

Poster Abstracts

Strength/Balance Training in Elderly/Chronic Diseases

Isolated unilateral strength training in stroke patients is more effective than combined unilateral and bilateral training

M. Aimet^{a,*}, R. Pokan^b, S. Kotzian^a, U. Musil^a, J. Pelikan^a, R. Skopetz^a, R. Spiesberger^a, J. Brandl^a, M. Rupp^a, P. Hofmann^c, S.P. vonDuvillard^d and U.A. Zifko^a

^aClinic Pirawarth, Austria

^bUniversity of Vienna, Austria

^cUniversity of Graz, Austria

^dCalifornia State Polytechnic University Pomona, USA

Introduction: Previous studies showed positive effects of combined unilateral and bilateral strength training as well as isolated unilateral strength training in stroke patients. The aim of this study was to compare these effects and find out which was the most effective training method.

Methods: Group 1 (10 patients; 60 ± 13 years; pre maximum strength (ms): bilateral 47 ± 5 kp, paretic arm 19 ± 6 kp, non-paretic arm 33 ± 5 kp; post ms: bilateral 57 ± 17 kp, paretic arm 22 ± 9 kp, non-paretic arm 33 ± 5 kp) trained both the arm extensor muscles of the paretic arm and both arms in one exercise unit. Group 2 (12 patients; 63 ± 16 yrs; pre ms: bilateral 47 ± 8 kp, paretic arm 19 ± 6 kp, non-paretic arm 27 ± 6 kp; post ms: bilateral 50 ± 12 kp, paretic arm 23 ± 9 kp, non-paretic arm 27 ± 8 kp) strengthened only the extensors of the paretic arm on the arm press machine. Both groups did two sessions per week with a resistance of 40–50% of the ms during their 4-week rehab stay and one repetition maximum test at the beginning and the end.

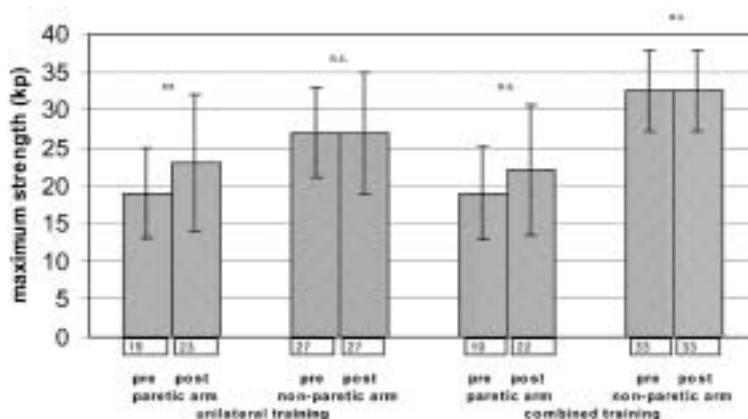


Fig. 1. Maximum strength of the paretic and the non-paretic arm before and after the training.

Results: Only the unilateral training showed a significant decrease of the absolute and relative difference between the arm extensor strength of the paretic and the non-paretic arm (Group 2: absolute difference: from 8 ± 3 kp to

*Corresponding author.

4 ± 4 kp, $p < 0.01$; relative difference: from $30 \pm 12\%$ to $15 \pm 15\%$, $p < 0.001$; Group 1: absolute difference: from 14 ± 10 kp to 11 ± 8 kp, n.s.; relative difference: from $39 \pm 23\%$ to $32 \pm 23\%$, $p < 0.05$) and a significant ms-increase of the paretic arm (from 19 ± 6 kp to 23 ± 9 kp, $p < 0.01$) (see Fig. 1).

Discussion: Unilateral 4-week strength training is more effective in decreasing the deficits compared to a combined unilateral and bilateral training in stroke patients, but it still does not produce equal values of the paretic and non-paretic arms in this short training period.

Conclusion: These results indicate advantages of the unilateral training method, because the combined training of the paretic arm and both arms in one session requires more time but is less effective.

References

- [1] M. Engardt, *Arch Phys Med Rehabil* **76** (1995), 419–425.
- [2] M. Aimet, *Neurol Rehabil* **6** (2000), 2.
- [3] E. Badics, *Neurorehabilitation* **17** (2002), 211–214.

Weight reduction and risk management – one-year results of a randomised controlled intervention trial with overweight adults.

P. Deibert*, D. König, A. Schmidt-Trucksäss, I. Frey, U. Landmann, H.-H. Dickhuth and A. Berg
University Hospital, Department of Rehabilitative and Preventive Sports Medicine, Freiburg, Germany

Introduction: Coronary heart disease is the leading cause of mortality in western countries. Determination of the risk of myocardial infarction within the next 10 years is easily estimated by the PROCAM risk score (Fig. 1). Many of the items used by this score are influenced by obesity. We investigated how much this risk score may be improved by a weight reduction in a sample of overweight people.

Methods: Eighty-three overweight people were treated with standardized weight reduction program aiming to reduce their body weight within the next six months about 10% (BMI difference of 2.5 kg/m^2) and to avoid a following weight gain. As for 29 of them the PROCAM score was not applicable (age range for females), 64 subjects were eligible for analysis.

The subjects were randomly assigned to follow either a lifestyle education group (LE-G), or the substitutional diet group or the substitutional diet group with additional instructions for physical activities. The lifestyle education group attended bi-monthly three teaching sessions, and two individual visiting periods led by experts in nutritional counselling. The subjects assigned to the substitutional diet group (SD-G) were instructed to replace two daily meals by a high-soy-protein and low-fat diet for the first 6 weeks followed by replacement of one daily meal for 18 weeks. In addition, a third group of subjects (SDPA-G) was motivated to attend two times weekly a endurance physical activity program, which was delivered by a sport physician, otherwise, they followed the rules of the substitutional diet group. Data collected at enrolment and thereafter in one months periods were weight measured on a single calibrated scale, waist and abdominal circumference, medical history, blood pressure, glucose and insulin and serum lipid levels and inflammatory markers (C-reactive protein, IL-6). For measuring the body composition, the technique of the air displacement plethysmography was used (Bod Pod[®]) [1]. The PROCAM risk score was calculated as described elsewhere [2].

Results: To calculate significant differences in anthropometric and biochemical parameters at week 48, the groups were merged for analysis. Body weight, total and LDL cholesterol were significantly reduced ($p < 0.001$). In the LE-G 20% of participants lost at least 10% of body weight, whereas the proportion was 33% in the SD-G and 30% in the SDPA-G. With the soy-protein supported diet muscle mass was preserved. The decline of triglycerides was dependent on baseline levels, but independent from weight loss. Systolic blood pressure was only significantly

*Corresponding author.

What is your gender? Male Female
 What is your age (in years)?
 Input range: Male:35-65 Years, Female:45-65 Years
 What is your LDL-cholesterol level?
 Input range: 75-250 mg/dl
 What is your HDL-cholesterol level?
 Input range: 25-75 mg/dl
 What is your fasting triglyceride level?
 Input range: 50-400 mg/dl
 What is your systolic blood pressure?
 Input range: 100-225 mm Hg
 Have you smoked cigarettes at any time during the past 12 months? No Yes
 Do you suffer from any form of diabetes mellitus? No Yes
 Known diabetes or fasting blood glucose levels \geq 120 mg/dl
 Did either of your parents, any of your brothers or sisters, or any of your children suffer a heart attack before the age of 60 years? No Yes

Fig. 1. PROCAM risk score (available at www.chd-taskforce.com).

reduced if a weight reduction more than 10% body weight was achieved. A relevant reduction of PROCAM risk score was only detectable in participants who lost at least 10% body weight (total risk reduction of 4.4%).

Discussion: A weight reduction in overweight people improves parameters determining the risk for myocardial infarction. To improve the 10 year risk – estimated by the PROCAM risk score – distinctly, a weight reduction of more than 10% body weight has to be achieved. The low-fat, high soy-protein diet has proved as a supportive therapeutic tool, as more participants in this group achieved the intended threshold of weight change by fat-mass reduction.

Conclusion: To defeat the thread of obesity – in respect of the individual fortune and socio-economic aspect – guided programmes with a controlled weight reduction of at least 10% body weight are needed. A dietary intervention on weight loss has more impact in overweight and obese people than physical activity or health education alone.

References

- [1] M.A. McGrory, T.D. Gomez, E.M. Bernauer and P.A. Mole, Evaluation of a new air displacement plethysmograph for measuring human body composition, *Med. Sci. Exerc.* **27** (1995), 1686–1691.
- [2] G. Assmann, P. Cullen and H. Schulte, Simple Scoring Scheme for Calculating the Risk of Acute Coronary Events Based on the 10-Year Follow-Up of the Prospective Cardiovascular Münster (PROCAM) Study, *Circulation* **105** (2002), 310–315.

Maximal and explosive force production capacity in elderly men: Implications for exercise

U. Granacher*, D. Strass and A. Gollhofer

Institute of Sport and Sport Science, University of Freiburg, Germany

Introduction: It has been frequently reported that human muscle strength and the ability to develop explosive force decrease with increasing age [1]. The consequence is a general slowing down of neuromuscular performance [4].

*Corresponding author.

The main mechanisms responsible for this phenomenon are supposed to be a decrease in number of large alpha-motoneurons accompanied by a reduction in number and size of type-II skeletal muscle fibres [2]. Muscle strength and the ability of the leg extensor muscles to develop force rapidly are especially in old age important factors that help managing activities of daily living and may prevent elderly people from falling. Therefore, the purpose of the study was to examine the impact of heavy resistance training (HRT) and sensorimotor training (SENSO) in elderly men (>60 years) on maximal bilateral isometric leg extension force (MIF) and rate of force development (RFD).

Methods: Sixty healthy males between the ages of 60 and 80 years (age 66.5 ± 4.6 yrs; body-mass-index = 25.34 ± 2.6 kg/m²) volunteered as subjects in this study. They conducted a twelve week training program with three training sessions a week. A one week pre training period was also part of the study. Group one (strength-group – $N = 20$) realized a lower limb HRT (80% of 1 RM). Group two (senso-group – $N = 20$) carried out a SENSO on wobble boards, on sissles and on uneven surfaces. In a weekly interval, intensity of the training regimen was progressively increased for both intervention groups. A control group ($N = 20$) was also incorporated in the study. All subjects were pre- and post tested for their MIF and their RFD on a leg-press with hip and knee angle adjusted at 90°. Each foot was resting on a one-dimensional KISTLER® force platform. Onset of force was determined at 2% of each individual's MIF. RFD_{max} was defined as the maximal slope at deflection of the force-time curve. Additionally submaximal RFD-values were calculated as mean slope of the force-time curve over time intervals of 0–30, 0–50, 0–100 ms. Force values were determined at 30, 50 and 100 ms relative to the onset of force and expressed as force relative to the MIF. EMG activity was recorded from M. soleus (SO) and M. vastus medialis (VM) of the right leg using surface electrodes. Integrated and time normalized EMG (mean amplitude voltage –MAV) was analysed in time intervals of 0–30, 0–50, 0–100 ms and 100 ms pre and post MIF, respectively. For statistical analysis, paired t-tests on 5% level were calculated. Data are presented as group mean values \pm SE.

Results: After the twelve week training period MIF increased in the strength-group from 1325 ± 291 to 1685 ± 355 N (= 27%; $p < 0.01$) and in the senso-group from 1414 ± 283 to 1600 ± 284 N (= 13.1%; $p < 0.01$). The MAV of the SO, analysed 100ms pre- and post MIF, significantly increased for both intervention groups ($p < 0.01$). In the same time interval an additional increase in MAV of the VM was observed in the strength-group lasting from 0.14 ± 0.068 to 0.172 ± 0.089 mV (= 23%; $p < 0.01$). RFD_{max} increased in the strength-group from 7.13 ± 3 to 11.1 ± 5.2 N/ms (= 56%; $p < 0.01$) and in the senso-group from 9.43 ± 3.2 to 11.8 ± 3.8 N/ms (= 25%; $p < 0.01$). Mean slope of the force-time curve significantly increased in intervals 0–30, 0–50, 0–100 ms (strength-group) and in time intervals 0–30, 0–50 ms (senso-group). A significant increase in MAV of the VM could be observed in time intervals 0–30, 0–50, 0–100 ms (strength-group).

Discussion: The investigated parameters demonstrate that SENSO and especially HRT have an impact on MIF and RFD in the elderly. The gains in MIF and RFD are accompanied by considerable increases in the maximal voluntary neural activation of leg extensor muscles (SO, VM). Three adaptational mechanisms in the neuromuscular system could account for the improved maximal and explosive force production capacity due to HRT. First, an increase in neural activation of the prime movers. Second, an improved coactivation of the synergists. Third, an increase in size of especially type-II-muscle fibres. With regard to SENSO, another three neuromuscular mechanisms might be the reason for the investigated increases in MIF and RFD. First, the age-related increase in presynaptic inhibition of Ia-afferents [3] could be reduced due to SENSO. Second, an improved coactivation of the synergists. Third, an increase in size of especially type-II-muscle fibres. The impact of SENSO on MIF and RFD is remarkable for the fact that maximal and explosive force capacity was not specifically trained. With regard to the prevention of falls and trips, it is of great functional interest that even in older subjects explosive force production capacity of the neuromuscular system remains trainable.

References

- [1] M. Izquierdo, et al., *Eur J Appl Physiol* **79** (1999), 260–267.
- [2] J. Lexell, et al., *J Neurol Sci* **84** (1988), 275–294.
- [3] H. Morita, et al., *Exp Brain Res* **104** (1995), 167–170.
- [4] A.A. Vandervoort, *Muscle Nerve* **25** (2002), 17–25.

The effects of free weights training for older adults

O. Knobl^a, N. Schott^b, K. Wirth^a and D. Schmidtbleicher^a

^aInstitute for Sport Science, Wolfgang-Goethe-University, Frankfurt, Germany

^bInstitute for Sport Science, Justus-Liebig-University, Gießen, Germany

Introduction: Over the last twenty years, many studies have shown that resistance training can increase the muscle strength of older individuals [2]. These studies were mainly focused on machine exercises and their strength benefits. Only a few investigations showed the positive effects of free-weight training and these focused only on free-weight training with low intensities (meta-analysis by [1]). In contrast, the present study is the first which reports the development of muscle strength for high resistance training in older people for machines as well as free-weights. This comparison was lacking not only for older, but also for younger adults.

Methods: Thirty-two women and men aged 60–86 yr (mean: 66.9, SD: ± 5.5) participated in this study. All subjects were physically active and familiar with fitness and resistance training, but had not been involved in any previous structured resistance training program. The older adults were divided into two groups: Machine exercises ($n = 16$) vs. free weight exercises ($n = 16$) and trained the same muscle groups over six months in the following pattern: Leg press, chest press, upper row, biceps cable curls and triceps cable extension versus squat, bench press, bent-over rowing, biceps curls and french press. The supervised, high intensity training program was twice a week and the subjects performed (for each exercise) three sets with 10–12 repetitions at the 12-Repetition-Maximum (12 RM), followed by 20 minutes of endurance training. Three measurements (dynamic, isometric strength and endurance) were carried out at the beginning, after 10 weeks and again after 24 weeks. A detraining period (test four and five after three and six weeks) revealed the decline of the dynamic strength without training.

Results: Significant increases were found in the free-weights group over the period of 6 months for squat (24 kg, $t = -8.84$, $df = 11$, $p < 0.001$), french press (9 kg; $t = -7.07$, $df = 15$, $p < 0.001$), bent-over rowing (16 kg, $t = -8.92$, $df = 14$, $p < 0.001$), bench press (12 kg, $t = -8.77$, $df = 15$, $p < 0.001$) and bicep curls (6 kg, $t = -7.54$, $df = 15$, $p < 0.001$). In the machine group we found the following results: Leg press (27 kg, $t = -9.01$, $df = 14$, $p < 0.001$), chest press (19 kg, $t = -15.52$, $df = 15$, $p < 0.001$), upper row (15 kg, $t = -6.87$, $df = 15$, $p < 0.001$), biceps cable curls (24 kg, $t = -8.68$, $df = 15$, $p < 0.001$) and triceps cable extension (4 kg, $t = -4.46$, $df = 15$, $p < 0.001$). Only for leg strength ($t = 5.15$, $df = 25$, $p < 0.001$) and triceps ($t = 5.67$, $df = 30$, $p < 0.001$) the free-weights group exhibited significant differences for the percentage increase over a period of 24 weeks compared to the machine group (Fig. 1).

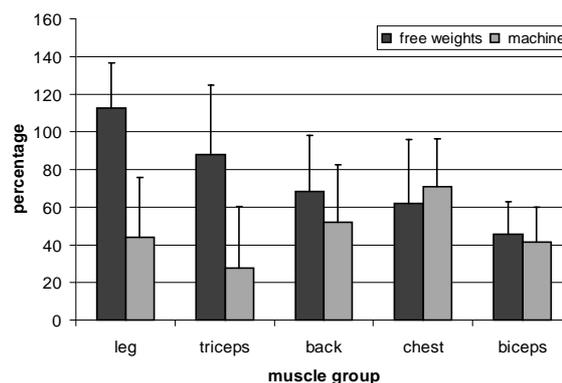


Fig. 1. Percentage increase after 24 weeks for free-weights and machine training (%).

Discussion: The results of the study demonstrated a significant increase in the overall strength. Free-weights training which includes exercises requiring good coordination (e.g. balance) revealed a better performance than

*Address for correspondence: Oliver Knobl, Ginnheimer Landstrasse, 39, 60487 Frankfurt, Germany. E-mail: oKnobl@aol.com.

the machine exercises. The association between leg strength and the risk of falling is well known. Our results demonstrate that especially the free-weights training has benefits in improving leg and arm strength and therefore serves as protection for injuries.

Conclusion: There is no doubt in the authors' minds that the evidence is conclusively impressive. The results suggest that: (1) dynamic strength gains from 6 months of resistance training in older individuals are sustainable (not entirely lost even after 6 weeks of detraining); (2) these effects are specifically related to the exercises performed in the training program (free weights vs. machine); (3) adoption of maintenance-level moderate-intensity training significantly attenuates the decline in dynamic strength of previously trained muscles; (4) free weights training improves the overall functional capacity of older adults.

References

- [1] D.R. Cholek, *Research Quarterly of Exercise and Sports* **71** (2000), A-105.
 [2] M.A. Fiatarone Singh, et al., *Am J Physiol* **277** (1999), E135-E144.

Function and bulk of respiratory and limb muscles after lung transplantation for cystic fibrosis

M. Lamotte^{c,*}, C. Pinet^a, P. Scillia^b, M. Cassart^b, C. Knoop^a, C. Mélot^d and M. Estenne^a

^aDepartment of Chest Medicine, Erasme University Hospital, Brussels, Belgium

^bDepartment of Radiology, Erasme University Hospital, Brussels, Belgium

^cDepartment of Physiotherapy, Erasme University Hospital, Brussels, Belgium

^dIntensive Care Medicine, Erasme University Hospital, Brussels, Belgium

Introduction: We recently reported that, for a given lean body mass, the bulk of the diaphragm and abdominal muscles is greater in patients with cystic fibrosis (CF) than in normal controls, whereas the bulk of the quadriceps is similar, consistent with a specific training effect of the disease on the respiratory muscles (Pinet et al, AJRCCM 2003, June 26). Lung transplantation produces dramatic changes in the clinical status of patients with CF, but whether or not respiratory and limb muscles recover a normal function and bulk after surgery is unknown.

Methods: We therefore assessed diaphragm mass using computerized tomography (CT) and ultrasonography, abdominal muscle thickness using ultrasonography, diaphragm strength by measuring twitch transdiaphragmatic pressure elicited by electrical stimulation of the phrenic nerves, abdominal muscle strength by measuring twitch gastric pressure elicited by magnetic stimulation of the lower thoracic nerve roots, quadriceps cross-section using CT, quadriceps isokinetic strength, and lean body mass in 12 stable CF patients who had undergone lung transplantation 48 months earlier; 12 normal subjects matched for sex, age, and height were studied for comparison. Patients had normal pulmonary function. Five patients were taken ciclosporine and 7 patients tacrolimus; the average daily dose of prednisolone was 11.8 ± 6.3 mg.

Results: Diaphragm strength and mass and abdominal muscle strength were similar in the two groups, but quadriceps strength and cross-section were decreased by $\sim 30\%$ in the patients. Patients had greater diaphragm mass, similar abdominal muscle thickness, and smaller quadriceps cross-section than controls when compared at a given lean body mass.

Discussion: In a multivariate analysis, the cumulative dose of prednisolone received between surgery and study was a significant predictor of quadriceps weakness and wasting. Quadriceps strength and cross-section in the patients showed tight positive correlations with maximal oxygen uptake, which averaged $59 \pm 13\%$ of predicted.

Conclusion: We conclude that in patients transplanted for CF, diaphragm and abdominal muscle function and bulk are preserved, but quadriceps strength and cross-section are markedly reduced. This impairment closely correlates with the reduction in exercise capacity.

* Address for correspondence: M. Lamotte, Erasme University Hospital, Cardiology unit, 808 rte de Lennik 1070 Brussels, Belgium. E-mail: mlamotte@ulb.ac.be

The impact of neuromuscular fatigue on isokinetic strength performance and reflex activity in young and elderly men

D. Strass*, U. Granacher, D. Förderer and A. Gollhofer

Institute of Sport and Sport Science, University of Freiburg, Schwarzwaldstrasse. 175, 79117 Freiburg, Germany
E-mail: dieter.strass@sport.uni-freiburg.de

Introduction: Neuromuscular fatigue in human beings has been studied extensively under a wide variety of experimental situations [1,4]. However, most of the research data are related to young subjects; only few results have been found in older human beings [2]. Therefore, the purpose of the present study was to compare the fatigability of young and elderly men (> 60 yrs) under two experimental conditions: (a) repetitive isokinetic contractions; (b) unexpected treadmill perturbations (PB). In fact, the impact of neuromuscular fatigue on the ability to compensate for gait perturbations has not yet been investigated in elderly men.

Methods: Fourteen male physical education students (age 27.0 ± 3.1 yrs; body-mass-index 23.6 ± 0.76 kg/m²; group I) and 14 healthy male subjects (age 67.2 ± 3.7 yrs; body-mass-index 25.5 ± 3.13 kg/m²; group II) volunteered to participate in this study. The activity level (kcal/week) was assessed by using the “questionnaire of physical activity of the medical clinic Freiburg”.

After warming-up, subjects were positioned in an isokinetic device (CYBEX – Orthodron[®]), performing four maximal contractions of the right foot (dorsal/ plantarflexion) at an angular velocity of 60 °/s. The best trial out of four maximal contractions was taken as maximal force (F_{max}). After determining F_{max} , subjects executed a fatigue protocol until they reached the desired fatigue level of 50% F_{max} . The contractions of the first and the last series were compared with regard to EMG activity of the M. tibialis anterior (TIB). Pre- and post fatigue tests also involved treadmill deceleration impulses: switches implemented in inlays of the right shoe were used as a trigger for decelerating the treadmill at heel contact. Treadmill velocity was decelerated while walking at a speed of 3.5 km/h to a backward velocity of 0.6 km/h in 0.4 s. EMG activity was recorded from the TIB of the right leg using surface electrodes. EMG data were quantified by integrating and time normalizing the rectified and averaged EMG signals (MAV). MAV of the TIB during the perturbation was also normalized on MAV during the first maximal isokinetic contraction. The ankle joint movements were indicated by a goniometer fixed along the Achilles tendon. The analysed time interval was 120 ms after the first physiological response in the goniometer signal. For statistical analysis, paired and unpaired t-tests were calculated. Data are presented as group mean values \pm SE.

Results: A comparable activity level was observed for the two groups (Group I 5886 ± 868 kcal/week; Group II 5005 ± 455 kcal/week. (a) Isokinetic contractions: in the non fatigued condition, F_{max} amounted to 28.54 ± 1.91 Nm for group I and 21.75 ± 1.38 Nm for group II (= 23.8%; $p < 0.01$). During the fatigue protocol, group II executed two more series than group I in order to reach 50% F_{max} . Due to fatigue, MAV of TIB in group I decreased from 0.465 ± 0.12 mV to 0.37 ± 0.1 mV (= 20.4%; $p < 0.05$) and in group II from 0.357 ± 0.095 mV to 0.354 ± 0.095 mV; = 0.75%). (b) Treadmill deceleration: the fatigue protocol induced no significant changes in mechanical (gonio-signal) as well as in neuromuscular parameters (MAV) for both groups.

Discussion: The observed age-related difference in maximal strength of the TIB is in line with previous findings [7]. However, in the fatigued condition, MAV of the TIB was significantly reduced in group I, whereas no changes could be observed in group II. Given the age-associated reduction in number of large alpha-motoneurons and in number and size of type-II-skeletal muscle fibres [6], it can be postulated that the neuromuscular system of the elderly subjects produced F_{max} with smaller motor units than that of the young. This can explain the finding that no changes were observed concerning EMG activity during isokinetic contractions in the elderly subjects. The 50% reduction in F_{max} in group I is most likely to be caused by central and, to a minor extend, by peripheral processes. However, primarily mechanisms in the sarcoplasmic reticulum (Ca²⁺-release) and in the extracellular space (K⁺-concentration) account for the decrease in F_{max} in group II.

It is argued [3] that gait perturbations are most likely to be compensated for by polysynaptic reflex mechanisms. With regard to reflex activity under fatigued conditions, LATASH [5] states that monosynaptic reflexes are affected by neuromuscular fatigue, whereas polysynaptic reflex mechanisms are not.

*Corresponding author.

Table 1
Individual and group results of the sit-up test before and after six weeks training

Subject	Rocking (<i>n</i> = 5)		Resistance strength training (<i>n</i> = 3)	
	Before	After	Before	After
1	0	0	0	0
2	0	6	13	21
3	14	30	15	20
4	15	20		
5	51	58		
Mean ± SE	16 ± 9	23 ± 10	7 ± 4	9 ± 6

References

- [1] B. Bigland-Ritchie, et al., *Muscle Nerve* **7** (1984), 691–699.
- [2] M. Bilodeau, et al., *J. Appl. Physiol.* **91** (2001), 2654–2664.
- [3] V. Dietz, in: *Strength and Power in Sport*, P.V. KOMI, ed., 2003, pp. 11–26.
- [4] S.C. Gandevia, *Sports Medicine* **13** (1992), 93–98.
- [5] M.L. Latash, *Neurophysiological Basis of Movement*, 1998.
- [6] J. Lexell, et al., *J Neurol Sci* **84** (1988), 275–294.
- [7] A.A. Vandervoort and A.J. McComas, *J Appl. Physiol.* **61** (1986), 361–367.

EMG activity and trainability of the rectus abdominis during rocking in a rocking chair with elderly men

I. Väänänen

Faculty of Social and Health Care, Lahti Polytechnic, Hoitajankatu 3, 15580 Lahti, Finland, Finland

E-mail: ilka.vaananen@lamk.fi

Introduction: Yesterday's “*Homo ludens*” (playing human) is now “*Homo sedens*” (sitting human). It is accepted that regular physical exercise promotes health and the ability to function. In Finland, the rocking chair is common furniture in the houses of the elderly people and traditionally familiar from the maternity wards in hospitals [5]. The therapeutic qualities of the rocking chair have been studied [1,3,5]. Furthermore, an adapted version has been developed from an ordinary rocking chair for use in rehabilitation [1], but the benefits of the rocking are not known. The purpose of this study was firstly, to quantify the electromyographic muscle activity (EMG) level of m rectus abdominis (RA) while rocking in a rocking chair and secondly, to clarify the training effects of the six weeks rocking chair training compared to the traditional resistance strength training with elderly men.

Methods: Eight male war veterans (77 ± 3 years, 72 ± 8 kg, 169 ± 4 cm) participated in this study. EMG data were collected while the subjects were rocking in a rocking chair. EMG activities recorded during rocking were compared with the maximum EMG level during maximal voluntary isometric contraction (MVC). After this five men rock daily about 30 min in a rocking chair, and three had resistance strength training session twice a week. Sit-up test was used to evaluate the training effects of the six weeks training program. Student's t-test was used to compare the differences between the groups and weeks.

Results: There were no differences between the groups. The mean EMG activity during rocking was 6% from the max EMG activity during MVC. There was a huge individual difference between subjects in sit-up test results (range 0–58, Table 1). The rocking chair group increased their sit-ups 44% ($P = 0.059$) and strength training group 29% ($P = 0.25$).

Discussion: The first part of this study showed that rocking in a rocking chair activated the m rectus abdominis, and therefore rocking in a rocking chair could be used as a training method for neuro-muscular activation in rehabilitation with elderly men. The significant training effects remained open because the preliminary character (small number of the subjects) of the second part of this study.

Conclusion: Elderly people with a decreased capability of moving may be passive to strength training at home. Instead of just sitting in a normal chair or lying in bed, rocking in a rocking chair may be beneficial for maintaining muscular activity of the rectus abdominalis and a very feasible “rehabilitation method” to put into practice without expensive equipment and staff in the home.

References

- [1] S. Avery, *Phys Ther* **59** (1979), 427.
- [2] B.E. Bishop, *Am J Matern Child Nurs* **4** (1979), 335.
- [3] J. Deussen, van and J. Kiernat, *Phys Occup Ther Ger* **4** (1985), 31–38.
- [4] B.L. Roberts and J.J. Fitzpatrick, *J Gerontol Nurs* **9** (1983), 151–156.
- [5] L. Valvanne, *Kättilölehti* **88** (1983), 49–55.

Low Back Pain – Management and Prevention

Test-retest reliability to the measurements of lumbar muscles using differently short and long RoM values

A. Baskent

Department of Physical Medicine and Rehabilitation, Istanbul Faculty of Medicine, Istanbul University, Istanbul, Turkey

E-mail: akinbaskent@yahoo.com

Introduction: The purpose of this study was to investigate the test-retest reliability of isokinetic measurements of the difference short and long range of motion (RoM) values to the lumbar extension and flexion muscle groups.

Methods: Eighteen healthy subjects participated as volunteers in this study. There were 16 males and 2 females in this study. The mean age was 23.44 ± 3.55 . The range was 19–32 years. The mean height for subjects was 173.78 ± 6.75 (cm); the mean weight was 65.56 ± 9.04 (kg). The measures were done with the Biodex System 3PRO isokinetic dynamometer at the back attachment system unit. Isokinetic measurements were made at the lumbar extension/flexion pattern, concentrically 30, 60, 90, 120, 150 and 180 °/sec angular velocities, with five repetitions at the each angular velocity. It was used semi-standing (functional position) without gravity correction. Two different ranges of motion (RoM) were used; first a full range at 120° (long RoM) and the second 60° (short RoM). Before the tests they did warm-up periods and some trial tests repetition. Every measures were repeated three days interval. For the reliability measures it uses SPSS program intraclass correlation coefficient (ICC). Peak torque values were investigated for the evaluation.

Results: For the reliability of test-retest; for long RoM, at the lumbar extension peak torque values ICC was between 0.81–0.91 and for the lumbar flexion peak torque values ICC was between 0.79–0.92. For short RoM, at the lumbar extension peak torque values ICC was between 0.84–0.92 and for the lumbar flexion peak torque values ICC was between 0.74–0.96 (Table 1).

Table 1

The ICCs for the lumbar extension/flexion peak torque values to the reliability of test-retest

	RoM	pattern	30°/s	60°/s	90°/s	120°/s	150°/s	180°/s
Range of Motion (RoM)	1200 (long RoM)	extension	0.91	0.87	0.81	0.84	0.81	0.86
		flexion	0.92	0.89	0.89	0.88	0.88	0.79
	600 (short RoM)	extension	0.92	0.89	0.84	0.92	0.93	0.88
		flexion	0.96	0.90	0.76	0.75	0.90	0.74

Discussion: Isokinetics tests are reliable, lumbar extension/flexion pattern on the semi-standing position for short and long RoM. The reliability of tests is not affected by whether the RoM is short or long.

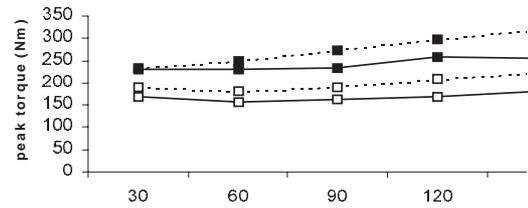


Fig. 1.

References

- [1] Z. Dvir, *Isokin Exerc Sci* **11** (2003), 9–12.
- [2] K.P. McLean, et al., *Isokin Exerc Sci* **4** (1994), 20–29.
- [3] M.D. Grabiner, et al., *JOSPT* **11** (1990), 590–598.
- [4] Z. Dvir, *Spine* **26** (2001), 1046–1051.

Measurements of lumbar isokinetics for different range of motion values

A. Baskent

Department of Physical Medicine and Rehabilitation, Istanbul Faculty of Medicine, Istanbul University, Istanbul, Turkey

E-mail: akinbaskent@yahoo.com

Introduction: The purpose of this study was to investigate lumbar extensor and flexor muscles groups for the different range of motion (short and long RoM) on the effects of peak torque values.

Methods: Thirty healthy male subjects participated as a volunteers in this study. The mean age was 22.93 ± 3.49 . The range was 19–32 years. The mean height for males was 175.83 ± 6.15 (cm); the mean weight for males was 69.13 ± 9.23 (kg). The measures were done with the Biodex System 3PRO isokinetic dynamometer at the back attachment system unit. Isokinetic measurements were made at the lumbar extension/flexion pattern, concentrically 30, 60, 90, 120, 150 and 180°/sec angular velocities, with five repetitions at the each angular velocity. It was used semi-standing (functional position) without gravity correction. Two different ranges of motion (RoM) were used; first is a full range at 120° (long RoM) and second at 60° (short RoM). Before the tests they did warm-up periods and some trial tests repetition. The results were analysed with the paired t-test. Peak torque (Nm) values were investigated for the evaluation.

Results: For all the angular velocities; peak torque values at 60 degrees (short RoM) extension/flexion were higher statistically than the peak torque values of 120 degrees (long RoM) extension/flexion ($p < 0.05$). There are no statistically significant differences, at the 30°/sec. angular velocities long and short RoM, extension values ($p > 0.05$), (Table 1).

Table 1

The results of peak torque values for short and long RoM.(Mean±SD)(Nm)

RoM	pattern	30°/s	60°/s	90°/s	120°/s	150 0/s	180°/s	
Range of Motion (RoM)	120° (long RoM)	extension	229.4±49.8 **	229.2±39.5*	232.1±36.8 *	257.5±50.3 *	253.5±55.2 *	
	flexion	167.4±42.7*	156.6±36.3*	162.1±30.4 *	167.6±30.5 *	180.8±30.5 *	200.1±40.5 *	
	60° (short RoM)	extension	233.4±51.0	248.3±44.5	273.8±52.4	299.1±60.3	320.4±63.2	319.6±62.8
	flexion	189.4±51.6	181.9±33.4	189.2±29.9	207.4±29.1	222.4±33.2	244.0±28.8	

** $p > 0.05$; * $p < 0.05$.

Discussion: Range of motion is important to the measurements of lumbar extension/flexion. Using differently short and long RoM, the results of peak torque values change. Short RoM peak torque values were higher than the long RoM peak torque values. Torque values increasing at the short range lumbar tests.

References

- [1] Z. Dvir, *Isokin Exerc Sci* **11** (2003), 9–12.
- [2] M.D. Grabiner, et al., *JOSPT* **11** (1990), 590–598.
- [3] J.L. Croisier, et al., *Isokin Exerc Sci* **11** (2003), 63–64.
- [4] Z. Dvir, *Clin Biomech* **16** (2001), 627–630.

Motor skills, spinal form and function in healthy school children aged 12–14 years

M. Küster

Physioklinik im Aitrachtal, Schlehenweg 4, 94360 Mitterfels, Germany

E-mail: jens.kuester@t.online.de

Introduction: Back pain, deficits in motor skills and cardiovascular syndromes are found already in childhood and are known as risk factors for chronic low back pain in later life. Therefore this study should assess the motor skills and spinal parameter in healthy pupils during pubertal stage because this age bears many developmental difficulties on the body. In order to develop a means of testing all necessary data in e.g. schools, we chose our test items.

Methods: To determine the relations between somatic data, gender weekly amount of PC / TV and sports with motor skills and spinal form and mobility in a cross-sectional design, 200 untrained schoolchildren (117 girls, 83 boys) were tested. Mean age was 158.1 months (± 9.59), mean height 161.4 cm (± 7.71), mean weight 119 pd (± 110.33). Mean weekly TV consumption was 679.4 min (± 471.3), PC consumption 236.4 min (± 287.2). Mean weekly amount of conditional sports was 287.5 min (± 269.9), conditional-coordinative sports 139.2 min (± 324.6), and coordinative sports 183.4 min (± 524.3). Independent variables, collected by a standardized questionnaire were: age, height, weight, gender, weekly scope of TV, PV and sports (conditional, conditional-coordinative, coordinative). Dependant variables were: motor skills, evaluated by the Munich Fitness Test, Biodex Stability System, and foot tapping; spine analysis, done by the Zebris CMS-System and IPN Back Check.

Results: The somatic data and gender affected the motor skills (Munich Fitness Test, Biodex Stability System, foot tapping) highly significantly. PC and TV consumption had negative effects on the spinal parameter, whereas esp. conditional-coordinative sports correlated positively.

Discussion: The test items proved suitable and the results should be broadened by a long-sectional design. For the Biodex Stability System, IPN Back Check and Zebris CMS System, we collected the first data for this age group. In the other tests with comparable data, our test persons showed negative results and their subjectively given mean time of movement was only 28 minutes per day. As subjective data in this field tend to exaggeration, the real data should be lower still.

Conclusions: For general health and preventive reasons, children need a daily minimum of 30 minutes of movement. Conditional-coordinative sports are suited best because of their multifactorial load on the body. The test items can be used as assessment of motor skills and spinal parameter in children and adolescents for the purpose of data collection and prevention.

Evidence Based Data in Rehabilitation

Anterior cruciate ligament rupture treatment in an occupational rehabilitation environment. A comparative study between patellar tendon vs. gracilis-semitendinosus graft

J. Chalera^{a,b,*}, E. Pujol^a, A. Abril^a, A. Maiques^a, C. Unyó^a, F. García^a, B. Müller^a and R. Garreta^a

^aPhysical Medicine & Rehabilitation Department, Mútua Egara and Hospital Mútua de Terrassa, Terrassa, Barcelona, Spain

^bSports and Physical Activity School, Blanquerna, Universitat Ramon Llull, Spain

Introduction: Anterior Cruciate ligament (ACL) reconstruction with Patellar Tendon Graft (PTG) has been widely used. Gracilis-Semitendinosus Graft (GSG) has been advocated in recent years. The best treatment option in order to improve outcome measures is sometimes controversial. There are few data about the best option in ACL reconstruction in occupational medicine. The objective of the present study is to compare the outcomes of ACL reconstruction with patellar tendon graft vs. Gracilis-Semitendinosus graft in an occupational rehabilitation environment.

Methods: Thirty-five patients referred to the PM&R department after ACL reconstruction participated in the study. Twenty underwent a PTG reconstruction, 15 underwent a GSG. All patients completed an accelerated rehabilitation program. Outcome evaluation was performed one year after surgery. Knee extension and flexion strength was evaluated with isokinetic tests. Time out of work and rehab treatment length were registered. Level of sports participation and former job return were evaluated. Overall function was assessed through the Lysholm scale. Relevant complications and patient satisfaction were registered.

Results: Flexor strength deficit (>15%) was significantly higher ($p < 0.05$) in patients treated with GSG. Those patients showed a deficit in 46% of the cases. Only 10% of patients treated with PTG showed knee flexor deficit. The rest of evaluations did not show significant difference between groups. Both groups showed a high rate of extensor deficit (ranging from 45% to 46%). 37% of patients with previous regular sportive activity gave it up. The Lysholm score mean reaches the excellent/good level in both groups. Most patients (97%) returned to their previous workplace. Complication rate was 17%. 63% of patients were highly satisfied with the treatment.

Discussion: The significantly high rate of knee flexor deficit registered in patients treated with a GSG compared with those treated with a PTG is remarkable. Although it does not imply significant differences in other aspects, the long term impact of this fact is unknown. The high rate of knee extensor deficit in both groups one year after surgery is quite concerning. The main objective of ACL reconstruction is to resume previous physical activity. In this group it has been only partially accomplished.

Conclusion: ACL reconstruction with a GCG shows no benefits in front of PTG in this group of patients. Rehabilitation strategies should be re-evaluated (i.e. enhancing the length and intensity of rehab treatment) in order to overcome the high rate of knee extensor deficit and the low levels of return to sport.

Effectiveness of different treatment strategies during in-patient rehabilitation after TKA

K. Erler^{a,**}, U. Neumann^a, C. Anders^b, HC. Scholle^b and L. Brückner^a

^aMoritzklinik Inc. & Co., H.-Sachse-Strasse, 46, D-07639 Bad Klosterlausnitz, Germany

E-mail: forschung@moritz-klinik.de

^bInstitute of Pathophysiology, Motor research Group, Friedrich-Schiller-University, Germany

Introduction: The implantation of a TKA leads to disorders of coordination, proprioception and strength which necessitates in-patient rehabilitation. Aim of the study was to verify the effectiveness of three different therapies for coordination training (special water therapy, Posturomed[®], coordination training in a gym) in patients with TKA.

Methods: Each patient received one of these therapies continuously for the three weeks of in-patient rehabilitation. SEMG was recorded from the M. quadriceps femoris in 60 TKA patients before and after surgery (4, 7 and 26 weeks). Further clinical and subjective data (questionnaires: FFbH-OA, NHP) were acquired, additionally isokinetic and sonographic examinations were performed. Data from 38 TKA patients, treated with a standard treatment programme, and from 20 healthy subjects were available for comparison.

*Address for correspondence: Joaquim Chaler, Mutua Egara, Servei de rehabilitació, c/Garcia Humet 40, 08221-Terrassa, Spain. E-mail: 27522jcv@comb.es.

**Corresponding author.

Results: Patients who underwent the coordination training therapies showed an activation of the examined musculature which was in accordance with the results of healthy subjects. Furthermore they showed better results in coordination and strength parameters compared to the patients group with the standard treatment programme.

Discussion: Patients who took part in the special water therapy reached the best results in all examined fields. The application of the water therapy resulted in an optimal advancement of coordination and strength. Furthermore, this therapy was characterised by a great acceptance on the part of the patients which gives motivation for continuation. The use of either the Posturomed® or the coordination training in a gym led to improved results in coordination. Therefore, these can be recommended as an alternative or in combination with water therapy.

Conclusion: A special coordination training is necessary to reduce the existing disorders in coordination, proprioception and strength in patients with TKA during in-patient rehabilitation.

References

- [1] K. Erler, U. Neumann, L. Brückner, J. Babisch, R. Venbrocks, C. Anders and H.C. Scholle, *Z Orthop* **138** (2000), S197–S203.
- [2] K. Erler, C. Anders, G. Fehlberg, U. Neumann, L. Brückner and H.C. Scholle, *Z Orthop* **139** (2001), S352–S358.
- [3] K. Erler, U. Neumann, C. Anders, R.A. Venbrocks, J. Babisch, K.S. Pieper, H.C. Scholle and L. Brückner, *Z Orthop* **141** (2003), S48–S53.
- [4] H. Bork, F. Hahn and J. Heisel, in: *Verband Deutscher Rentenversicherungsträger (Hrsg.) Reha-Bedarf – Effektivität - Ökonomie, DRV-Schriften Band 12*, M. Frankfurt, 1999, pp. S322–S323.

Effects of one-year mixed aerobic and resistance pool exercise training on bone mass in women with fibromyalgia syndrome: Randomized controlled trial

N. Gusi^a, P. Tomas-Carús^a and A. Leal^b

^a*Sport Sciences Faculty, University of Extremadura, 10.071, Cáceres, Spain*

E-mail: ngusi@unex.es

^b*Unit of Traumatology, Hospital of Cáceres, Cáceres, Spain*

Introduction: Physical therapy is recommended to prevent the deconditioning and bone mass loss related to the daily physical activity reduction in persons with Fibromyalgia Symptoms (FM). Exercise programs in warm-water have shown their usefulness to increase muscle strength and resistance in persons with Fibromyalgia Syndrome (FM), but the effect on areal Bone Mass Density (aBMD) has been not studied yet. The purpose of this study was to evaluate the effect of a water-based exercise program for women with FM.

Methods: Twenty-four women [mean (sd) age 52 (10), duration of symptoms 20 (9) years and number of tender points 17 (1)] with FM were randomly assigned to a training group in a waist-high pool (FMT, $n = 12$) or control group (FMC, $n = 12$). The supervised one-year exercise training consisted of three hour sessions per week which included 20 minutes of aerobics, 10 minutes of proprioception and 50 unilateral leg squats in both sides. The aBMD of femoral neck, trochanter, ward triangle and lumbar spine was assessed by DXA technique (Norland Excell Plus). Data were analysed by analysis of co-variance ANCOVA adjusted by weight and age.

Results: The aBMD remained unchanged (p : from 0.229 to 0.527) in all four sites. No inter-group effect was found in the aBMD of the lumbar region ($p = 0.853$), femoral neck ($p = 0.518$), trochanter ($p = 0.308$) or ward triangle ($p = 0.617$).

Discussion: This study has been a pioneer in measuring the effects of water-based exercise therapy in subjects with FM. However, the research in other population found similar results: the lack of effect on the skeletal system in non weight-bearing.

Conclusion: The exercise programme in waist-high pool had no effect on the aBMD in women with severe FM, so it is suggested to complement this type of rehabilitation with another specific treatment or to identify water-based exercises with higher mechanical impact on bone mass. The response of skeletal system to the program in patients with FM was similar to this in no-patients.

References

- [1] R.L. Swezey and J. Adams, *J Rheumatol* **26**(12) (1999), 2642–2644.
- [2] G. Bravo, et al., *Arch Phys Med Rehabil* **78**(12) (1997), 1375–1380.

Nerval and mechanical rhythms in rehabilitative balance training

C.T. Haas^a, S. Turbanski^a and D. Schmidtbleicher^a

^a*Institute of Sport Sciences, J. W. Goethe-University Frankfurt, Ginnheimer Landstrasse 39, 60487 Frankfurt am Main, Germany*

E-mail: c.haas@sport.uni-frankfurt.de

Introduction: Postural instability (PI) is a feature of several diseases or injuries. In the field of orthopaedics a direct trauma frequently leads to a long lasting disturbed postural control. Apart from changes in the biomechanical structures of joints and ligaments the main problem in rehabilitation seems to be connected to an irreversible loss of mechanoreceptors [2]. This leads to a modified afferent set and disturbed cortical activation patterns and in a further step to muscular atrophy and deficits in reflex mechanisms [3]. In the literature several methods for balance training can be found. Most of them are based on standing on one leg on an instable platform. From a neurophysiological point of view these treatments are connected with some problems regarding a relative long time for muscular reaction as well as a relative constancy of the stimulus [4]. Since we got positive results in balance training with Parkinson's disease (PD) patients achieved by a treatment based on whole-body-vibration we proved if these effects are disease specific or other postural disturbances (e.g. after an ACL rupture) can be treated by this method effectively, too [1].

Methods: The design of the study is based on two groups. One consisted of 12 healthy physical education students, another group contained 9 high performance athletes who had ACL ruptures. Spontaneous effects were primarily focused to enable a comparison to previous studies. The treatment was based on applying whole-body-vibration (using ZEPTOR-med, \hat{y} 3 mm, 6 Hz) in 5 series lasting one minute each. In order to get information about the effectiveness of the treatment frequency, oscillations of 10 Hz were applied in an additional training session in the students' group. Pre and post treatment postural control was analyzed by a standardized test on a two dimensional platform. Shifts of the platform were measured by an acceleration sensor. Electromyographic analyses were performed in single cases to get data about muscular activation.

Results: In the students' group the 6 Hz treatment resulted in a highly significant optimized postural control ($p < 0.01$) of 44% on average, whereas under the 10 Hz condition an improvement of 19% on average was found, but failed statistical significance ($p > 0.05$). Comparison of directions shows that improvements were larger in x- than in y-direction (ant.-post. vs. med.-lat.). In the group of high performance athletes significant improvements ($p < 0.01$) in postural control by 37% on average were found on the injured side. On the healthy side the treatment led to an optimized control of 25% on average which failed significance only hardly ($p > 0.05$). In EMG analyses it became evident that improved balance is connected with lower intensity of muscular activity. Spectral analyses of acceleration as well as the electromyographic data showed shifts of predominant peak to a higher frequency range.

Discussion: After a general consideration of all findings postural control can be highly improved by vibration treatment. However, it seems not possible to explain the results by a single or simple function. One can speculate that the shifts of the predominant peak in spectral analysis result from a quicker neuromuscular reaction. This could be achieved on one hand by an optimized sensitivity of the receptors and on the other hand by a changed stiffness preset arranged by cortical structures. In case of a quicker muscular reaction large platform shifts are prevented early and therefore overall a lower muscular activity is necessary to keep up balance. Since comparable effects were also found in studies with PD patients and moreover it is known that vibrations affect physiological functions on several levels it is likely that the treatment is connected with modified cortical activation patterns.

Conclusion: The presented vibration treatment can be regarded as an effective device for optimizing postural control in healthy as well as injured subjects. However, the type of reaction depends on the vibration parameters deeply. With respect to critical time spans in case of falling or ligament injuries vibration stimuli in the θ frequency range seems to be more practicable than other balance training methods that usually produce stimulation frequencies in the lower δ range.

Table 1
Ground reaction forces values obtained (*: $p < 0.05$, **: $p < 0.01$ significant difference with and without knee brace)

running condition	pathological side		healthy side	
	without	with	without	with
passive peak (N)	113.55 (7.03)	* 108.46 (8.76)	118.10 (6.29)	** 109.05 (6.58)
active peak (N)	190.65 (5.21)	ns 189.07 (6.81)	215.62 (4.36)	* 210.53 (7.40)
breaking peak (N)	-19.26 (1.57)	** -21.30 (2.34)	-19.14 (2.43)	ns -17.96 (2.16)
pushing peak (N)	21.34 (1.47)	ns 20.54 (1.73)	19.50 (1.59)	ns 19.70 (2.10)

References

- [1] C. Haas, et al., *16th International Scientific Conference Mittweida 2003*, in press.
- [2] P.A. Borsa, et al., *Am. J. Sports Med.* **25**(3) (1997), 336–340.
- [3] Urbach, et al., *Unfallchirurg* **103** (2000), 949–955.
- [4] J.S. Dufek and B.T. Bates, *Sports Med* **12**(5) (1991), 326–337.

Effect of knee brace on running dynamics of a subject with ACL rupture

E. Mutter^a, M. Banizette^a, F. Courtet^b, A. Geysant^b and A. Belli^a

^aLaboratory of Physiology – GIP E2S, University of Saint Etienne, France

^bThuasne, France

Introduction: The biomechanical effects of knee braces on pathological knee have been mainly studied by means of isokinetic machines [1] and during walking on a force plate [3]. However, few studies analysed the effects of knee braces during running, which is probably the most critical type of exercise for subjects with unstable knee. So the aim of this case study was to analyse the possible influence of wearing knee brace on the dynamic of running for a subject with ACL rupture.

Methods: After warm up and treadmill accommodation, one subject (85 kg, 178 cm, 24 yrs) with ACL rupture at the left knee, was asked to run at 8 km.h^{-1} during 2 min on a treadmill ergometer [2]. Ground reaction forces were sampled at 400 Hz starting at 1'40 and during 10 seconds. Vertical and antero-posterior forces were then measured on 25 left and 25 right consecutive steps. Average and standard deviation values of typical ground reaction force parameters (vertical passive and active peaks and horizontal breaking and pushing peaks) were calculated on left and right sides. A Student t-test was used to compare the force parameters obtained with and without knee brace at both pathologic and healthy sides.

Results: Wearing knee brace induced a significant decrease of the vertical passive peak for both sides and a significant increase of the horizontal breaking peak on pathological side, vertical active peak was also reduced on healthy side.

Discussion: It is first important to note that when measured on many successive steps during running, a significant effect of knee brace could be evidenced in this pathological subject. It seems that the knee brace allows a better breaking action in pathological side, which could enhance the stretch shortening cycle behaviour of lower limb muscles and thus increase the efficiency of running. It should be also mentioned that knee bracing reduced the asymmetry of vertical forces between pathological and healthy sides.

Conclusion: Although the present results should be confirmed on a sufficient number of subjects, the measurement of ground reaction force parameters during running on a treadmill ergometer seems to be a promising method to evaluate and quantify the biomechanical effects of knee brace on pathological subjects.

* Address for correspondence: Elodie Mutter, Hôpital St Jean-Bonnefonds, Pavillon 12, CHU St Etienne, 42055 St Etienne Cedex, France.
E-mail: elodie.mutter@univ-st-etienne.fr.

Table 1
Subjects test performance. Isokinetic peak torque values (in Nm) and jump abilities (in cm)

	CC			OSG			P
	Injured	Non injured	difference	Injured	Non injured	difference	
PF torque 30°/s	40.43 ± 25.43	42.15 ± 16.58	-5.78 ± 12.66	50.16 ± 15.78	44.14 ± 12.87	6.02 ± 6.64	0.37
DF torque 30°/s	10.73 ± 3.07	11.65 ± 2.01	-0.46 ± 1.26	14.04 ± 3.16	13.52 ± 3.69	0.52 ± 0.84	0.32
PF torque 120°/s	24.90 ± 9.06	28.23 ± 8.54	-3.14 ± 2.61	32.00 ± 11.45	34.76 ± 12.03	-1.16 ± 2.33	0.24
DFtorque 120°/s	4.43 ± 0.99	5.28 ± 1.37	-0.62 ± 1.27	6.70 ± 2.12	7.14 ± 1.61	0.42 ± 2.80	0.21
Drop jump	14.60 ± 2.80	16.00 ± 2.90	-1.40 ± 1.85	17.40 ± 3.01	16.80 ± 2.99	0.60 ± 1.85	0.42
Long jump	176 ± 22	176 ± 24	00 ± 3	195 ± 19	196 ± 20	1 ± 14	0.41

References

- [1] J.P. Albright, et al., *Sports Med* **20**(5) (1995), 281–301.
 [2] A. Belli, et al., *J Biomech* **34** (2001), 105–112.
 [3] P. DeVita, et al., *Am J Sports Med* **26**(6) (1998), 778–784.

Isokinetic and sport motoric ability following lateral ankle and calcaneocuboid joint ligament repair

T. Nauck^{a,b,*}, H. Lohrer^a, J. Schöll^a and D. Schmidtbleicher^b

^a*Institute of Sports Medicine, Frankfurt/Main, Germany*

^b*Institute of Sport Science, Johann Wolfgang Goethe University Frankfurt/Main, Germany*

Introduction: Isolated calcaneocuboid joint instability is a rare condition. It has to be regarded in the differential diagnoses of lateral ankle ligament instability. Both pathologies may result in recurrent giving away. If conservative treatment fails surgery is indicated. Following rehabilitation for ability in sport and leisure activities should be reconstituted. This study compares the treatment results in a young, sports engaged group of patients after surgery and specific rehabilitation.

Methods: A follow-up investigation was performed 18.6 ± 15.5 months after periosteal flap repair of lateral calcaneocuboid ($n = 5$) or lateral ankle ligament ($n = 5$) instability in a case control study design. As a part of a complex investigation isokinetic abilities of the ankle were tested using a standardized concentric/concentric dorsal/plantarflexion protocol at 30 and 120 Nm respectively. From this peak torque values were calculated for either ankle. Sport motoric ability was examined by a single leg drop jump and a single leg long jump test. Analysis was done as a side to side comparison and by comparison of the treatment groups. Statistical analysis was performed through a descriptive analysis. The Pearson coefficient was calculated to express the degree of the linear relationship between the two groups and between the injured and non injured leg respectively.

Results: Statistical comparison of peak torques in isokinetic testing and of the jumping abilities does not reveal any relevant difference comparing the dorsolateral calcaneocuboid ligament repair and the lateral ankle ligament repair group respectively. Additionally, no difference could be revealed between the injured non injured leg respectively. However, a positive relation exists between the point in time of follow-up investigation and the achieved motoric performance. Differences between injured and uninjured legs were not significant for all tests performed ($p > 0.05$). $P =$ statistical comparison between calcaneocuboid and ankle group differences (Table 1).

Discussion: Dorsal calcaneocuboid ligament injury is a rarely described condition. Obviously it is frequently overlooked in clinical practice. Operative treatment using a periosteal flap augmentation leads to full sports rehabilitation as measured by evaluated questionnaires. Muscular function as measured by isokinetic and single leg drop and long jump respectively could be shown to result in a balanced situation in side to side comparison. Taking into consideration, that the performance of the dominant leg is about 10 percent superior to the opposite side [2] however, a long-lasting post-operative deficit must be stated.

* Address for correspondence: Tanja Nauck, Institute of Sports Medicine, Otto-Fleck-Schneiße 10, 60528 Frankfurt/Main, Germany. E-mail: nauck@smi-frankfurt.de.

Conclusion: Treatment results after dorsal calcaneocuboid ligament surgery using a periosteal flap augmentation are equal to the results after operative treatment of lateral ankle ligament instability with respect to specific muscular parameters. Results seem to improve with time after surgery.

References

- [1] A. Gollhofer, Sportwissenschaften und Trainingspraxis, *STF Verlag* (1987), S108ff.
 [2] A. Gollhofer, DSB Abschlußbericht, *Betreuungsprojekt Volleyball* (2003).

Effect of different exercise regimes on patellofemoral pain syndrome

V. Strojnik^a, R. Vengust^b and V. Pavlovčič^b

^aFaculty of Sport, University of Ljubljana, Ljubljana, Slovenia

^bOrthopaedic Clinic, University Clinical Centre, Ljubljana, Slovenia

Introduction: In order to improve the success rate in conservative treatment of patellofemoral pain syndrome (PFPS) and gain understanding in its mechanisms we tested three different exercise modalities which could be related to different aetiologies of PFPS. Knee extensions during the last 30 degrees till the full extension purported to selectively activate the vastus medialis oblique muscle to increase medial pull on the patella [1]. Electrical stimulation of the vastus lateralis muscle may selectively increase its strength and increase medial pull to patella. Proprioceptive training may improve reflex sensitivity and intermuscular coordination.

Methods: Forty subjects suffering from patellar hondropathia (25 subjects) and subluxation (15 subjects) volunteered for the study. They were divided into four groups performing different types of training: muscle activation training (ACT, $N = 9$), proprioceptive training (PRO, $N = 7$), electrical muscle stimulation (ES, $N = 12$), and combination of muscle activation and proprioception (ACT+PRO, $N = 12$). In all occasions, the training was performed three times per week for 8 weeks. Before and after the training, the measurements were obtained including torque and EMG signal during maximal voluntary contraction (MVC). Clinical testing included Kujala questionnaire.

Results and conclusions: Clinical improvement showed on a general efficiency of the training in PFPS patients. Among the treatments, the electrical stimulation was inferior to the other exercise regimes. Seven out of 40 subjects didn't change or even slightly decreased (up to -4%) their clinical results and four of them were from ES group. Muscle activation training seemed more effective in conservative treatment of PFDS. It was speculated that muscle activation deficit might have greater impact on PFDS than muscle atrophy.

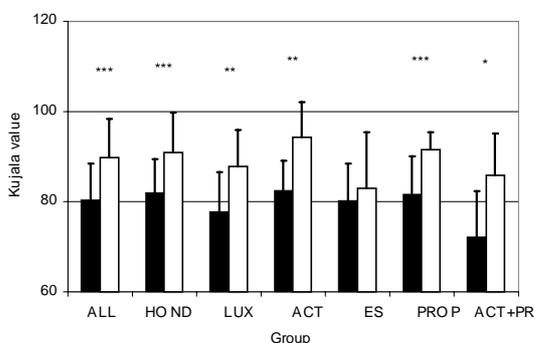


Fig. 1. Clinical test.

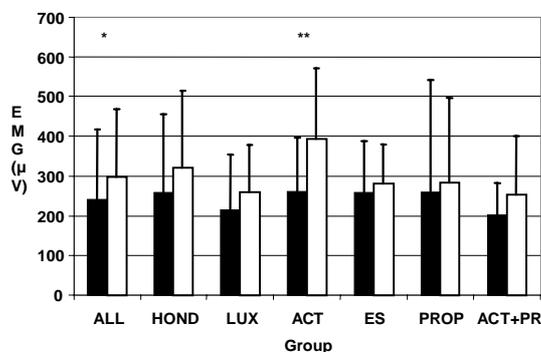


Fig. 2. EMG of VL muscle.

Reference

- [1] H.J. Hehne, Biomechanics of the patellofemoral joint and its clinical relevance, *Clin Orthop* **258** (1990), 73–85.

Ankle instability and delayed neuromuscular response: Acceleration time parameters

E.H.R. van Cingel^{a,b,*}, G.J. Kleinrensink^{c,d}, E.J. Uitterlinden^c, P.P.G.M. Rooijens^c, P.G.H. Mulder^f, G. Aufdemkampe^e and R. Stoeckart^{c,d}

^a*Sports Medical Center Papendal, Arnhem, The Netherlands*

^b*Netherlands Olympic Committee, Netherlands Sports Confederation, Elite Sports Department, Arnhem, The Netherlands*

^c*ErasmusMC; University Medical Center Rotterdam, Department of Neurosciences, The Netherlands*

^d*Lowlands Institute of Surgical and Applied Anatomy (LISA), Rotterdam, The Netherlands*

^e*Polytechnic of Utrecht, Department of Physical Therapy, The Netherlands*

^f*ErasmusMC; University Medical Center Rotterdam, Department of Epidemiology & Biostatistics, The Netherlands*

Introduction: Reaction time is an essential element in joint protecting reflexes since joint loading requires fast and coordinated muscle action. In case of a (sudden) inversion movement the effectors of the reflex are formed by the evertor muscles, counteracting this movement. Adequate neuromuscular response is crucial and a delayed response could contribute to inversion trauma and subsequently to (chronic) ankle instability. Surface EMG studies using trapdoor mechanisms show different outcomes in the response of lower leg muscles. These conflicting results require further research with different scopes. The acceleration time (ACC-TIME) parameter provides valuable information on neuromuscular response. The purpose of this study was to assess whether in subjects with unilateral chronic ankle instability the ACC-TIME of the affected ankle differs from the healthy ankle and ankles of healthy controls.

Methods: Patients with unilateral chronic ankle instability ($n = 11$) and healthy controls ($n = 11$) were measured on a Cybex 6000 isokinetic dynamometer during three sets of three reciprocal inversion/eversion movements of either ankle at 30 and 120°/sec.

Results: For the evertor muscles at 30 and 120°/sec a significantly prolonged ACC-TIME was found when comparing the affected ankles to the contra lateral ankles and both ankles of healthy controls. For the invertor muscles at 120°/sec a significantly prolonged ACC-TIME was found when comparing the affected ankle to the unaffected ankles of patients and healthy controls.

Conclusion: Since the principal evertor muscles are innervated by the peroneal nerves, the significantly prolonged ACC-TIME of the affected ankle is consistent with the finding of a lowered motor nerve conduction velocity of the peroneal nerves after inversion trauma. The results support the concept of a delayed neuromuscular response as an important factor in the etiology of chronic ankle instability. Further research to assess the importance of the ACC-TIME parameter may contribute to rehabilitation strategies for patients with ankle instability.

Standardized Methods for Testing (1)

Multiple angle isometrics knee flexion/extension torque ratios

*Address for correspondence: Robert van Cingel, De Bogaert 44, 6983 HE Doesburg, The Netherlands. E-mail: r.vancingel@wxs.nl.

A. Baskent

Department of Physical Medicine and Rehabilitation, Istanbul Faculty of Medicine, Istanbul University, Istanbul, Turkey

E-mail: akinbaskent@yahoo.com

Introduction: The purpose of this study was to investigate, the values of the isometric muscle strength (peak torque) to the knees extension and flexion muscle groups for healthy subjects.

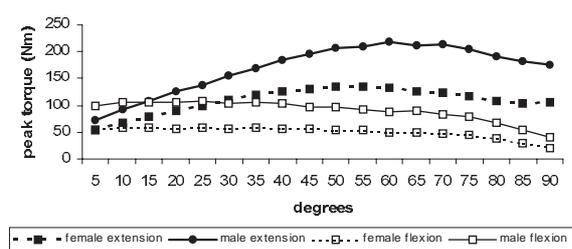


Fig. 1. Multi-angle isometrics.

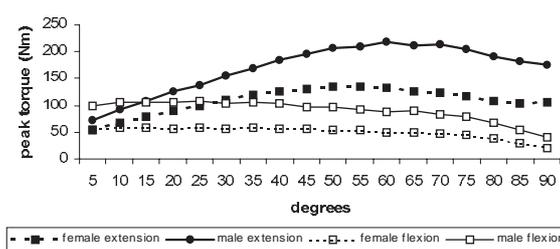


Fig. 2. Multi-angle isometrics agonist/antagonist ratio.

Methods: Seventy healthy subjects participated as volunteers for this study. There were 34 males and 36 females in this study. The mean age for the males was 22.88 ± 1.82 , for females was 22.72 ± 1.89 . The range was 20–30 years. The mean height for males was 176.91 ± 7.06 , and for females was 165.89 ± 5.41 (cm); the mean weight for males was 72.94 ± 9.14 , and for females was 56.89 ± 6.40 (kg). The isometric tests were done with the dynamometer of Biodex System 3PRO. Dominant side was tested. Before the tests they did warm-up periods and some trial tests repetition. The measures were done isometrically at the reciprocal knee extension/flexion pattern. It accepted 0 degree knee total extension. As the test protocol; to the extension 5 sec maximal isometric contraction, after 5 sec relaxation time, after for flexion 5 sec maximal isometric contraction was recorded. And between them 30 sec rest period was recorded. It was tested at the 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90 angles values. The results were analysed with the Mann-Whitney U test and paired t-test. Peak torque (Nm) values and agonist/antagonist ratio (%) were investigated for the evaluation.

Results: For all the angles; for males extension/flexion muscles strength were statistically higher than females ($p < 0.05$). There is no statistically significant difference between agonist/antagonist ratios at the 50, 55, 60, 70, 75, 80, 85, 90 angles ($p > 0.05$). Except these angles, there was statistically significant differences ($p < 0.05$). For males; at the 15 and females at the 50 for extension/flexion peak torque values, it wasn't statistically significant ($p > 0.05$). For other angles, it is statistically significant ($p < 0.05$).

Discussion: It occurs imbalances on the knee problems due to the muscle weakness. It uses normal torque ratios for the rehabilitation of muscles imbalance.

References

- [1] J.P. Lord, et al., *Arch Phys Med Rehabil* **73** (1992), 324–330.
- [2] J.J. Kpanik, et al., *Phys Ther* **63** (1983), 938–947.
- [3] D.B. Starkey, et al., *Med Sci Sports Exerc* **28** (1996), 1311–1320.
- [4] M.A. Welsch, et al., *Arch Phys Med Rehabil* **79** (1998), 971–978.

Influence of limb dominance on knee flexor:extensor ratio of ACL reconstructed patients

J. Baumeister^{a,*}, C. Ries^b and M. Weiß^a

^a*Institute of Sports Medicine, University of Paderborn, Warburger Str. 100, 33098 Paderborn, Germany*

E-mail: jochen@sportmed.upb.de

^b*PHYSIOmed, Rehabilitation Center, Germany*

Introduction: Diagnostic strength measurements and rehabilitation programs after reconstructions of the anterior cruciate ligament (ACL) seemed to be based on the opinion of injured and non-injured side to be comparable with the aim to restore the injured side to the level of the uninjured leg. Although the human body appears to be bilaterally symmetrical, it has been proved that the right and left side are not identical [5]. This asymmetry seems to be not important in healthy people but could possibly influence the biomechanical output of injured (“disordered”) individuals. The purpose of the study was to examine the limb dominance of ACL-reconstructed patients on peak torque and the hamstring/quadriceps peak torque ratio. If the dominant limb plays a role after reconstruction of the ACL that would lead to altered testing results and therapy strategies.

Methods: Twenty-two patients (11 males; 11 females; 21 right-footed, 1 left-footed) after ACL reconstruction were divided into two different groups: a) dominant leg injured (age 29.82 ± 4.14 ; weight 68.55 ± 9.73 , 11.09 ± 4.68 weeks after surgery) and b) non-dominant leg injured (age 26.64 ± 3.67 ; weight 75.64 ± 18.8 ; 16.0 ± 7.5 weeks after surgery). No subject had other ligamentous injury, repairable meniscal damage or defects in articular cartilage. Ten healthy subjects (5 males; 5 females; 9 right-footed; 1 left-footed) served as a control group (age 26.5 ± 4.4 ; weight 70.4 ± 12.89). Leg dominance were based on asking all subjects about their preferred limb as well as the choice of foot for kicking a ball and stepping up on a chair [4]. Subjects were seated on an isokinetic dynamometer (CybexNORM). The hip was stabilized with straps with hip and knee joints at 90° flexion. The session included 6 sets each with 8 trails at a velocity of $60^\circ/\text{sec}$ with aim at maximal possible torque output in extension and flexion. All subjects were familiarized with equipment and procedures. Torque display were not in view for patients. Measured parameters were maximal torque in extension and flexion and flexor to extensor peak torque ratio (F:E ratio).

Results: The statistical analysis showed significant differences in mean F:E ratio (over the sets) between ACL reconstructed and healthy subjects ($p = 0.013$). In more detail F:E ratio is significant between all single sets. Inside the ACL-group there were differences between subgroups dominant and non dominant limb ($p = 0.037$) (in detail 1., 2. and 4. single set) whereas there are no subgroup-differences inside the healthy subjects. Bigger differences in mean F:E ratio were found between the dominant limb of the ACL patients and the healthy group ($p = 0.016$) (as well as between all single sets). Reconstructed non-dominant leg vs. healthy group showed no differences.

Discussion: Following the results there seems to be evidence that the ACL reconstructed dominant limb act different compared to the reconstructed non-dominant and both limbs of the healthy subjects. Our results in the healthy people correspond with the results from other authors who found no (normal subjects) or only tendential differences (athletes) between the dominant and non-dominant limb [2]. The muscle balance (F:E ratio) seems to react more sensitive if the dominant side is injured. If we suppose that the nerve conduction shows no differences [3] this leads to the idea that there are potentially different strategies in central activation and movement preparation depending on the lateral dominance of the injured leg. Valeriani [6] shows changes in somatosensory evoked potentials after ACL reconstructions. Differences in movement preparation and cortical activation after ACL reconstruction in dependence of lateral dominance were found by Barthel [1] who support the idea of a different strategy of movement preparation if the dominant extremity is injured.

Conclusion: Limb dominance has an influence on biomechanical output of ACL reconstructed extremities. This means testing strategies and rehab programs after ACL reconstruction have to be reconsidered. Further studies should focus on this theory.

References

- [1] Barthel, et al., *European Workshop on movement science* (2003), 90–91.

*Corresponding author.

- [2] Demura, et al., *Percept Mot Skills* **93**(1) (2001), 11–23.
 [3] Engelhardt, et al., *Eur J Sports Traumatol Rel Res* **23**(2) (2001), 76–81.
 [4] Gabbard, et al., *J General Psychol* **123**(4) (1996), 289–296.
 [5] Oda, *The right and left in exercise* (1998).
 [6] Valeriani, et al., *Acta Neurol Scand* **99**(5) (1999), 303–307.

Realtime method to determine the ankle joint axes

H. Hochwald^{a,*}, W. Alt^a and G. Busch^a

^a*Institut of Sport Science, University of Stuttgart, Reuchlinstrasse 13, 70178 Stuttgart, Germany*

E-mail: harald.hochwald@sport.uni-stuttgart.de.

Introduction: Today used methods to determine the ankle joint axes, e.g. photogrametrie [1] or mechanical methods [2], need a lab environment and a significant instrumental setup. They can hardly be used in field measurements. The aim of the present project was the development of an easy to use application that is able to measure the position and orientation of the upper as well as the lower ankle joint axes in real time.

Methods: According to already existing *in vivo* procedures for the determination of the ankle joint axes, this method is based on a motion analysis of the ankle joint. The position and orientation of the ankle joint axes are computed using the recorded data from the movement of several markers attached at the forefoot and at the tibia. In order to ensure a to a large extent automated operational sequence of the data collection and the data evaluation, the CMS20 system of the company Zebris[®] was used. This system is based on the ultrasonic run time measurement, using triangulation procedures to calculate the exact position of up to 8 ultrasonic transmitters with an accuracy of 1/100 mm – 1/10 mm. Two different mathematical procedures are used for the computation of the ankle joint axes. The lower ankle joint axis is computed with the procedure of the *Helical Axis* [3], where the three dimensional movement of three markers is recorded.

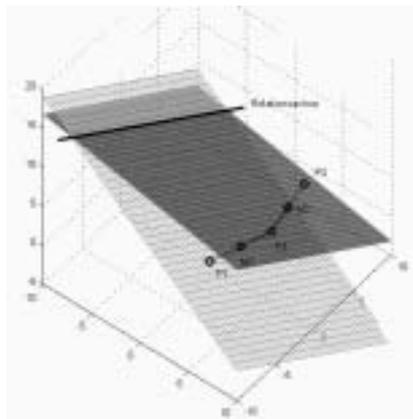


Fig. 1. Method to calculate a rotation axis using one marker.

For the determination of the lower ankle joint axis a new developed procedure is to be used. The advantage of this new procedure is that only one marker is needed. If this marker is attached near the lower ankle joint axis, the upper ankle joint axis can be determined sufficiently exactly, although there is superposed movement by the lower ankle

*Corresponding author.

joint. Since during a rotation in a three-dimensional space the center of rotation of one point must be on a straight line, the straight line between two snapshots of one rotating point is representing the normal vector of a plane.

With three snapshots of one rotating marker, we can calculate two normal vectors representing two planes.

Results and discussion: In a first study to verify the new developed application the upper ankle joint axis at a mechanical foot model was determined. Comparing the directly measured and the computed angles the error for the inclination angle α was $\Delta\alpha < 1.4^\circ$ and for the deviation angle $\beta\Delta\beta < 0.5^\circ$.

References

- [1] W. Alt, *Biomechanische Aspekte der Gelenkstabilisierung*, C.Maurer Druck & Verlag, 2000.
- [2] J.R. Engstberger, *A Method to Determine the Range of Motion of the Ankle Joint* (1992).
- [3] H.A.C. Jacob, Biomechanics of the forefoot, Bioengineering Unit, University of Strathclyde, *Dissertation. Author A: Int J Sports Med* 2006 **27** (1989), S11–S18.

Energy turnover at the Race Across AMERICA (RAAM) – A case report

B. Knechtle^a, A. Enggist^{b,*} and T. Jehle^c

^a*Institute of Sports Medicine, Swiss Paraplegic Centre, Nottwil, Switzerland*

^b*Enggist Medical Fitness GmbH, Bahnhofstrasse 43, 9470 Buchs, Switzerland*

E-mail: medfit@bluewin.ch

^c*Praxisteam, Schaan, Fürstentum Liechtenstein*

Introduction: We report energy intake and energy expenditure in an official finisher of the Race Across America (RAAM) in 2003.

Methods: Energy intake from nutrition was continuously recorded. Energy expenditure was measured by continuously heart rate recording with a portable heart rate monitor POLAR[®] S710 to estimate energy expenditure during physical activity.

Results: Our athlete (33 years, 179 cm, 73 kg, $\text{VO}_{2\text{max}}$ 60 ml · min⁻¹ · kg⁻¹, lactate threshold at 77% $\text{VO}_{2\text{max}}$) finished the 4.701 km with 25.826 meters of altitude in 9 days 16 hours and 45 minutes in 4th place. He completed 470 ± 72.9 km (372 km–541 km) per day with 2.582 ± 1.576 (683 – 5.047) meters of altitude. During the whole race, he expended a total energy of 179.650 kcal with 17.965 ± 2.165 (15.100 – 23.280) kcal per day. Total energy intake was 96.124 kcal with an average of 9.612 ± 1.500 (7.513 – 12.735) kcal per day. He ingested per day an energy of 9.612 ± 1.550 (7.513 – 12.735) calories, consisting of 1.814 ± 310 (1.336 – 2.354) g of carbohydrates, 172 ± 47 (88 – 251) g of fat and 207 ± 52 (128 – 286) of protein. Of total ingested calories, 75.2% derived from carbohydrates, 16.2% from fat and 8.6% from protein. A total deficiency of 83.526 kcal resulted after the race while the athlete lost five kg of body weight. The average daily energy deficiency amounted to 8.352 ± 2.523 (4.425 – 13.631) kcal.

Conclusion: These results provide data about energy intake and energy expenditure in the RAAM for future athletes, nutritionists and coaches.

Anaerobic power and isokinetic strength of basketball players

C. Lehance^{a,**}, J-L. Croisier^b, M. Schiltz^b, D. Maquet^b, J-M. Crielaard^b and T. Bury^a

^a*Department of Sports Physiology, University of Liège, Belgium*

^b*Department of Physical Medicine and Rehabilitation, University Hospital Center, Liège, Belgium*

*Corresponding author.

** Address for correspondence: Cédric Lehance, Institut Supérieur d'Education Physique et de Kinésithérapie, B21, Allée des Sports 4, B-4000 Liège, Belgium. E-mail: clehance@ulg.ac.be.

Introduction: Basketball involves intermittent physical activity in which sequences of actions requiring a variety of skills of varying intensities are strung together. Explosive type efforts such as sprints, jumps and duels are important factors for successful basketball performance. These efforts depend on maximal strength and anaerobic power of the neuromuscular system, more particularly of the lower limbs. Therefore we assessed anaerobic power and muscular strength of basketball player to clarify which parameters are relevant in basketball practise.

Methods: Elite junior basketball players ($n = 10$, age 19 ± 1.1 years) and sedentary subjects ($n = 20$, age 23 ± 3.2 years) were examined. The isokinetic strength of knee extensor and flexor muscles was measured in the eccentric mode ($30^\circ \cdot \text{sec}^{-1}$ and $120^\circ \cdot \text{sec}^{-1}$) and through concentric exertions ($60^\circ \cdot \text{sec}^{-1}$ and $240^\circ \cdot \text{sec}^{-1}$). Anaerobic power based on vertical jump (one leg and two legs) and 10 m sprint time, was assessed using Optojump system. Possible relationships between sprint, jumps and isokinetic data were estimated through correlation analysis.

Results: The elite junior basketball players showed higher knee flexor torques than the sedentary group for all modes of contraction and angular velocities ($p < 0.05$), except for concentric $240^\circ \cdot \text{sec}^{-1}$. A mixed eccentric flexor/concentric quadriceps ratio(1) was significantly ($p < 0.05$) reduced in the sedentary group compared to elite group. Counter movement jump, counter movement jump free arms, drop jump dominant leg and power dominant leg were significantly higher ($p < 0.05$) in basketball players. For bodyweight normalized parameters, jumps were correlated only with the extensors concentric peak torque at the concentric speed of $240^\circ \cdot \text{sec}^{-1}$ in basketball group (drop jump dominant leg, $r = 0.96$; 10 s dominant leg, $r = 0.89$; counter movement jump, $r = 0.81$; counter movement jump free arms, $r = 0.78$).

Discussion: In our study, knee flexor muscle strength and jumping ability differ between elite junior basketball players and sedentaries. These results would tend to support the use of such tests for aiming to determine the relative importance of strength and anaerobic power to sporting performances and also for muscle strength disorders identification in sports dominated by the physical qualities of strength and power. In basketball group and sedentary group, we demonstrated few correlations between isokinetic muscle strength and anaerobic power performances. This could imply that isokinetic tests do not reflect the movement of lower limbs involved during jumping or sprinting.

Conclusion: The results demonstrated that isokinetic and vertical jump tests may be used to effectively discriminate between individuals with different performance levels. Further researches are requested to determine the most effective assessment protocols to differentiate basketball player performance levels.

Reference

- [1] J-L. Croisier, *Am J Sports Med* **30**(2) (2002), S199–S203.

The relation between the heart rate recovery and the heart rate performance curve

M. Luger^{a,*}, R. Pokan^a, P. Hofmann^b, S.P. von Duvillard^c, M. Wonisch^b, G. Smekal^a, N. Bachl^a and P. Schmid^a

^aDepartment of Sport Sciences, University of Vienna, Austria

^bDepartment of Sport Sciences, University of Graz, Austria

^cCalifornia State Polytechnic University, Pomona, CA, USA

E-mail: rochus.pokan@univie.ac.at

Introduction: Previous research established two facts. An abnormal heart rate recovery after exercise is linked to cardiovascular risk and the deflection of the heart rate performance curve (kHR) that reflects the myocardial function. In this investigation we studied the relationship between the heart rate recovery (HRR) and kHR in a sample of healthy subjects and patients.

Methods: Sixty-three healthy and 36 diseased subjects (hypertension and/or coronary artery disease) underwent a sitting symptom limited cycle ergometer exercise test. We measured maximal heart rate, maximal power output per

*Address for correspondence: Melanie Luger, Kaiserstr. 51-53/12, 1070 Vienna, Austria. E-mail: MeL.luger@yahoo.com.

weight (W-max/kg) and calculated lactate turn points (LTP_1 , LTP_2), kHRs. The HRR is calculated as the time the heart rate decreases from the maximum level to the level of LTP_2 .

Results: We observed significant correlation between kHR and time (t) t- LTP_2 in healthy subjects ($p < 0.0001$), however the sample data of patients did not provide significant evidence for correlation between kHR and t- LTP_2 . After adjusting for age and W-max/kg, we found statistically significant correlation for the healthy subjects. The healthy subjects recovered from exercise considerably faster ($t - LTP_2 = 59.6 \pm 44.1$ sec) than the patients ($t - LTP_2 = 83.8 \pm 71.6$ sec). The kHRs of the patients tend to be negative and that of the healthy subjects positive. There was a statistically significant difference between the average kHRs of the two groups.

Conclusion: We found a significant correlation between the HRR and kHR for the healthy subjects only. The lack of correlation for the patient's group may be due to the relatively small sample size. In recent years, there has been ample data available on heart rate recovery and also on the significance of kHR value. In this regard, we consider further research on the relationship between these two parameters of high relevance. Our current research results warrant new and additional inquiry.

References

- [1] C.R. Cole and E.H. Blackstone, *Pashkow: N Engl J Med.* **341** (1999), 1351–1357.
- [2] P. Hofmann, R. Pokan and K. Preidler, *Int J Sports Med* **15** (1994), 232–237.
- [3] R. Pokan, P. Hofmann and K. Preidler, *Eur J Appl Physiol* **67** (1993), 385–388.
- [4] R. Pokan and P. Hofmann, *Von Duillard SP: Med Sci Sports Exerc* **30** (1998), 1475–1480.
- [5] J. Watanabe and M. Thamilarsan, *Blackstone: Circulation* **104** (2001), 1911–1916.

Load distribution under children's midfoot walking barefoot or in shoes

K. Moser*, S. Müller, C. Mahler, H. Baur and F. Mayer

Medical Clinic, Department of Sports Medicine, University of Freiburg, Germany

Introduction: In literature, walking barefoot is described as the best way to support gait development in children [2]. Nowadays children can hardly avoid wearing shoes because shoes give protection from injuries and infections [3]. Therefore in this study it was of major concern to find out, if walking in shoes has any influence on children's gait in different developmental stages, especially the development of the longitudinal arch. If this arch erects with age, flatfoot in younger children would be a normal developmental step and would not have to be corrected by insoles. For this reason, load distribution was investigated especially under the children's midfoot in barefoot vs. shoe condition.

Methods: 38 healthy children (Group1: 11 between 4 and 5, Group 2: 16 between 6 and 7, Group 3: 11 between 8 and 9 years) were analysed walking on a treadmill (hp cosmos, quasar) at 3.5 km/h. After 5 min adjustment subjects walked in randomised order with a standardized children's shoe and a gymnastic shoe, the latter simulating the barefoot condition. Plantar pressure distribution (PPD) was measured between foot and shoe/treadmill (pedar mobile by Novel, sampling frequency: 50 Hz, 1 sensor/2 cm²). For each condition and subject an average step of 10 single steps was calculated. Peak Pressure divided by body mass (PP_{rel}) was analysed in different regions of the foot (Fig. 1). Descriptive statistics were followed by One-way-ANOVA ($\alpha = 0.05$).

Results: In the barefoot condition in region 3 and 4 PP_{rel} values decreased with age (Table 1). The differences between group 1 and 3 in region 3 were statistically significant ($p < 0.05$) (Fig. 2). Under region 3 and 4 there were no statistically significant differences concerning load distribution in the shoe condition.

Discussion: Developmental patterns in PPD under the midfoot are different when walking barefoot or in shoes. The significantly reduced load distribution under the medial midfoot in the ages 8 and 9 underlines the development of the longitudinal arch in these ages. This pattern could not be observed in the shoe condition. The reduction of

*Address for correspondence: Katharina Moser, Am Karlsplatz 6, 79098 Freiburg, Germany. E-mail: kamosia@hotmail.com.

Table 1
PP_{rel} values in group 1-3 under regions R3 and R4

Barefoot	R3	R4	Shoe	R3	R4
Group 1	0.36 ± 0.13	0.39 ± 0.09	Group 1	0.30 ± 0.11	0.36 ± 0.12
Group 2	0.30 ± 0.19	0.34 ± 0.15	Group 2	0.38 ± 0.20	0.39 ± 0.19
Group 3	0.19 ± 0.11	0.28 ± 0.09	Group 3	0.31 ± 0.11	0.31 ± 0.10

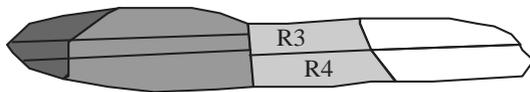


Fig. 1. PRC-Mask with 10 regions [1].

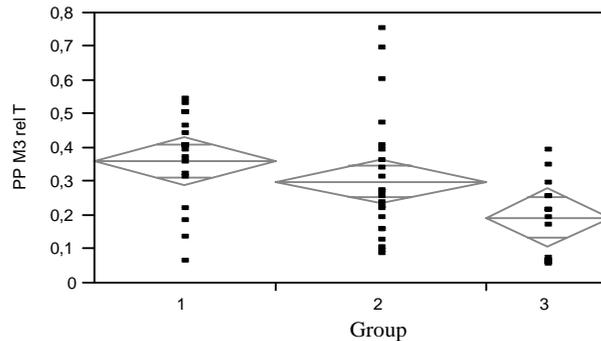


Fig. 2. One-way ANOVA of PP_{rel} under M3.

load under the medial midfoot in the barefoot condition does not cause a load shift to the lateral side because under region 4 the values are also decreasing, however, not significantly.

Conclusion: From these findings, it can be concluded that as the longitudinal arch erects with age, a flatfoot in young children is absolutely normal and needs not to be corrected by insoles. Furthermore it was found that walking in shoes does not seem to promote gait development in children.

References

- [1] M. Rodgers and P. Cavanagh, *Medicine and Science in Sports and Exercise* **21**(1) (1989), 23–28.
- [2] K. Kirsten, J. Kastner, S. Holzreiter and P. Wagner, *Engel A.: Z. Orthop.* **136** (1998), 457–462.
- [3] L. Staheli, A review, in *Pediatrics* **88**(2) (1991), 371–375.

A short-lasting isokinetic bicycling test in comparison with an endurance and isometric strength test

B. Stapelfeldt^{a,*}, Y.O. Schumacher^b and A. Gollhofer^a

^a*Institut für Sport und Sportwissenschaft, Universität Freiburg, Schwarzwaldstrasse 175, D-79117 Freiburg, Germany*

E-mail: bjoern.stapelfeldt@sport.uni-freiburg.de

^b*Abteilung Präventive und Rehabilitative Sportmedizin, Medizinische Universitätsklinik Freiburg, Germany*

Introduction: A new generation of electromagnetically braked cycle ergometer combines isokinetic test modus with measurement of torque during the pedalling movement. Depending on test intensity and duration, different fractions of anaerobic and aerobic metabolism contribute to the power output and also muscular strength has to be taken into account discussing the influencing factors. Using the isokinetic mode of an SRM-ergometer (SRM, Schoberer, Jülich, Germany) a bicycling test with maximal intensity lasting 75 s has been established. Depending on the isokinetic mode, pedalling frequency is constant (90 rpm) and power output (P , W_{att}) is calculated from torque, measured directly at the cranks. P decreases exponentially from peak power during the beginning, approaching

*Corresponding author.

an asymptote during the final seconds of the test. The level of the asymptote is defined as plateau power (P_{pav}). Therefore the test is named plateau-power test (PPT). In order to determine the hypothesis of the limiting factors of PPT, the data has been related to data derived from a) a long-lasting incremental exercise test (IET) and b) a maximum isometric strength test (MIS) using linear regression.

Methods: Nineteen competitive German national team cyclists (road and off-road) completed the PPT, the IET and the MIS on the same day. Within the PPT power output was registered in one-second-interval, with maximum power (P_{max}) as the highest single value and P_{10s} and P_{pav} as the arithmetic mean of the initial 10 s and the plateau, respectively. IET starting at 100 W with 20 W increase every three minutes until volitional exhaustion was also performed on a SRM-ergometer. During the last 30 s of every stage, a blood sample (25 ml) was taken from the earlobe for lactate analysis. To evaluate exercise intensity, P at 2 mmol/l lactate level (P_{lac2}) and at exhaustion (P_{exh}) were determined. MIS to assess maximal unilateral isometric leg extension force (F_{max} , sum of left and right leg) was conducted using a leg-press with hip and knee angle adjusted at 90° and one feet resting on a one-dimensional KISTLER force platform. Values from descriptive statistic are reported as mean \pm standard deviation relative to body mass (BM). Stepwise multiple linear regression using absolute values of P_{max} , P_{10s} and P_{pav} as dependent variables and absolute values of P_{lac2} , P_{exh} , F_{max} and BM as independent variables has been conducted to identify those factors best predicting the performance of PPT.

Results: Power output was 3.0 ± 0.8 W/kg and 4.8 ± 0.4 W/kg for P_{lac2} and P_{exh} in the IET, and 13.5 ± 1.7 W/kg, 11.6 ± 1.4 W/kg and 5.7 ± 0.5 W/kg for P_{max} , P_{10s} and P_{pav} in the PPT. Mean F_{max} was 25.8 ± 3.3 N/kg and mean BM 67.7 ± 4.9 kg. BM explained 56% and 63%, together BM and P_{exh} explained 69% and 71% of the variance of P_{max} and P_{10s} , respectively. Neither the inclusion of F_{max} nor of P_{lac2} improved the squared correlation substantially. In contrast to this P_{lac2} explained 62% of the variance of P_{pav} , whereas the other variables were rejected.

Discussion: Subjects' performance during the PPT was determined predominantly by BM and exercise intensity at exhaustion during IET regarding P_{max} and P_{10s} and by exercise intensity at 2 mmol/l lactate regarding plateau power. From the latter it can be assumed, that the capacity of aerobic energy supply shows a major contribution to power output during the plateau phase. This is corroborated by several studies, which showed that an increasing fraction of energy is supplied by aerobic metabolism beyond 30 s of maximum cycling exercise [1,2]. Major fraction of energy within the initial 10 s of maximum cycling exercise is supplied by ATP-PC system [1,2]. This might explain the high proportion of explained variance of P_{10s} by BM, because lean BM is proportional to absolute amount of ATP-PC storage. It is muscular strength which should give an explanation for the correlation between P_{exh} and P_{10s} , where maximum torque values occur regarding the particular test. But the results do not sustain this thesis. Muscular strength played a minor role during maximum cycling exercise. This is surprising since the peak pedal forces occur at 90° crank angle and hence during the leg extension phase.

Conclusion: Depending on exercise time, performance in PPT is determined by different factors, mainly the energy supply systems. PPT might be an alternative for interindividually differentiating cyclists anaerobic as well as aerobic capabilities with reduced time requirements compared to IET, but it is not suitable to determine the capacity nor the flow rate of the metabolic systems as proposed elsewhere [3].

References

- [1] N. Bachl and R. Baron, in: *Jeschke D., R. Lorenz, eds, Köln 1998*, pp. 49–64.
- [2] H. Heck and H. Schulz, *Dtsch Z Spomed* **53** (2002), S202–S212.
- [3] D. Jeschke and R. Lorenz, *Dtsch Z Spomed* **54** (2003), S148–S150.

Training Efficiency in Recreational Sports

Training parameters and center of pressure characteristics of healthy runners and patients

H. Baur^{a,*}, A. Gollhofer^b, V. Bächle^a, I. Janz^a, N. Kimmich^a and F. Mayer^a

^aMedical Clinic, Department of Rehabilitative and Preventive Sports Medicine, Hugstetter Straße 55, D-79106 Freiburg, Germany

E-mail: baur@msm1.ukl.uni-freiburg.de

^bInstitute for Sport and Sport Science, University of Freiburg, Germany

Introduction: Several studies analyzed causative factors for injury development in running [2]. Depending on research design and selection of study population, different factors like training errors, previous injury or static foot alignment (Wen 1997) are pointed out as contributing, while weekly mileage (>32 km or 20 mi) is one of the few generally accepted factors [2,4]. Since static foot alignment is thought to be not a major factor for injury development (Wen 1997), a demand for dynamic analysis comparing injured and healthy populations was stated [3]. Purpose of the study was therefore to compare dynamic foot function (analyzed with plantar pressure distribution) as well as training history between healthy runners and runners with lower extremity overuse complaints.

Methods: Overall 60 healthy runners (HE) and 49 runners with lower extremity overuse complaints (IN), examined and diagnosed after orthopaedic examination (weekly mileage >32 km), were enrolled in the study (Table 1).

Table 1
Anthropometric and selected training data of subjects

group	[n]	age [years]	height [cm]	weight [kg]	BMI	training experience [months]	weekly mileage [km]	training units/week	average running pace [min/km]
HE	61	37 ± 8	178 ± 7	74 ± 9	23.1 ± 2.1	123 ± 102	44 ± 16	3.8 ± 1.0	5.22 ± 0.53
IN	49	38 ± 7	178 ± 6	77 ± 10	23.5 ± 2.3	117 ± 90	48 ± 24	4.3 ± 1.7	5.25 ± 0.56

All subjects were interviewed about their training regimen. Age, height, weight, training experience, weekly mileage, average running pace, training surfaces, number of road races per year, used shoe models (classified by construction as neutral (1), medium stability (2) and stability shoe (3)) as well as the shoe's age were recorded. Subjects ran in randomized order barefoot (B) and with a standardized neutral running shoe (S) on the treadmill (hp cosmos, quasar) at 12 km·h⁻¹ while plantar pressure distribution (PPD) was measured (pedar mobile, Novel, 50 Hz, 1 Sensor per 2 cm²). Characteristics of the Center of Pressure (COP) like the lateral (A_{lat}) and medial (A_{med}) deviation of the path of the COP from the bisection of plantar angle [cm²], maximum and mean velocity [m·s⁻¹] and instant of maximum velocity [% of contact time] served as quantities to describe dynamic foot function. Descriptive statistics was followed by One-way-ANOVA ($\alpha = 0.05$).

Results: Concerning age, height, weight, BMI, training experience, weekly mileage, training units per week, average running pace (see Table 1) as well as training surfaces (concrete: HE: 41 ± 27%, IN: 44 ± 26%; trail: HE: 44 ± 29%, IN: 40 ± 29%), number of races per year (HE: 8.7 ± 6.9; IN: 6.5 ± 5.9) and average age of shoes (HE: 12.6 ± 8.9 months; IN: 11.9 ± 7.8 months) no difference between healthy and injured could be revealed. Analysis of shoe models showed a higher stability index for shoes of injured runners (HE: 2.2 ± 0.6, IN: 2.5 ± 0.6; $p = 0.01$). For maximum velocity, mean velocity and instant of maximum velocity of COP, no differences between groups were found but both velocities were higher in B compared to S ($p < 0.05$). A_{lat} showed statistically significant higher values in IN compared to HE for B and S ($p = 0.001$). In contrast to that, A_{med} was smaller in IN compared to HE also for B and S ($p = 0.001$).

*Corresponding author.

Discussion: The presented training parameters are more likely an expression of the homogeneity of both groups rather than able to distinguish between HE and IN. Shoes may play an important role in the development of overuse injuries. A bigger A_{med} in HE might indicate a more distinct push-off, over the first ray. In contrast to that, a bigger A_{lat} in IN might indicate that rear foot stability is less compared to HE.

Conclusion: It is concluded that shoe selection is critical for runners and stability shoes might not be beneficial for the average runner. Results for dynamic foot function indicate, that adaptations due to injury are not always injury specific. Therefore, therapy with orthotic devices might focus primarily on movement pattern and secondary on pathology.

References

- [1] J.M. Hootmann, *Am J Epidemiol* **154** (2001), 251–258.
- [2] D.F. Murphy, *Br J Sports Med* **37** (2003), 13–29.
- [3] T.F. Novacheck, *J Bone Joint Surg* **80-A** (1998), 1220–1233.
- [4] W. Van Mechelen, *Sports Med* **14** (1992), 320–335.

‘ADAPT’ CD-ROM – A new educational tool in adapted physical activity

S. Djobova*, I. Dobрева, A. Van Peteghem and H. Van Coppenolle
KULeuven, Tervuursevest 101, B-3001 Leuven, Belgium
E-mail: stefka.djobova@flok.kuleuven.ac.be

Project co-ordinator: Prof. Herman Van Coppenolle

Introduction: Despite promotions and regulations on integration of *people with disabilities*, it is a fact that too many people are still excluded and deprived of opportunities to participate in society.

Children and adults with a disability are often excluded from participation in regular physical education due to the fact that they are not fully integrated in the regular school system and society. Partly this is due to the lack of knowledge. The European education system is unprepared for meeting the needs of people with disabilities in an integrated setting.

In order to bridge this educational gap in 1999 a Thematic Network for Educational and Social integration of Persons with a Disability through Adapted Physical Activity (THENAPA) was started. The aim of the project was to improve education of Adapted Physical Activity (APA) professionals throughout Europe to in turn improve quality of life for persons with disabilities.

During four years, experts from 23 European countries united their knowledge and experience and agreed on a common European programme of the basics in APA and sports for persons with a disability. They defined the number of credits as well as the fundamental content of the future European training programmes in this domain at all educational levels, in the studies of physical education, rehabilitation, recreation and sport performance.

In order to make this basic curriculum attractive and visual, we have produced the CD-ROM ‘ADAPT’.

Results: The ‘ADAPT’ CD-ROM is a multimedia tool and valuable resource for on campus and distance learning and is intended for students, professionals (teachers, coaches, instructors) and layman (volunteers, family members and friends of individuals with a disability) interested in Adapted Physical Activity and sport. Its purpose is to function as a self-study guide for the students and to assist the teachers in their classes with video materials and brief outlines. ADAPT is also a mean for lifelong learning that can be used by current specialists and practitioners, who don’t have enough information about the field of Adapted Physical activity and sports.

By using a rich collection of inspiring visual materials the intention of the CD-ROM is to motivate individuals with disabilities to participate in APA at all levels and areas, including rehabilitation, education, recreation and elite sports.

*Corresponding author.

The ultimate goal of ADAPT is to increase the quality of life of individuals with disabilities across their life-span through participation in quality programmes of APA.

The ADAPT provides the basic information in 10 categories: APA Concepts; Health Conditions; Assessment; Intervention; Sports and Organisations; Classification; Training, Teaching, Coaching; Technology and Accessibility; Social Environment; Science. The CD-ROM is accessible by main categories and subcategories. A separate link, named “Read more” is available for those who are looking for references or more resources, related to a specific topic.

The ADAPT gives an access to the THENAPA website, making available the updated information of the ever developing community services and technical aspects of APA.

Drop jumps added to a warm-up increases the jump height compared to an ergometer warm-up only. A single blind randomized crossover trial. A pilot study

J. Fontannaz^{b,*}, D. Fellay^a, H. Fellay^b, K. Jordan^a, H. Spring^a and R. Hilfiker^a

^aSwiss Olympic Medical Center, Rehasentrum Leukerbad, Switzerland

^bClinique romande de réadaptation, Sion, Switzerland

Introduction: Warm up followed by eccentric load of the involved muscles is frequently used by athletes in the immediate preparation (warm up) of competitions in speed or jump disciplines. The eccentric load should lead to a short lasting effect, enhancing the performance. In this study we tested the hypothesis that drop jumps added to an ergometer warm up lead to a higher jump compared to an ergometer warm-up without eccentric elements.

Table 1
Demographic data (n = 19)

	Mean	SD	Range
Age	27	3	22–35
Gender	9 f / 10 m		
Weight	68	9	53–86

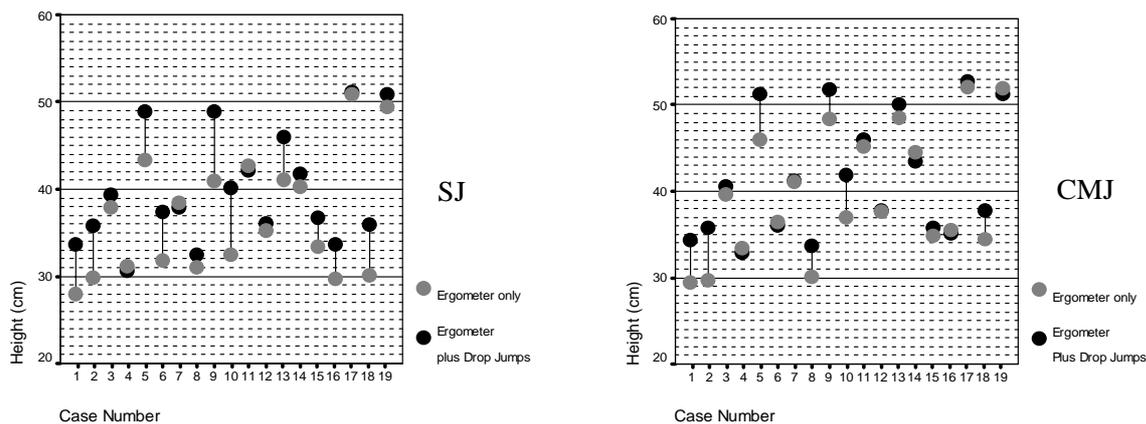


Fig. 1. Individual differences of jump height.

Methods: Subjects: Nineteen recreational sportive subjects were randomised in two groups. Both groups executed a standardized warm up on an ergometer. One group added six adapted drop jumps (drop from 60 cm, land and block

*Address for correspondence: Joel Fontannaz, Rue de Saladey, 1976 Premploz, Switzerland. E-mail: rhlfi@freesurf.ch.

in a 90° knee angle). On the second test day the other group added the drop jumps after the warm up. *Outcome measures:* Both groups performed three countermovement jumps (CMJ) and three squat jumps (SJ) on the two test days. The height (center of mass) of the CMJ and the SJ were measured on a Kistler force platform (Kistler Instrumente AG). The tester was blinded to the type of warm-up. *Statistical analysis:* Differences of the jump height between the warm up with and without drop jumps were analysed with a two-tailed, paired t-test. Significance level was set to 0.05.

Results: Table 1 shows demographic data of subjects. Adding drop jumps to the warm up increased the height in SJ in average by 3.3 cm (95% CI: 4.63 to 1.88) and by 1.8 cm (2.9 to 0.66) in CMJ. Individual differences for SJ and CMJ are shown in Fig. 1. Height increased by 9% in the SJ and 5% in the CMJ. This results in a standardized effect size of 0.5 for the SJ and 0.25 for the CMJ. These results are statistically significant: $p = 0.004$ for the CMJ, 0.000 for the SJ.

Discussion: Drop jumps seem to improve immediately the jump performance. Many athletes in different sports use this fact for years. This study showed a quantitative and statistical significant difference between a normal warm up and a warm up with drop jumps. *Limitations:* The lap between test day one and two were not standardized. Further studies should include high trained athletes from speed sports and standardize the delay of the second test day. Further research is needed for the optimal drop jump height.

Conclusion: Athletes in disciplines with a need for explosive force development should add eccentric elements to their warm up program (at the end of the warm up).

References

- [1] H. Spring and K. Jordan, *Schw. Z Med Traumat* **2** (1994), S29.
- [2] A. Grossenbacher, P. Bourban, T. Held and B. Marti, *Schw. Zschr. Sportmed. Sporttraumat.* **46** (1998), S150–S154.

Influence of stretching and somatic parameter on countermovement jumps in tennis players

M. Küster

Physioklinik im Aitrachtal, Schlehenweg 4, 94360 Mitterfels, Germany

E-mail: jens.kuester@t-online.de

Introduction: Stretching is often disregarded in leisure sports but many people train with high efforts and sports injuries are common. Aim was to determine the relations between somatic data, gender and and jump force in mediocre trained tennis players.

Design: Cross-sectional.

Methods: Test persons were 42 mediocre trained tennis players, 29 men, 13 women. Mean age of the test group 29.5 years (± 10.26), control group 30.1 years (± 9.23); mean height test group 176.1 cm (± 8.29), control group 178.7 cm (± 9.64); mean weight test group 75.5 kg (± 13.94), control group 77.7 kg (± 16.13). Mean weekly tennis was 5.11 hours (± 2.26 , Min. 2, Max. 10). Independent variables: age, height, weight, gender. Dependent variables: jump height and time in countermovement jumps, assessed by a contact mat.

Results: Somatic data and gender correlated highly significant with jump height and time. Men achieved higher jumps than women. Dynamic stretching had no significant influence on the jump force.

Discussion: In our case, stretching did not influence the jump parameter significantly because the mediocre trained test persons were not used to it and their muscles did not respond sufficiently. Regarding the somatic data, we found new data for the chosen age group.

Conclusions: For general health and preventive reasons, people in leisure sports should care regularly for stretching.

The influence of prescribed stretching program on heart rate variability in untrained subjects

M. Moser*, M. Mück-Weymann, S.P. von Duivillard, P. Hofmann, G. Smekal, M. Wonisch, N. Bachl, P. Schmid and R. Pokan

University of Vienna, Friedrich-Knauergasse 8/2/14, 1100 Vienna, Austria

E-mail: mariettamarietta@hotmail.com

Introduction: The purpose of this study was to measure the influence of 4 weeks of stretching program on cardio-autonomic function and heart rate variability (HRV) in 15 female (age: 42.7 yrs) and 9 male (age: 44.7 yrs) untrained subjects. The test of flexibility was conducted according to Janda, 2000.

Methods: The testings started with the examination of the actual flexibility (Janda, 2000). Before the stretching program, at rest, we measured 3 min of HRV via Polar heart rate telemetry (Polar Electro, Finland) in continuous beat-to-beat mode (sitting), 3 min of HRV measurements during prescribed tempo breathing, followed by 3 min HRV measurements in standing position. Subsequently, the patients were subjected to 20 min of prescribed stretching program in standing position. After 4 weeks of stretching program, the final tests were conducted (Table 1).

Table 1
Heart rate variability "men at rest"

Sitting	Day 0	Day28	signifikanz
HF[1/min]	70.78(12.8)	69.78(12.3)	0.610
PNN50[%]	5.6(5.5)	5.0(8.1)	0.671
RMSSD[ms]	29.6(13.4)	27.8(15.3)	0.523
LF/HF[%]	7.06(7.27)	9.87(13.25)	0.319

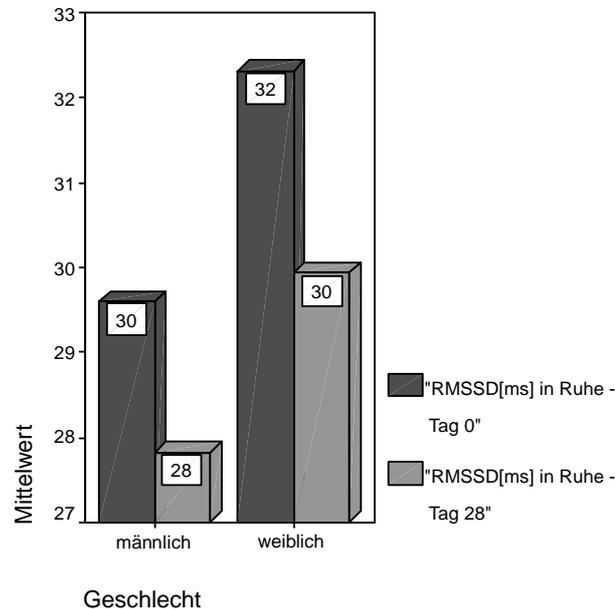


Fig. 1.

Results: The results of measurements showed no significant changes of the HRV-parameters. The statistical analysis revealed the following: In males: resting HR (bpm), day 0: 70&78; day 28: 69&78 ($P = 0.61$). pNN50

*Corresponding author.

(pNN50=fraction of successive NN intervals which differ more than 50 ms in %) day 0: 5.6 and day 28: 5.9 ($P = 0.67$). RMSSD (RMSSD=mean square root of the successive differences between consecutive NN intervals in ms) on day 0: 29.6, day 28: 27.8 ($P = 0.52$); LF/HF (LF/HF=low frequency/high frequency in %) on day 0: 7.06, day 28: 9.087 ($P = 0.32$). RR_{systolic} (mm Hg) day 0: 134.4, day 28: 134.7 ($P = 0.96$) and RR_{diastolic} (mm Hg) on day 0: 88.4, day 28: 86.3 ($P = 0.59$). In males, flexibility measurements were significant: biceps femoris on day 0: 3.8, day 28: 4.3 ($P = 0.01$); pectoralis major on day 0: 3.9, day 28: 4.7 ($P = 0.01$). In females: resting: HR (bpm) on day 0: 74.1, day 28: 72.3 ($P = 0.4$). pNN50 (%) on day 0: 5.6, day 28: 5.9 ($P = 0.87$). RMSSD on day 0: 32.3, day 28: 29.9 ($P = 0.62$). LF/HF on day 0: 4.2, day 28: 4.7 ($P = 0.67$). RR_{systolic} (mm Hg) on day 0: 122.7, day 28: 117 ($P = 0.03$) and RR_{diastolic} (mm Hg) on day 0: 80.2, day 28: 78.5 ($P = 0.48$). In females, flexibility measurements were also significant: rectus femoris: day 0: 3.3, day 28: 3.9 ($P = 0.0001$); biceps femoris on day 0: 4.1, day 28: 4.5 ($P = 0.004$); pectoralis major on day 0: 4.2, day 28: 4.7 ($P = 0.001$).

Discussion: Our study suggests that prescribed regimen of stretching has no influence on the autonomous regulation of the heart related to either an increase in the parasympathetic or decrease in sympathetic tone.

References

- [1] K. Albrecht, *Stretching. Das Expertenhandbuch. Grundlagen für Trainer und Sportler, Heidelberg: Haug (1997).*
- [2] K. Hottenrott, *Herzfrequenzvariabilität im Sport/Prävention – Rehabilitation und Training, Czwalina (2001).*
- [3] G. Janshoff, H. Mück and M. Mück-Weymann, *Czwalina (2002), 131–140.*
- [4] M. Malik, *Heart rate variability. Standards of measurement, physiological interpretation and clinical use. Circulation 93 (1996), 1043–1065 and European Heart Journal 17 (1996), 354–381.*

Comparative study between the biofeedback systems Myotrainer and AutoMove on poststroke patients with weakened m. tibialis anterior

N. Simon^a, R. Pokan^a, M. Aimet^b, E. Urban^b, R. Spiesberger^b, S. Kotzian^b, U. Musil^b, J. Pelikan^b and U. Zifko^b

^aISW, Universities of Vienna, Esterházygasse 30/B/4, A-1060 Vienna, Austria

E-mail: ninusch88@hotmail.com

^bKlinik Pirawarth, Austria

Introduction: We examined whether the addition of biofeedback training with Myoexerciser or AutoMove could accomplish a better recovery of m. tibialis anterior. Myoexerciser II Dual: Muscles electrical activity is recorded by 3 surface electrodes (MEDICOTEST Blue Sensor) and displayed on the monitor. The patient has to meet a variable threshold level of EMG activity by ankle dorsiflexor to trigger a signal. AutoMove800 combines electromyographic application and electrical muscle stimulation (electrodes: BIOMEDICAL Life Systems). At the threshold level the appliance triggers neuromuscular electrical stimulation to assist the muscle to a full ROM.

Methods: Twenty-one hemiplegic patients (stroke \geq one year) were randomly assigned to either Myoexerciser group ($n = 10$) or AutoMove group ($n = 11$) and completed at least ten treatment sessions beside conventional therapy (3 blocks, 2 min break, 10×10 sec contraction). Active as well as passive ankle dorsiflexor, muscle strength score of m. tibialis anterior using the MRC scale and results of a subjective questionnaire were taken during the first and the last session and used for statistic analyses.

Results: In comparison with control group ($n = 10$) both types of biofeedback electrotherapy can be recommended as a valuable additive method in rehabilitation of stroke. Statistically significant differences were measured for active (My: $4.9^\circ \pm 3.6^\circ$ AM: $3.4^\circ \pm 3.5^\circ$) and passive (My: $3.8^\circ \pm 4.5^\circ$ AM: $3.6^\circ \pm 3.6^\circ$) ankle in both experimental groups and muscle strength score (0.4 ± 0.4) in the Myoexerciser group.

Conclusion: The study yielded that Myoexerciser assessment proved to be superior to AutoMove assessment: better contraction force and ankle were recorded as well as life quality was evaluated higher by the patients. Because AutoMove combines two applications contrary results were expected. An additional evaluation without those patients who achieved no increase of ankle dorsiflexor led to the same conclusion. This is supposed to be explained by the longer active contraction of m. tibialis anterior for the Myoexerciser group.

References

- [1] J. Cauraugh, K. Light, S. Kim, M. Thigpen and A. Behrman, *Stroke* **31** (2000), 1360–1364.
 [2] T. Mokrusch, F.P. Bossert, E. David, A. Lange and B. Blum, *ZEE* **1** (1999), 30–36.
 [3] H. Woldag and H. Hummelsheim, *Journal of Neurology* **49** (2002), 518–528.

24 hour heart rate- and 24 hour blood pressure response in individuals with metabolic syndrome of three week duration at different altitudes

R. Spiesberger^{a,*}, R. Pokan^a, P. Schmid^a, E. Humpeler^b, W. Schobersberger^b, A. Klinger^b, H. Hörtnagl^b, H.C. Gunga^b, D. Fries^b, P. Hofmann^c and S.P. von Duvillard^d

^aUniversity of Vienna, Austria

^bUniversity of Innsbruck, Austria

^cUniversity of Graz, Austria

^dCalifornia State Polytechnic University, Pomona, USA

Introduction: Many people spend their vacations in a health resort at low or moderate altitude. Some of these individuals suffer from metabolic syndrome. The aim of the present study was to evaluate physical working capacity (PWC), blood pressure (BP) and heart rate (HR), of such patients, before, during and 6 weeks after a three weeks stay at low or moderate altitude.

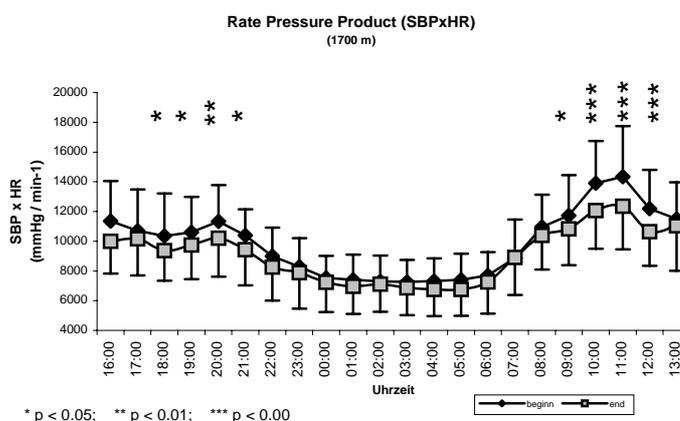


Fig. 1. Rate Pressure Product 1700 m above sealevel.

Methods: Seventy-one male patients with metabolic syndrome participated in the study. Thirty-eight male patients (age: 55 ± 7 years, height: 175 ± 5 cm, BMI 31.9 ± 3.6) spent 3 weeks in form of a holiday stay at an altitude of 1.700 m and 33 male patients (age: 55 ± 8 years, height: 175 ± 6 cm, BMI: 31.3 ± 2.9) at an altitude of 200 m. On the first or second day and the 19th or 20th day patients were monitored by means of 24-hour ambulatory BP measurements and 24-hour Holter – ECG monitoring. A symptom-limited cycle ergometry in upright position (25 W, 2 min) was performed at low altitude before, one week after and 6 weeks after their holiday stay.

Results: In both groups, systolic and diastolic BP, HR and rate pressure product ($RR_{sys} \times HR$) (see Figs 1,2) were significantly lower after the 3 week intervention with almost circadian rhythm. The maximal PWC, determined by (W_{max}/kg) were significantly higher in the third test (post: 2.12 ± 0.38 W_{max}/kg , pre: 1.98 ± 0.32 W_{max}/kg)

*Address for correspondence: R. Spiesberger, Clinic Pirawarth, Rehabilitation Center, Kurhausstrasse 100, 2222 Bad Pirawarth, Austria. E-mail: r.spiesberger@chello.at.

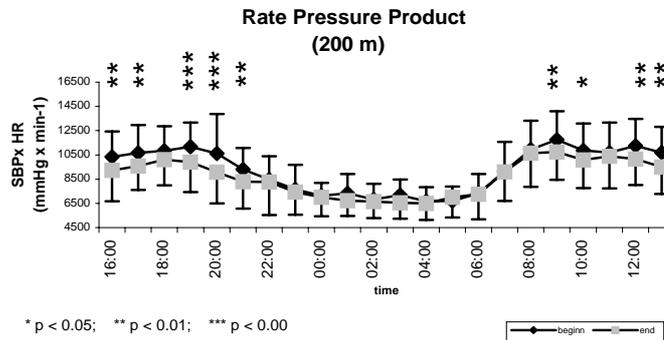


Fig. 2. Rate Pressure Product 200 m above sealevel.

after altitude exposure compared to low altitude. HR at 100 W was significantly lower in the post test at moderate altitude, systolic and diastolic BP at 100 W was significantly lower in both groups.

Conclusion: Patients with metabolic syndrome may spend their holidays at moderate as well as low altitude as determined by the decrease in BP, HR and RPP during 24-hours monitoring. Both groups benefit as depicted via PWC test.

References

- [1] W. Schobersberger, et al., *Eur J Appl Physiol* **88** (2003), 506–514.
- [2] P. Schmid, et al., *Eur J of Physiol* **441:6** (2001), P30-3 R231.
- [3] E. Humpeler, et al., *Eur J of Physiol* **441:6** (2001), P30-1 R231.

Standardized Methods for Testing (2)

Reliability of the knee extension/flexion multiple angle isometrics

A. Baskent

Department of Physical Medicine and Rehabilitation, Istanbul Faculty of Medicine, Istanbul University, Istanbul, Turkey

E-mail: akinbaskent@yahoo.com

Introduction: Knee problems occur at every age. We use isometric tests and protocols for evaluation and working in their rehabilitation program. The measure of isometric muscle strength is specific for the angle tested. This is important for evaluation of the treatment and for the results. The purpose of this study is to determine the reliability of the values of muscle strength in a sitting position, for the isometric measures at multiple angles of the knee extension/flexion.

Methods: Thirty healthy subjects participated as volunteers in this study. There were 15 males and 15 females. The mean age was 22.47 ± 2.21 (20–29) years. The isometric tests were done with the dynamometer of Biodex System 3PRO. Dominant side was tested. Before the tests they did warm-up periods and some trial tests repetition. The measures were done isometrically at the reciprocal knee extension/flexion pattern. Zero degree is accepted for knee full extension. As the test protocol; to the extension 5 sec maximal isometric contraction, after 5 sec relaxation time, after for flexion 5 sec maximal isometric contraction was recorded. And between them 30 sec rest period were

Table 1
The ICCs for the knee extension/flexion peak torque values to the reliability of test-retest

test angles	05°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
pattern extension (quadriceps)	0.96	0.91	0.92	0.92	0.93	0.93	0.93	0.93	0.85	0.94	0.94	0.90	0.93	0.94	0.91	0.95	0.95	0.94
flexion (hamstring)	0.93	0.92	0.96	0.92	0.91	0.94	0.93	0.91	0.91	0.92	0.93	0.91	0.93	0.91	0.94	0.90	0.82	0.81

recorded. It was tested at the 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90 angles values. Every measure was repeated twice for every subject with the 5–7 days interval. For the reliability measures it uses SPSS program intraclass correlation coefficient (ICC). Peak torque values were investigated for the evaluation.

Results: For the reliability of test-retest, knee extension peak torque values, ICC was between 0.85–0.96 and for the knee flexion peak torque values ICC was between 0.81–0.96. The confidence interval of knee extension were higher than the knee flexion (Table 1).

Discussion: It is reliable, for healthy subject, for the measures of peak torque values with the dynamometer of Biodex System 3PRO for the multiple angle isometric test to the knee extension/flexion. As a result, for the rehabilitation it uses with important the isometric tests and exercises. It doesn't effects to use multiple angle isometrics for the reliability of tests.

References

- [1] J.P. Lord, et al., *Arch Phys Med Rehabil* **73** (1992), 324–330.
- [2] J.J. Kpanik, et al., *Phys Ther* **63** (1983), 938–947.
- [3] D.B. Starkey, et al., *Med Sci Sports Exerc* **28** (1996), 1311–1320.
- [4] M.A. Welsch, et al., *Arch Phys Med Rehabil* **79** (1998), 971–978.

Functional characteristics of safety shoes

H. Baur^{a,*}, A. Gollhofer^b, D. Bültermann^a, P. Deibert^a, I. Frey^a and F. Mayer^a

^aMedical Clinic, Department of Rehabilitative and Preventive Sports Medicine, University of Freiburg, Germany

^bInstitute for Sport and Sport Science, University of Freiburg, Germany

Introduction: Injuries and accidents at the workplace implicate high costs for health insurance funds [1,3]. Therefore foot protection by safety shoes is required in work fields with a high risk for injury. Nevertheless, a non-compliant use of safety shoes can be observed because of harmful carrying properties [6]. Standard testing procedures of safety shoes (Standards of the European Union: EN-Norm 344, 345, 356, 347) analyze material as well as component elements of shoes, whereas consequences on the biological system are not considered. The purpose of this study was therefore to develop a new test design to analyze long term effects of different shoe constructions on biomechanics of safety shoe wearing workers.

Methods: 48 subjects were included in this study (age: 41 ± 13 , height: 177 ± 6 , weight: 80 ± 13). Each subject got in a single-blinded design a new pair of safety shoes (A + B). Shoe A differed from shoe B only in a newly developed cushioning element. In-shoe plantar pressure distribution (PPD, Pedar mobile, Novel®, 50 Hz, 1 Sensor / 2 cm²) as well as muscular activity (EMG, 1000 Hz) of M. tibialis anterior, M. peroneus longus und M. gastrocnemius lateralis were measured while subjects walked on a treadmill ($3.5 \text{ km} \cdot \text{h}^{-1}$) and while a step-down test from a 29 cm-step (2 euro-pallets) in barefoot and in shoe condition. Comfort ratings of shoes and possible injuries or complaints were collected with a questionnaire. Subjects wore the new safety shoes for the next 6 months

* Address for correspondence: Heiner Baur, Medical Clinic, Department of Rehabilitative and Preventive Sports Medicine, Hugstetter Straße 55, D-79106 Freiburg, Germany. E-mail: baur@msm1.ukl.uni-freiburg.de.

during the whole work day. The measurement was repeated 3 and 6 months after initial testing. Peak Pressure and Force-time-integrals in rear, mid and fore foot were extracted from PPD. Integrated EMG in intervals before (−50–0ms) and after touchdown (0–50 ms and 0–500 ms) was calculated from EMG data [4]. Descriptive statistics (Mean ± 95%-Confidence interval) was followed by One-way ANOVA ($\alpha = 0.05$) to detect shoe differences.

Results: Cushioning properties of shoe A were rated statistically significant better compared to shoe B by means of subjective questionnaire ($p < 0.05$). Other criteria like shoe flexibility, safe feeling while walking, space in toe area or climate control showed no statistically significant differences between shoe A and B ($p > 0.05$).

Analysis of PPD showed statistically significant lower values in rear and fore foot area for peak pressure and force-time-integrals between barefoot and shod condition ($p < 0.05$). Values for peak pressure and force-time-integrals were also reduced in Shoe A compared to Shoe B. This was evident not only on measurement day 1 but also 3 and 6 months after initial testing.

Muscular activity (IEMG) before (−50–0 ms) and after touchdown (0–50 ms and 0–500 ms) showed no differences between barefoot and shod and between shoe A and B acute, 3 and 6 months after initial testing ($p > 0.05$).

Discussion: Shoe A was rated better concerning cushioning properties than shoe B. This was confirmed acute and over a wear time of six months by plantar pressure measurements. Therefore the new cushioning element of shoe A works and seems to be durable. The enhanced cushioning seems not to provoke harmful effects in muscular activity like more fatigue [5]. Functional test designs supplement pure mechanical testing procedures.

Conclusion: Cushioning characteristics and footwear comfort of safety shoes can be improved. It is concluded that more lifelike testing of safety shoe properties in workday situations should improve assessment of safety shoes.

References

- [1] N. Bull, T. Riise and B.E. Moen, *J Occup Environm Med* **42** (2000), 621–628.
- [2] European Committee for testing standards: European standards for safety shoes in commercial use, Brussels 1997.
- [3] C.F. Federspiel, D. Guy, D. Kane and D. Spengler, *J Occup Med* **31** (1989), 919–924.
- [4] A. Gollhofer and H. Kyöläinen, *Int J Sports Med* **12** (1991), 34–40.
- [5] P. Madeleine and M. Voigt, *Arendt-Nielsen L: Eur J Appl Physiol* **77** (1998), 1–9.
- [6] S.J. Marr and S. Quine, *Occup. Med. (Lond.)* **43** (1993), 73–77.
- [7] J. O'Brien, *Occupational Health and Safety* **12** (1991), 2–23.

Workload demands during professional road cycling competition

L. Heinrich^{a,*}, S. Vogt^a, YO. Schumacher^a, A. Blum^a, B. Stapelfeldt^a and A. Schmid^a

Abteilung Sportmedizin, Medizinische Universitätsklinik Freiburg, Germany

E-mail: lotharmh@t-online.de

^b*Institut für Sportwissenschaft, Universität Freiburg, Germany*

Introduction: The intensity of exercise in road cycling competitions has been widely studied. Most studies have focused on physiological variables, such as heart rate to evaluate exercise intensities and workload. Nevertheless, the central variable to describe physical workload in cycling is the power output deployed by the cyclist to propel the bicycle. Only few data have been published using direct power measurements. The purpose of this study was to describe the workload demands during professional cycling road races using direct power measurements together with heart rate as an indicator of physical exercise intensity, and to compare these findings to physiological data obtained during laboratory exercise tests. The presented information could add to the description of performance structure of bicycle racing and thereby be helpful for coaches in designing training programs.

Methods: Six professional road cyclists were studied during a five day cycling stage race (total distance 605 km, UCI category 2.3). Cycling Power output (P) was measured directly using a strain-gauge based crank dynamometric

*Corresponding author.

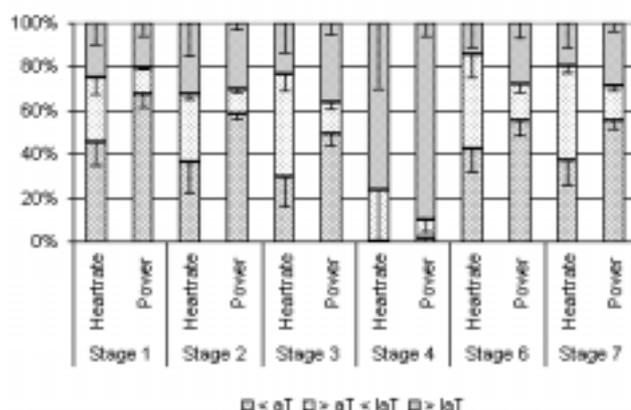


Fig. 1. Distribution of intensities (%) in power and heart rate during the different stages of the race based on values from previous exercise testing.

Table 1

Average power output and heart rate during a five day stage race in 6 professional road cyclists

Stage	Length	Average power	Average heart rate
1	165 km	2.66 W/kg	141 bpm
2	163 km	2.79 W/kg	140 bpm
3	90 km	3.8 W/kg	147 bpm
4	13 km TT	5.48 W/kg	169 bpm
5	168 km	3.18 W/kg	140 bpm
6	160 km	3.04 W/kg	141 bpm

power measurement system (SRM, Schoberer Messtechnik, Jülich, Germany). The device measures the power output (P, Watts) applied by the rider to the pedal in 1 sec. intervals throughout the race and adds no significant weight to the cyclist's equipment. At the same time, the system registers heart rate (HR) through conventional heart rate monitor technique. The data is displayed directly on a microprocessor fixed on the bicycles handlebar. The data was transmitted to a central computer for further processing.

Prior to the race, every subject performed an incremental cycling exercise test until exhaustion on a stationary cycle ergometer (SRM Ergo, Schoberer Messtechnik, Jülich, Germany). P and HR at aerobic (aT), anaerobic threshold (iaT) and at exhaustion were determined through lactate analysis. Descriptive statistics were calculated for the data. *Results:* Incremental exercise testing revealed the following benchmarks for the physiological characteristics in the tested riders (HR, Power output): aT: 137 bpm, 2.94 W/kg; iaT 163 bpm, 4.57 W/kg, Max 187 bpm, 5.46 W/kg.

Discussion: The description of exercise intensity in cycling is mainly based on heart rate. However, power output is the most appropriate variable to describe the sustained workload. Our data demonstrate that during competition, workload mainly ranges at intensities below iaT on normal stages. Heart rate overestimates the intensity of exercise when compared to power output measurements based on previous exercise testing at low and moderate intensities and tends to underestimate times spend at intensities above iaT. This is possibly due to a slow and delayed responsiveness of this variable. Furthermore, heart rate shows a high inter-individual variability, whereas power output presents with more stable variables. It is known, that heart rate depends not only on exercise related factors, but can be influenced by numerous variables unrelated to exercise, such as mental stress or nutritional aspects. Our data suggests that the direct measurement of power output during cycling gives appropriate description of exercise intensity and should be used to characterise workload demands and design training programs.

Conclusion: During professional road cycling competition average power output ranges between 2.66 and 5.48 W/kg body weight. Power output can be used to adequately describe the intensity of exercise in road cycling competition.

References

- [1] B. Fernandez-García, *Med Sci Sports Exerc* **32**(5) (2000), 1002–1006.
- [2] R.W. Kenefick, *J Sports Med Phys Fitness* **42**(4) (2002), 396–402.
- [3] A. Urhausen, *Int J Sports Med* **14**(3) (1993), 134–139.
- [4] G.S. Palmer, *Med Sci Sports Exerc* **26**(10) (1994), 1278–1283.

Reproducibility of isokinetic peak torque in the knee and ankle joint

T. König*, H. Baur, S. Müller and F. Mayer

Medical Clinic, Department of Rehabilitative and Preventive Sports Medicine, University of Freiburg, Germany

Introduction: Reproducibility can be considered as the amount of measurement error that has been deemed acceptable for the effective practical use of a measurement tool [1]. The correlation coefficient used in many test-retest-studies of isokinetic peak torque measurements as the only interpretation medium does not offer sufficient information as an indicator, because it measures the strength of any linear relation between two variables and not the agreement between them [2]. Consequently, there is a great need for comparison material which quantifies the components of the measurement errors (bias and random error) and the existing variability and thus provides legitimation for qualitative statements. The aims of this test-retest-study were thus i) to cover the aspects relative stability, linear changes and scattering of the data with the help of additional statistical methods and ii) by combining consideration of these methods, to present an adequate assessment with respect to the reproducibility of isokinetic peak torque measurements.

Methods: Nineteen male and 9 female competitive athletes (age: 32.5 ± 9.4 , height: 175.8 ± 5.7 , weight: 80.7 ± 4.7) participated in the test-retest study to determine peak torque (P_{tmax}) in the knee joint (KJ) and ankle joint (AJ) using a Multi-Joint-Dynamometer (CON-TREX MJ, CMV AG, Switzerland). The interval between the 2 measurements was 8 weeks without change in the personal environmental conditions. Measurements on both sides of the body included concentric and eccentric reciprocal flexion/extension movements at an angle velocity of 60°/s. Statistical analysis was performed using Pearson's coefficient of correlation, the Test-Retest Variability (TRV) and the limits of agreement (LOA). The following auxiliary measures were also applied: Bland-Altman-Plots, the coefficient of repeatability crep and the exploration of the presence/absence of heteroscedaticity and normality (Shapiro-Wilk-Test) that is inherent in this analysis.

Results: The values of the Pearson's coefficient of correlation are in a range from $r = 0.84 - 0.92$ in KJ (Table 1) and from $r = 0.59 - 0.91$ in AJ. Lower values ($r < 0.8$) were registered in AJ in concentric plantar flexion with values between $r = 0.59 - 0.64$. The TRV ranged for KJ from 8.5–14.4% and from 7.22% to 16.32% for the AJ. In addition, it is seen in the presentation of the LOA that the limits of the random errors are not far apart (taking the height of the absolute values into consideration). In the study of reproducibility coefficients, values of $\text{crep} = 0.91 < 0.95$ can be observed only in plantar flexion movement (KJ and AJ). Significant differences with respect to the muscle work modus can be seen only in dorsal flexion, whereby better values were achieved for eccentric mode. In general, taking logarithms of the test values is recommended for nearly all measurements due to the evidence of heteroscedaticity and non-normality, so that the LOA should be presented as ratios.

Discussion: The various indicators for reliability indicate adequate reproducibility in their interplay in all knee and ankle measurements. The selected statistics system offers sufficient information in these measurements to make various influence factors such as group size or heterogeneity of the subjects visible by means of the indicators. When the crep is used, it must be remembered that it only becomes important with increasing group size.

Conclusions: Taken together, the selected statistical procedures can offer a satisfactory proof procedure for measurement errors. Isokinetic peak torque measurements can be performed with the method described (test-retest interval: 8 weeks, etc.) with high reproducibility, even in small and heterogeneous samples.

*Address for correspondence: Timo König, Am Floßgraben 2, 79102 Freiburg, Germany. E-mail: td-timo@web.de.

Table 1
Indicators for reproducibility (example of left knee joint measurements)

Work mode		Nr. value	TRV [%]	LOA: Bias \pm random error	LOA: Bias \pm random error	crep	
Eccentric	Extension	25	0.88	11.16	-2.56 ± 53.5	$0.97 \times / \div 1.32$	0.95
	Flexion	25	0.85	9.62	0.08 ± 34.1	$1.00 \times / \div 1.27$	0.95
Concentric	Extension	26	0.89	11.60	0.00 ± 38.19	$1.00 \times / \div 1.33$	0.96
	Flexion	26	0.89	8.48	-2.31 ± 23.40	$0.98 \times / \div 1.22$	0.95

References

- [1] G. Atkinson and A.M. Nevill, *Sports Med* **26** (1998), 217–238.
 [2] J.M. Bland and D.G. Altman, *Lancet* (1986), 307–310.
 [3] F. Mayer, T. Horstmann, K. Kranenberg, K. Röcker and H.H. Dickhuth, *Int J Sportsmed* **15** (1994), 26–31.

Evaluation of plyometric exercise training on functional performances and isokinetic strength

C. Lehance^{a,*}, J-L. Croisier^b, D. Maquet^b and T. Bury^a

^aDepartment of Physiology of Sports, University of Liège, Belgium

^bDepartment of Physical Medicine and Rehabilitation, University Hospital Center, Liège, Belgium

Introduction: Plyometric or stretch-shortening cycle exercises evoke the elastic properties of the muscle fibers and connective tissue, allowing muscle to store energy during the deceleration phase and then releasing energy during the acceleration period. The end result is that muscles are trained under tensions greater than those achieved by conventional slow-speed resistance training. The purpose of this study was to evaluate the plyometric training effects on isokinetic and functional performances.

Methods: Twenty sedentary subjects were randomly assigned to 2 groups: either a plyometric training group (PT; $n = 10$) or a control group (CG; $n = 10$). The isokinetic strength of knee extensor and flexor muscles was measured in the eccentric mode ($30^\circ \cdot \text{sec}^{-1}$ and $120^\circ \cdot \text{sec}^{-1}$) and through concentric exertions ($60^\circ \cdot \text{sec}^{-1}$ and $240^\circ \cdot \text{sec}^{-1}$). Vertical jump (one leg and two legs) and 10 m sprint time were measured by Optojump system. Functional performances, mechanical power and maximal leg strength were measured before and after six weeks of plyometric training. PT performed plyometric training, in the form of dynamic depth jumps, two times per week for 6 weeks.

Results: After six weeks, the plyometric training significantly improved ($p < 0.05$) the functional tests results (drop jump: +27.9%; counter movement jump: +19.7%; counter movement jump free arms: +19%; drop jump dominant leg: +15.6%). We observed a trend toward an increase (no significant) of the knee flexor and extensor isokinetic strength in concentric ($60^\circ \cdot \text{sec}^{-1}$ and $240^\circ \cdot \text{sec}^{-1}$ for both flexor and extensor muscles) and eccentric ($30^\circ \cdot \text{sec}^{-1}$ and $120^\circ \cdot \text{sec}^{-1}$ for flexors) (Fig. 1). Only flexors in eccentric at $120^\circ \cdot \text{sec}^{-1}$ showed significant ($p < 0.05$) increase (+13.4%).

Discussion: Our results showed that a plyometric training significantly improve vertical jump height (one leg and two legs) compared to control group. This observation can be attributed to neuromuscular adaptations and to a rise in positive energy production. The eccentric isokinetic strength and power of leg flexors at high velocity ($120^\circ \cdot \text{sec}^{-1}$) improved significantly after training. This finding is relevant because hamstring muscle strains are common injuries in sports with high demands on speed and power, such as soccer. Strength training has been advocated as a preventive measure in order to avoid hamstring muscle injuries [1]. Increasing amounts of evidence point to the advantages of

* Address for correspondence: Cédric Lehance, Institut Supérieur d'Education Physique et de Kinésithérapie, B21, Allée des Sports 4, B-4000 Liège, Belgium. E-mail: clehance@ulg.ac.be

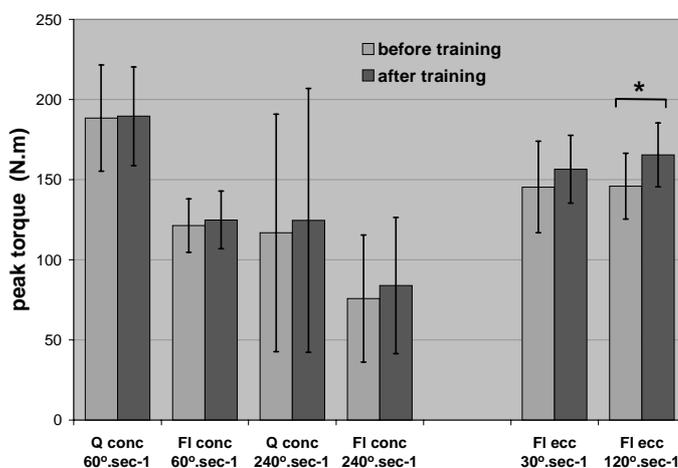


Fig. 1. Knee flexor and extensor isokinetic strength after plyometric training (* $p < 0.05$).

including eccentric muscle actions in strength training regime to achieve optimal effects. This has been demonstrated both in studies of changes in maximal strength performance and in rehabilitation studies [2].

Conclusion: In a sedentary group, plyometric training improves functional abilities (especially vertical jump), eccentric strength and power of leg flexors at high velocity. It would be fit to conduct the same experimentation in sports with high demands on speed and power. One can suggest that plyometric training would be beneficial both for injury prevention and for field performance enhancement.

References

- [1] J.-L. Croisier, *Am J Sports Med* **30**(2) (2002), S199–S203.
 [2] C. Askling, *Scand J Med Sci Sports* **13** (2003), S244–S250.

Effects of orthotic insoles on biomechanical gait characteristics in healthy children

S. Müller*, H. Baur, A. Hirschmüller and F. Mayer

Medical Clinic, Department of Sports Medicine, University of Freiburg, Hugstetterstr. asse. 55, 79106 Freiburg, Germany

E-mail: mueller@msm1.ukl.uni-freiburg.de

Introduction: The incidence of treatments of children's feet with orthotic insoles is discussed controversially. An excessive number of children are treated under preventive aspects with these devices [2]. The effect on the neuromuscular system in healthy children is still unclear. The purpose of the study was to investigate the effect of orthotic insoles on neuromuscular activity in healthy children.

Methods: 234 children, without foot related complains, were analyzed once while walking on a treadmill ergometer (HP COSMOS®, Quasar) (Table 1). Bipolar surface electromyography (sample frequency 500 Hz) was measured on 3 lower leg muscles (M. tibialis anterior, M. peroneus longus, M. gastrocnemius medialis). Subjects walked barefoot (a), with an reference shoe (b) and with three different insoles (c: neutral flexible insole; d: rigid leather insole with brace and longitudinal wedge; e: flexible insole with longitudinal and detorsion wedge) at an age-based speed (2; 3.5; 5 km/h) in random order. EMG amplitude quantities in weight acceptance (A_{wa}) and mid stance

*Corresponding author.

Table 1
Anthropometric data of subjects

subject [n]	height [cm]	weight [kg]	age [years]	age range [years]
234	129 ± 19.7	30.0 ± 12.1	7.7 ± 3.3	2–15

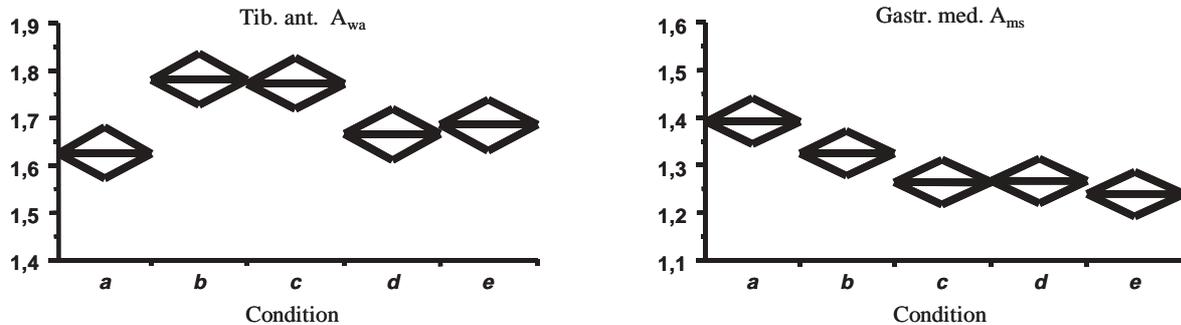


Fig. 1. EMG amplitude (M. Tib. ant. A_{wa};, M. Gastr. med. A_{ms}) in conditions.

(A_{ms}) phase were extracted [3]. Walking conditions were analyzed descriptively followed by univariate ANOVA ($\alpha = 0.05$).

Results: Statistical significant higher values in condition *b* and *c* (1.78, 1.77) compared to *a* (1.63) appeared in A_{wa} of M. tibialis (Fig. 1). Condition *c*, *d* and *e* (1.27, 1.27, 1.24) showed statistical significant lower values for A_{ms} of M. gastr. med. than condition *a* (1.39). There were no changes in all other quantities.

Discussion: An influence of footwear (*b,c*) on the activation pattern of M. tibialis was found in weight acceptance phase which confirm the sensitivity of this muscle to footwear changes [1]. These effects disappeared with the use of orthotic insoles including the functional element longitudinal wedge and approximate A_{wa} of M. tibialis to barefoot values. A_{ms} of M. gastrocnemius medialis is influenced in a different direction in its conditions. Changes in A_{ms} of M. gastr. med. occur in all insoles, that were used, independent of the functional element combination. Contraverse to expectations, the activation pattern of M. peroneus longus was not effected. The results of this acute examination show phase specific functions of used elements.

Conclusion: The neuromuscular activation pattern of M. tibialis (A_{wa}) and M. gastrocnemius medialis (A_{ms}) are influenced by footwear conditions in children. Since long term adaptation processes as well as resulting effects on the sensorimotor development in children are still unclear, the use of orthotic insoles for preventive issues should be thought over.

References

- [1] D-A. Nawoczenski, *Arch Phys Med Rehabil* **80** (1999), S540–S544.
- [2] G. Rodriguez, *Pediatrics* **103** (1999), e84.
- [3] D. Winter, *The biomechanics and motor control of human gait*, Waterloo (1991).

Influence of time of day on the force-time-relation in the upper extremity

A. Schlumberger^{a,*}, S. Kisling^b and D. Schmidtbleicher^b

^aEDEN Reha, Rehabilitation Clinic, Lessingstraße 39-41, 93093, Donaustauf, Germany

E-mail: schlmb@aol.com

^bInstitute of Sports Sciences, Johann Wolfgang Goethe-University, Germany

*Corresponding author.

Table 1
Means (\pm standard deviations) of MVIC and RFD at six times of day

Time of day	8.00	10.00	12.00	14.00	16.00	18.00
MVIC [N]	725 \pm 363	711 \pm 354	711 \pm 352	713 \pm 365	721 \pm 371	707 \pm 349
RFD [N/ms]	6.5 \pm 2.6	6.21 \pm 2.4	6.6 \pm 2.5	6.4 \pm 2.5	6.4 \pm 2.6	6.5 \pm 2.5

Introduction: According to several studies human performance and some related physiological variables seem to be influenced by the diurnal rhythm. Regarding muscle strength, scientific results reveal no clear influence of time of day on performance. I.e. Martin et al. [3] and Gauthier et al. [2] observed strength maxima in the early evening (about 18 h) in single joint movements of hand and arm muscles. On the other hand, in a study of Deschenes et al. [1] isokinetic peak torque of the knee extensors showed no daily variation in slow velocities but a tendency towards a better performance at fast isokinetic velocities in the evening compared to the morning. To further elucidate the influence of time of day on force-generating capabilities in a typical training setting, we investigated the force-time-characteristics throughout the time frame of a typical training day (between 8 and 18h) in the multi-joint movement bench press.

Methods: Ten female and ten male physical education students (age: $x = 25.2 \pm 2.8$ years, weight: 73.3 ± 11.6 kg, height: 174.9 ± 10.9 cm; $n = 10$ women; $n = 10$ men) with experience in strength training volunteered to participate in the study. Each subject performed on six different times within one test day (8.00 h, 10.00 h, 12.00 h, 14.00 h, 16.00 h and 18.00 h) maximal voluntary isometric contractions (MVIC) on a special bench press testing device (supine position, 80° elbow angle). Within one test session, after warm-up (5 min on a rowing ergometer, individual constant stretching) subjects completed three maximal effort contractions with explosive force production over a 2 sec contraction period. Rest between attempts was 60 sec. Maximal force (MVIC) and rate of force development (RFD) were determined from the force-time-curve. Data were analyzed using a repeated measures ANOVA ($p < 0.05$).

Results: The mean values of maximum strength showed no significant differences between the six test sessions (minimum-maximum-difference 2.6%, see Table 1). Furthermore, analysis of rate of force development (RFD) revealed also no significant differences throughout the day (minimum-maximum-difference 5.6%, see Table 1).

Discussion: The main finding of our study is that maximum and explosive force production in the bench press exercise do not vary significantly at typical times of training (between 8h and 18h). The results of maximum strength are in accordance with the observations of no significant daily variation in maximum strength of the knee extensors [1] but contradictory to other findings showing a clear daily variation of strength of arm and leg muscles with an acrophase in the late afternoon or early evening (for review see [2]). The reason for our results may be that some exogenous factors overly the typical endogenous circadian rhythm of muscle function normally resulting in a diurnal variation of strength (like an unfamiliar and long stay at the laboratory during the testing day and the related change of the typical daily habits of body and muscle use of the subjects). Furthermore, it might be speculated that chronobiological variation is difficult to detect in a multi-joint situation (like the bench press exercise) since the complex synergistic-antagonistic muscle interplay may allow for a more frequent reproduction of a high maximal and explosive force production compared to the single-joint movements investigated in other studies.

Conclusion: Despite the well-known fact that several strength performance-related physiological variables (like core temperature or hormonal state) are subjected to chronobiological variation, the time of day may not be a critical factor in actually upregulating maximal and explosive force output and therefore training efficiency in a typical multi-joint strengthening exercise of the upper extremity.

References

- [1] Deschenes, et al., *Med Sci Sports Exerc* **30** (1998), 1399–1407.
- [2] Gauthier, et al., *Eur J Appl Physiol* **84** (2001), 249–252.
- [3] Martin, et al., *Muscle Nerve* **22** (1999), 1380–1387.

Lifestyle and Body Composition

An evaluation of body composition and cardiorespiratory fitness in university students

Aslan^{a,*} and U.B. Aslan^b

^aDepartment of Physical Education and Sports, Pamukkale University, Turkey

^bPhysical Therapy and Rehabilitation High School, Pamukkale University, Turkey

Introduction: Cardiorespiratory fitness and body composition are two important components of health related physical fitness and these components reflect habitual, moderate and vigorous intensity physical activity. The purposes of this study were 1) to determine gender differences in cardiorespiratory fitness and body composition, 2) to assess the relationship between cardiorespiratory fitness and body composition in university students.

Methods: Two hundred and six male students (age=21.23 ± 1.77 yr, height=175.06 ± 8.89 cm, weight=69.16 ± 7.89 kg, BMI=22.54 ± 2.26 kg.m³, VO_{2maks} =51.29 ± 7.23 mL.kg².min⁻¹) and 196 female students (age=20.01 ± 1.31 yr., height=161.79 ± 5.41 cm, weight=54.51 ± 6.92 kg, BMI=20.83 ± 2.54 kg.m⁻², VO_{2maks}=42.89 ± 7.22 mL.kg⁻².min⁻¹) served as participants. Cardiorespiratory fitness was measured in a 400 m outdoor track with one-mile walking test and predicted VO_{2maks} estimated by Kline's formula. Body composition was measured with Body Mass Index (BMI) and BMI calculated by dividing body weight in kg by the height in m⁻². Height was measured to use of a laboratory scale in cm and weight was measured to use of a stadiometer in cm.

Results: Male students have higher predicted VO_{2maks} and BMI values than female students ($p < 0.05$). Predicted VO_{2maks} was inversely correlated with BMI in male students ($r = -0.19$, $p < 0.01$), but it was not found a significant correlation in female students ($r = -0.06$, $p > 0.05$).

Discussion: It is known that body composition is significantly different in women compared with men and also men have higher cardiorespiratory fitness capacity in all age groups compared with women. The association between BMI and cardiorespiratory fitness is negative in male students, but it was not found a significant relationship for female students. This may be due to gender differences for body composition and cardiorespiratory fitness.

Conclusion: From these results we have suggested that male students have higher cardiorespiratory fitness level and BMI values than female students. In addition, cardiorespiratory fitness does relate to the BMI in male students, but it was not female students and further research is needed.

References

- [1] American College of Sports Medicine, *Med Sci Sports Exerc* **30** (1998), S975–991.
- [2] American College of Sports Medicine, *Med Sci Sports Exerc* **33** (2001), S2145–2156.
- [3] S.N. Blair, et al., *JAMA* **262**, S2395–2401.
- [4] C. Bouchard, et al., *Am J Clin Nutr* **37** (1983), S461–467.
- [5] P.T. Williams, *Med Sci Sports Exerc* **33** (2001), S611–621.

A relationship between physical activity and body composition in female university students

U.B. Aslan^{a,**} and Ş. Aslan^b

^aPhysical Therapy and Rehabilitation High School, Pamukkale University, Turkey

^bDepartment of Sports, Pamukkale University, Turkey

* Address for correspondence: Şehmus Aslan, Beden Eğitimi ve Spor Bölümü, Pamukkale Üniversitesi, İncilipınar, 20020, Denizli, Türkiye. E-mail: sehmosa@pamukkale.edu.tr

** Address for correspondence: Ummuhan Baş Aslan, Fizik Tedavi ve Rehabilitasyon Yüksek Okulu, Pamukkale Üniversitesi, Bayramyeri, 20020, Denizli, Türkiye. E-mail: umbaslan@yahoo.com.

Introduction: An inverse relationship between physical activity and adiposity is evident for vigorous leisure-time activity and frequently observed total activity. Physical activity record is an assessment method of physical activity. We have examined the relationship between energy expenditure based on physical activity record and body composition in female university students.

Methods: One hundred and one students (age=20.59 ± 1.26 yr, height=161.43 ± 5.62, weight=54.01 ± 6.53 kg, BMI=20.72 ± 2.32 kg.m⁻²) aged between 18 to 25 years completed seven 24-hour physical activity records. Students have recorded types and duration of all activities performed throughout the day in the physical activity record. Activities were categorized based on MET intensity into low (<3 METs), moderate (3–6 METs) and vigorous (>6 METs) and MET values of activities found from Compendium of Physical Activities. MET-hour from individual activities were summed and grouped into the appropriate intensity categories based on their assigned MET levels. Weekly total energy expenditure was found by summing the MET-hours for all activities, including sleep. Body composition of students was measured with Body Mass Index (BMI) and BMI calculated by dividing body weight in kg by the height in m⁻².

Results: Moderate summary score (73.07 ± 36.53 MET-hour) was higher than light (49.30 ± 30.70 MET-hour) and vigorous (9.31 ± 25.72 MET-hour) summary scores and weekly total energy expenditure was found 183.65 ± 54.10 MET-hour. It was not found a significant correlation BMI with the corresponding energy expenditure of physical activity indexes among female university students (total activity, $r = -0.08$; vigorous, $r = 0.03$; moderate, $r = 0.02$, light, $r = -0.01$) ($p > 0.05$).

Discussion: It is known, physical activity record gives in highly detailed information on the types of activity and time devoted by individuals to specific activities, but there is limitation on the representativeness of the habitual physical activity. Lack of association between physical activity record and BMI may be due to measuring physical activity in one-week period and/or the effects of other components in BMI.

Conclusion: It was concluded that physical activity record in one-week period was not related with BMI in female students, but further evaluation physical activity of in female students in longer than one-week period with physical activity record is needed.

References

- [1] B.E. Ainsworth, et al., *Med Sci Sports Exerc* **25** (1993), S71–80.
- [2] B.E. Ainsworth, et al., *Med Sci Sports Exerc* **32** (2000), S457–464.
- [3] J.M. Convey, et al., *Am J Clin Nutrition* **75** (2002), S519–525.
- [4] M.J. Lamonte and B.E. Ainsworth, *Med Sci Sports Exerc* **33** (2001), S370–378.
- [5] P.T. Williams, *Med Sci Sports Exerc* **33** (2001), S611–621.

An evaluation of the physical activity level and cardiorespiratory fitness in male university students

UB. Aslan^{a,*} and A. Livanelioğlu^b

^aPhysical Therapy and Rehabilitation High School, Pamukkale University, Turkey

^bPhysical Therapy and Rehabilitation High School, Hacettepe University, Turkey

Introduction: Physical activity questionnaire and cardiorespiratory fitness are two methods of physical activity assessment. We have examined the relationship between physical activity level determined by a questionnaire and cardiorespiratory fitness in male university students.

Methods: One hundred and six students (age=21.39 ± 1.58 yr, height=174.35 ± 8.15 cm, weight=68.73 ± 8.84 kg, BMI=22.57 ± 2.13 kg.m⁻²) completed a physical activity questionnaire (PAQ) which shown to be reliable and valid in Turkish university students. Cardiorespiratory fitness was measured with one mile walking test and

*Address for correspondence: Ummuhan Baş Aslan, Fizik Tedavi ve Rehabilitasyon Yüksek Okulu, Pamukkale Üniversitesi, Bayramyeri, 20020, Denizli, Türkiye. E-mail: umbaslan@yahoo.com.

predicted VO_{2max} estimated by Kline's formula. MET/hour per week values for total activity and specific types of activity from PAQ were calculated for each student. Activity level of students grouped on sedentary, active and very active based on energy expenditure of sports, transport (walking) and stair climbing section of PAQ.

Results: Activity level of student was determined %16.98 ($n = 18$) as sedentary, %21.70 ($n = 23$) as active and %61.32 ($n = 65$) as very active group. The difference between cardiorespiratory fitness of the groups was found significant. The very active group had higher VO_{2max} value than the other groups and the active group had higher VO_{2max} value than the sedantary group ($p < 0.05$).

Discussion: The relationship between physical activity level and cardiorespiratory fitness in male has been previously observed in different studies, but the levels of this relation was shown differences. Cardiorespiratory fitness is influenced by many factors beside physical activity, including genetic predisposition, enviromental condition, mesurement methods, and test-retest variability.

Conclusion: These results suggested that physical activity level determined by the physical activity questionnaire does relate to the cardiorespiratory fitness in male university students.

References

- [1] B.E. Ainsworth, et al., *Med Sci Sports Exerc* **25** (1993), 25:S71–80.
- [2] *American College of Sports Medicine: Med Sci Sports Exerc* **22** (1990), S265–274.
- [3] I.M. Lee, et al., *Am J Epidemiol* **135** (1992), S169–179.
- [4] D. MacAuley, et al., *Int J Sports Med* **19** (1998), S503–511.
- [5] R.S. Paffenbarger, et al., *Med Sci Sports Exerc* **25** (1993), S60–70.
- [6] S. Sidney, et al., *Am J Epidemiol* **133** (1991), S1231–1245.

Training with patients with COPD: Functional and psychological aspects

K. Bastian

Abteilung Sport-und Bewegungstherapie, Reha-Zentrum Reichshof-Eckenhagen, Germany

Introduction: Chronic lung diseases show a worldwide rise in morbidity and mortality. COPD (“chronic obstructive pulmonary disease”) is at present the fourth leading cause of death in the USA. Unfortunately COPD at this time obtains only small public and health political attention. The essential complaints of COPD patients are dyspnea and disability, which lead to a considerable restriction of living quality. Rehabilitation training program for patients with COPD lead to an increase of exercise tolerance and relief of dyspnea

Method: To evaluate whether aerobic training (training groups P1 and P4), strength training (P2 and P5) or a combination of both (P3 and P6) is the most useful, 69 patients (44 m/25f) with moderate to severe COPD were randomized to a three week inpatient training program with supplemental oxygen (LOX, P4–P6) and without (P1–P3). Before and after the training program lung function and exercise tests were carried out with all patients. Subjective dyspnea was measured by means of a “Visual Analogue Scale”, the exertional feeling with the “Borg-Scale”. A subgroup of patients ($n = 16$) was asked for anxiety and depression (Hospitality Anxiety and Depression Scale) and for life quality (Aachener Lebensqualitätsinventar). Aerobic Training was given four times a week on a calibrated ergometer with 80% of maximum capability, strength training four times a week with 40% of the maximum power. Important changes in lung function and arterial blood gas were not visible.

Result: The aerobic training groups (P1 and P3) gained from an easy decrease of airway obstruction while the strength group P2 could significantly increase its inspiration power. Aerobic training with hardly affected COPD patients (P4) led to a better oxygen saturation. All strength and combination groups (P2, P3, P5, P6) showed significant increases in their strength capacity, while only the aerobic training groups without LOX (P1 and P3) could clearly improve their aerobic exercise-capacity. The six-minute-walking test (6MT) showed a significant increase of the walking distance in all groups except for P2 (60–83). The time required to finish a test set of daily activities (TAF) was reduced in all groups (5–58 sec) and reached significance in P1, P3, P5 and P6. Exertional dyspnea after

the 6MT improved except for P4 in all groups (significant in P1 and P3), after the TAF in all groups (significant in P2 and P5). The health related life quality increased while depression decreased significantly.

Conclusion: A short-term inpatient training rehabilitation program is efficient for patients with COPD. Patients with advanced disease (P4–P6) profit by a strength training (alone and in combination with aerobic training), whereas for patients with moderate disease (P1–P3) aerobic training is recommended. Secondary to an increase in exercise tolerance and a relief of dyspnea, the patients achieve a higher quality of live. As a consequence of these results, participation in a rehabilitation program, in an independent domestic-training or in one of these unfortunately still rare lung-sport-groups is recommended.

The association of different habits of bag carrying with pain experience among young university students: A preliminary study

A. Ghanbari*, R. Stephenson and M. Watson

The School of Allied Health Professions, University of East Anglia, Norwich, NR4 7TJ, UK

E-mail: ali.ghanbari@uea.ac.uk

Introduction: Carrying bags may lead to some musculoskeletal problems, especially in children, adolescents and young adults [1–4]. Although many studies have investigated the effects of carrying a load on the human body, there is no information regarding the influence of asymmetrical carrying of bags in musculoskeletal pain problems. The aim of this study was to determine if a history of habitual asymmetrical carrying of a school bag on one shoulder is associated with more musculoskeletal pain problems compared to symmetrical carrying of bags on both shoulder.

Methods: An internet survey methodology was used. An email message was sent to every student in one school of a UK university. This requested recipients to access and complete an online questionnaire on the authors' web page. Students within the age range of 18 to 24 years old were asked to participate in the study. The questionnaire asked about the habits of carrying school bags during four periods of childhood, teenage years, adulthood and the present. Respondents were also asked to state any experience of pain with unknown origin during the previous six months. The responses were submitted directly to a database on the survey control web site.

Results: From a total number of 690 students, 123 responses were received. Among the respondents 76% reported carrying a backpack most of the time during their childhood and adolescence until the time of the study while only 23% of them had carried a shoulder bag. Except for the teenage years, during which most of the subjects (75%) reported carrying their bags on one shoulder, similar numbers of subjects reported carrying bags on both shoulders and on one shoulder at other periods. Pain experience was stated by 35% of the students in at least one site during the previous six months. The most common pain was back pain (32%) followed by knee pain (16%), neck pain (14%) and shoulder pain (12%). The only statistically significant result was the difference in number experiencing pain between the backpack group (31.8%) and the shoulder bag group (56%) ($p < 0.05$).

Discussion: Apart from the difference in pain experience in backpack and shoulder bag groups, the study did not reveal any significant results regarding the association of past and present habits of bag carrying and musculoskeletal pain problems. However, it provided a source of descriptive normative data on bag carrying habits in young people, and will be used to inform a larger scale study.

Conclusion: The results of this preliminary study suggest that carrying a shoulder bag instead of a backpack may be associated with a greater risk of developing musculoskeletal pain disorders especially low back pain. Whilst the focus of this study was young university students, the results may also apply to other groups who routinely carry bags, especially children and adolescents who constitute one of the largest bag carrying populations.

*Corresponding author.

References

- [1] W. Chansirinukor, *Aus J Physiotherapy* **47** (2001), S110–116.
- [2] K. Grimmer, *Applied Ergonomics* **31** (2000), S 343–360.
- [3] K. Grimmer, *Spine* **24** (1999), S 2262–2267.
- [4] D. Pascoe, *Ergonomics* **40** (1997), S 631–641.

Physical fitness of obese children: Comparison to a reference group and effects of the therapy program FITOC

U. Korsten-Reck^{a,*}, T. Kaspar^a, G. Rücker^a, S. Jotterand^a and K. Bös^b and A. Berg^a

^a*Department of Rehabilitation, Prevention and Sports Medicine, University of Freiburg, Hugstetterstrasse 55, 79106 Freiburg, Germany*

E-mail: u.korsten-reck@msm1.ukl.uni-freiburg.de

^b*University of Karlsruhe, Department of Sports and Sports Science, Germany*

Introduction: Motor performance of overweight and obese children is usually described by the aerobic capacity. The purpose of this study is to give a more subtly differentiated view of these abilities. Moreover, this study shows the development of the children's motor skills in the course of the therapy program FITOC (Freiburg Intervention Trial for Obese Children) [1]. As part of the outpatient therapy program FITOC (Freiburg Intervention Trial for Obese Children), an improvement in physical fitness is one important criterion for therapeutic success.

Methods: Obese children (BMI > 97th percentile), aged 8–12, who take part in the FITOC therapy program (3 times regular physical exercise per week, comprehensive dietary and behavioural education, seven meetings separate with parents and children) were tested at the beginning of the therapy (group 1: $n = 147$; 73 ♂, 74 ♀; age $\bar{O} = 10.7$). A subgroup was retested at the end of the 8-month intensive phase (group 2: $n = 49$; 20 ♂, 29 ♀; age $\bar{O} = 10.7$). A fitness test battery was used to test the children's conditional and coordinative skills [2]. Additionally, the BMI-SDS and the aerobic capacity (Watt/kg body weight) were measured. The results were evaluated on the basis of norms for age and sex.

Results: In group 1, the results of the running exercises ranged from below average to extremely below average. The children's results for the cycle ergometry were also below average. The performance of the coordinative tests varied from below average to average. The values for the strength endurance test were also within this range. However, the test for speed combined with strength (determined by throwing a 1-kg ball) showed an above-average mean value (Fig. 1). The BMI-SDS was 2.38 ± 0.44 .

A retest was conducted in group 2. The performance improved significantly for all motor fitness tests ($p < 0.05$ or $p < 0.01$), as did performance in the cycle ergometry ($p < 0.001$). The BMI-SDS decreased significantly ($p < 0.001$).

Discussion: Selection of the fitness test was made from scientific and economical aspects. The AST has high test-retest reliability (0.93 for the test battery [2]), whereby all four motor capacities are included. Few materials are required beyond equipment available in a gymnasium. The test can be performed with a group size of 15 children in a double sports lesson (1.5 hours) with three examiners. The evaluation of sports training in the therapy setting is an important component of the most effective and successful therapy program given the increasing importance of quality management. The change in the child's natural movement patterns may have greater influence on a long-term healthy life-style than focusing only on cardiorespiratory fitness. The fitness test battery fulfils the requirements in light of examination and development of the complex pattern of cardiorespiratory and neuromotor fitness in children [3].

Conclusion: This study shows that not all motor abilities of obese children are at a low level. Obesity does however pose an obstacle for motor development. The unexpected range of performance of obese children shows the necessity of an individualized exercise program, which focuses on developing the lacking motor skills.

*Corresponding author.

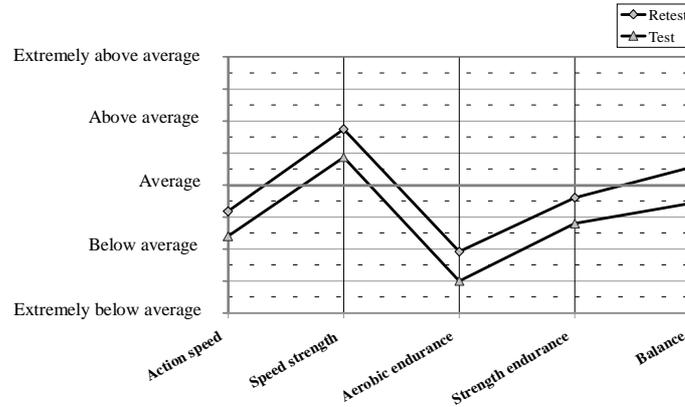


Fig. 1. Test and Retest of Group 2.

References

- [1] Korsten-Reck, et al., *Versicherungsmedizin* **54** (2002), 21–25.
- [2] Bös, et al., *Haltung und Bewegung* **20** (2000), 5–16.
- [3] Trost, et al., *Int J Obes Relat Metab Disord* **25** (2001), 822–829.

Measuring bone mineral density of female athletes in variety sport (weight bearing and non weight bearing) and comparison with standards of Iran and the world

A.M Rahimian* and B.P. Hejazi
 Alzahra University, Tehran, Iran

Introduction: The purpose of this study was to measure the BMD of neck of femur and radius in female athletes participating in weight bearing (WB) activities and non weight bearing activities and non athlete females in Iran and in the world.

Methods: Twenty-three female athletes (age 20 to 25) were selected to approach this study. They all were from Iranian swimming, Tennis, Table tennis or gymnastic national teams and had sport activity at least for 10 years, 3 days a week. Filling a questionnaire, subjects were selected what had no problem which might affect their bone mineral density. BMD was measured in two areas of the body (neck of femur and radius) for each subject using DEXA method. The standard values of BMD in Iran and in the world for non athlete female of same age were considered. Statistical analysis was performed on data using ($\alpha = 0.05$).

Table 1
 Statistics of athletes on swimming, tennis, tennis table and gymnastic Iranian national teams

	n	Weight	Height	Age	Mean BMD Femur	std. deviation BMD Femur	Mean BMD Radius	Std. deviation BMD Radius
Swimming	8	55.90	4.168	5.21	078.1	123.0	653.0	04.0
Tennis	5	2.53	2.164	5.20	116.1	031.0	612.0	024.0
Table tennis	4	0.55	0.166	5.21	035.1	146.0	667.0	069.0
Gymnastic	6	5.53	5.158	5.20	240.1	089.0	700.0	050.0

Results: In neck of femur, values of BMD for female athletes were higher than standard values of BMD for non athlete females. In comparison with standard values of BMD in Iran, the difference was significant for the gymnasts,

* Address for correspondence: Maryam Rahimian, no. 30, Azarmand alley, Ammar street, Niavaran avenue, Tehran, Iran. E-mail: mehdiesf1@yahoo.com.

the tennis players and the swimmers but not for the table tennis players. In comparison with standard values of the world the difference was significant for the gymnasts and the tennis players but not for the swimmers and the table tennis players.

In radius, the values of BMD for the female athlete were lower than standard values for non-athlete but the differences were not significant for the two groups of table tennis players and gymnasts. Comparing the four groups of athletes there were differences in values of BMD in the two areas, but only for the gymnasts was the difference meaningful. BMD for the swimmers (NWM) was lower than other groups of athletes (WB) in this study but the difference was not significant.

Discussion: Our result in comparing effects of WB and NWB sport on BMD was the same as studies by Taaffe [1, 2,4]. Research by Grandhad [3], Robinson [4] has also showed that in gymnastic activities the stress on bone is 10 to 12 times more than the stress caused by weight of body and this result support our result.

Conclusion: As a result, both WB and NWB activities in high intensity and long duration increase BMD in femur, but such effect on radius in all activities was not significant except in swimming in which the effect was negative. In this study, it seems that gymnastics increases BMD more than other sports. In addition, there is no significant difference between BMD in WB and NWB sports in both femur and radius.

References

- [1] L. Advienne, *13th Annual Research Day* (2001).
- [2] A. Menkes, *J Appl Physiol* **74** (1993), 2473–2484.
- [3] H. Grandhad, *Spine* **12** (1987), 146–149.
- [4] D.R. Taaffe, *J Bone Min Res* **10** (1995), 586–593.