BOOK OF ABSTRACTS

from

Training and testing in climbing workshop

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Editors: Jiří Baláš, Lucie Kalkusová, Andrew J. Martin

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Training and testing in climbing workshop programme

Saturday 24th November

8:00 – 8:45	**Registration for the Climbing workshop** – faculty entrance
9:00 - 9:30	Michail Michailov - *Optimisation of finger strength and endurance training*
9:30 - 10:00	David Giles - *Critical power in rock climbers*
10:00 - 10:30	Dicle Aras, Güney Çetinkaya - *Effects of four-week fingerboard local electromyostimulation training on wrist strength and endurance*
	Mirjam Limmer - *Acute effects of kinesio tape application over wrist flexor muscles on grip strength and sports climbing performance*
10:30 - 11:00	**COFFEE BREAK**
11:00 - 11:30	Stefan Künzell et al. - *Tactical decisions in bouldering after failures*
	Andrey Shunko, T. Kravchuk - *The effect of the psychomotor abilities level on the result in speed climbing of young climbers 1-2 years of study*
11:30 – 12:00	**Poster section**
	Sofie Cataldo: *Investigation of outdoor learning themes and practice in British Primary Schools*
	Jan Gajdošík: *Physiological responses to indoor wall climbing and climbing on the treadwall*
	Maria Stefania Ionel: *Psychological benefits of indoor cycling while immersed in a virtual environment*
	Jan Kodejška: *Individual effect of cold-water immersion on handgrip performance in rock climbers*
	Dominika Krupková: *The effect of passive recovery on repeated isometric performance and the relationship of the results to the observed data*
	Oto Louka: *Teaching freediving at KTVS PF UJEP*
12:30	**LUNCH**

14:00 – 14:30	Espen Hermans et al. - *Climbing specific training methods and its effect on performance*
14:30 - 15:00	Jiří Baláš - *Recovery during and after climbing*
15:00 - 15:30	**COFFEE BREAK**
15:30 - 16:30	„Climbing“ laboratory visit
16:30 – 17:30	Round table "Science for Practice" - scientists, trainers, competitors. What the science can offer and what the climbers need from science.
19:00	Banquet

Organisers:

Partners:

Optimisation of finger strength and endurance training

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Background
Sport climbing will make its Olympic debut at the Summer Olympics in Tokyo 2020. This will increase the competition and the demands upon sport climbers' preparation and will surely require monitoring and evaluating sport performance-limiting factors to optimize training workloads. To be useful, the tests for the assessment of climbers' physical fitness should provide reliable, valid, objective and comprehensive feedback. Therefore, these tests should meet a number of conditions. They should be standardized (i.e. some workload parameters; climbing hold size; body, arm and finger positions, etc.) and reflect the specificity of the sport. Sport-specific ergometers should be used and the test protocols should be developed according to the ability, they are intended to assess.

Aim
Climbing workload will be characterized and biomechanical and physiological aspects will be outlined, which are important to be taken into consideration when developing informative tests for the assessment of key indicators of climbers' training state. A new evidence based methodology for the assessment of sport-specific finger strength and endurance in climbers will be presented.

Method
This methodology was developed after conducting several studies. It comprises of a combination of strength and muscular endurance tests performed on a specifically developed force measuring device with real time feedback and the ability to prescribe and control workload parameters.

Results
Test parameters (maximal and average force, test time, and force-time integral) were highly reliable with the exception of the rate of force development from the maximal strength test and the fatigue index from the all-out test. Therefore, climbers should endeavor to perform these tests correctly and should repeat them to increase the reliability of the measurement. It was observed that arm fixation during finger flexor testing provides slightly higher test–retest reliability. However, the scores from the tests without fixation correlated more strongly with climbing ability compared to scores from tests with arm fixation. Arm fixation compromised climbing specificity and testing without arm fixation is recommended. Construct validity evidence was provided through principal component analysis and calculation of the relative energy system contribution during the performance of each test from the test battery.

Conclusion
These methods showed how much information provides each test and test parameter on strength component, aerobic and anaerobic lactic capacity. The newly developed testing device and methodology ensure a comprehensive evaluation of both physical qualities and physiological functions at a local muscle level and can serve to optimize the training process of climbers which may further the development of rock climbing.

The determination of finger flexor critical force in rock climbers: background, methods and implications of its use

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Background

Rock climbing requires repeated isometric contractions of the finger flexors, responsible for flexion of the metacarpophalangeal and interphalangeal joints. These contractions cause regular periods of ischemia in the forearms; the extent of this ischemia and the subsequent recovery from it has been shown to differentiate ability groups of rock climbers (Fryer et al., 2017a), differ between disciplines (Fryer et al., 2017b) and is likely to be a trainable characteristic (Giles et al., 2017). As such, the fatigue resistance of the finger flexors is considered one of the most important factors in climbing performance. However, while methods for the determination of maximal finger flexor strength have been described in the literature (e.g. Baláš et al., 2014), as yet there are no tests to determine functional aerobic metabolic capacity, delineating steady and non-steady state.

Aim

The presentation will discuss the theoretical background of CF, methods for its determination in climbing populations, interpretation of results and future avenues.

Method

A literature review was conducted.

Results

A test of Critical Force CF provides an approximation of two parameters: the CF, and the Anaerobic Work Capacity (AWC) (Monod & Scherrer, 1965). CF is the maximum isometric force that a (synergistic) muscle group, in this case, the finger flexors, can maintain for an extended duration without fatigue. The AWC is the total amount of work that can be completed above CF (Poole et al., 2016). While CF is limited by the availability of oxidative substrates (glycogen), hyperthermia and central fatigue, AWC is limited by progressive depletion of high-energy phosphates and accumulation of metabolites associated with peripheral fatigue (Jones et al., 2008).

Conclusion

The determination of CF is important in rock climbers for: 1) understanding exercise tolerance, 2) determining optimal training prescription and 3) accurate monitoring of performance. As such, it is likely that determining both CF and AWC would be of value to coaches, climbers and researchers.

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Effects of four-week fingerboard local electromyostimulation training on wrist strength and endurance

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Aim
Electromyostimulation (EMS) has been defined as the stimulation of the nerves and muscles over the skin in superficial form at different frequencies (Hz) and intensity (mA). The purpose of the research was to investigate the effects of four-week fingerboard local electromyostimulation training on wrist strength and endurance.

Methods
A total of 16 physically active, non-climber adults (9 male and 7 female) participated in the study voluntarily. The participants were divided into two groups as EMS and NonEMS. Each group performed the same training program for about 25 min a day, 3 days a week for four weeks. The EMS application was performed with a Bosch TENS+EMS Dual Therapie (Stuttgart, GERMANY) device with a signal width of 260 ms and a frequency of 60 Hz. Before and after training, isokinetic force measurements were done with Biodex brand System 4 Promodel (NY, USA). Wrist strength and endurance was recorded during flexion and extension at 60 and 180 °/sec. The parameters used in the research were Peak Torque (Nm, PT), Peak Torque/Body Weight (%, PT/BW), and Average Power (W,AP).

Results
The only significant increases observed in the NonEMS group were in the right and left wrist AP parameters during flexion at 180 °/sec ($p<0.01$). However, the EMS group showed statistically significant changes in all of the parameters ($p< 0.01$ and $p< 0.05$) except in the left wrist AP parameters during flexion and extension at 180 °/sec. Another substantial finding of the research was that both groups showed enhancements in all of the strength and endurance parameters recorded.

Conclusion
Although the participants were physically active individuals, training on a sport specific plate, such as fingerboard, improved their wrist strength and endurance in the both EMS and NonEMS groups. The EMS group showed significant increases in almost all of the parameters. Being one of the basic components of rock climbing, muscular fitness has an essential role in climbing performance. This study's findings suggest that EMS training on fingerboards could be used to enhance climbing performance. Future studies could include measuring the isokinetic strength and endurance of muscle groups not placed with EMS in order to understand whether EMS is effective only in the muscle groups in which it is placed.

Acute effects of kinesio tape application over wrist flexor muscles on grip strength and sports climbing performance

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Background
Kinesio taping is a commonly used intervention in sports. Kinesio tape applications became popular within recent sports climbing and bouldering competitive events. Kinesio tape application is suggested to positively influence the muscle's ability to maintain strength during fatigue. Applications over wrist flexors have already been shown to reduce muscle fatigue during repeated concentric muscle actions. However, evidence of the effect of kinesio tape applications on grip strength and endurance is still controversial and there is a lack of existing studies with high applicability for sport disciplines.

Aim
The aim of this study was to evaluate the immediate effects of kinesio taping on muscular strength and endurance of wrist flexor muscles in sports climbers.

Method
In a randomized crossover design, twenty recreationally trained active sports climbers (10 men, 10 women) aged 28.5 ± 10.6 years performed one familiarization trial and subsequently two test trials either with (TAPE) or without (CONTROL) kinesio tape application over the flexor digitorum superficialis muscles. Test trials consisted of three performance measurements (hand grip strength and endurance, finger hang on a 3.5 cm ledge, and lap climbing) at intervals of 48 hours in a randomized order.

Results
We observed no significant differences in the parameters hand grip peak force (TAPE: 374.8 ± 80.1, CONTROL: 370.1 ± 75.1 N), fatigue index (TAPE: 27.6 ± 6.4, CONTROL: 28.0 ± 6.9 %), ledge hang time (TAPE: 44.9 ± 18.4; CONTROL: 46.7 ± 18.5 s), lap climbing distance (TAPE: 63.9 ± 38.2, CONTROL: 58.6 ± 26.6 m) and lap climbing time (TAPE: 8.7 ± 5.0, CONTROL: 8.0 ± 5.0 min), and maximum blood lactate values after lap climbing (TAPE: 6.6 ± 2.5; CONTROL: 6.5 ± 2.0 mmol/L) between both test trials ($p < 0.05$). In addition, the participants' UIAA climbing ability was significantly correlated with the maximum edge hang time (TAPE: $r = 0.540$, $p = 0.014$; CONTROL: $r = 0.667$, $p = 0.001$) and peak lactate concentration after exhausting lap climbing ($r = 0.521$, $p = 0.019$) in the CONTROL trial.

Conclusion
Kinesio tape applications over the flexor digitorum superficialis muscles did neither enhance hand grip strength and muscle endurance nor sports climbing performance parameters. The use of kinesio tape applications for a performance improvement in sports climbing could not be confirmed within this study and should therefore be considered with caution when applied to athletes competing in sports climbing and bouldering events.

Tactical decisions in bouldering after failures

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Background
In boulder competitions, athletes have to solve a boulder problem within a climbing period. The time available for one climbing period is limited, usually five minutes in the semi-finals and four minutes in the finals, respectively. However, the number of attempts is not restricted, though, in case of a tie, athletes with fewer attempts in the number of tops and zones will be ranked higher.

Aim
After a failure in an attempt, the boulderer has to decide whether to change the climbing tactic or retry the boulder in the same manner as before. The aim of our study is to investigate if, in the grand mean, it pays off to invest time to find a new solution or if athletes are better off with sticking to their previous solution.

Methods
We analysed the video footage of the finals of 6 men and women boulder world cups in 2017. Additionally, an expert climber and licensed route setter independently analysed 2 of the world cup finals.

Results
Overall, in 1005 attempts of 288 climbing periods, the average number of attempts was 3.5 per climbing period. A change in climbing tactics was stated if the athletes used an obviously visible different solution and was counted as such in the two following attempts as well. A change includes using holds in a different sequence, using different grip techniques or positions or changing from a dynamic to a static solution. Cohen's κ was run to determine if there was an agreement between two raters' judgement on whether the boulderers maintained or changed their solution based on the analysis of two competitions. There was good agreement between the two raters´ judgements, $\kappa = .80$, 95% CI [.729, .871], $p < .001$. In 231 climbing periods, the boulderer failed on the first attempt. On the second attempt, the athletes changed their tactic in 62 climbing periods and stayed with their strategy in 169 climbing periods. The conditional rate of success in all changed attempts was 30% and 6% after a stay. Notably, regarding the 4th and later attempts, conditional rate of success in all changed attempts was still 17%, while it dropped to 2,1% after a stay.

Conclusion
We are aware that the number of possible solutions is dependent on the features of the boulder problem. However, on the grand mean, our investigation suggests changing the climbing tactic no later than after the third attempt. Otherwise, the probability of success drops dramatically and presumably does not compensate the degree of fatigue that comes along with multiple attempts.

The effect of the psychomotor abilities level on the result in speed climbing of young climbers 1-2 years of study

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Background
The elementary stage of climbing training should focus on the calisthenics of future climbers. Harmonious development of all physical qualities contributes to the creation of a basis for further improvement. The calisthenics include not only the development of strength and flexibility, but also psychomotor abilities. However, the modern system for the elementary stage of climbing training does not pay attention to the development of psychomotor abilities.

Aim
To determine the effect of psychomotor development level on the speed climbing result.

Methods
The research was conducted from October 2015 to February 2017 with the Youth Sports School of Olympic Reserve (YSSOR). The research contained 3 stages:
(1) Identification of the most significant psychomotor abilities for speed climbing from a group of 15 climbers with 5 years experiences: reaction on moving object, reaction on sound, build of segments, individual minute, taping test. Reliable results were obtained using the correlation analysis between the speed climbing result and certain psychomotor abilities.
(2) The development and implementation of methodology for the development of psychomotor abilities for elementary level climbers at the YSSOR: exercises for attention and speed of reaction (exercises with balls and special equipment), realizable with game and competition methods.
(3) Experimental verification of the implementation efficiency of the methodology. 36 elementary level climbers were separated arbitrarily into 2 groups: control and experimental. The methodology of psychomotor ability developing was applied to the experiemental group. The control group has trained with common program. Before and after experiment a speed climbing competition was conducted, considering time and stability of climbing.

Result
The average climbing time the experimental group before the experiment was 44,04 secs, and after 34,97 secs, a significant decrease of 28,7%. In the control group there was no significant changes. The number of wrong attempts (falsestart and falling) in the control group didn‘t changed, while in the experimental group they decreased by 33,3% - from 15 to 10. Also the stability of climbing in the experimental group increased, which is expressed in the reduced time with each new try on the route. Before the experiment only 3 of 10 showed the reduction of time on each new try, after the experiment 6 of 10 demonstrated a better time after each try.

Conclusion
(1) Model characteristics of the level of psychomotor abilities for elementary level climber were identified.
(2) Methods for psychomotor abilities were developed, which were tested and included in YSSOR program.
(3) The relationship between speed climbing result and level of psycomotor abilities development was revealed.

Climbing specific training methods and its effect on performance

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Aim

The aim of all our three intervention studies has been to investigate the effects of different climbing specific training methods on performance. We have conducted training interventions on core-, basic- and finger strength in climbers with different skill levels.

Method

(1) 19 advanced and elite climbers (IRCRA grade 19) were randomized into a dynamic (DCT) or isometric (ICT) core training group and trained twice weekly for ten weeks. The climbers were tested using two climbing-specific core tests (body lock-off and body-lift) and four non-specific core strength tests—one dynamic (superman) and three isometric (trunk flexion and trunk rotation left and right).

(2) We compared the effects of different strength training intensities on climbing performance and climbing specific tests. Thirty lower grade and intermediate-level climbers participated in a 10-week basic strength training program. The participants were randomized into three groups: high resistance–few repetitions training groups (HR-FR), low resistance–high repetitions training groups (LR-HR) and a control group (CON) which continued climbing/training as usual.

(3) Twenty-five climbers with climbing ability ranging from intermediate to elite level (IRCRA grade 10 to 20) were randomized into a control group (CON) or a hang board training group (HBT). HBT completed a program on the Beastmaker 1000 series hang board twice a week for 10-weeks. The "BeastMaker" training app was used to standardize the training protocol. Grip endurance was measured performing finger hang on 23mm list, while isometric grip strength (peak- and maximal average force) and rate of force development (RFD) were performed on both the 23mm list and jug holds.

Results

(1) There were no differences between the groups at post-test ($p = 0.328–0.824$) and neither group demonstrated greater improvement compared with the other ($p = 0.300–0.926$). The ICT group demonstrated 10.8% and 29.6% improvement in trunk flexion and body-lift ($p = 0.029–0.037$ with no improvement in body lock-off and rotation ($p = 0.101–0.343$). The DCT group demonstrated 5.0–14.9% improvement in the core strength tests ($p = 0.012–0.043$), a non-significant 33.8% improvement in body-lift ($p = 0.100$), and no improvement in body lock-off ($p = 0.943$).

(2) There were climbing performance improvements in the HR-FR and LR- HR ($p = 0.088–0.090$). The HR-FR and LR-HR improved their time in both Dead-hang ($p = 0.004–0.026$) and Bent-arm hang ($p < 0.001–0.002$). No differences were observed in the CON group in any of the tests ($p = 0.190–0.596$), except for improvement in Bent-arm Hang ($p = 0.018$). No differences between groups were observed in any of performance tests ($p = 0.507–1.000$). The training groups reduced their climbing sessions during the intervention compared to the CON group ($p = 0.057–0.074$).

(3) The results revealed significant improvement for the HBT group in peak force on 23mm list (21%), maximal average force in both jug holds (9%), and 23mm list (15%) and grip endurance (15%). However, no statistical differences were observed between groups in any of the tests.

Conclusion

(1) Both dynamic and isometric core training improved climbing-specific test performance. Dynamic training was slightly more favorable, although not significantly.

(2) The HR-FR and LR-HR training program demonstrated an 11% and 12% non-significant improvement in climbing performance despite a 50% reduction in climbing sessions, but improved the results in strength and climbing-specific tests.

(3) The hangboard training program can increase grip endurance and isometric finger strength.

Recovery in climbing: A literature review

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Background
Three types of recovery are distinguished in sport climbing: 1) recovery between intermittent contractions during an ascent; 2) recovery between ascents; 3) recovery after training.

Aim
The aim is to present an overview of the current research related to recovery methods in sport climbing.

Method
A literature review was conducted of research related to recovery methods in sport climbing.

Results
Early research suggested the beneficial effect of active recovery over passive rest after difficult climbs (Draper, Bird, Coleman, & Hodgson, 2006; Watts, Daggett, Gallagher, & Wilkins, 2000). The specificity of active recovery is still under discussion (Valenzuela, De la Villa, & Ferragut, 2015). Recently, shaking during climbing was found to speed up recovery during intermittent contractions (Baláš et al., 2016). The hot topic in recovery strategies after difficult climbs is muscle cooling (Heyman, De Geus, Mertens, & Meeusen, 2009; Kodejska, Balas, & Draper, 2018).

Conclusions
The use of cooling, its imitations and application will be presented. Finally, recovery strategies after training methods will be discussed.

References
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Physiological responses to indoor wall climbing and climbing on the treadwall

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Aim
The aim of the study was to compare physiological responses of indoor wall and treadwall climbing in intermediateand advanced climbers.

Methods
Eighteen male intermediate and advanced climbers participated in the study.Climbers completed two identical routes,one in the climbing gymand the other on the treadwallat two velocities (4 m/min and 6 m/min respectively) on two separate visits. A portable gas analyser was used to assess the physiological responses during the climb and the 10 min recovery.

Results
There were no significant differences for oxygen consumption between climbing on the treadwall (1.71 ± 0.40 L·min^{-1} for 4m·min^{-1} and 2.05 ± 0.42 L·min^{-1}for 6 m·min^{-1})and climbing in the gym (1.78 ± 0.38 L·min^{-1}for 4 m·min^{-1} and 2.09 ± 0.45 L·min^{-1} for 6m·min^{-1}). However, climbing in the gym induced higher heart rate (139 ± 26 beats·min^{-1}for 4m·min^{-1} and 149 ± 26 b·min^{-1} for 6m·min^{-1}) than treadwall climbing (132 ± 26 b·min^{-1}for 4m·min^{-1} and 144 ± 25 b·min^{-1} for 6m·min^{-1}). Greater increase in heartrate was noted for intermediate climbers. There was significant higher energy cost during climbing in the gym (8.9 ± 1.88 kcal·min^{-1}) than on the treadwall (8.39 ± 2.01 kcal·min^{-1}) at 4 m·min^{-1} when the recovery period was included, the energy cost at 6 m·min^{-1} was 10,82 ± 2.64 kcal·min^{-1} (indoor wall) and 10,59 ± 2.49 kcal·min^{-1}.

Conclusion
Based upon these results, the heart rate responseduring climbing in the gym is more elevated than on the treadwall and the differences are related to climbing experience. The energy cost during climbing in the gym is significantly higher when O_2 deficit is calculated.

Psychological benefits of indoor cycling while immersed in a virtual environment

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Aim
The purpose of the present study was to assess the psychological benefits (cognitive and emotional) of indoor cycling while immersed in a virtual environment: real outdoor video (natural stimuli) versus artificial video (artificial stimuli). According to previous literature, watching images of natural settings favors positive affect and enhances cognitive performance. We extend this view to an indoor controlled environment.

Methods
A total of 21 Sport Science students participated in the study. During session one, participants completed an incremental effort test in order to obtain their anaerobic power threshold. During session two and three, participants cycled for 55 minutes at 75% of their anaerobic power threshold under one of two conditions: video with natural or artificial stimuli. The order of presentation of the two sessions was counterbalanced across participants. Immediately after the cycling session, participants completed a psychological assessment that tapped cognitive and emotional functioning including inhibition, vigilance, working memory, anxiety, rumination, negative and positive affect. Additionally, heart rate variability (HRV) was measured while participants performed the physical effort, and the cognitive tasks.

Results
Preliminary results failed to support superior cognitive performance after performing physical activity exposed to natural, compared to artificial stimuli, and also did not support the benefits of this environment on subjective reports of emotional experiences. Our findings are in contrast with previous research suggesting that Attention Restoration Theory (ART) would allow the neural mechanisms to rest and replenish the directed attention, thus improving cognitive performance, or the Stress Reduction Theory (SRT) which states the impact of nature experience on affect and well-being. A more immersive virtual reality could allow us to see other results, taking into consideration the fact that we had a trend, but not statistically significant.

Conclusion
Future research should compare indoor cycling to a "green", nature-based outdoors environment in order to assess what elements of the natural environment impact cognitive function and mental health, and which are the possible neural mechanisms responsible for these effects. This research is needed to enhance the understanding of the science behind this lifestyle factor, and to establish public health recommendations.

Individual effect of cold-water immersion on handgrip performance in rock climbers

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Aim
To determine the individual effect of cold-water-immersion (CWI) at two temperatures (8°C and 15°C) on repeat handgrip performance to failure.

Methods
A total of 29 participants completed 3 intermittent trials to failure on a climbing-specific handgrip dynamometer on 3 laboratory visits. For each visit, a different recovery strategy was employed: passive (PAS) recovery, CWI at 8°C (CW8), or CWI at 15°C (CW15). The force time integral (FTI: time of contraction multiplied by the force of contraction) was determined to assess handgrip performance. Minimum detection change (MDC) for FTI was taken as a criterion for individual assessment of CWI effect. At the end of the last CWI participants were asked to assess subjective perception of the procedure (agreeable, neutral, and disagreeable) and water temperature on a 7 grade scale (cold -3; neutral 0; warm 3).

Results
Individual responses to CW8 show that 8 males and 5 females increased their performance above MDC, and 7 males and 9 females performed inside the limits defined by the MDC (MDC 6322 Ns). Individual responses to CW15 show that 10 males and 5 females increased their performance above MDC, and 5 males and 9 females performed inside the limits defined by the MDC. CW8 was scaled as disagreeable for 27 and 21 participants and neutral for 2 and 8 participants after the first and second recovery period, respectively. On the other hand, CW15 was evaluated as disagreeable only for 3 and 7, neutral for 13 and 11, and agreeable for 13 and 11 participants after first and second recovery period, respectively.

Conclusion
Our data showed that the application of CWI should be prescribed individually. Future research should focus on the explanation of physiology mechanisms related with improved recovery.

The effect of passive recovery on repeated isometric performance and the relationship of the results to the observed data

D. KRUPKOVÁ[1], J. KODEJŠKA, J. BALAS[2]

Aim

The aim of the study was to assess inter-individual variability of passive recovery after repeated isometric handgrip performance of finger flexors to exhaustion.

Methods

The study was attended by a group of climbers consisting of 16 men (aged 30.8 ± 7.2 years) and 18 women (aged 26.7 ± 4.5 years). Participants came in the laboratory, where three repeated intermittent handgrip isometric performance until exhaustion with passive recovery strategy were completed. The passive recovery consisted in seated rest for 20 min. Anthropometric, training and performance variables were related to the repeated performance changes using Pearson correlation coefficient.

Results

The average decrease in results was 17.9% with the range was from 0% to 49.3%. There was no strong relationship found between drop in performance and selected variables. Moderate relationship was found with the initial time to exhaustion ($r = 0.44$) and climbing hours per week ($r = -0.32$). No other relationship was found.

Conclusion

Passive recovery has a negative effect on repeated isometric performance to failure. There is a large inter-individual variability in the performance decrease. We found a moderate relationship between initial length of contraction and climbing hours per week. This might be connected with the use of anaerobic metabolic pathways and the level of fitness. However, other major factors must have influenced the speed of recovery.