised controlled trial

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2: University of Queensland, Australia.

INTRODUCTION

Exercise as medicine has been proven effective for many disorders. In a workplace setting, adherence among participants is a challenge since low adherence and compliance compromise effectiveness of exercise. Training diaries provide unique information of importance for compliance and for quantification of participants' adherence and dropout. The aim of this study was to determine drop out and adherence in a strength training intervention using training diaries. The effect on muscle strength/endurance and musculoskeletal pain was investigated.

METHODS

A total of 763 office workers were cluster-randomised to a training group, TG, or a control group, CG. CG attended health promotion information sessions one hour weekly. TG performed five specific strength training exercises explained detailed according to biomechanical principles in the training diary to ensure optimal compliance (forward and backward neck bend, front and side raise, and reverse pull) for 12 weeks, 3x20 min sessions a week -three sets per session- with 1/3 supervised. Training diaries were completed with repetitions and resistances performed. Dropout was defined as missing two sequential weeks of training, and the time point for 25% dropout was determined by Kaplan Meier analysis. Adherence was calculated as number of attended training sessions in the diary out of a maximum of 36 sessions. Adherence ≥70% was used in the dose-response analysis. Intensity of neck/shoulder pain last three months was evaluated by a 10-point numerical scale (0-9, 9=worst possible pain). Muscle strength/endurance was measured for neck flexion/extension and shoulder raise. Intention-to-treat (ITT) analysis and adherence dose-response analysis was performed by Wilcoxon test between groups with $p<0.05$ for significance.

RESULTS

Time point for the 25% drop out was week 10. Participants had an average adherence of 60%. Out of nine possible training sets each week, on average five training sets were completed (95% CI: 5.04-5.21). TG increased significantly neck flexion strength (mean±SD (6.4±22.0%)) and endurance (28.6±72.7%), neck extension endurance (30.0±100.3%), and shoulder raise strength (10.9±26.4%) and endurance (43.6±103.5%), compared with CG. Neck and left shoulder pain decreased significantly more (~0.5points) among TG participants with adherence ≥70% compared to those with adherence <70%.

CONCLUSIONS

Specific strength training performed according to detailed biomechanical information proved effective in improving muscle strength/endurance and decreasing neck/shoulder pain when adherence was ≥70%. A novel finding is the Kaplan Meier analysis showing 25% of the participants had dropped out at week 10, suggesting reinforcement of motivational initiatives already around week 8-9. Training diaries provide unique opportunities to examine the training volume that will contribute with important knowledge for future implementation of workplace health promotion interventions.

PASSIVE FINGER TAPPING IS SUFFICIENT TO ELICIT REPEATED BOUT RATE ENHANCEMENT

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*Ph.D. student

INTRODUCTION

The freely chosen frequency of voluntary rhythmic movement like finger tapping is suggested to be controlled by spinal central pattern generators (CPGs) in an interrelationship with supraspinal descending input and sensory feedback [1,2]. Moreover, it has been shown that the freely chosen finger tapping frequency increases in the second of two consecutive tapping bouts separated by a rest period. The latter phenomenon has been termed repeated bout rate enhancement [3]. The overall aim of the present study was to further investigate the phenomenon of repeated bout rate enhancement. More specifically, it was to elucidate whether sensory feedback, caused by passive finger tapping, would be sufficient to elicit repeated bout rate enhancement.

METHODS

Healthy individuals (n = 21; 16 men and 5 women, 1.83 ± 0.08 m, 82.6 ± 13.1 kg, and 25.3 ± 3.1 years) participated. Each participant reported to the laboratory twice, referred to as Session A and B. The sessions were separated by a three-week washout period [2,3]. In Session A, two 3-min index finger tapping bouts were performed at freely chosen tapping frequencies. In Session B, a 3-min passive index finger tapping bout was followed by a 3-min tapping bout at freely chosen frequency. It applied to both Session A and B, that the bouts were separated by 10 min rest. The passive tapping was performed by using a custom-built machine that could move the passive finger. The tapping frequency during the passive tapping bout corresponded to the average tapping frequency that the participant had applied during the first tapping bout in Session A.

RESULTS AND DISCUSSION

The tapping frequency in the first bout in Session A was used as a reference tapping frequency. The tapping frequencies in the second bout in session A and B were 12.9 ± 14.8% ($p < 0.001$) and 9.9 ± 6.0% ($p = 0.001$) higher than the reference tapping frequency, respectively (Fig 1). These differences were not significantly different ($p = 0.438$). The results from Session A support previous findings by replicating the phenomenon of repeated bout rate enhancement [3,4]. The elicitation of repeated bout rate enhancement in Session B constituted a novel finding. It has been suggested that an increased CPG-mediated movement frequency output might be caused by increased supraspinal descending drive [5]. However, it is also possible that an increased movement frequency can occur without increased supraspinal descending drive as a result of excitation of the rhythm generating part of the CPG. The latter could be caused by neuromodulators released as a consequence of e.g. afferent feedback [6,7]. The present results from Session B might support the latter.

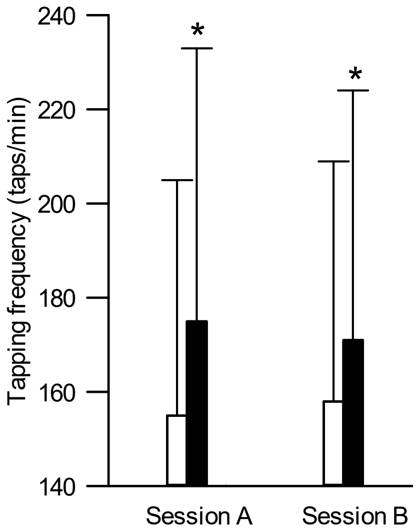

Fig. 1 Mean + SD tapping frequencies in Session A (applying freely chosen tapping in 1. bout) and Session B (applying passive tapping in 1. bout). White and black bars represent first and second bouts, respectively. The second bouts consisted of freely chosen tapping. *different from the first bout ($p < 0.01$).

CONCLUSIONS

We showed for the first time that the phenomenon of repeated bout rate enhancement also is elicited after passive tapping (Session B). These results are interpreted to support a working hypothesis suggesting that sensory feedback to the spinal CPG might excite this and explain the increased tapping frequency during repeated bout rate enhancement.

ACKNOWLEDGEMENTS

The present research is supported by The Ministry of Culture Committee on Sports Research.

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THE INFLUENCE OF ADDED COGNITIVE LOAD ON THE TRANSITION BETWEEN WALKING AND RUNNING

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INTRODUCTION

Many studies search for a specific trigger behind the behavioral change in locomotion that appears when the walking transits into running. However, it has so far been difficult to find evidence for a single determinant [1]. The majority of researchers examining the walk-to-run transition (WR-transition) consider the speed of locomotion to be the main determinant. A different view has been proposed by Hansen et al. (2017) [2] who examined the stride frequency as the main determinant for the WR-transition and they provided evidence for the transition to occur at the frequency 'midpoint' between two behavioral attractor states represented by the preferred walking and running speed/frequency combinations. In any case, it cannot be ignored that the transition point is sensitive to a variety of factors [1] and a few studies have examined how added cognitive load in dual-tasks involving locomotion influence the WR-transition [3,4]. Conflicting results have been found and therefore, a dual-task paradigm adding cognitive load by subtraction tasks was applied in this study to re-examine to which degree cognitive loading influences the WR-transition.

METHODS

Eighteen healthy participants (13 men and 5 women) were recruited (age; 23.9 ± 1.5 years, height; 1.77 ± 9.6 cm, body mass; 77.3 ± 12.8 kg). All participants were accustomed to treadmill walking/running prior to the experiment. Before the running trials force sensing resistor footswitches (FSRs, Interlink, USA) were placed under the insole of the right shoes of the participants. One was placed under calcaneus and the other was placed under the heads metatarso-phalangeal joints 1-2. The sensitivity of each footswitch was individually adjusted, to avoid false triggering. A 10-minute warm-up/adaptation period was applied. The treadmill (Woodway XL Pro, Waukesha, USA) speed was initially 1 km/h and was increased by 1 km/h each minute until the final speed at 10 km/h was reached. After four minutes of rest the 'preferred' WR-transition was determined. The initial treadmill speed was 5 km/h and increased by 0.1 km/h each 10th second until the final speed of 9 km/h was reached. The speed immediately before the transition was determined. This was followed by four minutes rest. Then the dual-task procedure began. The primary task was subtraction tasks and the secondary task was the walking/running protocol identical to the protocol for determination of the 'preferred' transition. The subtraction task consisted of consecutive subtraction of 7 starting at 911 (e.g. 911-7 = 904. 904-7 = 697 and so on). The participants were instructed to state the answers aloud. The test leader controlled all the answers and in case of an error, the answer should be corrected until right. The participants would be told how well they had performed in the subtraction task compared to the other subjects as motivation. The sampling frequency of the footswitches was 1000 Hz. Data were processed in MATLAB (R2018A, The MatWorks BW, Natrick, USA). The exact WR-transition was determined based on the stride-to-stride changes in duty factor (i.e. the relationship between stance time and stride time).

Data were organized in Excel (version 15.4, Microsoft Corporation, Bellevue, WA, USA) and analyzed in SPSS (PASW statistics, version 25.0, SPSS Inc., Chicago, USA). Paired samples t-tests were used to examine if any difference between preferred and dual-task transition were present. Two subjects were excluded from the analysis because the WR-transition was absent during the dual-task trials

RESULTS

The preferred WR-transition stride frequency was 67.0±3.1 strides/min and the dual-task WR-transition stride frequency was 68.4±3.7 strides/min. This 2.2% difference was not statistically significant (p=.137). The preferred WR-transition speed was 7.5±0.5 km/h and the WR-transition speed during the dual-task trial was 7.6±0.5 km/h. This 1.2% difference was also not statistically significant (p=.073).

DISCUSSION

No significant effect on WR-transition speed or WR-transition stride frequency of an added cognitive load during locomotion was found. This finding supports the work by Abdolvahab (2015) [4] in which it was found that the Froude number did not change significantly when cognitive load was added. The unchanged Froude number indicated that the transition speed did not change. However, it should be noted that they also found that the Froude number at the transition from running to walking was significantly decreased at transition by added cognitive load, and the decrease was correlated with the intensity of this added load. As mentioned previously, it cannot be ignored that the added cognitive load might influence the gait-transition and that the magnitude of the influence most likely is proportional with the intensity of the added cognitive load. So, in the present study the cognitive load may have been so limited that it did not affect the WR-transition for most of the participants.

According to the work by Hansen et al. [1] it is suggested that the stride frequency is the best predictor of the WR-transition. The critical WR-transition stride frequency may depend on a critical dynamic state of the moving body, which is sensitive to many different factors e.g. added cognitive load, changes in inertia of the body segments and prior movement history [5].

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IDENTIFICATION OF HAND EXERCISES USING WEARABLE SURFACE ELECTROMYOGRAPHY

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INTRODUCTION

Electromyography (EMG) from surface electrodes can detect muscle activity, [1] and EMG obtained using small, Ag/AgCl electrodes have previously been used for identification of movements. [2] This study aimed to explore, if it is possible to identify movements using dry electrodes and machine learning in a wearable device.

METHODS

52 participants (33 (63%) women, 15 (29%) injured) performed a series of 24 hand exercises including extensions, flexions, and rotations at different loads (0, 2, and 5 kg) paced by an instruction video using their dominant hand. Surface-EMG was obtained at 1043 Hz using the PreCure Elbow (PreCure IVS, Havnebakken 26, 3770 Allinge, Denmark) wearable device on dry or dampened skin.

18 EMG features were used to characterize the movements including direct characterization of the EMG signal, a 201-sample windowed root-mean-square (RMS) signal, and frequency spectrum features. The features were based on a 10-second segment of each exercise. In addition, the sex was available in the classification stage.

We trained a conditional inference tree (ctree) to classify movements on 70 % of the recordings. Feature extraction was performed in MATLAB R2018a and the ctree was implemented in R v. 3.5.0 using package 'party'.

RESULTS AND DISCUSSION

1205 (96.6%) exercises yielded valid recordings. Of the 359 exercises in the test set, 90 (25.1%) were correctly identified. We found a large variation in accuracy between exercises (Table 1). We found that exercises tended to be better identified if they were a) with the 5 kg load, b) extensions or, c) involving as few muscle groups as possible.

Many strictly incorrect predictions may be considered partly correct. For instance, computer mouse operations were identified as static hand holds, which is known to be a major constituent of the exercise. [3] There was a large overlap in muscle activity between the exercises, and often it was difficult to differentiate between 0 kg- and 2 kg-exercises.

CONCLUSIONS

Identification of hand movements across movement types using surface EMG was possible with an accuracy of 25%.

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Table 1 Confusion matrix for the test set – prediction (P) against actual exercise (E).

	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14	E15	E16	E17	E18	E19	E20	E21	E22	E23	E24	E25
P2	**19**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
P3	0	**4**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
P4	0	0	**4**	5	1	0	0	1	0	1	1	1	0	0	0	0	4	0	0	0	0	1	0	0
P5	0	0	1	**3**	0	3	0	1	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0
P6	0	0	0	1	**10**	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	4	0	2
P7	0	0	6	1	0	**4**	7	4	2	1	1	3	0	0	0	0	1	0	0	0	3	0	7	0
P8	0	1	0	0	0	2	**2**	0	0	0	1	5	1	0	0	1	0	1	0	1	1	1	2	1
P9	0	0	0	1	0	1	0	**0**	3	2	0	1	0	1	0	7	1	0	0	2	0	0	0	1
P10	0	1	2	0	0	2	1	5	**3**	3	6	0	1	0	0	0	0	1	0	1	0	0	0	5
P11	0	1	1	0	0	0	1	1	3	**2**	3	1	1	0	0	0	0	0	0	0	1	0	0	1
P12	0	0	0	0	0	0	4	0	2	0	**1**	0	0	0	0	0	0	1	0	2	0	0	0	0
P13	0	0	0	0	0	0	1	0	0	0	0	**0**	0	0	0	0	0	0	0	0	0	0	0	0
P14	0	0	0	4	0	0	0	1	0	0	0	1	**10**	0	0	3	1	0	0	0	0	2	4	1
P15	0	1	0	0	0	0	0	0	0	0	0	0	0	**2**	0	0	0	0	1	2	0	0	0	0
P16	0	1	0	0	0	0	0	1	1	0	1	0	0	0	**1**	0	0	0	0	3	0	0	0	0
P17	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	**3**	0	0	0	0	0	0	0	0
P18	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0	0	0	1
P19	0	3	0	0	0	0	0	3	0	0	2	1	0	7	1	1	0	**6**	5	1	0	0	1	0
P20	0	2	0	0	0	0	0	1	0	0	0	0	0	5	8	0	0	3	**8**	4	0	0	0	0
P21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0	0	0
P22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**7**	8	1	2
P23	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	4	**1**	0	1
P24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0
P25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**

STRIDE FREQUENCY AS DETERMINANT FOR THE TRANSITION BETWEEN WALKING AND RUNNUNG

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INTRODUCTION

It is generally believed that the walk-to-run transition (WR-transition) occurs at a critical walking speed [1]. However, recent studies [2,3] have, based on Dynamic Systems Theory, provided evidence for the WR-transition to be triggered at a critical point occurring at the frequency 'midpoint' between two behavioral attractor states represented by the 'preferred' or 'basic' walking and running stride frequency/speed combinations. If a given critical stride frequency truly determines the basic WR-transition, then this should be independent of the speed of locomotion. During locomotion, speed and stride frequency are closely linked since: speed = stride length × stride frequency. However, speed and frequency can be de-coupled in locomotion tests, where the speed is kept constant and the stride frequency increased systematically. We hypothesize 1) that the WR-transition stride frequency (WRTSF) at preferred walking speed (PWS) and with increasing stride frequency is not different from the basic WRTSF and 2) that the WRTSF is independent of the initial speed/frequency combination of walking until the basic WR-transition.

METHODS

Eighteen healthy participants were recruited (13 men and 5 women, age; 23.9 ± 1.5 years, height; 1.77 ± 0.10 m, body mass; 77.3 ± 12.8 kg). All participants were familiar with treadmill running in advance.

Force sensing resistor footswitches (FSRs, Interlink, USA) were placed under the insole in the right shoe of the participant: 1) under Calcaneus and 2) under the Metatarso-Phalangeal joints 1-2. The sensitivities of the footswitches were adjusted individually for each participant to avoid false triggers.

A 10-minute warm-up/adaptation period was used. The initial treadmill (Woodway XL Pro, Waukesha, USA) speed was set at 1 km/h and increased by 1 km/h each minute until the final speed at 10 km/h was reached. Following 4 minutes rest, the 'preferred' or 'basic' WR-transition speed (BTS) and stride frequency were determined: the initial treadmill speed was set at 5 km/h and increased by 0.1 km/h each 10 seconds until a final speed of 9 km/h was reached. After additional 4 minutes rest the 'preferred' walking speed was determined: the walking speed was initially set at 0 km/h and the participants were instructed to change the speed of the treadmill until the preferred walking speed (PWS) (and stride frequency) was found. No feedback concerning treadmill speed was given. After another 5 minutes of rest, 4 tests involving stride frequency modulation were executed at 4 different speeds: 1) PWS, 2) WS25 = PWS+0.25(BTS-PWS), 3) WS50 = PWS+0.50(BTS-PWS) and 4) WS75 = PWS+0.75(BTS-PWS). The order of the execution of the four stride frequency modulations was randomized. At each speed, the participant adapted to their preferred stride frequency and the metronome set accordingly, and after 30 seconds with this constant stride frequency, the metronome beat frequency was changed by 2 strides each 15th second and the participant should follow the beat until the WR-transition emerged. To verify the transition, participants were equipped with a hand-switch to utilize whenever they felt the WR-transition occurred. The sampling frequency of the footswitches signals was 1000 Hz. Data were processed in MATLAB (R2018A, The MatWorks BW, Natrick, USA). Stride-to-stride duty factors were extracted, and the WR-transitions were determined based on the abrupt changes in this parameter at transition combined with the hand-switch signal when available. Transition speeds and stride frequencies for all situations were determined.

A paired t-test was applied for the comparison of the basic WRTSF and the WRTSF induced at PWS. A One-Way Repeated Measures ANOVA combined with a Holm-Sidak post hoc test was used to examine differences in WRTSF's in the frequency modulation tests.

RESULTS

1) There was no significant difference between the basic WRTSF (open circle in Fig. 1) and the WRTSF at PWS (diff: 4.4±10.8%, $p < 0.096$) and 2) There were differences between the WRTSF's in the frequency modulation tests ($F_{(17,3)} = 3.79$, $p \leq 0.0013$) and WSTSF at PWS was significantly lower than WSTSF at WS75 ($p < 0.009$).

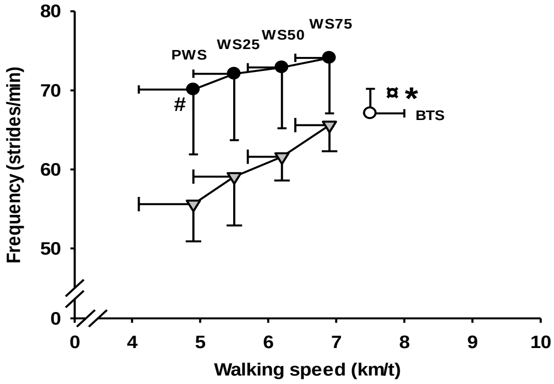

Fig. 1 *WR-transition frequencies (circles) and initial frequencies before frequency modulation (triangles). For abbreviations see text. ¤ PWS vs. BTS n.s, * BTS < WS25, WS50, WS75 (p<0.004) and # WS25 < WS75 (p<0.031).*

DISCUSSION

Our first hypothesis was confirmed, since no difference was found between the basic WRTSF and the WRTSF by frequency modulation at PWS. Our second hypothesis was not confirmed, since WRTSF's during frequency modulation increased with increasing initial walking speed.

According to the work of Hansen et al. [2] and the present study, it is suggested that the critical WRTSF may depend on a specific critical dynamic state of the moving body, which is sensitive to many different factors. The present data indicate that specific movement history before the WR-transition is one of the factors that can have an influence on the critical WRTSF.

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A NEW DEVICE FOR MEASURING FORCES IN THE FOOTREST AND SEAT DURING SPRINT KAYAKING

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INTRODUCTION

The paddler develops forces in the shaft during kayak paddling, which are transferred through the body to the kayak by two contact points in the kayak: the seat and the footrest[4]. Forces produced in the lower legs contribute positively to the velocity of the kayak during flatwater kayaking[1,2,3]. Brown et al. (2010) investigated the activation of the major muscles in the legs thorughout a stroke cycle in eight international level paddlers (six men and two women). The study reported a strong activation of the major muscle groups in the trunk and the legs during the stroke cycle. A study by Lee Chong-hoon et al. (2014) showed that the legs contribute with 6% of the total force production. In addition, Nilsson & Rosdahl (2016) investigated the leg kick during maximal velocity kayaking. The maximal velocity dropped 16% when the legs where restricted compared to non-restricted leg movement. These three studies underline the importance of the leg kick during a kayak stroke cycle[1,2,4].

There are currently no studies that have investigated the forces applied on the seat of the kayak. However, with the seat being one of two contact points between athlete and kayak, forces are evidently applied here as well.

Michael et al. (2010) compared a regular fixed seat with a swivel seat (a seat that allows ratation around the central axis) on a kayak ergometer. The swivel seat produced 6.5% higher power output. This underlines that the seat-type might have a significant influence on the performance[3].

The purpose of this study is to develop a device to measure the forces transferred from the paddler to footrest and seat during on-water kayaking. It is essential that this device does not influence the paddling technique.

METHODS

Three force transducers (LCM200 Miniature Tension and Compression Load Cell, Futek -10 Thomas, Irvine, CA 92618, USA) were implemented in the devices: two in the footrest and one in the seat. The footrest device consists of a metal plate shaped like a Nelo fourth generation footrest. The footrest device is displayed in Figure 1. Aluminum spacers are screwed onto the plate, together with two Futek load cells, threaded into the metal plates of the footrest. Two separated plates are screwed onto the spacers.

The two plates are separated on the left- and right-hand side of the footrest, thus making it possible to distinguish between left- and right-side forces. Rubber O-rings has been added between the screws to minimize shear forces and noise in the signals.

The footrest forceplate is fixed to the original frame of the footrest and fits into a Nelo 4th gen. kayak.

A Nelo seat was used for the seat device. This seat was fixed on a linear ball bearing (T rail TW-01 drylin®), gliding on a steel profile. A Futek load cell was attached between the sliding seat and a metal bar. This metal bar was fixed to the seat frame of the kayak and must be moved in order to place the seat in the preferred seat-footrest distance.

A portable custom-built data acquisition system consisting of a LattePanda microcontroller running MATLAB in Windows 10 was constructed. A DAQ NI USB-6009 (National Instruments, Austin, Texas) was used as A/D converter. A single-ended setup was used. A biovision force amplifier (Biovision, Wehrheim, Germany) was placed between each transducer.

Each force transducer required an excitation voltage of +/- 10 V. Each force transducer sampled with a frame rate of 1000 Hz. An Anker power bank (Anker, Seattle, USA) of 20100 mAh powered the setup with 5 V and 4.8 A.

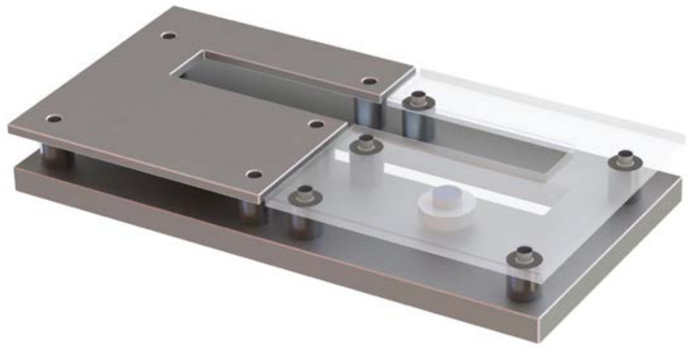

Figure 1: *Illustrates the footrest design. The right part of the footrest is shown transparent for visual clarification.*

The top plates are made of 4 mm aluminum (Figure 1). Each aluminum plate rests on five aluminum plugs that are secured with five screws and a rubber O-ring in between. The thickness of the plate enables bending whenever a force is applied. The bending of the plate enables the force transducer to measure forces. The current setup can measure the leg kick in flatwater kayaking.

Next step is to validate the current setup.

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ESTIMATION OF SPINAL LOADING DURING MANUAL MATERIALS HANDLING USING ONLY INERTIAL MOTION CAPTURE AND PREDICTED GROUND REACTION FORCES - A VALIDATION STUDY

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INTRODUCTION

Musculoskeletal models are often used to gain insight into the internal loading of the musculoskeletal system. Typically, these models use measurements of kinematics and ground reaction forces and moments (GRF&Ms) to compute the joint contact forces bottom up. However, these measurements often require a complex setup of infrared cameras, reflective markers and force plates, and is usually limited to laboratory environments. Recently, a study showed that these joint contact forces can be estimated accurately during gait based exclusively on inertial motion capture (IMC) and musculoskeletal modeling [1]. If this system can provide accurate estimations of joint loads outside a laboratory environment, it would provide important opportunities to assess musculoskeletal loads in the field, as for instance, during ergonomic job evaluation. Therefore, the aim of the present study was to validate the estimation of L4-L5 spinal forces based on a musculoskeletal model driven exclusively using IMC data and ground reaction force prediction during various lifting and transferring tasks. This approach will help determine if musculoskeletal models driven by IMC data and ground reaction force prediction can be used to estimate spinal loading during MMH tasks in the field.

METHODS

Nine healthy males and 4 healthy females (age 25.7 ± 3.4 years, height 179.3 ± 7.8 m, weight 76.4 ± 12.8 kg) volunteered to participate in the study. All subjects performed six different lifting tasks and two transferring tasks in their own pace, including symmetrical lifting (5-20kg box), asymmetrical lifting (5-10kg box) and load transferring (10kg box and 5kg weight). Motion analysis was performed simultaneously using optical motion capture (OMC) and IMC, specifically a Qualisys marker-based system (Qualisys, Göteborg, Sweden) and 17 inertial measurement units (Xsens MVN Awinda, Xsens Technologies BV, Enschede, The Netherlands). GRF&Ms were measured using floor-mounted force plates (AMTI, Watertown, MA, USA). Based on these measurements, two biomechanical models were constructed in the AnyBody Modeling System [2] to estimate the L4-L5 joint reaction forces: 1) OMC and measured GRF&Ms OMC-MGRF) and 2) IMC and predicted GRF&Ms (IMC-PGRF).

RESULTS AND DISCUSSION

Table 1 shows relative root mean square error (rRMSE) between the OMC-MGRF and IMC-PGRF models. The rRMSE ranged from 21.35 % to 28.44% for SYM and ASYM while rRMSE were 56.83% and 78.40% for TRA-BOX and TRA-OH, respectively. Fig. 1 shows a Bland-Altman plot comparing L4-L5 axial compression force for OMC-MGRF and IMC-PGRF with a mean -0.021 log(%BW). Errors between IMC-PGRF and OMC-MGRF might be related to differences in scaling methods, full-body kinematics and prediction of GRF&Ms.

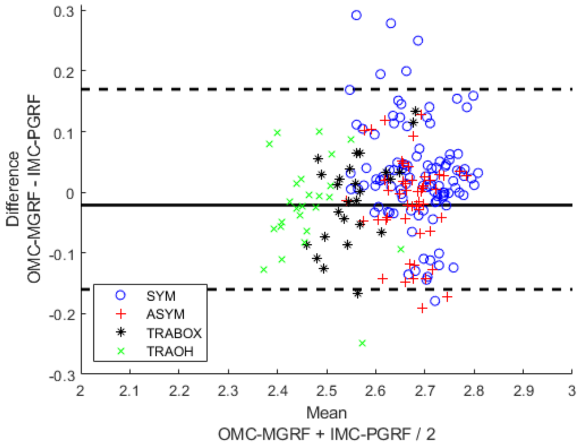

Fig. 1 Bland Altman plot comparing L4-L5 axial compression force log(%BW) for the two biomechanical models showing the mean (solid line) and upper and lower limit of agreement (dashed lines). Blue circles represent symmetric lifting, red plus sign asymmetric lifting, black asterisk box transferring, and green cross one-handed dumbbell transferring.

CONCLUSION

The present results showed L4-L5 axial compression forces were underestimated for IMC-PGRF compared with OMC-MGRF with outliers. IMC-PGRF models should therefore be used with caution to estimate L4-L5 joint load in the field.

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Table 1 rRMSE (mean ± SD) for L4-L5 axial compression force IMC-PGRF versus OMC-MGRF for the eight lifting scenarios.

	Agreement between L4-L5 axial compression forces (%BW)							
	SYM 5	**SYM 10**	**SYM 15**	**SYM 20**	**ASYM 5**	**ASYM 10**	**TRA-BOX**	**TRA-OH**
rRMSE	26.96	23.35	27.42	28.44	22.47	21.35	56.83	78.40
(%)	±21.17	±11.49	±21.17	±21.45	±12.60	±11.85	±36.29	±41.85

Scapular Muscle Activity in Healthy Individuals during Serratus Punch Exercises

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INTRODUCTION

Scapulothoracic (ST) dysfunction is commonly seen in relation to shoulder pathologies. It has been suggested that patients with ST dysfunction show increased activation of the upper trapezius (UT), while the serratus anterior (SA) is not activated enough. Rehabilitation programs that restore normal scapular movement by strengthening the SA, while minimally activating the UT, could therefore be helpful[1]. As such the UT/SA muscle activity may be a relevant outcome. The UT/SA muscle activity ratio during various relevant shoulder rehabilitation exercises is yet to be investigated. Thus, the purpose of the present study was to assess the UT/SA muscle activity ratio in healthy individuals, during different scapular punch exercises.

METHODS

A single session, controlled laboratory study, measuring the UT, middle trapezius (MT), lower trapezius (LT) and SA activity, using surface electromyography (sEMG) was performed. Bipolar electrodes on the three trapezius muscle parts were applied according to the SENIAM guidelines. The SA electrodes were applied below the axilla, anterior to the latissimus dorsi and posterior to the pectoralis major.

Eight healthy, right handed, subjects participated in the study. They performed 14 well known shoulder rehabilitation exercises. Three of these exercises; the serratus punch in three different positions (table 1), were analyzed further. Peak EMG activity for each muscle of interest was determined for normalization, using MVIC contractions through manual muscle tests.

All analyses were done using SAS software. A repeated measurements linear mixed model was used. A statistically significant interaction was broken down (post hoc), using paired t-tests. Level of significance was set to 5% (P = 0.05).

RESULTS AND DISCUSSION

No statistically significant differences were found between the UT/SA ratio of activity between positions (figure 1). However, results may reflect a pattern of decrease in the UT/SA ratio of activity when increasing the angle of action from 90° to 120° on the right side. It is evident that the UT/SA ratio is similar at 120°, when changing positions from standing to side lying. This holds true for both sides. This was expected since the elimination of gravity is equally reduced for both muscles when changing positions.

It is important to address the very small sample size in this study, which renders any conclusions tentative. Further research is needed to determine if the pattern suggested here holds true, why there is a change in ratio of activity and to see how the activity in each muscle changes throughout the different exercises.

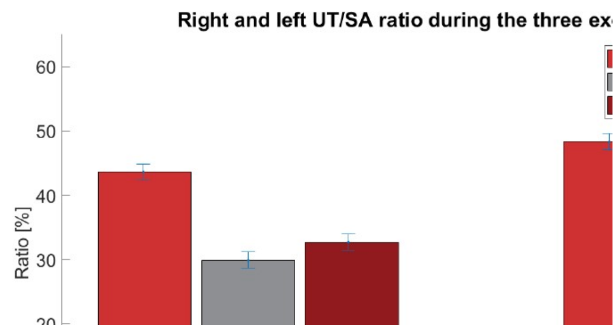

Figure 1 - UT/SA ratio during the three serratus punch exercises for both the right and left arm

CONCLUSIONS

The results of this study do not show any statistically significant difference in the UT/SA muscle activity ratio in any of the exercises.

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Table 1 - The SA exercises, start position and description of movement.

Position	Exercise	Start position	Description of movement
Standing	SA punch, 90°	Shoulder flexed to 90°. Arm fully extended, holding an EB, hand 120 cm from the wall. Scapula fully retracted.	Protraction against the resistance of EB.
Standing	SA punch, 120°	Shoulder flexed to 120°. Arm fully extended holding an EB, hand 120 cm from wall. Scapula fully retracted.	Protraction against the resistance of EB.
Side lying	SA punch, 120°	Shoulder in 120° flexion and the elbow extended.	Protraction in the horizontal plane.

DYNAMICS OF POSTURAL CONTROL IN ELITE SPORT RIFLE SHOOTERS

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INTRODUCTION

Standing rifle shooting is a highly technical Olympic sport that requires extreme accuracy from the sport rifle shooters (SRS), and postural control has been identified as a critical factor for performance [1]. Quantification of the dynamics of the center of pressure (COP) trajectories during upright stance has been used to investigate the postural control in different populations [2,3]. However, it is unknown how the COP dynamics of SRS during two-legged and single-legged stance differs from that of non-sport shooters (NSS). Furthermore, it is unknown how COP dynamics is related to shooting performance.

The purpose of the present study was: 1) to investigate if the dynamics of postural control differs between SRS with extensive postural control training background and untrained NSS, and 2) to investigate if there is a correlation between the dynamics of postural control and level of performance during shooting.

METHODS

Thirteen SRS ranging from Danish national level to world-class level (males/females: 6/7, mean±SD age: 20.2±4.0yrs, body weight: 71.0±14.0kg and body height: 174±11.0cm) and eleven NSS (males/females: 4/7, mean±SD age: 28.1±4.9yrs, body weight: 71.1±10.5kg and body height: 175.2±9.0cm) performed two 90s barefooted standing tasks: 1) shoulder wide on both feet (BF) and 2) unilateral stance on the right foot (RF) with hands kept akimbo. Then, only the SRS performed a 20-shot competition-like standing rifle shooting task. Both tasks were performed on a force plate (AMTI AccuPower) and anterior-posterior (AP) and mediolateral (ML) COP trajectories from 60s of standing and from the last 9s prior to each shot were extracted. To assess the dynamics of the postural control, four different nonlinear methods were applied to the COP trajectories: sample entropy (SaEn) to quantify regularity, the largest Lyapunov exponent (LyE) to quantify rate of trajectory divergence, entropic half-life (EnHL) to quantify the level of time dependency, and the correlation dimension (CoD) to quantify dimensionality. A two-way mixed design ANOVA was used to test the effect of group, task and their interaction on the dependent variables during the standing task. A Pearson correlation analysis investigated the relationship between the level of performance and the dependent variables during the shooting task. The significance level was set at 0.05.

RESULTS

There was a significant overall effect of group on SaEn and CoD in AP and ML ($p<0.001$). The SRS had significantly lower SaEn and CoD than the NSS (Figure 1). There was a significant effect of task for all extracted variables in AP and ML (Figure 1). There was a significant group-task interaction on the RF on SaEn AP and ML, LyE and EnHL ML, and CoD AP ($p<0.001$), and on both BF and the RF on CoD ML ($p=0.002$ and $p=0.014$) (Figure 1). There was a significant group-task interaction on both the SRS and the NSS in SaEn AP ($p=0.027$ and $p<0.001$), LyE AP ($p=0.026$ and $p<0.001$) and EnHL AP ($p<0.001$ and $p<0.001$) (Figure 1), on only the NSS in SaEn, LyE and EnHL ML ($p<0.001$) and CoD AP ($p=0.002$), and on only the SRS on CoD ML ($p=0.018$) (Figure 1). The correlation analysis between the four different non-linear parameters in the AP and ML directions and the level of performance of the SRS showed no correlation.

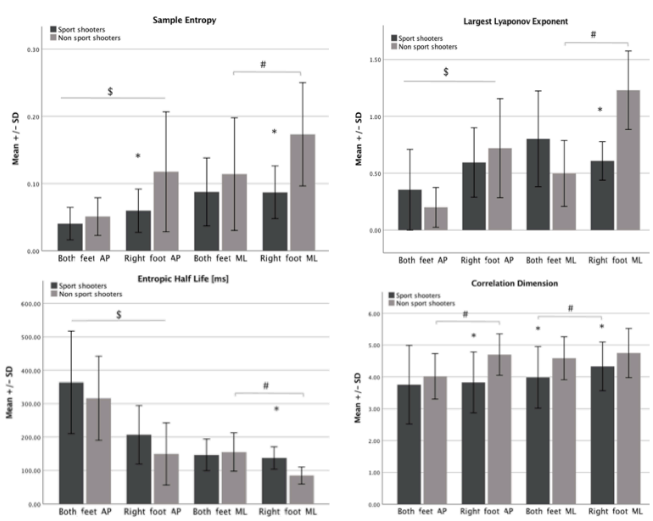

Figure 1: SaEn (top left), LyE (top right), EnHL (bottom left) and CoD (bottom right) in AP and ML direction for BF and RF, * indicates significant group difference, $ indicates overall significant task difference and # indicates significant task difference within a group.

CONCLUSIONS

The present study suggests that extensive training in maintaining upright quiet standing may be associated with altered postural control as the SRS solved the challenging nature of the unilateral task by use of a less complexed movement pattern compared to the NSS. However, during the standing shooting task, no correlation was found between the level of performance and the COP dynamics, suggesting that other parameters than the postural control (e.g. aiming accuracy and strategy, mental strength and ability to maintain high concentration) is determining for the performance of SRS at a high level.

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ACKNOWLEDGEMENTS

The authors thank The Danish Sport Shooting Association for helping with subject recruitment.

BODY DISCOMFORT AND TRUNK MUSCLE ACTIVATION DURING A WRITING-TASK ON A DYNAMOSTOL INCHARGE CHAIR WITH EITHER A STABLE OR UNSTABLE BASE OF SUPPORT

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INTRODUCTION

Lower back pain (LBP) is the most common work-related injury and the leading cause of absenteeism from work [1]. Prolonged sitting is proposed to be a risk-factor for the development of LBP. However, it has recently been shown that sitting duration alone does not lead to LBP [2]. A potential factor influencing the level of LBP is the degree of spinal movement during sitting [3]. Indeed, it has been hypothesized that chairs with an unstable base of support may increase spinal motion leading to less muscle fatigue due to alternating muscle activation [4]. The purpose of the present study was to compare perceived body discomfort and trunk muscle activation during a writing task on a Dynamostol InCharge with either a stable of unstable base of support.

METHODS

Sixteen healthy subjects (25±1 year, 182.8±6.5 cm, and 82.4±16.9 kg) volunteered to participate in this randomized cross-over study. Upon arrival to the lab, the subject had electromyography (EMG) electrodes placed over the external oblique (EO), internal oblique (IO), rectus abdominis (RA), superficial lumbar multifidus (LM), iliocostalis lumborum pars thoracis (ICLT) and thoracic erector spinae (TES) in accordance to the SENIAM recommendation. Thereafter, subjects were instructed to perform the plank for 30 seconds for assessing submaximal activation of trunk muscles. EMG data during the exercise was extracted and used for normalization of EMG data during the typing task with.

The subjects performed two, 10-minute typing tasks; one performed on a Dynamostol InCharge with a stable base of support (static), and the other on a Dynamostol InCharge with an unstable base of support (dynamic). Neither of the chairs had a backrest. The order in which chair the subjected sat in first was randomized. During the tests, 5-second epochs of EMG data were collected each minute to determine the level of muscle activation. Moreover, the subjects rated their discomfort using the body part discomfort scale prior to, half-way through, and upon completion of the task [5].

The middle 3 seconds of each epoch of raw EMG data from the typing task were processed using a root-mean-square algorithm, expressed as %SMVIC.

A repeated measures ANOVA was used to compare the muscle activity over time for each chair, as well as comparing the difference of muscle activation between the chairs.

RESULTS AND DISCUSSION

No differences (P>0.20) were found in mean values of the epochs for any of the muscles, when comparing the static to the dynamic chair (Table I). Lower back discomfort measurement from the BPDS showed a significant main effect of time, with discomfort gradually increasing from pre (0.16±0.45) to half-way (0.35±0.75) and post (0.65±1.08) (P<0.01), but no main effect of chair (P=0.79) or interaction effect (Time×Chair) was found (P=0.82).

The results are in line with previous studies suggesting that dynamic sitting does not result in major differences in muscle activation [4,6]. It is possible that adjustments of postural control on the unstable chair are maintained by trunk muscles lying deeper than those measured in the present study. Moreover, the relative short duration of the typing task may have limited the likelihood of capturing any significant differences in muscle activation and discomfort.

CONCLUSIONS

The chair with the unstable base of support did not lead to any differences in muscle activation in any of the examined muscles, nor did it lead to a decrease in discomfort of the lower back, when compared to the chair with the stable base of support.

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Table I – Mean muscle activity during typing task as a percentage of side plank test (SMVIC) (±SD). External oblique (EO), internal oblique (IO), Rectus abdominis (RA), superficial lumbar multifidus (LM), Iliocostalis lumborum pars thoracis (ICLT) and thoracic erector spinae (TES) (N=16).

	EO	IO	RA	LM	ICLT	TES
Static (%SMVIC)	0.9 ± 0.6%	4.2 ± 3.2%	2.1 ± 1.5%	3.2 ± 2.9%	1.5 ± 1.5%	4.6 ± 3.6%
Dynamic (%SMVIC)	0.8 ± 0.5%	4.2 ± 3.7%	2.1 ± 1.6%	3.2 ± 2.7%	1.3 ± 1.0%	4.5 ± 3.6%

ANODAL TRANSCRANIAL DIRECT CURRENT STIMULATION DOES NOT IMPROVE VOLUNTARY ACTIVATION LEVEL OR MAXIMAL VOLUNTARY CONTRACTION IN QUADRICEPS

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INTRODUCTION
Anodal transcranial direct current stimulation (a-tDCS), a non-invasive brain stimulation technique, has previously been used to increase cortical excitability [1]. Moreover, a-tDCS has recently been investigated as a potential ergogenic aid in sports. For instance, maximal voluntary contraction (MVC) [2,3] has been shown to increase following stimulation. The mechanisms responsible for the positive effects of a-tDCS are still widely unknown, but it has been hypothesized that increases in voluntary activation levels (VAL) may play a signficant role [2]. The purpose of this study was therefore to investigate the effects of a-tDCS on cortical excitability, MVC, and VAL. We hypothesized that a-tDCS would lead to increases in cortical excitability resulting in increased MVC due to increased VAL.

METHODS
Nine healthy male participants (25±3 years, 185.0±4.5 cm, and 89.6±19.4 kg) were recruited for this randomized sham-controlled experiment. All participants were untrained and had not performed strength training at least six months prior to the experiment. The participants reported to the lab on two separate days, with at least seven days in between, where they received either a-tDCS or sham-stimulation. At each test day: 1) baseline cortical excitability, 2) MVC, and 3) VAL were assessed prior to receiving either a-tDCS or sham-stimulation. Ten minutes post-stimulation cortical excitability, MVC and VAL were assessed again to evaluate the effects of the two types of stimulation.

Transcranial magnetic stimulation was used to assess the cortical excitability of the cortical representation at M1 of the right rectus femoris, by averaging 20 motor evoked potentials elicited with 120% of the threshold stimulation intensity. Femoral nerve stimulation was applied to determine the VAL. A current intensity at two times the intensity of the M_{max} was used. The first stimulation was applied manually at the plateau of the MVC and the second stimulation ~5 seconds after the MVC in a relaxed state. Anodal-tDCS and sham-stimulation was applied through saline-soaked sponge electrodes (5x7 cm) with the anode placed over the motor representation of the right rectus femoris and the cathode centered over the contralateral deltoid muscle. During the a-tDCS condition, the electrical current amplitude was ramped up over 30 seconds to 2 mA and kept constant for 9 minutes and ramped down again over 30 seconds, this procedure was repeated three times separated by two 5-minute breaks. During the sham-stimulation the current was ramped up to 2 mA over 30 seconds, and then ramped down over 30 seconds to zero again followed by 9 min without stimulation. This procedure was repeated three times with two 5- minute breaks.

Two-way ANOVAs were carried out to assess differences in the MVC and VAL pre to post a-tDCS or sham-stimulation. T-tests were carried out to determine the differences in cortical excitability pre and post a-tDCS and sham-stimulation.

RESULTS AND DISCUSSION
The results of the present study showed that the cortical excitability was significantly higher following a-tDCS (Table I). However, this increase in cortical excitability did not result in any changes in MVC (P>0.72) or VAL (P>0.33) (Table 1). The lack of improvements may be due to a ceiling effect, i.e. further increases in cortical excitability may not improve recruitment and/or increase firing rates of motor units in healthy subjects as the M1 may have a preexisting high excitability. So, if the motor cortex is pre-exited in healthy subjects further cortical excitation should have no effect on MVC and VAL [4].

CONCLUSIONS
In conclusion, the a-tDCS protocol applied in the present study resulted in increased cortical excitability. However, this increase did not lead to improvements in either MVC or VAL.

ACKNOWLEDGEMENTS
We would like to thank the participants who volunteered to participate in the study.

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Table I – The average pre and post scores and the percentage differences in motor evoked potentials (MEP), maximal voluntary contractions (MVC) and voluntary activation levels (VAL) following a-tDCS and sham-stimulation (N=9). *: P<0.05

	a-tDCS			Sham		
	Pre	**Post**	**% ∆**	**Pre**	**Post**	**% ∆**
MEPs (µV)	415.19 ± 366.97	564.06 ± 415.22*	45.53 ± 63.74	484.92 ± 628.99	404.71 ± 405.37	-3.11 ± 20.66
MVC (N)	994.25 ± 237.79	984.28 ± 254.43	-1.60 ± 7.07	1043.1 ± 235.0	1015.0 ± 227.51	-2.33 ± 5.70
VAL (%)	86.04 ± 8.75	87.38 ± 8.71	1.67 ± 4.95	87.21 ± 5.05	86.25 ± 9.14	-1.22 ± 7.60

VARIABILITY OF FOOT STRIKE CHARACTERISTICS IN RUNNERS WITH DIFFERENT SELF-REPORTED RUNNING RELATED INJURIES

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INTRODUCTION

While traditional kinematic and kinetic based movement analysis requires advanced and expensive laboratory setting, the use of pressure plate instrumented treadmills can provide easy accessible information of the foot strike characteristics during locomotion. Such assessments could be relevant for analyses, rehabilitation and prevention of running injuries. While running related overuse injuries have been linked to the level of lower limb coordination variability [1,2], it is unknown if similar links exist between lower limb injuries and foot strike variability. The present study investigated the variability in foot strike characteristics in runners with self-reported running related injuries. We hypothesized that injured runners would exhibit a different amount of variability in their foot strike characteristics compared to healthy runners.

METHODS

Eighty-three recreational runners with self-reported running-related injuries and twenty-five non-injured runners were included in the study (Table 1). The injured participants were divided into three groups depending on the location of the reported injury (hip group n=12, knee group n=25 and ankle group n=46) (Table 1). All participants completed three minutes running on a pressure plate instrumented treadmill at their self-selected running speed and data from 140 steps were extracted. Mean, and coefficient of variation were calculated from the time series of contact time, peak vertical ground reaction force, total impulse and step time. Additionally, the variation of center of pressure trajectory was calculated. To investigate the effect of group on the scalar variables a one-way ANOVA was applied with a Holm-Sidak post-hoc test. Statistical parametric mapping (SPM) was applied to investigate the effect of group on the variation of center of pressure trajectory. Level of significance was set at 5%.

RESULTS

No differences were observed between groups in the mean and coefficient of variation of the investigated variables. The variation of center of pressure trajectory was significantly lower in the injured groups compared to the non-injured group (figure 1).

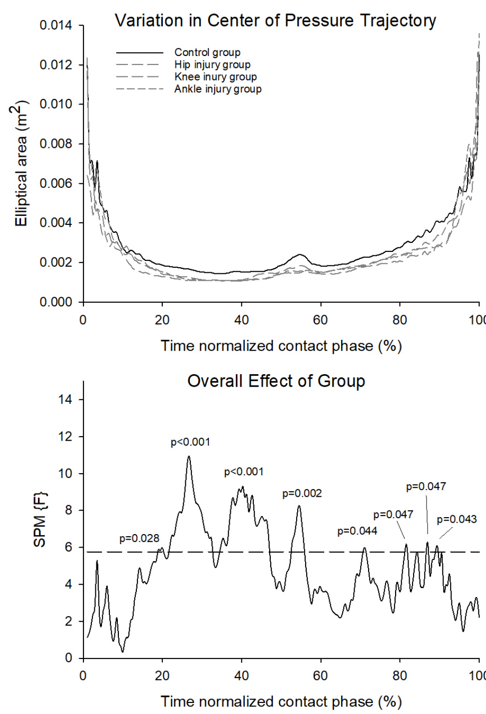

Figure 1: Top graph: The elliptical area plotted as a function of the time normalized contact phase for the uninjured control group and the three injured groups. Bottom graph: SPM analysis of the overall effect of group on the elliptical area. SPM{F} above the dashed line (F*) indicates a significant effect of group.

CONCLUSIONS

In conclusion, the present study observed that recreational runners with self-reported injuries had lower variation in the center of pressure trajectories compared to uninjured runners. This confirms our hypothesis and supports an elaboration of the theory proposed by Hamill and colleagues to include the variation in center of pressure trajectory in the link between coordination variability and running injuries.

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Table 1: Number of participants (M=males, F=females) and mean and standard deviation of age, body mass, body height, investigated running speed, normal training volume, normal training pace for the four groups. NB: When tested with a one-way ANOVA, no significant group differences were observed.

	Control group	Hip injury group	Knee injury group	Ankle injury group
Number (M/F)	25 (10/15)	12 (7/5)	25 (15/10)	46 (34/12)
Age (years)	32.5 ± 13.4	42.6 ± 12.0	38.7 ± 9.2	34.4 ± 11.5
Body mass (kg)	65.6 ± 13.3	71.2 ± 10.2	72.1 ± 12.3	73.7 ± 13.0
Body height (m)	1.73 ± 0.09	1.76 ± 0.07	1.77 ± 0.10	1.78 ± 0.09
Speed (km/h)	10.6 ± 1.0	10.8 ± 1.4	10.6 ± 1.0	10.5 ± 1.3
Training volume (km/week)	32.6 ± 14.6	37.2 ± 23.1	30.5 ± 26.4	38.3 ± 30.9
Training pace (min:sec/km)	5:40 ± 0:39	5:39 ± 1:03	5:48 ± 0:32	5:27 ± 0:35

DYNAMICS OF POSTURAL CONTROL IN INDIVIDUALS WITH LATERAL ANKLE SPRAIN

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INTRODUCTION

The center of pressure (CoP) trajectory reflects the neuromuscular processes executed to maintain postural control. It has previously been suggested that individuals with ankle instability rely more on visual input to maintain postural control during unilateral stance compared to healthy individuals [1]. The present study tested this notion by assessing the dynamics of CoP trajectory in individuals with previous lateral ankle sprain (LAS) and ankle instability, as well as healthy controls during unilateral stance with and without visual input. We hypothesized that the CoP dynamics of individuals with LAS during unilateral stance with no visual feedback would be characterized by lower regularity, higher dimensionality and shorter time dependency compared to healthy controls. In contrast, the characteristics of the CoP dynamics during unilateral stance with visual input were expected not to differ between groups.

METHODS

Sixteen individuals with previous LAS (males/females: 9/7, mean±SD age: 30.9±4.7 yrs, body mass: 73.4±11.9 kg and body height: 176.4±9.5 m) and nine healthy controls (CON) (males/females: 7/2, mean±SD age: 29.3±4.5 yrs, body mass: 72.5±11.3 kg and body height: 178.6±11.5 m) performed 30 seconds of shod unilateral stance (on the affected leg for the LAS individuals and preferred leg for the healthy controls) with 1) eyes open (EO) and 2) eyes closed (EC). Anterior-posterior (AP) and mediolateral (ML) CoP trajectories were extracted from the middle 20 seconds of each trial, filtered using a Daubechies wavelet and down sampled to 100Hz. To assess the dynamics of the postural control, three different nonlinear methods were applied to the CoP trajectories: sample entropy to quantify regularity, the correlation dimension (CoD) to quantify dimensionality, and entropic half-life (Ent) to quantify the level of time dependency [2]. To investigate the effect of task (EO vs EC), group (LAS vs CON), and the task-group interaction on the dependent variables, a two way mixed-design ANOVA was applied. In case of an overall effect, a Holm-Sidak post hoc test was applied. Level of significance was set at 5%.

RESULTS AND DISCUSSION

There was a significant effect of task (p=0.003) and group (p=0.028) on SaEn in the AP direction and a significant interaction (p=0.019) on the SaEn in the ML direction. The post hoc test revealed that CON had a significant lower regularity (higher SaEn) compared to LAS for the eyes open task (p=0.013, Figure 1). There was a significant effect of task (p=0.001) on CoD in the ML direction, indicating that the CoP trajectory during EC had lower dimensionality compared to during EO (Figure 1). There was a significant effect of task (p=0.001) on Ent in the AP direction, indicating that the CoP trajectory during EC had shorter time dependency compared to during EO. There was a significant interaction (p=0.028) on the Ent in the ML direction. The post hoc test revealed that CON had significantly shorter time dependency (p=0.024) during EO compared to LAS.

We could not confirm our hypothesis as we did not observe concomitant group differences in the CoP dynamics during EC and no group differences during EO. The significant effect of visual information for Ent in the AP direction but not in the ML direction suggests that visual feedback plays a more pronounced role for AP postural control.

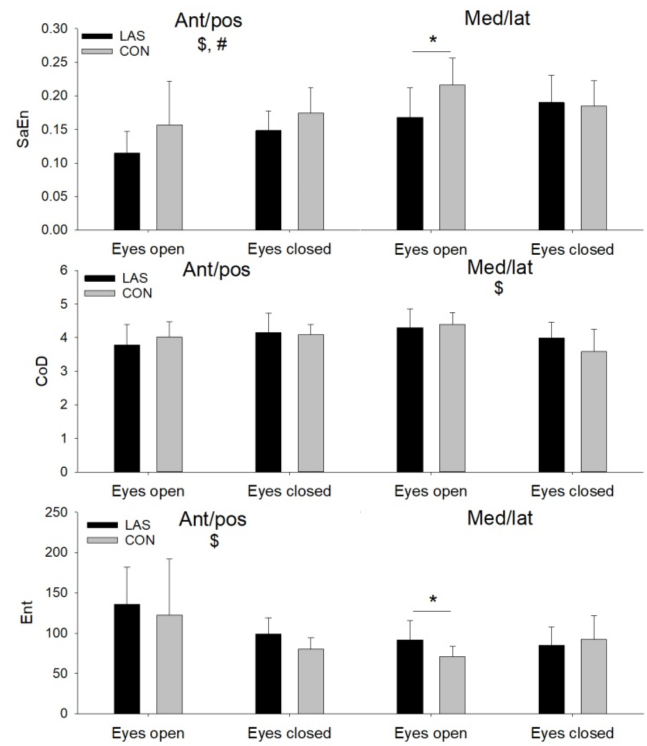

Figure 1: SaEn (top), CoD (middle), and Ent (bottom) in anterior/posterior and mediolateral direction for unilateral stance with eyes open and eyes closed for the CAI and CON group. $) indicates a significant effect of task, #) indicates a significant effect of group, and *) indicates a significant interaction effect and a significant group difference within a task.

CONCLUSIONS

The present study did not support the notion that individuals with LAS rely more on visual input during unilateral stance compared to healthy controls. However, higher regularity in the CoP trajectory was observed suggesting that the motor control system of LAS individuals rely on fewer functional degrees of freedom to maintain postural control [3].

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HOW DIFFERENT IS THE NEW BADMINTON SERVE?

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INTRODUCTION

The International Badminton Federation has imposed new rules for the serve. In the old rule, the racket head had to be below the lowest rib at the time of the serve, which favors tall players because they can launch the shuttle cock from a higher position than players of shorter statures. In the new rule, the shuttle cock has to be hit by the racket below a height of 1.15m for any player.

The change of rules have been received differently in different player populations, so we investigate the statistical consequences of the new rule in doubles using a computational model capable of firing an unlimited number of random serves on which we perform statistical analysis. The model is calibrated with serves performed by a top-class player.

METHODS

One top-10 female doubles badminton player was recruited for the experiment to which she gave informed consent. She performed a number of serves according to the old and new rules, respectively, on a court established in the motion capture lab. The shuttle cock cork was stained with reflective paint, allowing it to be tracked by a Qualisys Oqus system at 500 Hz.

A computational model of ballistic flight with drag was developed using 4th order Runge-Kutta time integration [1]. The initial velocity vector of the serves was fed into the model, which subsequently computed the shuttle cock trajectory. An optimization routine minimized the difference between the measured and simulated trajectories by variation of the aerodynamic properties of the shuttle cock and air, thus identifying the aerodynamic conditions leading to correct simulation.

The identified model was subsequently executed 5000 times from each of the experimentally identified launch heights of the old and new serves respectively, with randomly varying launch velocities and angles, but always in directions that would qualify as "into the T" (Figure 1).

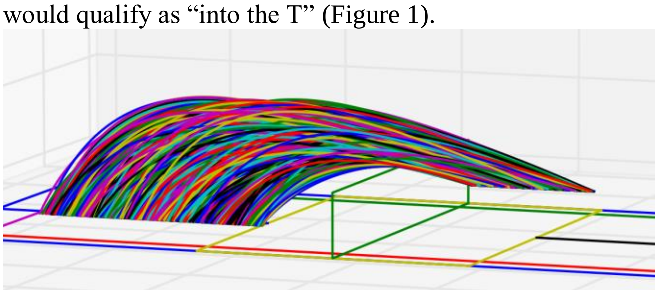

Fig. 1 5000 random serves from 1.21m launch height.

Serves that hit the net or land outside the doubles service box are discarded. The remaining serves are assessed with respect to two criteria:

1. The area of the part of the trajectory that is over net height in the receiver's court.
2. The time-of-flight from launch until the shuttle is 1m past the net on the receiver's side (TF1).

The 100 best serves of the 10,000 performed according to criterion 1 are selected and assessed with respect to criterion 2.

RESULTS AND DISCUSSION

The experiments show that the test subject launches the serves from a mean height of 1.21m with the old rule and 1.02m with the new rule. Out of the 100 best serves according to criterion 1 (Figure 2), 68 are launched from 1.21m and 32 from 1.02m, verifying that it is possible to perform good serves from both launch heights, but it is more difficult from the new, lower height.

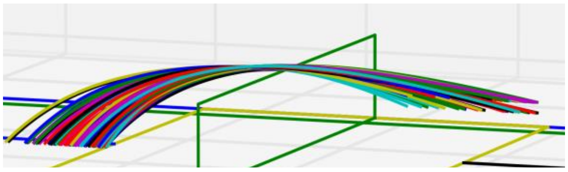

Fig. 2 The best 100 serves out of 10,000.

According to criterion 2 (Figure 3), there is a negative correlation between launch proximity to the net and TF1, indicating that launch positions further back on the court do tend to give the receiver more reaction time. However, a few serves launched from larger distance manage the minimum TF1 of about 0.2s, because the larger distance also requires larger launch velocity and enables an initially flatter trajectory.

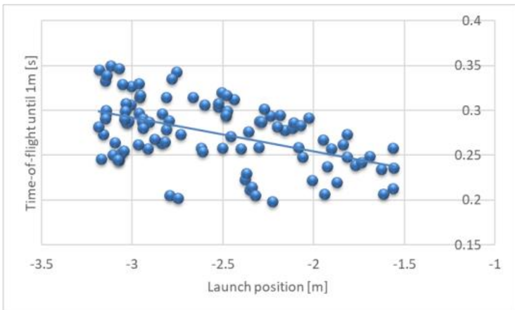

Fig. 3 TF1 for the best 100 serves out of 10,000 as a function of launch position.

CONCLUSIONS

The new serve rule makes it harder but not impossible for the test subject to perform good serves. The goto launch position seems to be close to the net, but alternative solutions with equally good results launched from larger distances are possible and could be exploited as a tactical variation.

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The effect of Nordic Hamstring Exercise as prevention of hamstring strain injury in physically active - A systematic review.

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INTRODUCTION

Hamstring strain injury (HSI) is one of the most common muscle injuries, appearing in a wide range of sports, with a high injury occurrence and recurrence, which does not seem to decrease despite interventions to prevent HSI[1]. There appears to be a consensus about eccentric strength training as a prevention for HSI, which seems to address morphological factors[2,3]. This has led to an increased focus on different exercises and particularly The Nordic Hamstring exercise (NHE) as an efficient intervention to decrease injury occurrence.

The purpose of this study was to determine what influence NHE has on morphological adaptions in the hamstring muscles in connection to prevention of HSI.

METHODS

This study is a systematic review that aimed to answer the research question through a systematic review of the literature. The included studies were based on quantitative data and our primary outcomes were assessed through paraclinical examinations. All three studies underwent "Cochrane risk of bias tool" to assess the internal validity of the included studies.

To perform a thorough literature search, four databases were chosen for this study; Pubmed, CINAHL, Cochrane and PEDro. Beforehand a search profile was made and a PICO-model was used to ensure a systematic search the databases (Figure 1)

P (population)	I (intervention)	C (comparison)	O (outcome)
Sport, sports, athlete, athletes AND Hamstring strain, Hamstring strains, hamstring sprain, hamstring sprains, hamstring injury, HSI strain, sprain, strains, sprains, AND hamstring muscles, bicpes femoris, semitendinosus, semimembranosus	Rehabilitation, rehab, prevention, treatment AND eccentric, eccentric exercise, eccentric training, eccentric strength, EE, Nordic hamstring, Nordic hamstring curl, nordic hamstring exercise, NHE, resistance training, training, strength training	–	En eller flere af følgende: Strength, eccentric strength, fascikel length, muscle length, adaptions, stiffness, muscle thickness, pennation angle, anatomical cross sectional area.

Fig. 1 **T**he PICO-model that was chosen for the systematic search including all words that was used for the search.

Inclusion criteria were: RCT-study, use of NHE, pennationangle, fascicle length or cross-sectional-area as outcome.

RESULTS AND DISCUSSION

The systematic search identified 828 studies, of which three where included. Studies were excluded using in- and exclusion criteria. The quality of the studies where assessed through the assessment tool, of which one study revealed "unclear risk of bias", while the remaining two were assessed as "low risk of bias". The results from the present study indicates, that NHE has a significant positive outcome on some of the morphological adaption, but not all (Figure 2).

	Fascicle length	Angle of pennation	Muscle volume	Average torque angle	Strength	Neural drive	Muscle stiffness
Lovell et al.	BEF ⇩ AFT ⇩	BEF ⇩ AFT ⇧	BEF ⇩ AFT ⇧	BEF ⇧ AFT ⇧	BEF ⇧ AFT ⇧	BEF ⇧ AFT ⇧	-
Seymore et al.	⊥ ⇨	⊥ ⇨	Cross-sectional area * ⇧ Volume * ⇧	* Same for KON ⇧	⊥ ⇨	-	⊥ ⇨
Bourne et al.	* ⇧	-	Cross-sectional area (*) ⇧ Volume * ⇧	-	* ⇧	-	-

⇧ = Positive results

⇨ = Unsure results or no change

⇩ = Negative results

* = significant

⊥ = non significant

- = Not included in the study

Fig. 2 indicates the results of the three studies on morphological adaptions; Fascicle length, Angle of pennation, Muscle volume, Average torque angle, Strength, Neural drive, Muscle stiffness.

CONCLUSIONS

By using NHE as a preventive tool for HSI, some of the morphological factors associated with HSI can be affected. NHE is useful as a part of HSI prevention among physical active adults. However, it doesn't seem to be able to stand alone as the only preventive tool addressing HSI. Furthermore, based on the low number of papers identified in the present systematic review, we cannot be very conclusive.

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FREELY CHOSEN FINGER TAPPING FREQUENCY IS INCREASED BETWEEN LIMBS DURING REPEATED BOUT RATE ENHANCEMENT

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INTRODUCTION

Rhythmic movements such as finger tapping are suggested to be controlled by spinal central pattern generators (CPGs) in collaboration with supraspinal descending input and sensory feedback [1,2]. Previous findings showed an increase of the freely chosen tapping frequency in the second of two consecutive bouts of finger tapping. This phenomenon was termed *repeated bout rate enhancement* [3]. The phenomenon was found when finger tapping was performed with the same hand. The purpose of the present study was to further investigate this phenomenon when the contralateral finger was used in the second bout. It was hypothesized that 1) the freely chosen frequency in unilateral index finger tapping was highly correlated between the dominant and non-dominant hands and 2) a single bout of tapping would subsequently increase the freely chosen frequency of the contralateral index finger.

METHODS

32 healthy subjects (20 men and 12 women, 1.79 ± 0.09 m, 80.5 ± 15.8 kg, and 26.1 ± 5.0 years) participated in two test sessions separated by a three-week washout period [3]. Each session consisted of two consecutive three-minute bouts of index finger tapping with a freely chosen frequency. Bouts were separated by ten minutes of rest. The participants were randomly counterbalanced into two groups. One group tapped with the dominant hand in bout 1 and the non-dominant hand in bout 2 in the first session. In the second session, the order was reversed. For the other group, the order was opposite to that of the first group.

RESULTS

The results showed a significant correlation between the freely chosen frequency of the two hands in bout 1 (r = 0.86, $p < 0.001$). In addition, the tapping frequency increased by 8.2 ± 17.2% ($p = 0.041$) and 14.1 ± 17.5% ($p < 0.001$) when tapping started with the dominant or non-dominant hand, respectively (Figure 1).

DISCUSSION

Perhaps the phenomenon of repeated bout rate enhancement occurs as a result of an increased net excitation of the spinal CPG itself [3,6]. The contralateral transfer of the tapping frequency could indicate that the spinal network between limbs is associated together, as previously proposed [7]. Since the magnitude of enhancement was similar to what was previously reported when tapping with the same hand in both bouts [4,5], a strong connection between the CPGs is expected. However, changes in supraspinal descending drive and sensory feedback cannot be excluded as an explanation.

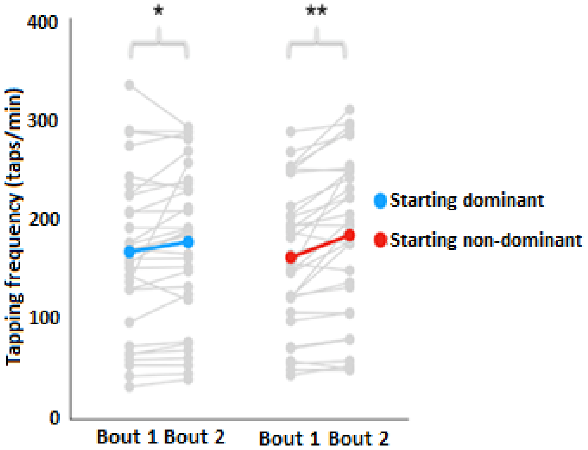

Fig. 1 Tapping frequency as a function of bout. Grey representations illustrate individual data. Grand means are shown as either the blue or red lines for starting with the dominant or non-dominant hand, respectively. *Difference from bout 1 to bout 2, p = 0.041. **Difference from bout 1 to bout 2, $p < 0.001$.

CONCLUSION

In the present study, we found that 1) the tapping frequency was highly correlated between hands, and 2) there was a contralateral transfer of the repeated bout rate enhancement phenomenon in index finger tapping.

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Effect of experimental tibialis posterior muscle pain on muscle recruitment: a parametric study

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INTRODUCTION

Pain and malalignment of the feet are common among patients with rheumatoid arthritis and over 85% of patients with rheumatoid arthritis experience painful feet at some point during the disease. Further, dysfunction of the tibialis posterior muscle has been reported with a prevalence of 64% among patients with rheumatoid arthritis [1].

Redundancy in the physiological function between different muscles gives the central nervous system multiple possibilities in order to perform the same movement [2]. However, if pain is present, the central nervous system might choose a compensation strategy that potentially could lead to further injury [3]. Therefore, in order to recommend the best treatment for foot pain, in-depth insight into the complex foot function is crucial. We combined experimental and computational approaches to investigate which muscles would compensate during experimentally induced pain in the tibialis posterior muscle.

METHODS

Twelve healthy subjects participated in the study. Experimental pain was induced in the tibialis posterior muscle by injecting 1 mL of hypertonic saline (5.0% NaCL) at the upper third point of the tibia via an anterior approach using an ultrasound-guided injection technique [4]. The participants' gait was captured by motion capture and force plates and musculoskeletal models created in the Anybody Modeling System V 7.0.1 (Anybody Technology, Aalborg) were used to systematically investigate compensation mechanisms in the lower leg when tibialis posterior was recruited less as a consequence of the induced pain. The isometric strength of the tibialis posterior muscle was systematically reduced to 40, 50, 60, 70, 80 and 90 % of the default strength.

RESULTS

The mean tibialis posterior muscle force decreased after simulating the experimental pain by lowering the maximal isometric force of the tibialis posterior muscle (Fig. 1), and, at the same time, the force of the flexor digitorum longus and flexor hallucis longus increased.

DISCUSSION

This study demonstrated that experimental tibialis posterior muscle pain and simulated reduced tibialis posterior muscle strength caused altered muscle recruitment and made flexor digitorum longus and flexor hallucis longus muscles compensate for the impairment of the tibialis posterior muscle. The increased muscle force found in the present study could indicate that alterations in muscle recruitment and muscle force distribution could be a contributing factor in the development of toe deformities observed in patients with rheumatoid arthritis (e.g. hallux valgus, claw toes, metatarsal instability, and cross-over-toes.). These foot deformities might be caused when planterflexion and foot invertion is increasingly performed in the forefoot, via the flexor digitorum longus and flexor hallucis longus muscles.

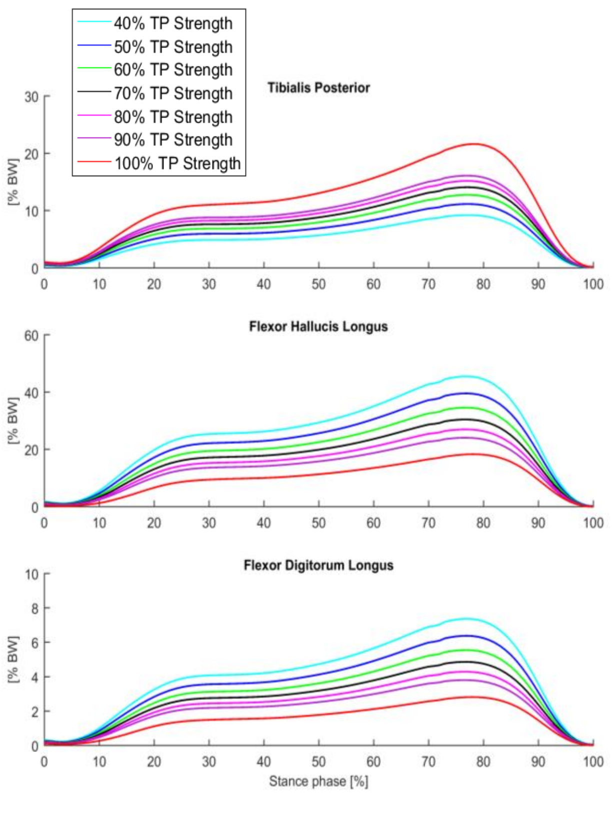

Fig. 1 Mean muscle force of selected muscles of the lower leg for 100, 90, 80, 70, 60, 50 and 40% of default TP muscle strength

ACKNOWLEDGEMENTS

Trygfonden (grant number 124714) and the Danish Rheumatism Association supported this study, (grant number R161-A5276).

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INCREASE IN CORTICAL EXCITABILITY ELICITED BY ANODAL TRANSCRANIAL DIRECT CURRENT STIMULATION DOES NOT AFFECT SELF-PACED CYCLING PERFORMANCE

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INTRODUCTION

The non-invasive brain stimulation technique, anodal trancranial direct current stimulation (a-tDCS), has been shown to increase cortical excitability [1]. Recently, a-tDCS has been investigated as a potential ergogenic aid in sports, showing improvements in time to fatigue (TTF) tests performed at 70-80% of VO_{2max} [2,3] during cycling. Improved performances were associated with a decreased rating of perceived exertion (RPE). The purpose of this study was to investigate the effect of a-tDCS on cortical excitability and on the performance in two self-paced cycling tasks, which were: 1) a five-minute RPE-clamp test and 2) a 250-kJ time trial (TT) (~10km). We hypothesized that a-tDCS would increase cortical excitability and that this would increase power output (PO) in both the RPE-clamp and the TT tests and improve TT performance.

METHODS

Twenty healthy, recreational trained participants were recruited for this counter-balanced sham-controlled experiment (16 males/4 females, 26±4 years, 181.5±9.9 cm, 83.9±17.9 kg). Eleven of the participants had their cortical excitability assessed using transcranial magnetic stimulation (TMS) prior to and following a-tDCS or sham stimulation. The participants reported to the lab four different days, separated by at least two days. The first test day served as familiarization and the following three test days included a control, sham, and a-tDCS test day, respectively, and were completed in a randomized order.

At all test days, the participants completed a three-minute warm-up, leading directly to an RPE-clamp test, where the participants were instructed to bike with an RPE of 13 on the Borg scale for five minutes. Following a 3-minute break, the participants then performed a 250-kJ TT as fast as possible. On the a-tDCS and sham test days the participants underwent the stimulation protocol, followed by a 10-minute break before any testing was carried out.

Cortical excitability was assessed using TMS, over the cortical motor representation of the right rectus femoris, by averaging 20 motor evoked potentials elicited with a stimulus intensity of 120% of the motor threshold. This was done before and after the a-tDCS and sham stimulation, respectively. a-tDCS and sham-stimulation was applied through an anode (4x9cm brass plate over a saline-soaked sponge) centered over Cz and a similar the cathode (5x7cm) centered over the right deltoid muscle. During the a-tDCS the electrical current amplitude was ramped up to 2 mA over 10 seconds and held constant for 13 min before being ramped down to zero over 10 seconds again. During the sham-stimulation the current was ramped up to 2 mA over 10 s and immediately ramped down again over 10 s to zero again and then waiting 13 min without stimulation.

One-way ANOVA tests were carried out to assess differences in performance time, PO, heart rate (HR), oxygen uptake (VO_2) and RPE between conditions. Paired t-tests were carried out to test for differences in cortical excitability between pre and post a-tDCS and sham, respectively.

RESULTS AND DISCUSSION

Significantly larger differences in cortical excitability from pre- to post-stimulation (P=0.01) was found following a-tDCS (44 ±34%) compared to sham-stimulation (6 ±31%). However, this increase did not lead to any changes in performance time, PO, HR, VO_2 or RPE in either the RPE-clamp or TT (P>0.05) (Table I). The lack of performance improvements may be explained by, that self-pacing seems to be influenced by muscle sensations and pain perception. As the cortical image of the homeostatic afferent pathway is located in the insular cortex [4], increased cortical excitability of M1 may not lead to improvements in self-paced exercise performance, as it is seen for externally driven exercise tests [2,3]

CONCLUSIONS

a-tDCS applied over the primary motor cortex for leg muscles led to increased cortical excitability in these areas. However, this did not lead to improvements in self-paced cycling performance in either RPE-clamp or performance time in TT tests.

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Table I – The average time trial time (TT Time), power output (PO), heart rate (HR), oxygen consumption (VO_2) and rating of perceived exertion (RPE) during the 250-kJ time trial (N=20).

	Time (s)	PO (Watt)	HR (BPM)	VO_2 (mL/min)	RPE
a-tDCS	1195 ± 361	227 ± 56	166 ± 9	3058 ± 643	16 ± 1
Sham	1182 ± 355	230 ± 60	164 ± 11	2973 ± 1160	16 ± 1
Control	1219 ± 372	223 ± 55	163 ± 11	3003 ± 557	16 ± 1