ACTA KINESIOLOGIAE UNIVERSITATIS TARTUENSIS

VOLUME 7
(SUPPLEMENT)

PROCEEDINGS OF THE 23RD ICPAFR INTERNATIONAL SPORT SCIENCE SYMPOSIUM

EDITED BY
TOIVO JÜRIMÄE AND JAAK JÜRIMÄE

ACTA KINESIOLOGIAE UNIVERSITATIS TARTUENSIS

7 (Supplement)

UNIVERSITY OF TARTU

ACTA KINESIOLOGIAE UNIVERSITATIS TARTUENSIS

VOLUME 7
(SUPPLEMENT)

PROCEEDINGS OF THE 23RD ICPAFR INTERNATIONAL SPORT SCIENCE SYMPOSIUM

THE MEASUREMENT AND TESTING IN PHYSICAL FITNESS, PHYSICAL ACTIVITY AND HEALTH: NEW PERSPECTIVES

September 5–September 8, 2002
Tartu, Estonia

TARTU 2002

Editor
Toivo Jürimäe
University of Tartu
18 Ülikooli street
50090 Tartu
Estonia

This journal is indexed in: Sport Discus Database

Printed by Tartu University Press
Tiigi 78, Tartu 50410, Estonia
Order No. 500

PREFACE

International Council of Physical Activity and Fitness Research (ICPAFR) is pleased to present the proceedings of the 23rd International Symposium hold at the Faculty of Exercise and Sport Sciences in the University of Tartu, Estonia from 5–8 September, 2002.

This publication includes the papers of the keynote lectures and accepted original research articles. The selection was made by the members of scientific committee. In the reviewing process, the papers were assessed according to the main theme of the symposium ***The Measurement and Testing in Physical Fitness, Physical Activity and Health: New Perspectives***. Although this publication does not contain the full scientific program of the symposium, we hope it allows interested colleagues to inspect recent scientific advances in testing theory.

The editors wish to thank all authors who contributed to the success of the symposium. Also we would like to thank all the reviewers working hardly with the submitted articles. We hope that this and future publications will contribute to the major goal of the International Council of Physical Activity and Fitness Research that is, to bridge the gap between sport scientists and practitioners in teaching, coaching, training and rehabilitation.

Toivo Jürimäe and Jaak Jürimäe

SPONSORS

ICSSPE

CIEPSS

MARS
incorporated

POLAR

EESTI KULTUURKAPITAL

TARTU ÜLIKOOL
UNIVERSITAS TARTUENSIS
1632

CONTENTS

INVITED PRESENTATIONS

N. Armstrong (United Kingdom) Aerobic fitness and anaerobic performance during childhood and adolescence 13

D. Bailey (Canada) Physical activity and bone strength: old and new perspectives 20

A. P. Hills (Australia) Obese children and adolescents — gait issues 26

R. Laukkanen, P. Oja, J. Parkkari, A. Mänttäri (Finland) Validity of the supervised and self-administered UKK walk test for predicting vo_{2max} 31

V. Linnamo, P. V. Komi (Finland) Is eccentric exercise more fatiguable than concentric exercise 36

J. F. Sallis, L. T. McKenzie, T. L. Conway, J. P. Elder, J. J. Prochaska, M. Brown, S. J. Marshall, J. E. Alcaraz, P. Rosengard, J. Strelow, H. Powers (USA) Promoting and measuring youth physical activity throughout the school day: project M-SPAN 44

ORIGINAL RESEARCH ARTICLES

L. Aberberga-Augskalne, M. Rumaka (Latvia) Cardiovascular response during voluntary apnea at the level of functional residual capacity in schoolchildren aged 7–17 57

K. Baciuliene, A.Vainoras, R. Zumbakyte (Lithuania) Evaluation of posture, muscle strength and cardiovascular parameters in children 62

R. Baubliene (Lithuania) The influence of physical activity on women's self-education 66

B. Dežman, F. Erčulj, G. Vučković (Slovenia) Differences between winning and losing basketball teams in playing efficiency 71

F. Erčulj, B. Dežman, G. Vučkovič, R. Milič (Slovenia) Functional abilities of elite female basketball players in different playing positions 75

S. G. Fawkner, N. Armstrong (United Kingdom) Modelling the vo_2 kinetic response to moderate intensity exercise in children 80

C. A. Geithner, S. R. Siegel, C. W.Weixel, C. R. Lemieux (USA, United Kingdom) Indices and prevalence of fatness in native american and non-native american children, ages 5–10 85

V. Juodžbalienė, K. Muckus, A. Krisciukaitis (Lithuania) Body mass center sway of the pupils with and without visual impairment 89

J. Jürimäe, J. Mäestu, P. Purge, T. Sööt (Estonia) Psychometric monitoring of rowing training 94

T. Jürimäe, K. Sudi, J. Jürimäe, D. Payerl (Estonia, Austria) Validity of optical device LIPOMETER and bioelectrical impedance analysis for body composition assessment in men 99

A. Koka, V. Hein (Estonia) The effect of after-school sport participation with various intensity on intrinsic motivation and perceived learning environment in physical education 103

A. Krisciukaitis, V. Masalskyte, K. Muckus (Lithuania) Equilibrium stability of the pistol shooters 108

T. Kums, A. Vain (Estonia) Anthropometrical characteristics and the functional state of musculoskeletal system in rhythm gymnasts 113

R. Laukkanen, H. Kinnunen, P. Virtanen (Finland) Scientific development and evaluation of the Polar Fitness Test™ 117

A. Leppik, T. Jürimäe, T. Sööt (Estonia) Reproducibility of skinfold thickness measurements in children (longitudinal study)..... 121

J. Lorkowski, A Skawina (Poland) Underfoot pressure distribution of patients after total hip replacement 125

J. Lorkowski, D. Zarzycki (Poland) Pedobarographic evaluation of foot with hallux valgus deformity before and after Kramer's osteotomy 129

R. Malinauskas (Lithuania) Assessment of basic social skills (based on the data of the research of athletes) 134

K. Milašius, M. Pečiukonienė, E. Švedas (Lithuania) Creatine food supplements in the nutrition of endurance-training sportsmen 139

M. Müür, V. Hein (Estonia) An impact of children cognitive processes on expected outcomes in physical education 144

A. Nurmekivi, T. Karu, E. Pihl, K. Kaarna, J. Kangasniemi (Estonia) On the possibilities of evaluating the metabolic effect of different training exercises on the basis of objective and subjective characteristics 149

W. Osinski, R. Szeklicki, R. Stemplewski (Poland) Physical activity and bone mineral density in elderly men 154

M. Pääsuke, J. Ereline, H. Gapeyeva, M. Proosa, K. Joost, K. Mõttus, P. Taba (Estonia) Motor performance testing in elderly women.. 159

D. Rajtmajer, M. Vehovar (Slovenia) Experiment in didactics of physical education 164

G. Schalow, M. Pääsuke, J. Ereline, H. Gapeyeva (Estonia) Device for movement coordination measurement and training 169

L. Siupsinskas, A. Vainoras, G. Pilkauskaite (Lithuania) Subjectively evaluated physical activity and objectively tested physical capacity among students 174

R. Stamm, M. Stamm, S. Koskel, H. Kaarma (Estonia) Testing of Estonian young female volleyballers' (aged 13–16) physical abilities considering their body build 177

A. Suchomel (Czech Republic) Morphological age of school-aged individuals with different levels of motor performance 182

A. Suchomel (Czech Republic) Anthropometric somatotype of children with low and high motor performance 187

K. Tantiphlachiva (Thailand) Developmentally enhance process in physical activity of young children 192

G. C. Trentin, F. Viviani (Italy) Sports dropout in the adolescents of the province of Vicenza (Italy) 198

F. Viviani, V. Rizzo (Italy) The ethology of triumph behavior in sport: considerations on observational research applied to movement science 203

V. Volbekiene (Lithuania) Efficiency of class climate on the physical self-education of girls 208

V. Volbekiene, R. Baubliene (Lithuania) Changes in health related fitness of 16–18 year old students 212

G. Vučković, B. Dežman, F. Erčulj, S. Kovačič, J. Perš (Slovenia) Computer tracking of players at squash matches 216

Y. Wang, K. Watanabe (Japan) Swing foot regulation following obstacle clearance: effects of approach velocity and obstacle height 221

INVITED PRESENTATIONS

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

AEROBIC FITNESS AND ANAEROBIC PERFORMANCE DURING CHILDHOOD AND ADOLESCENCE

N. Armstrong
University of Exeter, Exeter, United Kingdom

INTRODUCTION

Peak oxygen uptake (peak VO2) is widely recognized as the best single indicator of young people's aerobic fitness. Cross-sectional data have consistently demonstrated an almost linear increase in peak VO2 (L/min) with chronological age. Boys' values are significantly higher than those of girls, at least from 10 years of age, with a progressive divergence in favour of boys during childhood and adolescence [1].

Direct measurement of anaerobic performance is not currently possible and research has focused on the assessment of short-term power output. Short-term power output has been estimated using a number of cycling and running tests but the Wingate anaerobic test (WAnT), which allows the determination of cycling peak power (PP), usually over a 1s or 5s period, has emerged as the most popular test with young people. Cross-sectional data are conflicting and predominantly refer to the age range 10–13 years where both no sex differences and higher PP in girls have been reported [1].

During childhood and adolescence peak VO2 and PP are conventionally expressed in ratio with body mass to account for changes in body size. Cross-sectional data suggest that girls' peak VO2 (mL/kg/min) progressively declines during adolescence whereas boys' peak VO2 remains stable over the age range 10 to 18 years. Inconsistent data indicate that PP (W/kg) increases with age in both boys and girls with girls' values reaching a plateau at about 14 years of age [1].

Longitudinal studies provide greater insight into the development of PP and peak VO2 but data are sparse and in some cases inappropriate statistical techniques have clouded understanding of the development of PP and peak VO2 [2, 4]. The emergence of multilevel regression modelling has, however, allowed a flexible and sensitive interpretation of longitudinal data in which, body size, maturation, age and sex can be partitioned concurrently within an allometric framework [8].

This discussion of the development of PP and peak VO2 during childhood and adolescence will therefore be founded upon data and text from a recently published longitudinal study [3, 4] which used a multilevel modelling approach to examine peak VO2 from 11 to 17 years and PP from 12 to 17 years.

METHODS

All children in year 6 attending the 15 state schools in Exeter were invited to participate in the study. Seventy percent of the population volunteered and provided written, informed consent signed by both the child and their guardian and the study received ethical approval. From those who volunteered 25% were randomly selected from each school. The children visited the Centre at age 11, 12 and 13 years and 63 subjects re-visited at age 17 years.

Age, body mass, stature, blood haemoglobin concentration, and skinfold thicknesses over the triceps and subscapular regions were determined on each test occasion. On the first three test occasions sexual maturity was visually assessed using the indices for pubic hair development described by Tanner [9] and on the final visit at age 17 years it was assumed that all subjects were stage 5. Peak VO2 was determined at ages 11, 12, 13 and 17 years using a discontinuous treadmill test to exhaustion. PP over 1s was determined at ages 12, 13 and 17 years using the WAnT.

RESULTS

PP and peak VO2 were investigated using the multilevel modelling programme MLwiN [8]. Multilevel modelling is an extension of multiple regression which is appropriate for analysing hierarchically structured data. In the present dataset, a simple two level hierarchy may be defined with the repeated test occasions (defined as level 1 units) grouped within the individual subjects who represent the level 2 units.

Multilevel modelling has the advantage of describing not only underlying trends in a response (the fixed part of the analysis) but also concurrently modelling the variation around this mean response at both levels of the analysis (the random structure). In this study the data were modelled within a multiplicative, allometric framework based upon previous work demonstrating this to be appropriate for body-size related exercise performance data, which tend to be skewed with heteroscedastic residuals. The level of significance was set at $p<0.05$ and the analyses were based upon 388 determinations of peak VO2 and 417 determinations of PP. Table 1 summarizes the multilevel regression models.

Table 1. Multilevel regression models for peak VO2 (n=388) and PP (n=417)

	Peak VO2	Peak Power
Parameter	Estimate (SE)	Estimate (SE)
Constant	–1.901 (0.140)	1.884 (0.165)
Ln mass	0.875 (0.043)	1.232 (0.050)
Ln stature	NS	NS
Ln skinfolds	–0.166 (0.017)	–0.159 (0.024)
Age	0.047 (0.009)	0.134 (0.010)
Age^2	NS	–0.034 (0.002)
Sex	–0.137 (0.012)	–0.054 (0.015)
Age x Sex	v0.021 (0.005)	NS
Maturity 2	0.034 (0.009)	NS
Maturity 3	0.036 (0.010)	NS
Maturity 4	0.054 (0.012)	NS
Maturity 5	NS	NS
Random		
Level 2 Constant	0.003 (0.001)	0.006 (0.001)
Level 1 Constant	0.003 (0.000)	0.011 (0.001)
-2* log (like)	–870.643	–530.243

Values are estimate (standard error of the estimate) NS, not significant ($p>0.05$)

DISCUSSION

The boys' peak VO2 values were significantly higher than those of the girls at each observation but sex differences in PP only reached significance on the final test occasion. The mean PP, expressed in W, increased from 12 to 17 years by 66% in girls and 121% in boys. Over the same age range peak VO2, expressed in L/min, increased by 50% in girls and 70% in boys. These data support the cross-sectional data that indicate that the anaerobic to aerobic power ratio increases through the teen years [1].

Longitudinal data on young people's PP are restricted to two published studies of boys [6, 7] and one study which included both sexes [5]. The studies of boys reported, in conflict with one another, an increase in PP with age [6] and no significant change in PP with age [7]. Both studies alluded to an effect of maturity on PP but an inappropriate means of controlling for body mass and not controlling concurrently for other covariates confound further interpretation. De Ste Croix et al. [5] controlled for body mass and skinfold thicknesses using multilevel regression modelling and reported PP to increase with age without significant sex differences over the age range 10 to 12 years.

The present data demonstrate a significant age effect over and above that due to anthropometric covariates although the negative age^2 term indicates that the magnitude of the age effect is reduced as rate of change in growth decreases. The negative parameter estimate for sex indicates the girls' lower PP but stages of maturity did not exert a significant independent effect on PP in either boys or girls once age and anthropometric variables had been controlled for. The introduction of skinfolds into the model increased the size of the mass exponent and reduced the magnitude of the sex term. This reflects the greater increase in skeletal muscle mass in boys over the age range 12–17 years.

De Ste Croix et al. [5] have demonstrated a significant effect of thigh muscle volume on PP generated through the WAnT even with other anthropometric variables controlled for. However, muscle action is not just a function of size and PP is also dependent on muscle fibre type. The distribution of type II fibres is age dependent and although there is no clear sex difference in either fibre distribution or size during childhood fibre diameter peaks in adolescence in girls but increases into young adulthood in boys. Boys have been reported to increase the size of their type IIX fibres more than girls [10].

The peak VO2 data are in direct conflict with the conventional interpretation of peak VO2 in relation to body mass (mL/kg/min) as the present data demonstrate that with body mass controlled for peak VO2 increases with age throughout the age range studied in both sexes. The girls' data are particularly noteworthy as previous longitudinal and cross-sectional data suggest little change in females' peak VO2 from about the age of 14 years [2]. The age by sex interaction term indicates that there is a progressive divergence in values with increasing age. Maturity exerts an additional independent effect on peak VO2 in both sexes even with body size and age controlled for.

A sex difference in peak VO2 was evident from the first year of the present study even when differences in body size were appropriately accounted for. As there is no evidence to suggest sex differences in either heart rate or arteriovenous oxygen difference at peak VO2 in 11-year-old children the girls' lower values may have been due to a lower stroke volume during exercise than in the boys. Smaller stroke volumes in girls can be attributed to their smaller heart size but stroke volume during exercise is not just a function of heart size and sex differences may lie in the interplay between ventricular preload, myocardial contractility, and ventricular afterload [2].

The increasing sex difference in peak VO2 has been related to girls' lower levels of habitual physical activity but the evidence linking habitual physical activity to peak VO2 during childhood and adolescence is equivocal. The physical activity patterns of the present subjects were estimated annually from age 11 to 13 years and no relationship between physical activity and peak VO2 was detected in either sex [1, 2].

Boys' muscle mass is about 54% of body mass at 17 years whereas, in girls, muscle mass reaches about 45% of body mass at age 13 years and then, in relative terms, declines due to fat accumulation in adolescence. The greater muscle mass of boys will contribute to the progressive divergence of peak VO2 values as it will not only facilitate the use of oxygen during exercise but also increase the venous return to the heart through the peripheral muscle pump and therefore enhance stroke volume. This is reflected in the model by the addition of the sum of triceps and subscapular skinfold thicknesses which explains much of the maturity effect on peak VO2 and reduces the size of the sex term.

It has been suggested that boys' greater blood haemoglobin concentration during late teens will augment further the sex differences in peak VO2 [2]. However, although at 17 years the boys had a significantly higher haemoglobin concentration than the girls, when haemoglobin was investigated as an additional explanatory variable for peak VO2 a non-significant parameter estimate was obtained with the present sample.

In summary, multiplicative allometric models have demonstrated that, in both boys and girls, PP and peak VO2 increases with age independent of body size. The increase with age in peak VO2 is more marked in boys and, in addition, stage of maturation exerts an independent positive influence on peak VO2 . The predominant influence on the growth of PP and peak VO2 in both sexes appears to be fat free mass.

REFERENCES

1. Armstrong N, Welsman JR (1997) Young People and Physical Activity. Oxford University Press, Oxford.
2. Armstrong N, Welsman JR (2000) Development of aerobic fitness during childhood and adolescence. Ped Exerc Sci 12: 128–149.
3. Armstrong N, Welsman JR (2001) Peak oxygen uptake in relation to growth and maturation in 11- to 17-year-old humans. Eur J Appl Physiol 85: 546–551.
4. Armstrong N, Welsman JR, Chia MYA (2001) Short term power output in relation to growth and maturation. Br J Sports Med 35: 118–124.
5. De Ste Croix MBA, Armstrong N, Chia MYH, Welsman JR, Parsons G, Sharpe P (2001) Changes in short-term power output in 10- to 12-year-olds. J Sports Sci 19: 141–148.
6. Duché P, Falgairette G, Bedu M, Fellmann N, Lac G, Robert A, Coudert J (1992) Longitudinal approach of bio-energetic profile in boys before and during puberty. In: Pediatric Work Physiology, J. Coudert, E. Van Praagh (eds). Paris: Masson, pp. 43–45.
7. Falk B, Bar-Or O (1993) Longitudinal changes in peak aerobic and anaerobic mechanical power of circumpubertal boys. Ped Exerc Sci 5: 318–331.
8. Goldstein H, Rasbash J, Plewis I, Draper D, Browne W, Yang M. Woodhouse G, Healy M (1998) A user's guide to MLwiN. University of London, Institute of Education, London.

9. Tanner JM (1962) Growth at Adolescence (2nd edition). Blackwell Scientific Publications, Oxford.
10. Van Praagh E (2000) Development of anaerobic function during childhood and adolescence. Ped Exerc Sci 12: 150–173.

PHYSICAL ACTIVITY AND BONE STRENGTH: OLD AND NEW PERSPECTIVES

D. Bailey
University of Saskatchewan, Saskatchewan, Canada
University of Queensland, Queensland, Australia

HISTORY

While the basic structure of the human skeleton is determined genetically, its final mass, shape, architecture and strength is influenced by adaptive mechanisms sensitive to three mechanical loading factors; gravitational force, muscle action, and external load. The relationship between the mechanical environment and skeletal form and strength in animals has been recognized since the time of Galileo [8] and the recognition that skeletal tissue has the ability to adapt to changes in the mechanical environment was first described by Darwin almost 150 years ago [4]. In his classical treatise, *The Origin of Species by Means of Natural Selection*, Darwin referred to this capacity as *functional adaptation*. He used the domestic duck to illustrate this process.

> " thus I find in the domestic duck that the bones of the wing weigh less and the bones of the leg more, in proportion to the whole skeleton, than do the same bones in the wild duck; and this change may be safely attributed to the domestic duck flying much less, and walking more, than its wild parents."

An anatomist from Berlin, Julius Wolff, is generally, and probably erroneously, given credit for first articulating a law to explain this phenomenon. He noted that bone tissue reorganizes when mechanical forces change. His seminal work in German, *Das Gesetz der Transformation der*

Knocken [22] published in 1891, has recently been translated into English by Maquet and Furlong under the title, *The Law of Bone Remodelling* [11] and Wolff's Law as it has come to be known, has been translated as follows,

> "the general form of bone being given, alterations to the internal architecture following mathematical rules, as well as secondary alterations of the external form of the bones, occur as a consequence of primary changes in the stressing of the bones."

Wolff's Law is now mentioned in almost every work dealing with bone adaptation. His name is familiar to every anatomist, orthopedic surgeon and sports medicine specialist. It is now over 100 years since the publication of Wolff's book, and Wolff's Law of Bone Transformation is now accepted by all researchers working in the area of bone dynamics. The irony is that a careful reading of Wolff's writings indicate that he either misunderstood or misinterpreted the basic biological principles on which "his" law is based. For instance, Wolff never accepted the concept of bone resorption as a basic component of bone transformation. He also had a different understanding of the term "function" which he viewed to be a static factor to be met rather than a dynamic influence involving action.

The person who should probably get credit for first understanding and articulating a law of functional adaptation in bone based upon the coupled processes of bone resorption and bone formation is Wilhelm Roux (1885). It was Roux who first argued that it was functional adaptation that shaped bone [15]. Roux and Wolff were to collaborate on a joint publication that never happened. In 1891 Wolff published his book alone, mixing his own erroneous ideas on function with Roux's correct interpretation of the form-function model.

Some four years after the publication of Wolff's book in 1895 Wilhelm Conrad Roentgen. a German physicist, made a discovery at the University of Wurzburg that resounded around the world and added a whole new way of looking at bone. Roentgen noted that a mysterious fluorescent glow was produced when a high voltage current was passed through a glass tube, fitted with positive and negative electrodes, that had been evacuated of air. When he shielded the tube with a piece of heavy black cardboard the light could still be seen on a screen 9 feet away. On further investigation, Roentgen found that this mysterious light could penetrate many substances opaque to ordinary light including wood, rubber and even human flesh so that only the bones and most minerals were visible. Because he did not know the nature of these light rays, he called them x-rays, “x” for unknown. Using his wife as a subject, Roentgen produced the first x-ray film of her hand in 1895.

The diagnostic potential of x-rays was recognized almost immediately. Within the space of one year, x-rays were being used clinically in Europe and the U.S. Numerous honors were showered on Roentgen and in 1901 he was awarded the first Nobel Prize in Physics. Roentgen is rightly credited as being the father of medical imaging.

MODERN TECHNOLOGIES

Today in studying bone, researchers use a number of medical imaging modalities based upon Roentgen’s original discovery. These include DXA, QCT, and pQCT. In addition to these x-ray based technologies, QUS and pMRI have also been used to study the response of skeletal tissue to altered loading patterns.

DXA — Dual Energy X-ray Absorptiometry is the most common measure of bone mineral content (BMC, g) and bone mineral density (BMD, g/cm^2). DXA is accurate and precise, provides little radiation exposure and can measure soft tissue as well as bone. The instrument can not differentiate between trabecular and cortical bone and it provides an areal density rather than a true density in (g/cm^3). Standard regions measured are the lumbar spine, proximal femur and the whole body.

QCT — Quantitative Computed Tomography provides a true volumetric density of trabecular or cortical bone and has been largely used to measure BMD of the vertebral bodies or the calcaneous. The relatively high radiation dose mitigates against its widespread use as a research tool for studying the influence of mechanical loading on bone in a normal population.

pQCT — Peripheral QCT is a recent technology that permits QCT evaluation of the appendicular skeleton (forearm and tibia) with reduced radiation exposure that may prove to be increasingly used in exercise-related research.

QUS — Quantitative Ultrasound is now being used in both a clinical and research context. This modality is less expensive than the imaging modalities dependent on radiation. It is lightweight, portable and employs no radiation. It is still unclear which bone parameters are measured by

QUS but it has been postulated that it may reflect bone microarchitecture. Standard regions measured are the calcaneous and tibia.

pMRI — Peripheral Magnetic Resonance Imaging is the newest, rarest and most expensive technology for looking at the appendecular skeleton. There are probably fewer than 10 of these instruments world wide, but with time it will undoubtedly become an invaluable technology for evaluating the impact of physical activity on bone.

SUMMARY

On the basis of studies employing these sophisticated medical imaging technologies, the modern-day observation that weight-bearing physical activity is an important regulatory factor in terms of bone shape and architecture as well as bone mineral acquisition during the growing years in humans should not be surprising. Studies on animals have documented changes in growing bone in response to mechanical loading dating back to Sedillot's studies on young puppies in the 1860's [17]. Even the design of plants is influenced by mechanical factors. Tree limbs automatically begin to increase in diameter when the curvature induced by increasing weight exceeds a set threshold [12]. This is analogous to the changes in animal long bones induced by bending loads.

In reviewing the historical documents of the many scientists who have investigated the relationship between mechanical loading and skeletal structure it is impossible not to conclude that mechanical loading is the pre-eminent factor in terms of bone mineral accumulation, bone architecture and the overall integrity of the skeleton. This was hypothesized by Galileo (1638), observed by Darwin (1859), described by Roux (1885), attributed to Wolff (1891), documented by Thompson in1917 [19], and explained by Frost in 1987 [7]. In the absence of the mechanical loading associated with physical activity, bone mass declines precipitously. This has been demonstrated in numerous disuse, immobilization and space flight studies [3,9,13,14,20,21].

CONCLUSION

In conclusion, it should be noted that heavy and prolonged physical activity has always been a major determinant of skeletal structure and function

[29]. The genetic makeup of humans remains adapted for circumstances as they existed 10,000 years ago, before the domestication of plants and animals and the rise of agriculture [6]. Humans evolved as active animals designed for an environment demanding high levels of activity. Thus, our present relatively sedentary lives may be out of step with our genetic makeup, which remains adapted to conditions of another time [5].

Human energy expenditure has declined over the past 10,000 years, and the decline has been most marked during the past century [1]. Taking this lifestyle difference into consideration, one would expect early humans to have a relatively greater skeletal mass and denser bones than present-day people, and anthropological studies have confirmed this [10,16,18]. Although the genetic argument does not prove that physical activity is necessary for skeletal health, it does suggest that we may be playing a dangerous game with our heritage if we fail to recognize the pre-eminent role played by mechanical loading through physical activity, as it applies to bone strength, bone mineral acquisition and bone preservation.

REFERENCES

1. Blair S, Kohl H, Gordon N (1992) How much physical activity is good for health? Ann Rev Public Health 11:99–126.
2. Bortz W (1985) Physical exercise as an evolutionary force. J Hum Evol 14:145–155.
3. Collett P, Ubelhart D, Vico L (1997) Effects of 1- and 6-month spaceflight on bone mass and biochemistry in two humans. Bone 20: 547–551.
4. Darwin C (1872) The Origin of Species by Means of Natural Selection (6^{th} Edition) New American Library, New York.
5. Eaton S, Konner M, Shostak M (1988) Stone agers in the fast lane: chronic degenerative diseases in evolutionary perspective. Am J Med 84:739–749.
6. Eaton S, Nelson D (1991) Calcium in evolutionary perspective. Am J Clin Nutr 54:281s–287s.
7. Frost H (1987) Bone mass and the mechanostat: A proposal. Anat Rec 219:1–9.

8. Galileo G (1638) Discorsi e demonstrazioni matematiche, intorno a due nuove scienze attentanti all meccanica ed a muovementi locali. (English Translation), University of Wisconsin Press, Madison.
9. Jee W, Li X, Ke H (1991) The skeletal adaptation to mechanical usage in the rat. Cells Mater Suppl 1:131s–142s.
10. Larsen C (1987) Bioarcheological interpretations of subsistence economy and behavior from human skeletal remains. Adv Archaeol Meth Theor 10:339–445.
11. Maquet P, Furlong R (1986) The Law of Bone Remodelling. Springer, Berlin.
12. McMahon T, Kronauer R (1976) Tree structures: deducing the principle of mechanical design. J Theor Biol 59:443–466.
13. Prince R, Price R, Ho S. (1988) Forearm bone loss in hemiplegia: a model for the study of immobilisation osteoporosis. J Bone Miner Res 3:305–310.
14. Rambaut P, Goode A (1985) Skeletal changes during space flight. Lancet 1050–1052.
15. Roux W (1885) Beitrage sur morphologie der funktionellen anpassung. 3. Beschreibung und erlauterung einer knockeren kneigelenksankylose. Archiv Anat Physiol Wissenschaftliche Medicin (Ch 6): 120–158.
16. Ruff C, Hayes W (1982) Subperiosial expansion and cortical remodeling of the human femur and tibia with aging. Science 217:945–948.
17. Sedillot C (1864) De l'influence des fonctions sur la structure et la forme des organes. Clin Rev 59:593.
18. Smith P, Bloom R, Berkowitz J (1984) Diachronic trends in humeral cortical thickness in Near Eastern populations. J Hum Evol 13:603–611.
19. Thompson D (1917) On Growth and Form. Cambridge University Press, London.
20. Uthoff H, Jaworski Z (1978) Bone loss in response to long-term immobilization. J Bone Joint Surg 60(B):420–429.
21. Vico L, Collett P, Guignandon A, Lafage-Proust M, Thomas T, Rehailia M (2000) Effects of long-term microgravity exposure on cancellous and cortical weight-bearing bones of cosmonauts. Lancet 355: 1607–11.
22. Wolff J (1891) Das Gesetz der Transformation der Knochen. Hirschwald, Berlin.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

OBESE CHILDREN AND ADOLESCENTS — GAIT ISSUES

A. P. Hills
Queensland University of Technology, Brisbane, Australia

INTRODUCTION

The World Health Organisation and the International Obesity Task Force recently termed the growing worldwide prevalence of obesity in both children and adults a 'global epidemic' and concluded that 'obesity should be regarded as today's principal neglected public health problem' [1]. Obesity-related health consequences in childhood are numerous and include psychosocial problems, accelerated growth and maturity, dyslipidaemia, elevated blood pressure, insulin resistance, and orthopaedic difficulties [1,2]. Further, many obese adolescents appear to be less physically active and less fit than their leaner peers [3] and fatness and elevated cardiovascular risk factors in childhood track through into adolescence and then adulthood. The aim of this paper is to provide an overview of gait and movement issues that may challenge a proportion of obese children and adolescents.

A physical activity context

Physical activity is essential for the normal growth and development of children. Irrespective of their size and shape, children must be provided with the opportunity to develop from a young age the motor skills necessary to participate in physical activity. In recent years a greater proportion of time for many children has been spent in sedentary tasks such as watching television and videos, and playing computer games. Commonly this trend is at the expense of participation in more active pursuits. Coupled with an energy intake that may include high fat and sugar consumption there is the potential to produce a sustained positive energy balance and consequent weight gain.

Physical fitness may be defined in terms of one's 'ability to perform daily tasks without fatigue' and includes numerous components including cardiorespiratory fitness, muscular strength and endurance, balance, flexibility, coordination and speed. Previous studies on obese children and adolescents have investigated cardiorespiratory fitness but there are gaps in our understanding of other health-related components. Recent research has referenced the physical challenges for the obese in the execution of simple activities of daily living. For example, despite our appreciation of the importance of static and dynamic balance in the development of motor abilities and in all activities of daily living, the differences in balance and postural skills between obese and non-obese children have not been investigated thoroughly.

What do we know about the gait characteristics of children and adolescents?

There is relatively little information regarding the structural and functional limitations imposed by the obese condition [4]. Similarly, we know little about the implications of the persistence of obesity on the musculoskeletal system and differences between children and adolescents of varying body composition status. Research to date has addressed the locomotor characteristics of obese children [5–7], plantar pressures under the feet of the obese [8,9], the influence of obesity on foot structure and functional performance of children [10].

The impact of increased loading on foot structure and function

The lower limbs, including the feet, are exposed to high ground reaction forces generated during weight bearing activities. Perhaps surprisingly, limited research has considered the effects of obesity on foot structure and function [9]. What is the impact of persistent loading of the feet through increased weight bearing forces caused by the obese condition? One consideration is that obese prepubescent children have significantly flatter feet than non-obese children of the same age and stage of development. However, we do not know if the greater prevalence of flat feet in obese children is due to the presence of a more prominent fat pad or is the result of a structural change such as a collapse of the longitudinal arch. A further unanswered question is whether changes in foot structure contribute to a lower participation of obese children and adolescents in physical activity. Ease of walking, as determined by discomfort experienced in the feet, may be a major limiting factor in the predisposition of the obese to participate in habitual physical activity such as walking [8]. In addition, musculoskeletal pain in the lower extremity may cause people to alter their gait pattern in an attempt to avoid or minimise any discomfort. Further research is required to consider the numerous unanswered questions in this area.

Limitations in muscular strength and power

A major limiting factor to successful participation in activities of daily living involving weight bearing is inadequate muscular strength and/or power, particularly of the lower limbs. In the obese, deficiencies in muscular strength may predispose such individuals to a greater risk of musculoskeletal fatigue and potential injury. The effects of obesity on the strength and power of the upper and lower limb has been assessed in simple tasks with obese and non-obese healthy, prepubescent children. Obesity does not commonly have a negative impact on upper limb strength or power but does affect the ability of obese children to perform tasks that require the movement of their larger mass against gravity. Limitations in muscular strength and power of the lower limbs of young children may affect the ability of children to master activities of daily living during their formative years. We need to increase our knowledge and understanding of a wider range of activities in which obesity may a negative impact. Further, we need to better understand the difficulties that may be faced by individuals of different body composition status. Similarly, it would be important to appreciate the impact of persistent obesity during the growing years. For example, is there a difference in the ability to manage daily tasks that is dependent on the length of time one has been overweight or obese? Answers to these questions would be of particular relevance to the design of more appropriate intervention strategies for obese youngsters.

Walking gait and other activities of daily living

Walking is the most common form of human movement and therefore is of central importance to daily physical activity participation. However, walking is a complex biomechanical process and we know relatively little about the relationship between mechanical and metabolic costs during this activity and how bigger people modify their gait pattern over time to enable the maintenance of a ‘normal’ pattern of walking [4]. For example, we do not know whether excess body weight, excess adiposity or both is a major limiting factor in movement tasks such as walking. A better understanding of the differentials in energy demand for the overweight and obese in activities of daily living such as walking has relevance for the treatment and management of the condition including the promotion of physical activity and also exercises prescription.

If repetitive load cycles in walking make significant demands on the musculoskeletal structures in normal weight individuals, how does the carriage of extra body weight (or body fat) add to these demands in the obese? What additional loading forces are experienced by the obese as a function of excess body weight (or body fat)? What additional demands, such as increases in energy expenditure are experienced by the obese compared to lean individuals in the same movement tasks [4]?

Previous analyses of the gait characteristics of obese children [5–7] have provided some understanding of movement-related difficulties in this population. Normal walking places considerable loads on the joints of the lower extremity and this increases in tasks such as stair climbing, jogging and running. A better understanding of the joint forces generated by obese individuals during walking and the change in pattern of loading when moving at speeds that are different from the normal, preferred pace of walking would be extremely valuable. We do know that the comfortable self-selected free speed of walking is generally less variable than an imposed walking speed. In obese children, Hills and Parker [6] found that obese pre-pubertal children showed greater gait asymmetry than non-obese children, and greater difficulty accommodating to changes in walking speed than non-obese children. Other differences in temporal characteristics between obese and normal weight pre-pubertal children [5] include a longer stance phase and slower speed of walking as reflected by a longer cycle duration, lower cadence, and lower relative velocity (statures/sec) in the obese. In summary, obese children display an unreliable gait pattern that is related to body composition and is influenced by the speed of locomotion. These findings reinforce the commonly held view of a slower, safer and more tentative walking gait in this population.

There is an urgent need to develop a normative database of the walking characteristics of obese children in order to better understand differences between obese and non-obese children of similar stature and age. This work should include a determination of the influence of speed of walking on children across the growing years and also the primary differences in static and dynamic balance.

SUMMARY

Due to the enormity of the obesity epidemic, and the relative paucity of information available, there is an urgent need to focus more attention on the physical consequences of repetitive loading of the lower extremity in overweight and obese children and adolescents. It is important for all health professionals to have a better understanding of the differences in the health-related components of fitness and movement characteristics of obese children and adolescents. This knowledge would be of great assistance in the prevention, treatment and management of the condition, including the design of more appropriate interventions.

REFERENCES

1. Bar-Or O, Baranowski T (1994) Physical activity, adiposity and obesity among adolescents. Ped Exerc Sci 6: 348–360.
2. WHO. Obesity. Preventing and managing the global epidemic. 1998. Geneva.
3. Dietz WH (1998) Health consequences of obesity in youth. Ped 101: 518–525.
4. Hills AP, Hennig E, Byrne NM, Steele J (2002) The biomechanics of adiposity — structural and functional limitations of obesity and implications for movement. Obes Rev (In Press)
5. Hills AP, Parker AW (1991) Gait characteristics of obese children. Arch Phys Med Rehab 72: 403–407.
6. Hills AP, Parker AW (1991) Gait asymmetry in obese children. Neur Orthop 12: 29–33.
7. Hills AP, Parker AW (1991) Gait characteristics of obese pre-pubertal children: effects of diet and exercise on parameters. Int J Rehab Res 14: 348–349.
8. Hills AP, Hennig EM, McDonald M, Bar-Or O (2001) Plantar pressures under the feet of obese adults: a biomechanical study. Int J Obes 25: 1674–1679.
9. Dowling AM, Steele JR, Baur LA (2001) Does obesity influence foot structure and plantar pressure patterns in prepubescent children? Int J Obes 25: 845–852.
10. Riddiford-Harland DL, Steele JR, Storlien LH (2000) Does obesity influence foot structure in prepubescent children? Int J Obes 24: 541–544.

VALIDITY OF THE SUPERVISED AND SELF ADMINISTERED UKK WALK TEST FOR PREDICTING VO_{2MAX}

R. Laukkanen [1], P. Oja [2], J. Parkkari [3], A. Mänttäri [3]
[1] *Polar Electro Oy, Kempele, University of Oulu, Finland*
[2] *UKK Institute, Tampere, Finland*
[3] *Tampere Research Centre of Sports Medicine, Tampere, Finland*

INTRODUCTION

Maximal aerobic power (VO_{2max}) is the best measure of cardiorespiratory fitness. Population studies have shown that individuals in the lowest fitness category had a significantly greater risk of all-cause mortality compared with those in the highest category [1]. Direct measurement of VO_{2max} requires expensive apparatures, laboratory facilities and test protocols that demands the individual to exercise to the exhaustion. Submaximal tests are widely used, inexpensive, safe and feasible for healthy adults. The UKK 2 km Walk Test (UWT) is a valid submaximal method for predicting VO_{2max} and it's changes in healthy sedentary and moderately active adults in field conditions [2–5]. The Walk Test results have also been shown to have a strong relation to physical activity and perceived health [6]. The UWT is a field test and it was originally developed to be done under supervision of a trained tester. The UWT is widely used for the health and fitness promotion purposes also in occupational health care. The purpose of this study was to asses the validity of a supervised and a self-administered heart rate monitor guided version of the UWT (Self Test) for predicting VO_{2max}.

METHODS

Twenty five voluntary healthy men and 26 women participated in this study. The subjects were selected from a large population study (Health 2000). The volunteers signed an informed consent and the study was approved by the ethical committee of the local sairaanhoitopiiri. They underwent three measurement sessions in three different days at least 5 days in between. In the first session they made the UWT on an 100 meter indoor track supervised and quided by a trained tester and a practice treadmill test to get used to direct assesment of VO_{2max}. To ensure the suitability of the subject for the maximal test the practice test was done under medical supervison with continuous ECG monitoring to a working level of at least 85 % of the age-predicted (220-age) maximum heart rate. In the second session they made a maximal graded treadmill test with gas analysis (Sensormedics Vmax29, Yorba Linda, California, USA). The test protocol started with 5 min warm-up with a treadmill speed of 4.5 $km \cdot h^{-1}$ or 5.5 $km \cdot h^{-1}$ on a 0 % incline and continued with 2 min ascending stress stages to the maximal exertion [2]. In the third session they made the Self Test on an 100 meter indoor track with a guidance of a heart rate monitor (Polar A5, Polar Electro Oy, Kempele, Finland). For the Self Test the subjects received a heart rate monitor with a brief manual. Their first task was to prepare the monitor ready for the test. The monitor then guided them first for a 5 min warm-up and then to perform the test. At the finish line the heart rate monitor recorded the walking heart rate and the walk time and did the VO_{2max} calculation.

RESULTS

Mean age, BMI and VO_{2max} of a study group were 43 years, 25.1 $kg \cdot m^{-2}$ and 39 $ml \cdot kg^{-1} \cdot min^{-1}$. Subject characteristics as well as measured and predicted VO_{2max} values are shown in Table 1. The mean difference (SD) of laboratory measured and Supervised Test predicted VO_{2max} was 1.4(4.8) $ml \cdot kg^{-1} \cdot min^{-1}$ and the total prediction error (E) 5.0 $ml \cdot kg^{-1} \cdot min^{-1}$. The predicted VO_{2max} explained 66 % of the variation of the measured VO_{2max}.(Fig. 1). The corresponding values of the Self Test were 0.9(4.5) $ml \cdot kg^{-1} \cdot min^{-1}$, 4.5 $ml \cdot kg^{-1} \cdot min^{-1}$ and 69 % (Fig. 2).

Table 1. Mean, standard deviation (SD), minimum (Min) and maximum (Max) of age, BMI, laboratory measured, supervised Walk Test and Self Test predicted VO_{2max} for the subjects (n=51).

	Age (*years*)	*BMI* ($kg \cdot m^{-2}$)	*VO_{2max}-measured* ($ml \cdot kg^{-1} \cdot min^{-1}$)	*VO_{2max}-predicted Supervised Test* ($ml \cdot kg^{-1} \cdot min^{-1}$)	*VO_{2max}-predicted Self Test* ($ml \cdot kg^{-1} \cdot min^{-1}$)
Mean	43	25.5	38.4	39.8	39.3
SD	8	3.6	7.0	8.3	8.0
Min	31	18.9	24.8	23.0	25.0
Max	61	35.7	56.3	62.2	61.0

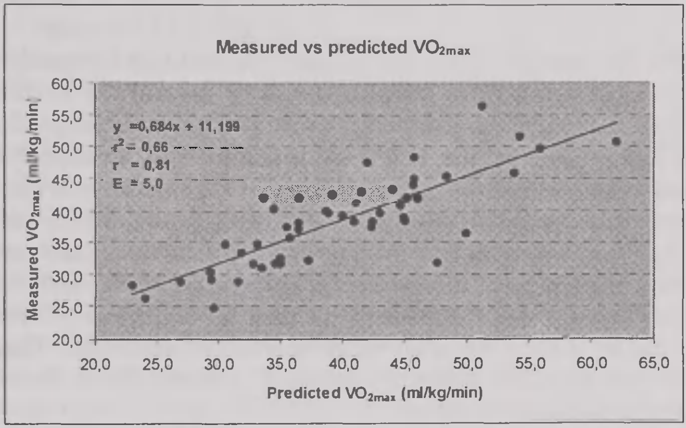


Fig 1. Graphic presentation of laboratory measured and Supervised Test predicted VO_{2max}. in the study group (n=51: 25m, 26 f)

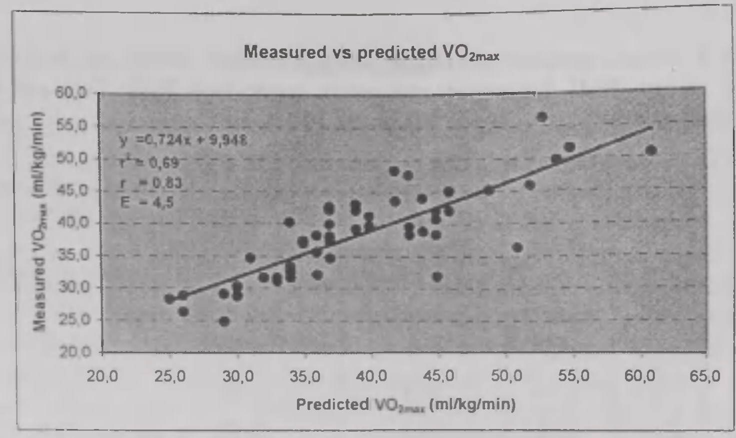


Fig 2. Graphic presentation of the laboratory measured and Self Test predicted VO_{2max} in the study group (n=51: 25m, 26f).

DISCUSSION

In previous studies of the UWT on sedentary and moderately active lean and obese adults the mean difference and the total error (E) of prediction have varied from –4.3 to –0.8 $ml \cdot kg^{-1} \cdot min^{-1}$ and from 6.9 to 3.2 $ml \cdot kg^{-1} \cdot min^{-1}$, respectively [2,3,4]. In those studies all the measurements have been supervised by a trained tester. In this study both the mean difference and E were within those ranges. Supervised UWT predicted VO_{2max} did not differ statistically from the Self Test predicted VO_{2max}. The Self Test was done after the supervised Walk Test and due to learning this may have an effect on the results.

These results confirmed our knowledge of the UWT's ability to predict VO_{2max}. This will encourage us to spread also the new Self Test version of the UWT for health care units as a valid and reliable method for testing physical fitness and enhancing physical activity among healthy adults.

CONCLUSION

The UWT is a valid VO_{2max} prediction method when done according to original instructions. The new Self Test version of the UWT done with a help of the heart rate monitor following a supervised test is also an accurate field test for predicting VO_{2max} in healthy adults.

REFERENCES

1. Blair SN, Kohl HW, Barlow CE, Paffenbarger RS, Gibbons LW, Macera CA (1995) Changes in physical fitness and all-cause mortality. JAMA 273: 1093–1098.
2. Oja P, Laukkanen R, Pasanen M, Tyry T, Vuori I (1991) A 2-km walking test for assessing the cardiorespiratory fitness of healthy adults. Int J Sports Med 12: 356–362.
3. Laukkanen RM, Kukkonen-Harjula TK, Oja P, Pasanen ME, Vuori IM (2000) Prediction of change in maximal aerobic power by the 2-km walking test after walking training in middle-aged adults. J Sports Med 21:113–116.
4. Laukkanen et al. (1993) Criterion validity of a two-kilometer walking test for predicting the maximal oxygen uptake of moderately to highly active middle-aged adults. Scan J Med Sci Sports 3: 267–272.
5. Laukkanen R, Oja P, Pasanen M, Vuori I (1992) Validity of two kilometre walking test for estimating maximal aerobic power in overweight adults. Int J Obes 16: 263–268.
6. Suni JH, Oja P, Miilunpalo SI, Pasanen ME, Vuori IM, Bos K (1999) Health-related fitness test battery for adults: associations with physical activity patterns. Int J Sports Med 20:183–191.

IS ECCENTRIC EXERCISE MORE FATIGUABLE THAN CONCENTRIC EXERCISE

V. Linnamo, P. V. Komi
University of Jyväskylä, Jyväskylä, Finland

Controversial results have been reported in the literature regarding the decrease in force after repeated maximal eccentric and concentric actions. Despite similar maximal EMG-activity the maximal force produced during eccentric actions can be much higher than that produced in concentric actions [12]. Asmussen [1] was one of the first authors to show how this higher mechanical loading during eccentric exercise would lead to delayed muscle soreness which was not observed after concentric exercise. Since then several laboratories have been interested in examining both the acute and delayed effects of eccentric and concentric exercises. The published studies report that muscle force due to fatigue may decrease more either in eccentric [14,15] or in concentric exercise [8,9,10,22,23] depending on a protocol and the muscles used. In some eccentric fatigue studies the eccentric force has decreased by 30–50% [2,3,5,14,15,20] while in some others there were hardly any changes in the eccentric force [10,23]. Although the changes in force have not been similar after eccentric and concentric exercise, no major differences have been reported in the changes in the average EMG [14,15,23]. Table 1 summarizes some of the results observed in studies comparing the force loss after eccentric and concentric exercises.

The recovery after eccentric exercise is generally longer than after concentric exercise because repeated eccentric actions are associated with delayed muscle soreness and structural muscle damage [7,11,18,20]. An indirect marker of muscle damage, serum creatine kinase (CK), has been

Table 1. Loss of force after maximal eccentric and concentric exercises

	Eccentric exercise	Concentric exercise
Grabiner & Owings [8]	–13%	–39%
Hortobagyi et al. [10]	+2%	–32%
Komi and Rusko [14]	–50%	–20%
Komi and Viitasalo [15]	–5%	–13%
Linnamo et al. [17]	–53%	–50%
Pasquet et al. [22]	–24%	–32%
Tesch et al. [23]	0%	–47%

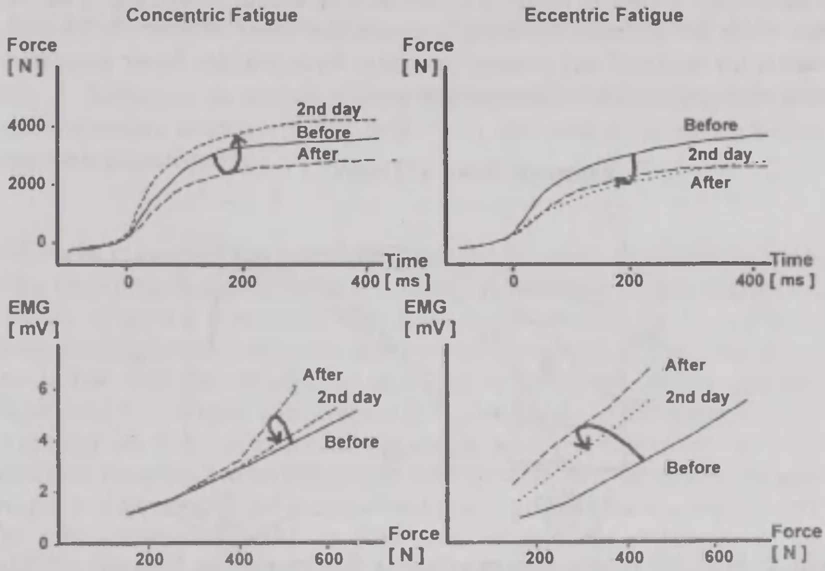


Fig. 1. Influence of 40 repeated maximum concentric and eccentric actions on the isometric force-time curve of the bilateral leg extension (upper graphs) and on EMG-force relationship in unilateral knee extension (lower graph). Note the delayed recovery of muscle performance following the eccentric fatigue (from Komi and Viitasalo [15]).

shown to increase and reach the highest value several days after eccentric exercise [6,17,19,21]. The recovery after repeated lengthening of the muscle may take more than a week as indicated by the increased stiffness and swelling [11]. An example of the delayed recovery after eccentric exercise is shown in fig.1 in the force-time characteristics and EMG/force ratio of isometric actions measured before and after eccentric and concentric exercise.

ROLE OF PREACTIVATION

The studies in which the eccentric action is started with maximal isometric preactivation appear to result in a considerable fatigue effect. Fig. 2 shows that when the eccentric action is started either from 50% or 0% preactivation, the maximal and average eccentric force remains lower compared with when maximal preactivation was used.

Essentric force at 2rad/s

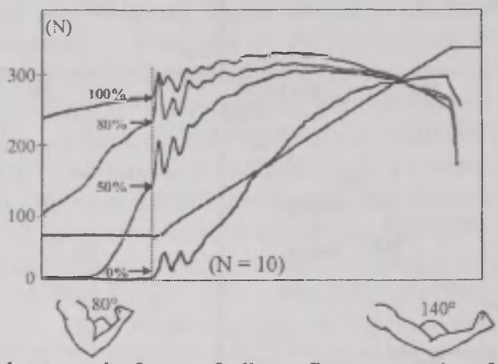
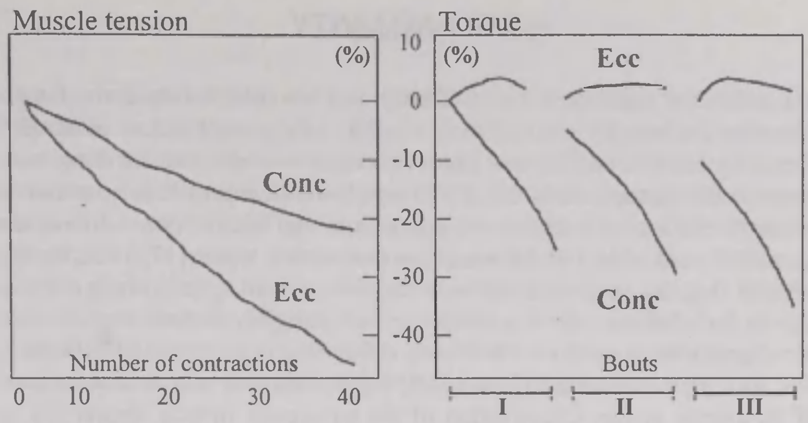


Fig. 2. Maximal eccentric force of elbow flexors starting from 0%, 50%, 80% and 100% isometric preactivation.

Therefore, if in the fatigue protocol the eccentric mode is started with zero preactivation [10,23] it is natural to expect that the overall eccentric loading is less than in the full preactivated mode [14,15]. Fig. 3 shows the difference in the fatigue response between two studies using maximal — and zero preactivation.



Modified from Komi & Rusko [14] **Modified from Tesch et al. [23]**

Fig. 3. Reduction in muscle tension and maximal force during eccentric and concentric exercise started with (left) and without (right) maximal isometric preactivation.

When the movement starts with maximal preactivation the mechanical loading (duration) in the eccentric is much higher and the fatigue response is usually of greater magnitude than after concentric exercise. Equal metabolic loading between eccentric and concentric exercise in these conditions are in line with this observation as indicated by almost similar glycogen depletion [15], oxygen consumption [14] and blood lactate values [15,17]. Although the same phenomenon regarding force levels between zero and maximal preactivation modes occurs also in concentric actions the fatigue response after concentric exercise using zero preactivation mode can still be quite dramatic [10,23]. In concentric actions, the difference in the absolute force levels between zero and full preactivation mode is most likely not as great as in corresponding eccentric conditions. This may at least partly explain why the subjects are able to fatigue themselves better with concentric as compared to eccentric action with zero preactivation mode.

EMG-ACTIVITY

The level of muscular activity (EMG) may also play a role in the fatigue response. Although maximal preactivation was used, Pasquet et al. [22] found a greater force decrease after concentric than after eccentric exercise. It seems that in their study the aEMG was lower in eccentric actions than in concentric, whereas in the recent study from our laboratory no differences in aEMG was observed between the two action types [17]. This would suggest that the subjects have been capable activating fully their muscles also in the eccentric mode. aEMG decreased slightly in both exercises but the changes were not dramatic. These rather small changes in aEMG are in line with previous studies [5,14,15,23] suggesting that fatigue may be more of peripheral origin. Coactivation of the antagonist muscle should not be responsible for the force reduction either because aEMG of triceps brachii muscle decreased during the exercises. The specificity of the fatigue was seen in the eccentric/concentric force relationship, which decreased after eccentric exercise and increased after concentric exercise [17]. The effect of eccentric actions was more substantial in a sense that concentric force decreased more after eccentric exercise than eccentric force after concentric (Fig. 4). This agrees with the study of Komi & Buskirk [13], which showed that for a long-term adaptation it is beneficial to exercise "eccentrically" to improve eccentric force and "concentrically" to improve concentric force.

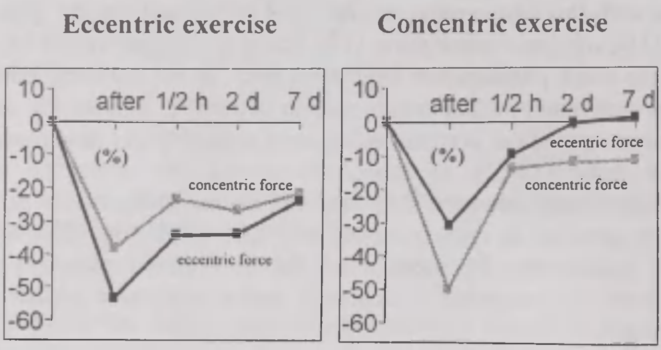


Fig. 4. Eccentric and concentric force after eccentric and concentric exercise

CONCLUSIONS

The immediate relative fatigue responses of eccentric and concentric exercises can be rather similar. This is, provided that the movement always starts with maximal isometric preactivation and aEMG levels are the same in the two conditions. On an absolute scale, the force decrease after eccentric exercise may be even greater than after concentric exercise. Eccentric fatigue leads to muscle soreness possibly associated with muscle damage, resulting in a longer recovery compared with concentric fatigue. Whether this delayed muscle damage and soreness are also included in fatigue response is a question of definition. Does the term fatigue refer only to the acute response or is it related to delayed response as well.

REFERENCES

1. Asmussen E (1956) Observations on experimental muscular soreness. Acta Rheum Scand 2, 109–116.
2. Brown S, Child R, Day S, Donnelly A (1997) Exercise-induced skeletal muscle damage and adaptation following repeated bouts of eccentric muscle contractions. J Sports Sci 15: 215–222.
3. Brown S, Day S, Donnelly A (1999) Indirect evidence of human skeletal muscle damage and collagen breakdown after eccentric muscle actions. J Sports Sci 17: 397–402.
4. Clarkson P (1997) Eccentric exercise and muscle damage. Int J Sports Med 18: S314–S317.
5. Day S, Donnelly A, Brown S, Child R (1998) Electromyogram activity and mean power frequency in exercise-damaged human muscle. Muscle & Nerve 21: 961–963.
6. Felici F, Colace L, Sbriccoli P (1997) Surface EMG modifications after eccentric exercise. J Electromyogr Kinesiol 7: 193–202
7. Friden J, Sjostrom M, Ekblom B (1983) Myofibrillar damage following intense eccentric exercise in man. Int J Sports Med 4: 170–176.
8. Grabiner M, Owings T (1999) Effects of eccentrically and concentrically induced unilateral fatigue on the involved and uninvolved limbs. J Electromyogr Kinesiol 9: 185–189.

9. Gray J, Chandler J (1989) Percent decline in peak torque production during repeated concentric and eccentric contractions of the quadriceps femoris muscle. J Orth Sports Phys Ther 2: 309–314.
10. Hortobagyi T, Tracy J, Hamilton G, Lambert J (1996) Fatigue effects on muscle excitability. Int J Sports Med 17: 409–414.
11. Howell J, Chleboun G, Conatser R (1993) Muscle stiffness, strength loss, swelling and soreness following exercise-induced injury in humans. J Physiol 464: 183–196.
12. Komi PV (1973) Relationship between muscle tension, EMG and velocity of contraction under concentric and eccentric work. New Developments in Electromyography and Clinical Neurophysiology. Desmedt JE, ed., Karger, Basel. 1: 596–606.
13. Komi PV, Buskirk ER (1972) Effect of eccentric and concentric muscle conditioning on tension and electrical activity of human muscle. Ergonomics 15: 417–434.
14. Komi PV, Rusko H (1974) Quantitative evaluation of mechanical and electrical changes during fatigue loading of eccentric and concentric work. Scand J Rehab Med Suppl 3: 121–126.
15. Komi PV, Viitasalo J (1977) Changes in motor unit activity and metabolism in human skeletal muscle during and after repeated eccentric and concentric contractions. Acta Physiol Scand 100: 246–254.
16. Lieber R, Friden J (1988) Selective damage of fast glycolytic muscle fibres with eccentric contraction of the rabbit tibialis anterior. Acta Physiol Scand 133: 587–588.
17. Linnamo V, Bottas R, Komi PV (2000) Force and EMG power spectrum during and after eccentric and concentric fatigue. J Electromyogr Kinesiol 10: 293–300.
18. McCully K, Faulkner J (1985) Injury to skeletal muscle fibers of mice following lengthening contractions. J Appl Physiol 59: 119–126.
19. Newham D, Jones D, Edwards R (1986) Plasma creatine kinase changes after eccentric and concentric contractions. Muscle & Nerve 9: 59–63.
20. Newham D, Jones D, Clarkson P (1987) Repeated high-force eccentric exercise: effects on muscle pain and damage. J Appl Physiol 63: 1381–1386.
21. Nosaka K, Clarkson P (1996) Variability in serum creatine kinase response after eccentric exercise of the elbow flexors. Int J Sports Med 17: 120–127.

22. Pasquet B, Carpentier A, Duchateau J, Hainaut K (2000). Muscle fatigue during concentric and eccentric contractions. Muscle & Nerve 23: 1727–1735.
23. Tesch P, Dudley G, Duvoisin M, Hather B (1990) Force and EMG signal patterns during repeated bouts of concentric or eccentric muscle actions. Acta Physiol Scand 138: 263–271.

PROMOTING AND MEASURING YOUTH PHYSICAL ACTIVITY THROUGHOUT THE SCHOOL DAY: PROJECT M-SPAN

J. F. Sallis, L. T. McKenzie, T. L. Conway, J. P. Elder, J. J. Prochaska, M. Brown, S. J. Marshall, J. E. Alcaraz, P. Rosengard, J. Strelow, H. Powers
San Diego State University, San Diego, USA

The Centers for Disease Control and Prevention [1] recommends multi-component approaches for promoting youth physical activity that combine classroom, family, environmental, policy, and community components. In practice, most consist primarily of classroom education [5]. Environmental and policy interventions are the least studied component of school health promotion [3,10], but there are examples of effective environmental interventions at schools. Environmental and policy approaches to improve physical education classes have increased students' physical activity in class and out of school [5,11,14]. The next generation of studies needs to identify opportunities for promoting physical activity throughout the school day. Because students accrue about 30% of daily physical activity at school [8,9], efforts to improve these behaviors on school campuses are needed and could have large cumulative effects.

The present study evaluated the effects of environmental and policy interventions on the eating and physical activity of students at school. The goals were to increase the availability of low fat food choices and physical activity opportunities and promote healthful choices through social marketing. Only the physical activity components of the study are reported here.

METHODS

School Recruitment and Characteristics

Twenty-four public middle schools (grades 6-8) in San Diego County, California, were recruited. The mean enrollment was 1109 (SD=356) students per school, of whom, 44.5% (SD=20.2) were non-white.

Study Design

The Middle School Physical Activity and Nutrition (M-SPAN) study was a randomized field trial, with the school as the unit of intervention and analysis. After baseline data collection, schools were randomly assigned to intervention (n=12) or control conditions (n=12). There were no significant differences between conditions at baseline on school characteristics or outcome variables (all p's > 0.05).

Intervention Overview

A primary aim was to increase the total energy expenditure from physical activity by the student population at school. Because the study was designed to test environmental interventions there was no classroom education. Cohen and colleagues [2] proposed a structural-ecological model of health behavior that can be used to classify the M-SPAN intervention approaches. The categories of structural and environmental influences on behavior are: (a) availability of protective or harmful products and services, (b) physical structures or characteristics of products and services, (c) social structures and policies, and (d) media and cultural messages.

Physical Activity Interventions

One component of the physical activity intervention was to increase physical activity in physical education (PE) classes through changing lesson context, lesson structure, and teacher behavior. PE was required daily in all grades. Another component was to increase physical activity in leisure periods throughout the school day when students could make choices. Consistent with baseline findings [13], targeted environmental changes were to increase supervision, equipment, and provision of organized activities. The main strategies used in the physical activity interventions are summarized in Table 1, categorized according to the structural-ecological model of Cohen et al [2].

Creating and Supporting Policy Change

Several strategies were used to create policy change in schools. Key school personnel met with project staff several times to select and implement policy changes to create healthier school environments. Examples of healthful policies were "Provide supervision and transportation for student physical activity after school," and "Upgrade PE facilities and equipment. "Student Health Committees consisted of 9–12 students and were supervised by a faculty member and project staff. The student committees set their own goals for creating more healthful school policies. Parental education was delivered via existing school communication channels, such as newsletters, Open House events, and PTA meetings. Intervention schools received $2,000 for physical activity programs or equipment. Prior to receiving funds, intervention school staff submitted plans for how money would be used to provide a more healthful environment for students.

Measurement

Physical activity outcome measures were collected by direct observation. The validated SOFIT method (System for Observing Fitness Instruction Time) [4,6] was used to evaluate student physical activity in a random sample of physical education classes. The SOPLAY method (System for Observing Play and Leisure Activity of Youth) [7] was developed for this study to assess the number and activity level of students during leisure times. For SOPLAY observations, all locations for physical activity were identified, and observers collected data in all locations before school, after lunch, and after school on randomly selected days. Table 2 summarizes measurement methods and provides citations for papers describing each method in detail. Reliability data in Table 2 cover the entire study period.

Table 1. Summary of main components of the M-SPAN Physical Activity Intervention categorized according to the structural-ecological model of Cohen et al [2]

Availability of protective or harmful products and services	Physical structures or characteristics of products and services	Social structures and policies	Media and cultural messages
Physical education: Five, 3-hour staff development sessions. Goals were to increase student PA time during class, improve teacher instructional skills, create action plans for promoting PA. Provide new curriculum materials.	Physical education: Project funds used for PE equipment.	Physical education: On-site visits to assist and give feedback. Staff development improved teacher support and promotion of PA. PE staff gave class credit for out-of-PE activities. Poster-style newsletters highlighted changes made in each school's PE programs.	Physical education: PE teachers promoted PA out of PE.
PA promotion throughout school day: Goal was to promote PA before school, after lunch, after school. Volunteer PA providers recruited from the community. Some volunteers received stipends or incentives. Make activity equipment available to students.	PA promotion throughout school day: Project funds used to purchase PA equipment.	PA promotion throughout school day: Policy group determined how project funds were used. Community providers recruited students to activity programs. PE staff supervised volunteer PA providers. Change policies to make more activity areas accessible.	PA promotion throughout school day: PA programs announced by flyers, school bulletins, parent newsletters, PTA meetings.

Note: PA = physical activity. PE = physical education.

Table 2. Summary of measures used to assess physical activity outcomes

Measure, target behavior, & references	Procedures and psychometrics	Schedule of measurement	Summary variable
Physical activity			
System for Observing Fitness Instruction Time (SOFIT), to assess PE classes. [4,6]	Observation of randomly selected students during PE classes. Codes of lying, sitting, standing, walking, very active transformed to energy expenditure. Interobserver agreement on categories = 83%.	Baseline: 3 randomly selected days per school. Intervention: 2 randomly selected days at each school per semester. 1947 classes observed.	Mean kilocalories expended in class = kcal/student/day.
System for Observing Play and Leisure Activities for Youth (SOPLAY), to assess out-of-PE activities. [7]	Observation of all activity areas before school, during lunch, and after school. All students coded as sedentary, walking, very active. Codes transformed to energy expenditure. Interobserver agreement on energy expenditure, R=.99.	Baseline: 3 randomly selected days per school. Intervention: 2 randomly selected days at each school per semester. Total of 5046 observations.	Total kcal observed divided by school attendance = kcal/student/day.

Note: PE = physical education.

Secondary Outcomes From Student and Parent Surveys

Data were collected by survey from separate random samples at baseline and at post-intervention. Students and their parent/guardian completed surveys at home and returned them to schools in sealed envelopes. A total of 1,678 students-parent pairs participated at baseline (response rate = 72%) and 1,434 pairs at post-intervention (response rate = 60%).

From a list of 32 physical activities (e.g., sports, dance, exercise) students reported the number of days of participation and average duration per day for the past seven days. Intensity values were assigned to each physical activity and multiplied by minutes to yield a weighted moderate to vigorous physical activity (MVPA) score. Students reported participation in nine sedentary behaviors (e.g., studying, computer/internet use) for the past seven days, and sedentary hours per day were calculated. Body mass index (BMI) was computed from student-reported height and weight.

Analysis Methods

We conducted randomized regression models using PROC MIXED in SAS to examine change over time in school-level physical activity outcomes by condition. Time points were baseline, intervention year 1, and intervention year 2. There were 24 schools and 72 observations available for analyses.

Randomized regression models also were used to examine changes in survey-based secondary outcomes by condition.

Effect sizes (d) were calculated by subtracting the change in control schools from the change in intervention schools and dividing by the overall SD of change. Change was examined from baseline to intervention year 2. Effect sizes were interpreted as small (0.20), medium (0.50), and large (0.80) [2].

RESULTS

Physical Activity at School

The time by condition interaction term for the total population was significant [$F(1,46)=7.53$, $p<.009$] with a large effect size ($d=0.93$). Intervention schools increased physical activity over time at a greater rate than control schools. Sex-specific analyses revealed the time by condition interaction was significant for boys [$F(1,46)=12.16$, $p=0.00$], with a large effect size of $d=1.10$. The interaction was not significant for girls [$F(1,46)=0.73$, $p=0.396$], but the effect size was small ($d=0.37$). The sex-specific results on kcals/day/child are shown in Fig. 1.

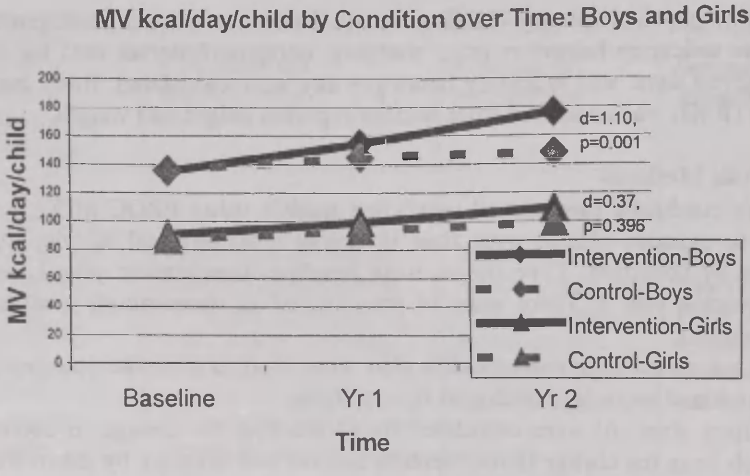


Fig. 1. Physical activity results. Observed moderate to vigorous physical activity by condition for boys and girls. N=12 intervention and N=12 control schools. MV= moderate to vigorous physical activity.

Secondary Outcomes

Data from the surveys revealed the intervention did not have a significant impact on reported physical activity or participation in sedentary behaviors. There was a small but significant reduction in self-reported BMI among intervention boys, compared to control boys, but there was no significant effect for girls.

DISCUSSION

The environmental and policy interventions implemented in middle schools were effective in increasing students' physical activity. There was no evidence that the school environment interventions improved health behaviors outside of school; nor was there evidence that students compensated for changes at school by decreasing physical activity or increasing consumption of fatty foods outside of school. The lack of changes outside of school was not surprising, as these environments were not targeted by the interventions. The significant intervention effect on boys' BMI suggests that boys may have increased their physical activity enough to produce physiological effects. Thus, the M-SPAN environmental and policy interventions appear to have had important effects on physical activity and weight control, although benefits were experienced mainly by boys. Perhaps activity offerings and instructional methods need to be more tailored to the wants and needs of girls.

The structural-ecological model of Cohen et al. [2] can be applied by considering how well the four components of the model were implemented for the multiple physical activity and nutrition targets. Changing "availability" of products and services is the first component. Availability of PE was not altered, but the intervention improved quality of the PE classes in intervention schools, while little change occurred in control PE classes. A major emphasis was placed on increasing the availability of activity programs throughout the school day. This intervention component appeared to be successful in some but not all schools.

The second structural change approach is to alter characteristics of products and services. The quality of PE classes was improved, which affected all students on a daily basis. More PE equipment was provided for intervention schools.

Cohen's [2] third approach is to change social structures and policies. There were examples of successful policy change, such as allowing students in activity areas after school and hiring aides to provide activity programs after school. The effectiveness of policy change groups in intervention schools, however, varied widely, and project support for the groups was probably inadequate to yield meaningful policy changes in most schools. The social context of physical education was changed through staff development. Physical activity providers were encouraged to recruit students personally to activity programs, but many were reluctant to do so.

The fourth structural component is the use of media to promote use of healthful products and services. Multiple school communication media were used, but media use may not have been as intensive as needed. In the context of popular mass media marketing of sedentary recreation, project media were inadequate to make a large impact.

The significant intervention effect on boys' BMI is consistent with boys' increased energy expenditure at school and suggests that school environment interventions have some promise for contributing to solutions to the youth obesity epidemic.

M-SPAN is one of very few diet and physical activity intervention studies in middle schools and filled gaps in the literature on environmental interventions for health promotion. New measures and intervention approaches were developed and implemented that can be applied in future studies. An important shortcoming of the study was the limited statistical power with 24 schools, so interpretation of effect sizes is important in putting the results in context. The effect sizes were substantial for the key outcomes. Results suggest the promise of environmental change but indicate the need for continued study to improve implementation of environmental and policy changes. Future studies need to evaluate the hypothesis that multi-level strategies that combine environmental and individual interventions will be most effective [12].

REFERENCES

1. Centers for Disease Control and Prevention. (1997) Guidelines for school and community programs to promote lifelong physical activity among young people. MMWR 46: 1–36.
2. Cohen DA, Scribner RA, Farley TA (2000) A structural model of health behavior: a pragmatic approach to explain and influence health behaviors at the population level. Prev Med 30: 146–154.
3. French SA, Story M, Jeffery RW (2001) Environmental influences on eating and physical activity. Ann Rev Public Health 22: 309–335.
4. Luepker RV, Perry CL, McKinlay SM (1996) Outcomes of a field trial to improve children's dietary patterns and physical activity: The Child and Adolescent Trial for Cardiovascular Health (CATCH). J Am Med Assoc 275: 768–776.
5. McKenzie TL, Sallis JF, Nader PR (1991) SOFIT: System for observing fitness instruction time. J Teach Phys Educ 11: 195–205.
6. McKenzie TL, Marshall SJ, Sallis JF, Conway TL (2000) Student activity levels, lesson context, and teacher behavior during middle school physical education. Res Exerc Sport 71: 249–259.
7. McKenzie TL, Marshall SJ, Sallis JF, Conway TL (2000) Leisure-time physical activity in school environments: an observational study using SOPLAY. Prev Med 30: 70–77.
8. Myers L, Strikmiller PK, Webber LS, Berenson GS (1996) Physical and sedentary activity in school children grades 5-8: the Bogalusa Heart Study. Med Sci Sports Exerc 28: 852–859.

9. Ross JG, Gilbert GG (1985) The National Children and Youth Fitness Study: a summary of findings. J Phys Educ Rec Dance 56: 45–50.
10. Sallis JF, Chen AH, Castro CM (1995) School-based interventions for childhood obesity. In Cheung LWY, Richmond JB, eds. Child Health, Nutrition, and Physical Activity. Champaign, IL: Human Kinetics, pp. 179–204.
11. Sallis JF, McKenzie TL, Alcaraz JE (1997) The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. Am J Public Health 87: 1328–1334.
12. Sallis JF, Bauman A, Pratt M (1998) Environmental and policy interventions to promote physical activity. Am J Prev Med 15: 379–397.
13. Sallis JF, Conway TL, Prochaska JJ (2001) Environmental characteristics are associated with youth physical activity at school. Am J Public Health 91: 618-620.
14. Stone EJ, McKenzie TL, Welk GJ, Booth ML (1998) Effects of physical activity interventions in youth: Review and synthesis. Am J Prev Med 15: 298–315.

ORIGINAL RESEARCH ARTICLES

CARDIOVASCULAR RESPONSE DURING VOLUNTARY APNEA AT THE LEVEL OF FUNCTIONAL RESIDUAL CAPACITY IN SCHOOLCHILDREN AGED 7–17

L. Aberberga-Augskalne, M. Rumaka
Medical Academy of Latvia, Riga, Latvia

INTRODUCTION

The aim of the study was to evaluate the changes of cardiovascular parameters at the onset and at the end of voluntary apnea at the level of functional residual capacity (FRC) and to compare these changes with data obtained from adults.

METHODS

During 10 year period 1042 observations were performed with 158 schoolchildren (85 girls and 73 boys) at the ages from 6.8 to 17.3. Body height, weight, chest circumference, subscapular and triceps skinfold thicknesses were taken and body mass index (BMI) was calculated. Habitual level of physical activity (HLPA) at the ages 14–16 was expressed as a score from questionnaire and running records were taken at the distances 300 m and 2000 m for girls and 500 m and 3000 m for boys. Impedance cardiography was used for measuring cardiac functions. Sphygmogramms (SPH) from a. carotis, a. radialis, a. femoralis and a. dorsalis pedis were recorded in supine position at normal quite respiration with muscles maximally relaxed and during voluntary apnea at quite expiration at the level of FRC. Arterial blood pressure (systolic-SBP and diastolic-DBP) was measured at rest, and at the beginning and end of breath holding test. Systolic volume (SV), cardiac output (CO), heart rate (HR), left ventricular ejection time (LVET), pulse (PP) and mean (MP) pressures, peripheral resistance (PR), pulse wave velocity (PWV) were calculated. The parameters obtained in all subjects under study were computed and statistical analyses were made by using SPSS program.

RESULTS

Average time of the breath holding at the FRC during 10 year period from age to age showed slight increase (on average by 31% in boys and 46% in girls) and was not statistically different for gender. It represented, on average, 18.0±4.3 seconds for females and 18.4±4.4 seconds for males. Changes of cardiovascular parameters during quite respiration, at the beginning and at the end of apnea are given in Table 1.

Average data showed slight response of cardiovascular system on the breath holding at FRC. At the beginning of apnea HR increased a little and then decreased at the end of test, more pronounced in girls. SBP and DBP also increased a little during apnea. More pronounced increase in DBP resulted in decrease of PP at the end of apnea test. SV did not change significantly. There were slight decrease in CO, duration of LVET related with cardiac cycle and PP. In polysphygmogramms changes in pulse waveform at the end of apnea were more pronounced in a. carotis. There was an increase of the amplitude of oscillation on the falling phase of the pulse wave caused by slow ejection during systole. The average PWV also increased at the end of breath holding, more pronounced in muscle type arteries.

Table 1. Cardiovascular parameters during breath holding in schoolchildren (mean ± SD).

Parameters	Sex	During quite respiration	At the onset of apnea	At the end of apnea
HR (t. p.m.)	f	79.5 ± 14.5	80.5 ± 14.8	77.6 ± 13.9
	m	76.4 ± 14.7	77.2 ± 15.4	76.2 ± 14.8
SBP (mmHg)	f	105.1 ± 11.4	108.6 ± 10.3	111.3 ± 12.1
	m	106.9 ± 11.6	110.3 ± 12.0	113.3 ± 12.6
DBP (mmHg)	f	64.6 ± 10.4	67.1 ± 9.9	72.5 ± 12.2
	m	66.7 ± 9.6	67.1 ± 9.7	72.9 ± 12.3
PP (mmHg)	f	40.6 ± 8.9	41.5 ± 9.5	38.8 ±10.4
	m	42.2 ± 10.0	43.1 ± 11.0	40.4 ± 11.9
MP (mmHg)	f	78.1 ± 9.9	80.9 ± 9.0	85.4 ± 11.1
	m	78.7 ± 9.2	81.5 ± 9.1	86.4 ± 11.1
SV (ml)	f	57.4 ± 20.0	56.2 ± 21.0	55.9 ± 20.4
	m	71.3 ± 25.4	72.0 ± 27.0	69.4 ± 27.0
CO (l/min)	f	4.49 ± 1.57	4.45 ± 1.66	4.28 ± 1.60
	m	5.32 ± 1.80	5.42 ± 2.02	5.15 ± 1.20
duration of cardiac cycle (sec)	f	0.78 ± 0.13	0.77 ± 0.14	0.79 ± 0.14
	m	0.81 ± 0.15	0.81 ± 0.16	0.82 ± 0.15
PR (mmHg*min/l)	f	52.9 ± 19.7	58.4 ± 21.1	61.8 ± 23.5
	m	44.2 ± 16.6	54.9 ± 16.7	59.3 ± 18.8
LVETrel. to cardiac cycle (%)	f	34.0 ± 4.7	34.4 ± 5.0	33.3 ± 5.1
	m	32.9 ± 4.7	33.2 ± 5.1	32.7 ± 5.0
PWV aorta (m/s)	f	5.14 ± 0.7	5.1 ± 0.8	5.3 ± 0.9
	m	5 ± 0.7	5 ± 0.7	5.3 ± 0.8
PWV foot (m/s)	f	8.2 ± 1.1	8.4 ± 1.2	8.6 ± 1.2
	m	8 ± 1	8 ± 1	8.3 ± 1

DISCUSSION

Slight increase in duration of breath holding at the FRC during 10 year growth and development of the organism, more pronounced in girls ($r=0.26$; $p<0.01$), should be related with maintained values of relationship between functional residual capacity and total capacity of lungs (FRC/ TC) during 7 to 14 period of age [5,6] and temporary slowing of the O_2 uptake in the lungs [4]. Average time of the breath holding at the FRC in our study was related with small, continuous linear increase of height, weight, chest circumference, body surface area, SBP, LVET and decrease of HR in girls and boys confirmed also by a weak but significant correlation. There were no significant gender differences neither in the duration of breath holding nor in the response of cardiovascular system. No significant gender differences in the duration of apnea at FRC and parameters of R -R intervals and systolic blood pressure were also found by Tavorka et al. [2]. Changes of HR in our subjects revealed two phasic reactions with slight increase at the onset and decrease at the end of the apnea test. These changes in HR is in agreement with Tavorka et al. [2] indicating during apnea a primary tachycardic reaction followed by a decrease in heart rate in young subjects with mean age 20.4 years. In our investigation shorter duration of holding breath ($p<0.01$) and more pronounced decrease in HR ($p<0.05$) during apnea was characteristic for schoolchildren with the higher initial values for HR. Increase in arterial blood pressure during apnea have also been reported by Tavorka et al. [2]. Hypertensive reaction is less pronounced in boys with higher initial systolic ($r=0.23$; $p<0.01$) and diastolic ($r=0.13$; $p< 0.01$) blood pressures. DBP at the end of apnea increased proportionally to increase of PR (in girls $r=0.4$; in boys $r=0.25$; $p<0.01$). It was found that increase in SBP during test in boys depends on the level of physical activity ($r =-0.56$; $p<0.01$), less pronounced increase of SBP was observed in boys with higher HLPA and physical fitness. Increased PR during the breath holding was higher in girls with lower physical activity ($r=-0.41$; $p<0.001$). In children with higher values for SV time of apnea was longer ($r=0.23$; $p<0.01$) and decrease was more pronounced at the end of the test ($r=0.15$; $p<0.01$). Decrease in SV at the end of the test was affected by increase in PR (in girls $r=-0.78$; in boys $r =-0.77$; $p<0.01$). Slight decrease in CO, duration of LVET due to cardiac cycle, PP and increase in PR characterized the adaptive response to the breath holding.

All the changes during breath holding are less pronounced as it is recorded for the adults [1]. Thus voluntary apnea at FRC is associated with slightly pronounced chronotropic effects and vasoconstriction, mediated partially by sympathetic nervous system and stimulation of arterial chemoreceptors. This is in agreement with [3].

In conclusion, the findings of this study of 7 to 17 years olds indicate that voluntary breath holding at the FRC are related with slight changes of cardiovascular response. Data revealed that the more physically active children had lesser cardiovascular response during apnea and longer duration of the breath holding. Voluntary breath holding at the FRC should be used in medical evaluations of the cardiovascular function, especially if the children are trained to this test.

REFERENCES

1. Aboltin-Abolin E. Changes of circulatory sphygmographic parameters under the influence of respiration. Tartu, 1980 (In Russian).
2. Javorka M, Zila I, Javorka K, Calkovska A (2001) Respiratory oscillations of cardiovascular parameters during voluntary apnea. Respir Physiol 126: 251–254.
3. Leuenberger UA, Hardy JC, Herr MD, Gray KS, Sinoway LI (2001) Hypoxia augments apnea-induced peripheral vasoconstriction in humans. J Appl Physiol 90: 1516–1522.
4. Lindholm P, Linnarsson D (2002) Pulmonary gas exchange during apnea in exercising men. Eur J Appl Physiol 86: 487–491.
5. Stocks J, Quanjer PhH (1995) Reference values for residual volume, functional residual capacity and total lung capacity. Eur Respir J 8: 492–506.
6. *Izledovanije funktsii vneshhego dohanija* (Investigation of functions of external respiration) Справочник по функциональной диагностике в педиатрии. Москва, Медицина, 1979, 265–291 (in Russian).

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

EVALUATION OF POSTURE, MUSCLE STRENGTH AND CARDIOVASCULAR PARAMETERS IN CHILDREN

K. Baciuliene[1], A.Vainoras[1,2], R. Zumbakyte[2]
[1]*Kaunas University of Medicine, Kaunas, Lithuania*
[2]*Kaunas Academy of Physical Education, Kaunas, Lithuania*

INTRODUCTION

In recent decade scientists show more interest in researching changes in growing human body during childhood. It is evident that prevention of functional and structural disorders of grownup humans starts in early school years. These changes are usually reflected by common enlarged physical load and increased activity. Adaptation reactions of bone and muscle structure, reactions of changes of cardiovascular system are different in children and in adults. Early influence of environmental factors such as incorrect posture during school years and lack of adequate physical activity predispose structural and functional changes in a grownup body. It is important to find possibilities of adequate development of a growing child's body and to prevent the majority of functional and structural body disorders. Regulation of cardiovascular system and adaptation of muscle strength to physical load in childhood differ from adults. Therefore, correct evaluation, early diagnosis and adequate complex of prevention means of structural and functional changes are very important. The main aim of our work was to investigate the correlation between structural and functional parameters of a growing body and to find out the main adaptation reactions to physical load in children.

METHODS

Group of 16 children aged from 7 to 9 years were investigated. The boys' group consisted of 8 boys, where average age was 7.9±0.2 years. The girls' group consisted also of 8 girls with average age 7.9±0.2 years. The bicycle ergometry (BE) test was performed using computerized functional test analysis system Kaunas-Load. The protocol of investigation was modified by Bruce protocol with decreased to one minute time interval for one step. The maximal load was usually limited by the submaximal heart rate. Load, arterial blood pressure, ECG in 12 leads synchronously was recorded at every step. The analyzed ECG parameters were arterial blood pressure (ABP), N_{max}, half recovery periods of heart rate, rec (HR ½), JT interval, rec (JT ½), systolic blood pressure, rec (S ½), delta DP, PWC170, Sv index of health, and adaptation (in percents). Sabia's scoliometer was used for current evaluation of the curves of spine. The scoliometer accurately measures areas of the body to detect scoliosis and detects abnormal antero-postero curves. Measurements were done in millimeters and degrees. We measured 7 areas of spine: shoulder tilt in degrees, pelvic tilt in degrees, shoulder tilt in millimeters, thoracic deviation in degrees, cervical, thoracic and antero-postero angulation L5 apex of sacrum in millimeters. Cirtometer was used to measure sagittal and spinal curves and lumbopelvic region of spine. We placed this instrument on the spinous process. These measurements were made in degrees. Nicholas Manual Muscle Tester (MMT) was used for evaluation of objectively quantifying eccentric muscle strength. Using MMT the peak force required to break an isometric contraction is measured as the examiner applies force against the subject. Fat mass was also measured in percent and in kilograms, fat free mass (FFM) in kilograms and total body water (TBW) in kilograms. We used Tanita body composition analyzer TBF – 300 for these measurements. We also measured height and weight of the children.

RESULTS

Fat value in percent was higher in girls than in boys. Accordingly, fat free mass was higher in boys than in girls. We also detected higher total body water in boys (Table 1).

Table 1. Anthropometric measurements in boys and girls.

Gender	Boys	Girls
Height (cm)	132.6±1.4	129.9±1.2
Weight (kg)	26.4±1.3	25.8±0.6
Fat (%)	13.9±0.8	17.1±2.1
Fat (kg)	3.8±0.4	4.5±0.6
FFM (kg)	22.7±0.9	21.4±0.3
TBW (kg)	16.6±0.6	15.7±0.2

Table 2. Values of EKG parameters in boys and girls.

Gender	Boys	Girls
Rec (HR) (s)	50.13 ± 10.6	36.13 ± 3.6
Rec (S) (s)	102.25 ± 35	127 ± 40
Rec(JT) (s)	96.13 ± 16	54.9 ± 9.1
Rec ((S-D)/S) (s)	248.5 ± 67.6	139.6 ± 33.2
Rec (JT/RR)(s)	43.63 ± 8.3	33.5 ± 5.1
Sum (-ST) (s)	–0.66 ± 0.2	–0.38 ± 0.1

Table 3. Values of developed maximal power (N), adaptation and integral value of health (Sv) in boys and girls.

Gender	Boys	Girls
N (W)	56.3 ± 4.9	48.1 ± 4.2
PWC_{170}	1.96 ± 0.1	2.09 ± 0.2
M	0.76 ± 0.07	0.92 ± 0.1
Adaptation (%)	16.39 ± 1.8	13.1 ± 1.8
Sv index (%)	52.1 ± 3.9	45.8 ± 2.8
Delta DP	1.94 ± 0.1	1.85 ± 0.1

Tables 2 and 3 show differences of adaptation reactions of cardiovascular system and developed maximal power in boys and girls. Developed maximal power was higher in boys than in girls, but there was no statistically significant difference. In our research we evaluated correlation between anthropometric, functional ECG, and structural anthropometric parameters.

Our results showed that there is a strong positive correlation between anthropometric values such as height, fat free mass, total body water and fat mass. This correlation is positive and very strong, and it is evident because of physiological factors of growing body. We also evaluated correlation of functional ECG values and anthropometric measurements and found out that summary value of ECG negative ST depended on children's height. The higher a child was, the lower the negative ST summary value was measured during BE. There was no significant interdependence between other ECG and anthropometric values. Parameters such as strength of abdominal muscles correlated with fat mass. The correlation was negative. There was a positive strong correlation between abdominal and back muscles strength. We also found out that spinal thoracic curve (kyphosis) positively correlated with fat free mass and total body water and with developed maximal power. There was a significant positive correlation between spinal lumbar curve (lordosis) and fat mass. The higher the amount of fat mass was measured, the higher values in degrees of lumbar curve were received.

DISCUSSION

1. There is a correlation between functional and structural parameters of children. Response of cardiovascular system under physical workload in children showed adequate reactions common to this age group.
2. Boys exhibited higher developed maximal muscle power (N) and higher value of integral health index during ergometry test. These values correlated with developed powers of different muscles.
3. Different reactions to physical workload and different structural features are noticeable already in young children and may be adequately corrected by choosing proper physical activity.

THE INFLUENCE OF PHYSICAL ACTIVITY ON WOMEN'S SELF-EDUCATION

R. Baubliene
Lithuanian Academy of Physical Education,
Kaunas, Lithuania

INTRODUCTION

The changes in one's mature age are possible and even can be very significant but are less universal and systematic than in one's childhood [5]. Positive life changes in one area are likely to markedly improve other spheres of life. The chain-of-response model of adult education by Cross [3] helps to reveal the peculiarities of adult self-education. Adequately organized physical activity can then be expected to provide overall strength and activate a process of self-education of adult women. We refer to the Weinberg's motivation theory of the interaction between a participant and situation in which an individual is being motivated both by personal factors (needs, interests, goals, etc.), and situational factors (a personality of a coach and his/her work tactics, hygienic factors) and interrelationship of these factors [6]. Aerobics is the most accepted as well as popular form of physical activity for women in Lithuania. Therefore, aerobics can be expected to have a wide spectrum of influence. During professionally organized aerobics classes, the leader can make a special effort to lead in a way that is orientated to self-education, along with conveying theoretical knowledge, assisting in a sharing of reciprocal experiences, and developing practical skills [1]. The aim of this study was to evaluate the influence of physical activity on women's self-education.

METHODS

The influence of physical activity in the various aspects of women's life was estimated by questionnaire. Natural experiment was applied in order to prove the possibilities of personality self-education in an aerobic system. A total of 420 women, age 35–65 years of various social statuses (married, divorced, single) were administered to a questionnaire. Respondents were subdivided into one experimental group and three control groups as follows: Experimental group — women, who attended an aerobics group that was specially designed to stimulate self-education (n=20). Control groups — women, who exercise aerobics at other fitness clubs (n=172); women, who are engaged in various kinds of independent physical activity exercises (n=103); women, who do not participate in any sort of physical activity (n=125). Duration of the experiment was one year.

RESULTS

The areas of life that were most influenced for the physically active women were examined (Table 1). Responses indicate that influence was particularly pronounced in leisure time activity, psychological balance, interaction with people and stimulation of intellectual abilities.

The experimental group of women indicated that the training had particularly great influence on various aspects of their lives. The results showed that women, who exercise regularly, pay more attention to self-education than those, who do not exercise (significant differences). 95% of the experimental group; 54.6% of the women, who attend aerobics in fitness clubs; 48.0% of those, who practice various forms of independent physical activity; and only 34.5% of those, who do not exercise, related an important or very important role for self-education.

Responses to the question — "What form of self-education do you consider to be the most important?" — made it clear that all respondents considered self-education, gained in group activities, whereby information is exchanged during interactions with other people, as most valued; although, the percentage of responses did differ: 100% of experimental group, 70.3% of the women, who attended aerobics in fitness clubs; 66.0% of those, who engaged in various forms of independent physical activity; and 42.4% of those, who did not exercise.

Table 1. "What influence does physical activity have on different aspects of life?"

Aspect of life	Frequency of responses (%)		
	Attending aerobics in fitness clubs	Engaged in various kinds of sports independently	Experimental aerobics group
1. Leisure time activity	81.3	82.9	100
2. Psychological balance	76.5	76.3	100
3. Stimulation of intellectual abilities	69.3	80.2	85.6
4. Interaction with people	75.5	70.0	100
5. Meaningfulness	56.6	65.8	90
6. Intimate life	55.8	44.7	95
7. Love	55.8	57.6	95
8. Career	48.4	54.6	75
9. Motherhood	40.8	50.6	90
10. Family relationship	40.1	45.8	80
11. Housekeeping	34.4	41.0	100

DISCUSSION

By the results of the experimental group we can judge the success of the aerobics class, specially designed for self-education. In working with this group, the effort was to provide basic information about a woman's organism; train physical aspects [2]; explain the structure of the lesson and the methods for the different parts of the lesson; familiarize with the mood, rhythm, and phrasing of the music; and increase awareness about nutrition, toughening up, work and rest schedules, relaxation techniques, breathing systems, and psychological perspectives. Information is provided in ways and tempos that are acceptable to adults [3]. Attention is paid to the fact that the women come to the training to relax after pressure from stress, and wants to become stronger physically. The optimal manner in which information was successfully received was in an atmosphere of ease, playfulness, and psychological relaxation [4].

Information would be provided in small doses before or after, or during the training sessions. During this process, information was unnoticeably interrelated with the performance of practical exercises, bearing in mind that people have come to exercise and relax, and not to expend great effort in learning [1].

Any subjects that are not directly related to the performance of an exercise are addressed at a time, other than during the training session in an informal atmosphere.

The participants in the experimental group learned to select exercises of a load and intensity that was geared to their individual needs. They were more accurate in the performance of the exercises, and they were more self-confident, because they understood well the essence of the training sessions, were better able at raising educational goals for themselves, and planning for the results of their activities. Aerobics that is oriented toward self-education involves psychological, intellectual, and emotional spheres of life, not only the physical aspects. A different kind of personal interaction occurred in this aerobics group than in the aerobics control groups. Experimental group was specially organized, so that the women could successfully share in one another's experience. This increased their abilities to interrelate, and supported their efforts in seeking recognition and respect from their peers.

In conclusion, experimental group women ascribe a greater role to self-education, and actively implement such by choosing a form of group activity. All the physically active women, who were tested for this research, claimed that physical activity has significant influence on different aspect of their life and could most easily implement their goals for self-education by means of leisure time activity psychological balance, interaction with people and stimulation of intellectual abilities. These goals are more reliably and successfully realized through groups that are specially oriented to promote self-education.

REFERENCES

1. Baublienė R (1998) *Moterų asmenybės saviugda aerobikos edukacine sistema*. Daktaro disertacija. Kaunas (In Lithuanian).
2. Cooper KH (1995) It's better to believe. Nashville Tennessee by Thomas Nelson.
3. Cross KP (1988) Adult as Learness. San Francisco–London: Jassey — Bass Publishers.
4. Forge RL (1995) 1995 Research Reports from the American College of Sports Medicine and the Society of Behavioral Medicine. In IDEA Today 1995 September, p. 51–60. International Association of Fitness Professionals.
5. Sugerman L (1986) Life-Span Development. Concepts, Theories and Interventions. London & New York.
6. Weinberg RS, Gould D (1995) Sport and Exercise Psychology. Human Kinetics.

DIFFERENCES BETWEEN WINNING AND LOSING BASKETBALL TEAMS IN PLAYING EFFICIENCY

B. Dežman, F. Erčulj, G. Vučković
University of Ljubljana, Ljubljana,Slovenia

INTRODUCTION

There are two forms of playing quality of players and teams in basketball. The first is named playing successfulness and the second playing efficiency.

Playing successfulness encompasses all relevant factors on which the quality of playing depends. It is assessed by the coach with the help of certain chosen criteria and descriptors, which determine the criteria achievement level on the chosen assessment scale.

Playing efficiency encompasses only those factors of playing quality, which can be obtained from the statistical record of standard and non-standard variables of playing efficiency in offence and defence (standard variables are those prescribed by FIBA). If this data is properly recorded, it enables a useful and objective analysis of partial and complete playing efficiency of the individual players and the team as a whole.

Many researchers all over the world use this data for scientific purposes. A part of the researches deals with forming various indices of playing efficiency of individual players and entire teams in offence, defence and together; and study their metric characteristics and practical usefulness [4, 5, 6]. The others are oriented into studying the particularities and differences in the structure of standard variables of playing efficiency of individual players and entire teams in light of the specificity of their playing roles or playing models [6].

In the current work we studied the differences in standard variables of playing efficiency of winning and losing teams.

METHODS

Sample of teams and matches

Thirty matches were included in the analysis, played by 2 x 6 teams in the first part of the competition in groups A and B at the 19^{th} European Championship for Junior Men in Croatia (Zadar, 14.–23.7.2000). In both groups the teams competed according to a round robin system.

Selection of variables

The variable sample included 14 variables of playing efficiency: FG1 – two point field goal (inside zone); FG2 – two point field goal (outside zone); FG3 - three point field goal; FT – free-throws made; ASS – assists; MFG1 – missed two point shots (inside zone); MFG2 – missed two point shots (outside zone); MFG3 – missed three point shots: MFT – missed free-throws; TO – turnovers; OR – offensive rebounds; DR - defensive rebounds; ST – steals and – blocked shots.

Methods of data acquisition and analysis

At each game, official statisticians of the 19^{th} European Junior Championship noted all end offence and defence actions (variables of playing efficiency) of both teams. These were noted according to the FIBA standardised instructions. The resulting data was input into a computer and analysed. The results were published in 12 official bulletins [1].

The data were analysed with one-way analysis of variance. The SPSS for Windows statistical package was used.

RESULTS

The results in Table 1 show that the teams that won the matches significantly differ from the losing teams in three offence variables (FG1 – two point field goal — inside zone, ASS – assists and MFG2 – missed two point shots – outside zone) and three defence variables (OR – offensive rebounds, DR – defensive rebounds and ST – steals). The winning teams achieved better results in all the variables.

Table 1. Test of equality of group means.

Variables	Means		SD			Signifi-
	W	L	W	L	F	cance
FG1	15.5	11.0	5.6	4.4	11.724	0.001
FG2	6.4	6.4	2.7	2.9	0.002	0.964
FG3	5.1	3.9	3.1	2.5	1.637	0.110
FT	16.9	15.3	6.8	6.5	0.860	0.358
ASS	10.4	6.5	4.6	4.2	11.852	0.001
MFG1	7.7	7.0	3.4	3.7	0.650	0.457
MFG2	10.5	12.8	3.7	4.1	5.025	0.029
MFG3	9.8	10.0	4.6	2.8	0.041	0.841
MFT	7.4	6.6	4.9	2.7	0.646	0.425
TO	13.4	15.7	5.6	4.7	2.733	0.104
OR	19.6	16.1	5.2	5.0	6.733	0.012
DR	9.5	7.2	4.0	3.6	5.322	0.025
ST	12.3	10.0	3.7	3.8	5.707	0.020
BS	2.7	2.8	2.1	1.9	0.036	0.851

Legend: W – winners, L - losers

DISCUSSION

Basketball is one of the most "measurable" sports games, since it is possible to determine quite reliably and objectively the advantages and weaknesses of individual players and entire teams with the help of variables of playing efficiency. This statement is also confirmed by the findings of this study, where we analysed the differences between the winning and losing teams at the 19^{th} European Championship for Junior Men in Croatia in 14 variables of playing efficiency.

The results show that players of the winning teams co-operated better in offence (they had more assists) and also scored better from inside the zone. These differences are probably the consequence of the superiority of their centres. This supposition is also confirmed by their more successful results in offensive rebounds. The guards of these teams were also more successful than their counterparts in the losing teams. They played more offensively (more steals) and jumped better for defensive rebounds. Apart from these advantages, the winning teams were quite equivalent to their adversaries in all the other variables of playing efficiency.

Collective play in offence, offensive play in defence and an efficient game in offence and defence inside both zones (under the baskets) was therefore the key to victory at the 19th European Championship for Junior Men.

REFERENCES

1. *Bulletin of 19th European Championship for Junior Men*, no. 1 to 12 (Zadar, July 14th to 23rd, 2000). Zadar.
2. Dežman B, Trninić S, Dizdar D (2001) Models of expert system and decision-making systems for efficient assessment of potential and actual quality of basketball players. Kinesiology 33: 207–215.
3. Erčulj F (1998) Morphologic-motor potential and playing efficiency of junior Slovene basketball selections. Doctoral dissertation, Faculty of Sport, University of Ljubljana, Ljubljana, Slovenia.
4. Lidor R, Arnon M (2000) Developing indexes of efficiency in basketball: Talk with the coaches in their own language. Kinesiology 32: 31–41.
5. Swalgin K (1998). The basketball evaluation system: a computerized factor weighted model with measures of validity. Kinesiology 30: 31–37.
6. Trninić S, Milanović D, Dizdar D (1997). Worin unterscheiden sich Sieger von Verlieren im Basketball [In what do the winners differ from the losers in basketball?]. Leistungssport, 29: 29–34.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

FUNCTIONAL ABILITIES OF ELITE FEMALE BASKETBALL PLAYERS IN DIFFERENT PLAYING POSITIONS

F. Erčulj, B. Dežman, G. Vučkovič, R. Milič
University of Ljubljana, Ljubljana, Slovenia

INTRODUCTION

Basketball has become a very complicated and demanding sport in the last few years due to very intense development of technique and tactics, which is evident predominantly from the search and development of specific models of sport form. Basketball is rich in movements; they differ in intensity and extent (duration). Therefore, the muscles of a player use different types of energy in different situations. During a basketball game, energy demands in 25% up to 40% of the playing time should be covered mainly by aerobic energy processes. The remaining part of the game takes place in anaerobic-aerobic and anaerobic conditions [6]. For less-prepared basketball players, the lactate concentration reaches 4 mmol/l (anaerobic threshold) already at a heart rate of 155–160 beats/min, while for well-prepared basketball players this happens when heart rate reaches 185–190 beats/min [3]. The purpose of this study was to obtain some more information about the level of functional dimensions of elite female basketball players and to define (establish) differences between different types of players (playing positions).

METHODS

The subjects in this study were top Slovenian female basketball players. The sample comprised of 19 national team players (average age 22.1 years) preparing for the European Basketball Championship 1997 and 1999. We grouped the players by their playing positions. We differentiated guards (n=9), forwards (n=7) and centres (n=3). For estimating the relative maximal oxygen consumption (VO_2Rel), the test PRAHA [5] was used. It belongs to the group of continuous immediate tests for the relative maximal oxygen consumption with open composition, which is performed on a treadmill. The test WINGATE [2] belongs to the group of intermediate-term anaerobic tests which generally last about 20 to 50 seconds and are designed primarily to assess the lactic anaerobic power and capacity of the involved muscles. The sample of variables comprised of the following eight items:

$RelVO_2$ [ml/kg/min]	relative maximal oxygen consumption
LAmax [mmol/l]	maximal concentration of blood lactate
HR AeT	heart rate at aerobic threshold
HR AnT	heart rate at anaerobic threshold
VO2AnT	oxygen consumption at anaerobic threshold
WINmin [W/kg]	minimal anaerobic power — the lowest power output in a 5 s period
WINmax [W/kg]	maximal anaerobic power — the highest power output in a 5 s period
FATIGUE [%]	index of fatigue — difference between the max. power and the min. power divided by maximal

Body height and body weight have been also measured for all 19 subjects.

RESULTS

Data was first processed for parameters of descriptive statistics. First we calculated the parameters for the whole sample (Table 1) and then for each sub-sample (group) (Table 2).

Table 1. Parameters of descriptive statistics for the whole sample.

Variable	Mean	S.D.	S.E.	Min.	Max.	K-S Z (2-Tailed P)
Height	179.89	7.08	1.62	168.0	191.5	0.57 (0.890)
Weight	69.84	6.48	1.49	59.5	80.0	0.83 (0.480)
VO2 Rel	50.48	3.40	0.78	44.6	57.1	0.58 (0.881)
LA Max	5.32	0.95	0.22	3.9	7.3	0.73 (0.649)
HR Max	188.53	5.80	1.33	174.0	198.0	0.61 (0.840)
HR AeP	158.53	5.95	1.36	146.0	170.0	0.66 (0.770)
R AnP	179.37	7.07	1.62	164.0	192.0	0.60 (0.859)
VO2 AnT	47.00	3.05	0.70	39.4	52.0	0.37 (0.999)
WIN Min	5.35	0.60	0.14	4.1	6.2	0.79 (0.558)
WIN Max	7.94	0.89	0.20	6.0	9.2	0.77 (0.584)
FATIGUE	32.30	6.35	1.44	19.4	40.9	0.98 (0.290)

Table 2. Parameters of descriptive statistics for the sub-samples

Variable	Guards		Forwards		Centres		F ratio	F prob
	Mean	S.D.	Mean	S.D.	Mean	S.D.		
Height	173.55	3.39	184.21	3.02	188.83	3.40	34.38	0.000
Weight	66.44	6.77	72.14	4.43	74.66	5.50	3.09	0.073
VO2 Rel	51.62	3.79	49.20	3.26	50.03	1.51	1.03	0.377
LA Max	5.54	1.08	4.95	0.65	5.50	1.15	0.80	0.464
HR Max	187.22	4.49	186.14	7.26	191.66	5.50	0.97	0.398
HR AeT	159.11	4.67	156.14	6.76	162.33	7.09	1.25	0.311
HR AnT	179.88	5.39	177.28	8.78	182.66	8.32	0.62	0.546
VO2 AnT	48.04	2.77	45.45	3.55	47.46	1.19	1.54	0.243
WIN Min	5.27	0.64	5.52	0.34	5.16	1.00	0.48	0.621
WIN Max	7.67	1.06	8.37	0.39	7.70	1.00	1.38	0.278
FATIGUE	33.30	5.78	33.87	5.31	32.73	11.64	0.03	0.967

DISCUSSION

Comparison with the results of some other studies performed on elite female basketball players shows that the subjects in our sample are approximately on the same level [4,6] or even achieve worse results [1].

The comparison of the results between different playing types (positions) tells us that in the variable VO2Rel the guards achieve the highest values and therefore best results, followed by centres with wings coming last. The differences in this variable, as was also the case in the others with which we assessed aerobic capacity, were not statistically significant.

In the fatigue index no larger differences can be established between the different types of players, something similar can be said also for the other two variables used to assess the anaerobic capacity of the players.

In light of the presented results, we can conclude that our sample of players in quite homogeneous in the variables used to measure their aerobic and anaerobic capacity.

In future we plan to construct norms for state selections for the individual playing positions by permanently monitoring the level of functional capabilities of the members of the state selections, and, if possible, compare them also with successful selections of other countries. In this way, combined with an appropriate programme of conditional preparation throughout the entire competitive season (club coaches shall be charged with its execution) we shall attempt to raise the level of conditional preparedness of the players in this important but not sufficiently accented segment of the training process in female basketball.

REFERENCES

1. Bale P (1986) A review of the physique and performance qualities characteristic of games players in specific positions on the field play. J Sports Med Phys Fit 26: 109–122.
2. Duquet W, Hebbelinck M (1990) Application of the somatotype attitude distance to the study of group and individual somatotype status and relations. In M. Bravničar, Fiziologija športa — vaje [Physiology of Sport — Exercises]. Ljubljana.

3. Hagedorn G, Niedlich D, Schmidt GJ (1985) Basketball -Handbuch, Teorie-Methoden-Praxis [Basketball Handbook, Theory, Methods, Praxis]. Reinbek bei Hamburg: Rowohlt Taschenbuch Verlag GmbH.
4. Hakkinen K (1993) Changes in physical fitness profile in female basketball players during the competitive season including explosive type strength training. J Sports Med Phys Fit 33: 19–26.
5. Krejci P, Piric J, Leso J, Bunc V, Potmesil J (1981) A laboratory methodology in the testing of special endurance of superior athletes in endurance events. Teorie-a-praxe-telesne-vychovy 29: 733–737.
6. Matković B, Heimer S, Matković B (1990) Physiological-functional indicators for female basketball players. Košarkarsko Medicinski vijestnik 5: 51–55.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

MODELLING THE VO_2 KINETIC RESPONSE TO MODERATE INTENSITY EXERCISE IN CHILDREN

S. G. Fawkner, N. Armstrong
University of Exeter, Exeter, U.K.

INTRODUCTION

When suitably modelled, the time constant (τ) of the oxygen uptake (VO2) kinetic response to moderate intensity exercise has been shown to closely represent the τ of oxygen uptake at the muscle [5]. It therefore provides a useful tool for the study of metabolic activity at the muscular level [2]. However, in order to quantify the exponential rise in VO2 at the mouth (phase 2), it is necessary to use suitable mathematical models that take into account the cardiodynamic phase (phase 1) which is independent of muscle metabolism [8]. With adults this has been shown to require the use of a model fitted to data following the end of phase 1, and to include a single exponential and delay term [5]. Studies that have described the VO2 kinetic response to moderate intensity exercise with children have used a variety of different models and their results vary widely [1,3,4,6]. At present, there is no literature that documents the suitable use of these models with children's data. The purpose of this study was therefore to identify the most appropriate model to quantify the time constant of the phase 2 response to moderate intensity exercise with children.

METHODS

15 boys and 15 girls (11–12y) volunteered to take part in the study following ethical approval. Each child and their parents signed informed consent forms. All exercise was carried out on an electronically braked cycle ergometer (Lode Excaliber Sport, Groningen, Netherlands) with gas exchange and ventilation measured breath-by-breath using a mass spectrometer (Airspec QP9000, Case, Kent, UK), and turbine flow meter (Interface Associates, California, USA). The children completed a ramp incremental exercise test to voluntary exhaustion for the assessment of their ventilatory threshold (Tvent) which was subsequently determined using the ventilatory equivalents method [7]. The children then completed at least six square wave transitions consisting of 360s of unloaded pedalling followed by 360s at a power output equivalent to 80% of their Tvent. Breath-by-breath responses were interpolated to 1s intervals, time aligned and averaged to form a single data set for analysis. Since the criteria for the phase 1- phase 2 transition could not be reliably met [8], the end of phase 1 was kept constant at 15s. The τ for each individual was estimated with the following general model using least squared non-linear regression analysis (SPSSinc., Chicago, Illinois, USA) where $\Delta VO2(t)$ is the increase in VO2 at time t above the prior control level; $\Delta VO2(ss)$ is the steady-state increment in VO2; τ and δ are the time constant and the delay term of the response respectively.

The model was adapted to provide four different analyses of the response data. Model 1 constrained the exponential to start at the onset of exercise (δ =0s), model 2 constrained the fitting window to the end of phase 1 (t >15s); model 3 allowed the exponential to begin following a delay (δ allowed to vary) and model 4 limited the fitting window to follow the end of phase 1 (t > 15s) and included a delay component.

The goodness of fit of each model was measured by calculating the adjusted mean of the squared residuals on a second to second basis and following the first 15s only for each model. A repeated measures analysis of variance and post hoc Scheffé tests were used to identify the model that best fit the data.

RESULTS

Model 4 provided a significantly better fit ($p<0.05$) than all other models (Fig. 1). The mean τ and δ for each model are given in Table 1. Data for subjects whose confidence intervals for τ were ≥ 5s were excluded.

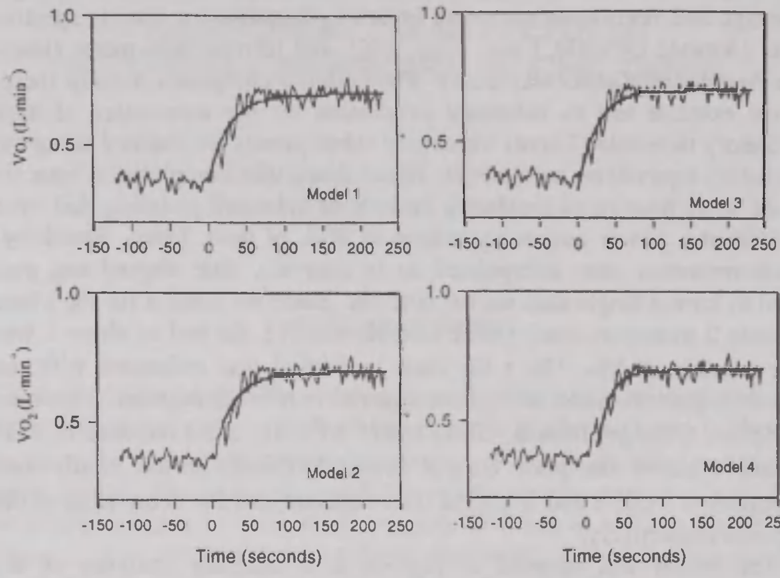


Fig. 1. Averaged breath-by-breath VO2 response to the step-change forcing function, and typical fits of each model 1 – 4 for a single subject.

Table 1. Mean time constants (τ) and delays (δ) for each model.

Model	Male (n = 11)		Female (n = 12)	
	τ (s)	δ (s)	τ (s)	δ (s)
1	29.5 ± 3.9		30.9 ± 4.5	
2	29.0 ± 3.9		30.5 ± 4.7	
3	25.9 ± 3.3	3.8 ± 1.5	27.8 ± 4.2	3.3 ± 1.6
4	19.0 ± 2.0	11.7 ± 2.9	21.0 ± 5.5	11.3 ± 2.4

Values are mean ± SD in seconds.

DISCUSSION

There are currently no data that address the use of mathematical fitting strategies to quantify the dynamic response to exercise with children. However, these results are consistent with previous work with adults [5,8]. Fig. 1 illustrates that models 3 and 4 provided a better description of the response during the initial rise in phase 2, but modelling without the exclusion of phase 1 (models 1 and 3) resulted in an underestimation of the VO2 as the exponential rose towards its asymptotic value. Fitting data without a delay term artificially forces the regression to extrapolate to the origin and hence resulted in longer time constants. We have clearly demonstrated that the use of different models in order to describe children's dynamic responses will have contributed to the equivocal findings relating to the value of τ at moderate intensity [1,3,4,6]. These results suggest that as with adults, the response to moderate intensity exercise is best described using a single exponential and delay term following phase 1.

REFERENCES

1. Armon Y, Cooper DM, Flores R, Zanconato S, Barstow TJ (1991) Oxygen uptake dynamics during high-intensity exercise in children and adults. J Appl Physiol 70: 841–848.
2. Barstow TJ (1994) Characterization of V02 kinetics during heavy exercise. Exerc Sports Sci Rev 26: 1427–1334.
3. Cooper DM, Berry C, Lamarra N, Wasserman K (1985) Kinetics of oxygen uptake and heart rate at onset of exercise in children. J Appl Physiol 59: 211–217.
4. Hebestreit H, Kreimler S, Hughson RL, Bar-Or O (1998) Kinetics of oxygen uptake at the onset of exercise in boys and men. J Appl Physiol 85: 1833–1841.
5. Rossiter HB, Ward SA, Doyle VL, Howe FA, Griffiths JR, Whipp BJ (1999) Inferences from pulmonary O2 uptake with respect to intramuscular (phosphocreatine) kinetics during moderate exercise in humans. J Physiol 518: 921–932.
6. Springer C, Barstow TJ, Wasserman K, Cooper DM (1991) Oxygen uptake and heart rate responses during hypoxic exercise in children and adults. Med Sci Sports Exerc 23: 71–79.

7. Wasserman K (1984) The anaerobic threshold measurement to evaluate exercise performance. Am Rev Respir Dis 129: S35–S40.
8. Whipp BJ, Ward SA, Lamarra N, Davis JA, Wasserman K (1982) Parameters of ventilatory and gas exchange dynamics during exercise. J Appl Physiol 52: 1506–1513.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

INDICES AND PREVALENCE OF FATNESS IN NATIVE AMERICAN AND NON-NATIVE AMERICAN CHILDREN, AGES 5–10

C. A. Geithner[1], S. R. Siegel[2], C. W. Weixel[3], C. R. Lemieux[4]
[1]*Gonzaga Unversity, Washington, USA*;
[2]*University of Wales Institute, Cardiff, UK*;
[3]*Coeur d'Alene Tribal Wellness Center, Idaho, USA*;
[4]*U.S. Army Institute of Environmental Medicine Research, Massachusetts, USA.*

INTRODUCTION

Approximately 25% of U.S. children are obese, representing in increase of more than 20% in the last 10 years [7]. Obesity in children and adolescents has reached epidemic proportions. Potential contributors to this increased fatness phenomenon include low physical activity levels [8, 9], TV viewing [2], and caloric over-consumption. Obese children are at increased risk for diabetes (NIDDM), hypertension, high serum cholesterol, and other health and orthopedic problems [1]. Large percentages of obese children and adolescents become obese adults [3, 5], which presents a burden to the public health care system and, in many cases, reduced quality of life due to disease and physical limitations associated with obesity. Data regarding overweight, obesity, physical activity, and disease risk in Native American children in the Northwestern United States are lacking and few comparisons among Native American tribes, or with other populations have been published. The purposes of this study were to assess and describe sex- and tribal membership status-associated differences and differences in body composition, fat distribution, body mass index (BMI), and prevalence of obesity in schoolchildren, ages 5–10 years (this would provide an indication of risk for diabetes and cardiovascular disease).

METHODS

Permission was obtained for a health and physical activity assessment from the Coeur d'Alene (CDA) Tribal Health Board and Tribal Council and Plummer-Worley Elementary School. Informational letters and permission slips were sent to parents. Children ages 5–10, grade K-4, were measured during their physical education class and identified as tribal (T) and non-tribal members (NT). Anthropometric data (height; weight; triceps, medial calf, subscapular, and abdominal skinfolds) were collected and BMIs and trunk/extremity skinfold ratios (T/E SF) were derived for 234 children (134 boys, 100 girls; 121 T, 113 NT). Data for 219 children (121 boys, 98 girls), about 50% of whom were tribal members, were analyzed using SPSS. Obesity and superobesity were operationally defined by the 85^{th} and 95^{th} percentiles for body mass index (BMI), and triceps skinfold (TRI), respectively [6]. Percent body fat (%Fat) was estimated using age, BMI, and sex-specific intercepts [4]. Means by age and sex (excluding 5-year-olds, n=190) were compared to BMI and triceps skinfold (TRI) percentiles from NHANES I [6]. ANCOVAs were run to compare BMI and TRI by sex and tribal status (T vs NT) while controlling for age.

RESULTS

More than 21% of boys and girls were obese, and 32.7% of boys and 27.9% of girls were superobese by BMI. Based on TRI, percentages were somewhat different. In addition, %Fat means indicated a high prevalence of obesity (boys: 28.0±5.3%, girls: 31.5±5.6%), and were greater in T vs. NT. T girls had greater weight for height by BMI and height/weight ratios than NT girls ($p<0.05$). T boys had greater T/E SF ratios ($p<0.05$), indicating greater relative trunk fat (more fat on the back and abdomen than on the arms & legs).

CONCLUSIONS

The prevalence of obesity among children varied depending on the criterion used; however, it was higher than is desirable, and the prevalence was higher in T than in NT children. T girls had a greater risk for obesity than NT girls. T boys had greater relative trunk fat than NT boys, suggesting a greater risk for chronic disease (e.g., obesity, CVD, and/or diabetes). The tendencies toward greater BMI and obesity in children are important in the context of public health, since BMI tends to track well after early childhood, childhood obesity predicts adult obesity, and obese children are at increased risk for diabetes and several chronic diseases. The data justify the need for funding and implementation of physical activity and educational interventions to improve the general health and fitness status of children, and prevent obesity, CVD, and diabetes in Native Americans in the Northwestern United States.

REFERENCES

1. Bar-Or O, Foreyt J, Bouchard C, Brownell KD, Dietz WH, Ravussin, E, Sable AD, Schwenger S, St Jeor S, Torun B (1998) Physical activity, genetic, and nutritional considerations in childhood weight management. Med Sci Sports Exerc 30: 2–10.
2. Gortmaker SL, Must A, Sobol AM (1996) Television viewing as a cause of increasing obesity among children in the United States, 1986–1990. Arch Ped Adolesc Med 150: 356–362.
3. Guo SS, Roche AF, Chumlea WC, Gardner JD, Siervogel RM (1994) The predictive value of childhood body mass indes values for overweight at age 35 yr. Am J Clin Nutr 59: 810–819.
4. Lohman TG, Caballero B, Himes JH, Hunsberger S, Reid R, Stewart D, Skipper B (1999) Body composition assessment in American Indian children. Am J Clin Nutr 69: 764S–766S.
5. Mossberg HO (1989) 40-year follow-up of overweight children. Lancet 2: 491–493.
6. Must A, Dallal GE, Dietz WH (1991) Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht^2) and triceps skinfold thickness. Am J Clin Nutr 53: 839-846.

7. Troiano RP, Flegal KM, Kuczmarski RJ, Campbell SM, Johnson JC (1995) Overweight prevalence and trens for children and adolescents. Arch Ped Adolesc Med 149:1085–1091.
8. US Department of Health and Human Services (1996) Physical activity and health: A report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services.
9. Wolf AM, Gortmaker SL, Cheung L (1993) Activity, inactivity, and obesity: racial, ethnic, and age differences among schoolgirls. Am J Publ Health 83: 1625–1627.

BODY MASS CENTER SWAY OF THE PUPILS WITH AND WITHOUT VISUAL IMPAIRMENT

V. Juodžbalienė[1], K. Muckus[1], A. Krisciukaitis[2]
[1]*Lithuanian Academy of Physical Education, Kaunas, Lithuania*
[2]*Kaunas Medical University, Kaunas, Lithuania*

INTRODUCTION

The equilibrium is stabilized using visual, vestibular and proprioceptive information [1,5]. The optimum interaction of visual and somathosensorical impulses guarantees control of the body segments orientation and stability. The stability and control of body segments location and response to environment are disconcerted if lack of visual information appears [4]. The visual information is very important for the control of the equilibrium and estimation of the motion speed of the objects and body segments. The lack of visual information can be compensated by intensification of the proprioception, tactile, vestibular or hearing function if loss of vision or any vision derangements appears. The aim of this study was to establish the influence of the vision derangement degree on the stability indexes of pupils, aged 10–16 years.

METHODS

Totally blind (8 subjects), legally blind (10 subjects) and control group of pupils with normal vision (8 subjects) voluntarily participated in the experiment. The average age of the participants was 12.4±2.3 years. The static posturography method was applied. The serial produced dynamographic platform MΆ-1 and computer equipment analyzing recorded signals were employed in the study. The curves of the changing co-ordinates of the Body Mass Center (BMC) in x (sagital direction) and y (transversal direction) were registered. The posturogram was registered while participants were standing in two postures with opened and closed eyes on the dynamographic platform. The 1st posture — legs closed together and hands let down, 2nd — Romberg posture. The quantity of BMC changes in x and y directions (Δx, Δy) and average of BMC motion velocity (v) were estimated. The spatial histograms showing how much time the BMC appears in certain place of the support were created. The discretization of the signal was 10 ms; the duration of the posturogram registration was 60 s.

RESULTS

The highest and most reliable differences between stability parameters under conditions opened and closed eyes were in 1st posture of pupils with normal vision. The values of all registered parameters of posturogram were reliably higher while standing with closed than with opened eyes. v increased from 9.8±0.9 mm/s to 16.4±2.0 mm/s ($p<0.01$) when sighted pupils eyes were closed. BMC dislocation in x direction increased from 23±2.2 mm to 36±5.8 mm ($p<0.05$) and y direction — from 24±1.6 mm to 33±3.4 mm ($p<0.05$). The differences between stability parameters under conditions opened and closed eyes of the legally blind pupils were lower and statistically unreliable in 1st posture. It is evidently seen in spatial histogram showing the influence of the vision on equilibrium stability (Fig. 1). The absolute values of the stability parameters of legally blind pupils with opened and closed eyes were closer to respective parameters values of the normally sighted pupils with closed eyes. The values of the parameters of totally blind pupils posturogram were closer to parameters of sighted pupils with opened eyes. The amplitude of BMC sway of the normally sighted pupils with opened eyes in 2nd posture was bigger than in 1st posture. The parameters of BMC sway in Romberg posture under condition closed eyes were similar to the 1st posture. The BMC change under condition closed eyes increased insignificantly in x direction from 31±6.4 mm to 32±3.7 mm ($p>0.05$) and y direction from 27±5.0 mm to 33±4.3 mm

(p>0.05), respectively. v difference with opened and closed eyes was also smaller comparing to 1[st] posture but increased reliably (p<0.05). The differences between stability parameters of the legally blind pupils with opened and closed eyes were insignificant and most of them statistically unreliable in Romberg posture. The values of the posturogram parameters of totally blind and normally sighted pupils with opened eyes did not differ significantly.

DISCUSSION

Many authors [3] studying the vision influence on the control of equilibrium asserts that the biggest part of the control of maintaining vertical equilibrium falls on the central vision. The central vision affects the lateral sway more than peripheral vision therefore remarkable lateral sway is noticed if derangement of central vision appears.

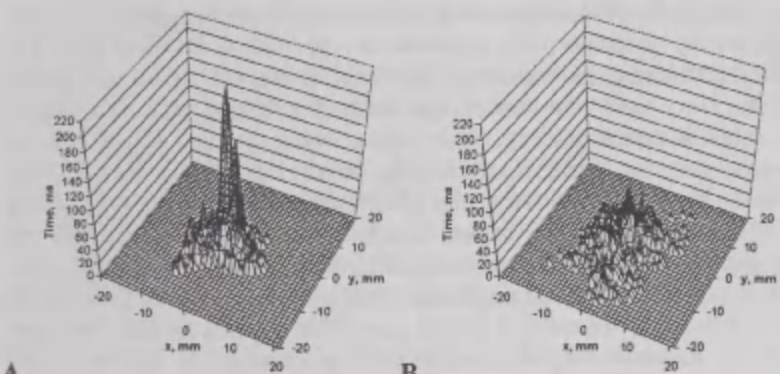


Fig. 1. Investigative G.B. normally sighted. **A** – BMC lateral sway with opened eyes, **B** – BMC lateral sway with closed eyes.

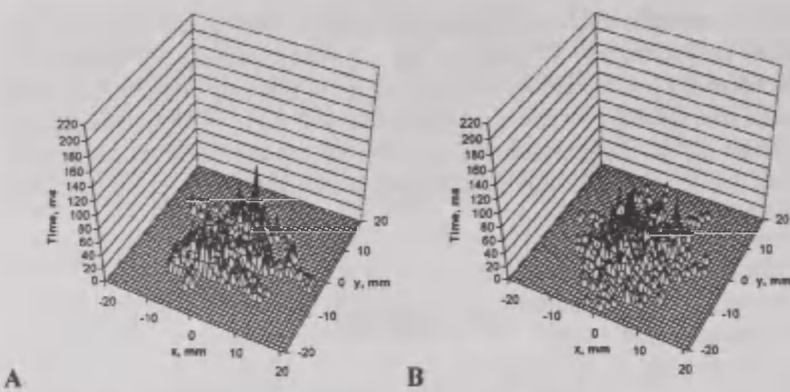


Fig. 2. Investigative L.E. legally blind. **A** – BMC lateral sway with opened eyes, **B** – BMC lateral sway with closed eyes.

The legally blind pupils with opened and closed eyes maintain the stability worse than normally sighted and totally blind pupils in all postures. It can be explained that poor information about the environment, location and orientation of the body segments is received mostly by deranged vision and compensatory proprioceptive reactions are developed insufficiently. The equilibrium stability parameters of the normally sighted pupils with closed eyes are lower than with opened eyes because proprioceptive information only supplies visual information for the normally sighted [2]. It is to be supposed that the equilibrium stability parameters of the legally blind pupils are low because visual acuity affects the equilibrium control directly [4]. The visual acuity and central vision of the legally blind pupils are deranged therefore equilibrium control is disconcerted. It may be concluded, that the totally blind pupils maintain equilibrium better than legally blind pupils with opened and closed eyes. This superiority may be determined by better-developed compensatory proprioceptive and vestibular reactions. The equilibrium stability parameters of the totally blind pupils appear also better than normally sighted pupils with closed eyes. It confirms the existence of the equilibrium compensatory reactions of the blind. The equilibrium stability parameters of the totally blind pupils are worse than normally sighted with opened eyes. It can depend on fact, that proprioceptive impulsation of the blind compensates the deficit of the visual information, but compensatory reactions can not replace the visual information totally.

CONCLUSIONS

1. Totally blind and legally blind pupils with opened eyes maintain equilibrium worse than normally sighted pupil with opened eyes.
2. Normally sighted pupils with closed eyes maintain equilibrium better than legally blind pupils, but worse than totally blind because of the visual information predominance in the control of equilibrium.

ACKNOWLEDGEMENT

Lithuanian State Fund for Science and Education supported the work (Grant Nr.22133, Contract T-561).

REFERENCES

1. Collins JJ, De Luca CJ (1994) The effects of visual input on open loop and closed-loop postural control mechanisms. Exp Brain Res 103: 151–163.
2. Fraiberg S (1977) Insights from the blind. Comparative studies of blind and sighted. New York: Basic Books.
3. Giacomini P, Sorace F, Margini A (1998). Alterations in postural control: the use of spectral analysis in stability measurement. Acta Otorhinolaryngol 18: 83–87.
4. Nougier V (1998) Contribution of central and peripheral vision to the regulation of stance: developmental aspects. Child Psych 68: 202–215.
5. Paulus WM, Straube A (1998) Visual stabilization of posture. Brain 107: 143–163.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

PSYCHOMETRIC MONITORING OF ROWING TRAINING

J. Jürimäe, J. Mäestu, P. Purge, T. Sööt
University of Tartu, Tartu, Estonia

INTRODUCTION

The existence of dose-response relationship has been demonstrated between training volume and mood disturbances [5]. Increases in training volume parallel corresponding elevations in mood disturbances [4]. Mood improvements occur when training volume is decreased [4,5]. Psychometric monitoring of endurance athletes has mostly focused on the relationship between overtraining and mood [5]. The recovery-stress state indicates the extent to which someone is physically and/or mentally stressed as well as whether or not the person is capable of using individual strategies for recovery and which strategies are used [2].

The purpose of the present study was to monitor the relationship between rapidly increased training volume, rowing performance and the recovery-stress state perceived by the Estonian male rowers.

METHODS

Seventeen national level male rowers volunteered to participate in the study (18.6±2.0 yrs; 186.9±5.7 cm; 82.4±6.9 kg). The subjects had trained regularly for the last 4.7±2.2 years. The training period constituted their first training camp on water after winter training period at the prospect of the coming season.

The training during the six-day training period amounted to 19.6±3.8 h, which was equivalent to an average increase in training load by approximately 100% compared with their average weekly training during the preceding four weeks. In total, 12 training sessions were completed during the heavy training period compared to six training sessions during previous four weeks. Eighty five percent was low-intensity endurance training (rowing or running), 5% was high-intensity anaerobic training (rowing) and 10% was resistance training. Rowing performance and recovery-stress state of rowers were assessed before (Test 1) and after (Test 2) the six-day training period. Maximal 2000 metre rowing ergometer test was performed on a wind resistance braked rowing ergometer (Concept II, Morrisville, USA). The Recovery-Stress-Questionnaire for Athletes (RESTQ-Sport) [3] was used to measure the level of current stress of rowers taking recovery-associated activities into consideration [2] before and after the heavy training period. The RESTQ-Sport is constructed in a modular way including 12 scales of the general Recovery-Stress-Questionnaire and additional seven sport-specific scales [2,3]. The RESTQ-Sport consists of 77 items (19 scales with four items each plus one warm-up item) and the 24 hour test-retest reliability has been reported to be above $r=0.79$ [3]. The 24-hour test-retest reliability of the Estonian version of RESTQ-Sport was also relatively high ($r>0.74$; $n=17$). The first seven scales cover different aspects of subjective strain (*General Stress*, *Emotional Stress*, *Social Stress*, *Conflicts/Pressure*, *Fatigue*, *Lack of Energy*, and *Somatic Complaints*) as well as the resulting consequences. *Success* is the only resulting recovery-oriented scale, which is concerned with performance in general but not in a sport-specific context. *Social Relaxation*, *Somatic Relaxation*, *General Well-Being*, and *Sleep* are the basic scales of the recovery area. Sport-specific details of stress (*Injury*, *Emotional Exhaustion*, and *Disturbed Breaks*) and recovery (*Being in Shape*, *Personal Accomplishment*, *Self-Regulation*, and *Self-Efficacy*) are examined in scales 13 to 19 [2,3]. A Likert-type scale is used with values ranging from 0 (never) to 6 (always).

Mean ± standard deviations (SD) were determined. Paired t-tests (two-tailed) were used comparing results from Test 1 to Test 2. Pearson correlation coefficients were calculated between dependent variables and changes in dependent variables during the heavy training period. For all tests, the level of significance was set at 0.05.

RESULTS

2000 metre rowing performance time was significantly increased after the heavy training period (396.9±10.8 vs 406.2±11.9 s; $p<0.05$). The recovery-stress state of rowers changed during the heavy training period. An increase ($p<0.05$) in *Fatigue*, *Somatic Complaints*, and *Fitness/Injury* from stress-related scales, and a decrease ($p<0.05$) in *Success*, *Social Relaxation*, *Sleep Quality*, *Fitness/Being in Shape* and *Self-Efficacy* from recovery-associated activities were observed (Table 1).

Increased training volume (19.6±3.8 h) of rowers was significantly related to the 2000 metre performance time measured in Test 2 ($r=0.59$). Significant relationships were observed between increased training volume, and *Fatigue* ($r=0.49$), *Somatic Complaints* ($r=0.50$) and *Sleep Quality* ($r=-0.58$) scales of the recovery-stress questionnaire at the end of heavy training period.

Table 1. Significant changes in the scales of RESTQ-Sport for athletes after the training period compared to the results obtained before the training period.

RESTQ-Sport Scales	O	N	Example Question	P-value
Fatigue	S	4	I was overtired	0.008
Somatic Complaints	S	4	I felt physically exhausted	0.004
Success	R	4	I was successful in what I did	0.031
Social Relaxation	R	4	I had a good time with my friends	0.026
Sleep Quality	R	4	I fell asleep satisfied and relaxed	0.030
Fitness/Injury	S	4	Parts of my body were aching	0.014
Fitness/Being in Shape	R	4	I was in good condition physically	0.047
Self-Efficacy	R	4	I was convinced that I had trained well	0.049

O, scale orientation; N, number of questions in each scale; S, stress, R, recovery.

DISCUSSION

The RESTQ-Sport for athletes has been used to assess the subjective stress and recovery during training cycles for major competitions in German rowers [2]. Estonian version of the RESTQ-Sport also allowed the psychometric assessment of competitive rowers during rapidly increased training volume in preparation camp when the focus was only on the monotonous low intensity rowing. The results of our study suggested that a dose-response relationship also exists between training volume and the subjective assessment of somatic components of stress and recovery. This is in line with other investigations [2,4], who have found that increases in training volume parallel corresponding increases in mood disturbances and mood improvements occur when training volume is reduced. The lowered levels of *Success*, *Social Relaxation*, *Sleep Quality*, *Fitness/Being in Shape* and *Self Efficacy* from recovery-associated scales demonstrated that emotional, physical and social aspects of recovery were not adequate during this training camp when training volume was rapidly increased. For example, a significant decrease in *Social Relaxation* scale demonstrated a drop in social activities during the heavy training period. However, it should always be considered that recovery is a process to reestablish psychological and physical resources [2]. Athletes should be aware of the importance of the active recovery in training process. This is even more crucial during preparation camps in rowers, when the focus is mostly on monotonous practicing [2]. Adequate recovery during phases of heavy training allows the adaptation of the athlete to stress and prevent from overtraining [5]. The results of the present study demonstrate that the RESTQ-Sport for athletes reflects the extent of different aspects of recovery in addition to stress during monotonous heavy training period in preparatory period of highly trained rowers.

In summary, the monitoring of training adaptation and the adaptation state of an athlete appears to be a very complex task. The results of present study demonstrated performance incompetence by the end of six-day overreaching training period and were interpreted to reflect a state of short-term overreaching. Overreaching was further diagnosed by changes in specific stress and recovery scales of the RESTQ-Sport for athletes.

REFERENCES

1. Jürimäe J, Jürimäe T, Purge P (2001) Plasma testosterone and cortisol responses to prolonged sculling in male competitive rowers. J Sports Sci 19: 893–898.
2. Kellmann M, Günther KD (2000) Changes in stress and recovery in elite rowers during preparation for the Olympic Games. Med Sci Sports Exerc 32: 676–683.
3. Kellmann M, Kallus KW (2000) Der Erholungs-Belastungs-Fragebogen für Sportler (The Recovery-Stress-Questionnaire for Athletes). Frankfurt: Swets and Zeitlinger, pp. 48.
4. Morgan WP, Brown DR, Raglin JS, O'Conner PJ, Ellickson KA (1987) Psychological monitoring of overtraining and staleness. Br J Sports Med 21: 107–114.
5. Raglin JS (1993) Overtraining and staleness: psychometric monitoring of endurance athletes. In: Handbook of Research on Sport Psychology, Singer RB, Murphey M, and Tennant LK (eds). New York: Macmillan, pp. 840–850.
6. Steinacker JM, Lormes W, Lehmann M, Altenburg D (1998) Training of rowers before world championship. Med Sci Sports Exerc 30: 1158–1163.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

VALIDITY OF OPTICAL DEVICE LIPOMETER AND BIOELECTRICAL IMPEDANCE ANALYSIS FOR BODY COMPOSITION ASSESSMENT IN MEN

T. Jürimäe[1], K. Sudi[2], J. Jürimäe[1], D. Payerl[2]
[1]*University of Tartu, Tartu, Estonia*
[2]*Karl-Franzens University, Graz, Austria*

Historically, the "gold standard" for estimating body fatness has been underwater weighing [1]. In the past decade the development of whole body dual-energy X-ray absorptiometry (DXA) has been suggested as a criterion method for measuring body fat % [6]. Bioelectrical impedance analysis (BIA) is a relatively simple, quick, portable and noninvasive method for body composition assessment. Lukaski et al [5] reported that the validity of the BIA method is high. Recently, computerized optical system (LIPOMETER) was developed in order to permit a noninvasive, quick, precise and safe determination of the thickness of subcutaneous adipose tissue (SAT) at specified body sites [7]. Previous results indicate good agreement (r=0.96) between LIPOMETER and total body electrical conductivity (TOBEC) in healthy women and men [8]. The aims of this study were to: (1) validate different SAT layers measured with LIPOMETER by body composition assessment with DXA; and (2) compare BIA results with DXA and SAT-layers measured with LIPOMETER.

METHODS

Subjects of this study were 21 males (18–60 yrs) volunteers with a wide range of body height, mass and body mass index. The height (Martin metal anthropometer) and body mass (A & D Instruments Ltd, UK) of the participants were measured to the nearest 0.1 cm and 0.05 kg, respectively, and BMI (kg/m^2) was calculated.

As a criterion method, body composition was measured using DXA. Scans of the whole body were performed on each of the subject using Lunar DPX-IQ scanner (Lunar Corporation, USA) [3]. Bioelectrical impedance was measured with a multiple-frequency impedance device (Multiscan 5000, Bodystat Ltd, UK). Body fat % was calculated using the equations of Lukaski et al. [5], Chumlea et al. [2] and Segal et al. [9]. Measurements of SAT layers were performed by means of the optical device LIPOMETER [7]. Measurement for the thickness of SAT-layers in mm were performed at 15 original body sites (neck, triceps, biceps, upper back, front chest, lateral chest, upper abdomen, lower abdomen, lower back, hip, front thigh, lateral thigh, rear thigh, inner thigh, calf) on the right side of the body in standing position [8]. The sums of 15 SAT-layers were calculated.

Standard statistical methods were used to calculate mean ($\bar{X}$) and standard deviation (±SD). Pearson correlation coefficients were used to determine the relationships between dependent variables. The effect of different single SAT-layers to the body fat % measured by DXA was analysed by stepwise multiple regression analysis. Significance was set at $p<0.05$.

RESULTS AND DISCUSSION

The main anthropometric and body composition characteristics measured by different methods are presented in Table 1.

Correlation analysis indicated that the body fat % measured by DXA significantly correlated with body fat % measured by different BIA equations: by Lukaski et al. [5] – r=0.70; by Chumlea et al. [2] – r=0.65; and by Segal et al. [9] – r=0.94. Accordingly, the validity was higher using Segal et al. [9] equation in our subjcts. However, the body fat % measured by three different methods correlated significantly each other (r=0.65 to r=0.99). The sum of SAT-layers correlated significantly with body fat % measured by three different BIA methods (r=0.71 to r=0.75).

Table 1. Anthropometric and body composition values in males (n=21).

	$\bar{X}$ ± SD
Age (yrs)	34.6±16.3
Height (cm)	183.8±7.2
Weight (kg)	83.7±11.4
BMI (kg /m^2)	24.8±3.0
Body fat %	
DXA	17.2±6.9
BIA, Lukaski et al [5]	12.9±7.2
BIA, Chumlea et al [2]	11.3±7.1
BIA, Segal et al [9]	18.7±6.0
Sum of SAT-layers by LIPOMETER (mm)	68.1±37.9

The relationship between body fat % measured by DXA and the sum of SAT-layers was also high (r=0.88; $p<0.05$), but slightly lower compared to previous results where LIPOMETER results were validated with TOBEC methodology (r=0.96) [8]. Stepwise multiple regression analysis were body fat % measured by DXA method was dependent variable and all 15 SAT-layers were independent variables indicated that only two SAT-layers (triceps, hip) significantly characterized of the total variance 82.74 % (R^2x100) (F=38.34, $p<0.00000$ and standard error of estimate – 3.95).

In summary, the results of this study indicate that the lipometer (sum of SAT-layers) is highly valid method for the measurement of subcutaneous adipose tissue in males. From the used BIA equations, only the equation presented by Segal et al. [9] was also highly valid for the assessment of body composition in males.

REFERENCES

1. Brozek J, Grande F, Anderson JT, Keys A (1963) Densitometric analysis of body composition: revision of some quantitative assumptions. Ann NY Acad Sci 110: 113–140.

2. Chumlea WC, Baumgartner RN, Roche AF (1988) The use of specific resistivity to estimate fat-free mass from segmental body measures of bioelectrical impedance. Am J Clin Nutr 48: 7–15.
3. De Lorenzo A, Andreoli A, Candeloro N (1997) Within-subject variability in body composition using dual energy X-ray absorptiometry. Clin Physiol 17: 383–388.
4. Heymsfield SB, Wang ZM, Visser M, Gallagher D, Pierson RN (1996) Techniques used in the measurement of body composition: an overview with emphasis on bioelectrical impedance analysis. Am J Clin Nutr 64: 478S–484S.
5. Lukaski H, Bolonchuk WW, Hall CB, Siders WA (1986) Validation of tetrapolar bioelectrical inpedance method to assess human body composition. J Appl Physiol 60: 1327–1332.
6. Mazess RB, Barden HS, Bisek JP, Hanson J (1990) Dual-energy X-ray absorptiometry for total body and regional bone-mineral and soft-tissue composition. Am J Clin Nutr 51: 1106–1112.
7. Möller R, Tafeit E, Smolle KH, Kullnig P (1994) "Lipometer": determining the thickness of a subcutaneous fatty layer. Biosens Bioelectron 9: VIII–XVI.
8. Möller R, Tafeit E, Smolle KH, Pieber TR, Ipsiroglu O, Duesse M, Huemer C, Sudi K, Reibnegger G (2000) Estimating percentage total body fat and determining subcutaneous adipose tissue distribution with a new noninvasive optical device Lipometer. Am J Hum Biol 12: 221–230.
9. Segal KR, Van Loan M, Fitzgerald PI, Hodgdon JA, Van Itallie TB (1988) Lean body mass estimation by bioelectrical impedance analysis: a four-site cross-validation study. Am J Clin Nutr 47: 7–14.

THE EFFECT OF AFTER-SCHOOL SPORT PARTICIPATION WITH VARIOUS INTENSITY ON INTRINSIC MOTIVATION AND PERCEIVED LEARNING ENVIRONMENT IN PHYSICAL EDUCATION

A. Koka, V. Hein
University of Tartu, Tartu, Estonia

INTRODUCTION

The intrinsic motive related to participation in physical education have received a lot of attention from sport psychologist. Majority of research in this area has been based predominately on self-determination theory [3,9]. According to self-determination theory, the individuals perceptions of competence have a positive impact on his or her motivation. Results of the research of Koka and Hein [5] indicated that the teacher's positive general feedback given in response to students performance resulted in increased perceptions of competence and corresponding increase in intrinsic motivation. Nowadays youngsters have an opportunities to become familiar with sport activities in setting other than school such as sport clubs. Therefore some are more familiar with the content of physical education lesson. On the other hand, for some students who have not played in a sport, participating in physical education may present a great challenge of their self-esteem. Such differences among students may be reflected in their motivation and perceptions in physical education. Several studies [2,4,6] have revealed that students with sport experiences reported higher intrinsic motivation toward physical education than students without sport experiences. However, there is limited empirical evidence regarding the effect of sport participation with various intensity (how many times a week one participate in sport) on motivation and perceptions of learning environment in physical education at school. The purpose of this study was to compare students who did not participate in sport with students who participated in sport with various intensity on several variables such as intrinsic motivation, perceived learning environment and perceived teachers' feedback in physical education.

METHODS

The participants were 783 secondary school students (375 boys and 408 girls) at the age of 12–15 years from five schools from the city of Tartu, Estonia. To measure intrinsic motivation in physical education the Intrinsic Motivation Inventory (IMI) [7] was used. Physical Education Learning Environment Scale (PELES) [8] with two dimensions of Perceived challenge and Perceived threat to sense of self was used to measure perceived learning environment in physical education. Koka and Hein [5] have reported results supporting the structural validity of the Estonian version of the inventory. To measure perceived teacher's feedback the Perceptions of the Teacher's Feedback (PTF) [5] with three dimensions of Perceived positive specific feedback, Perceived positive general feedback and Perceived knowledge of performance was used. To judge participation in sports students were asked to indicate whether they trained in a sport outside of school hours and how many times a week. Students were divided then into three groups: students who did not participate in a sport after school; students participating in a sport up to three times a week; and students participating in a sport more than three times a week.

RESULTS

MANOVA was performed with the three groups of students (not in sport = Group 1; in sport up to three times a week = Group 2; and in sport more than three times a week = Group 3) as the independent variables and ratings on Intrinsic motivation, dimensions of Perceived learning environment, and dimensions of Perceived teachers feedback as dependent variables. There was an overall multivariate effect, Wilks's lambda = .91, Raos's

R (12, 1382) = 5.30, p<0.0001. Subsequent Post hoc Tukey HSD for unequal N multiple comparisons tests revealed that Group 2 and Group 3 students scored significantly higher on Intrinsic motivation than Group 1 (Fig. 1A). Furthermore, same groups of students (Group 2 and Group 3) perceived physical education to be significantly less threatening to their self esteem than Group 1 students (higher score represents lower perception of perceived threat) (Fig. 1A). Finally, Group 3 students perceived significantly higher than Group 1 students that teachers gives them positive general feedback (Fig. IB).

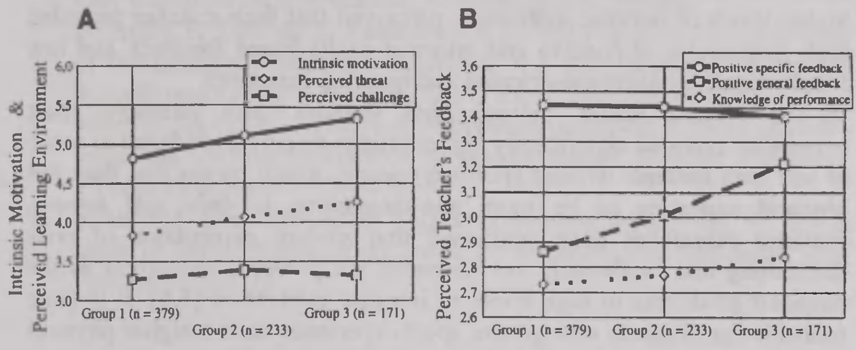


Fig. 1. Differences in mean scores regarding the effect of sport participation with various intensity on Intrinsic motivation and Perceived learning environment (A), and Perceived teacher's feedback (B).

DISCUSSION

The results of the present study indicated that students who take part in sport more than three times a week reported significantly higher ratings on intrinsic motivation than students without sport experience. Also they were higher on intrinsic motivation in comparison with students who participated in sport up to three times a week. Parallel can be drawn with previous works in this domain [2,4,6], although these studies only focused on the period of sport participation. Authors of these studies argued that physical education either favours those students who are familiar with sports or these are the students who are motivated in the first place. Probably this is the case with Estonian students in current study.

Teacher's feedback, particularly positive general feedback, has been shown to be a significant predictor of students' intrinsic motivation and thereby influences positively their attitudes towards participation in physical education [5]. In the present study, students with more intensive sport experience perceived significantly higher that teachers gives them positive general feedback than students with limited sport experience. It seems that higher motivation level and general positive attitude toward school physical education lets them to perceive their teacher's behavior friendlier. It is consistent with previous study [1], found that athletes with higher levels of intrinsic motivation perceived that their coaches provided high frequencies of positive and informationally based feedback and low frequencies of punishment-oriented and ignoring behaviors.

The present results indicate that students with intensive sport experience reported significantly higher ratings on perceived threat to sense of self than students without sport experience, which means that they felt physical education to be more non-threatening to their self esteem. Previous researches have confirmed that student perceptions of non-threatening and challenging environments are powerful constructs as the strongest predictors of high levels of intrinsic motivation [5,8]. It is quite probable that students with greater sport experience have a higher physical ability and tasks in physical education classes for them are more appropriate than for students with limited sport experience. Therefore, it is understandable that students with limited sport experience might feel physical education to be more threatening to their self esteem. This is also consistent with literature [3,9].

REFERENCES

1. Amorose AJ, Horn TS (2000) Intrinsic motivation: Relationships with collegiate athletes' gender, scholarship status, and perceptions of their coaches' behavior. J Sport Exerc Psychol 22: 63–84.
2. Anderssen N. (1993) Perception of physical education classes among young adolescents: do physical education classes provide equal opportunities to all students. Health Educ Res 8: 167–179.

3. Deci EL, Ryan RM (1985) Intrinsic motivation and self-determination in human behavior. New York: Plenum Press.
4. Goudas M, Dermitzaki I, Bagiatis K (2001) Motivation in physical education is correlated with participation in sport after school. Psychol Rep 88: 491–496.
5. Koka A, Hein V (2002) Perceptions of teacher's feedback and learning environment as predictors of intrinsic motivation in physical education. Psychol Sport Exerc (In Press).
6. Koka A, Hein V (2002) An impact of sport participation after school on intrinsic motivation and perceived learning environment in secondary school physical education. Kinesiology (Accepted).
7. McAuley E, Duncan T, Tammen VV (1989) Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: A confirmatory factor analysis. Res Q Exerc Sport 60: 48–58.
8. Mitchell SA (1996) Relationships between perceived learning environment and intrinsic motivation in middle school physical education. J Teach Phys Educ 15: 369–383.
9. Ryan RM, Deci EL (2000) Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am Psychol 55: 68–78.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

EQUILIBRIUM STABILITY OF THE PISTOL SHOOTERS

A. Krisciukaitis[1], V. Masalskyte[2], K. Muckus[2]
[1]*Kaunas University of Medicine, Kaunas, Lithuania*
[2]*Lithuanian Academy of Physical Education, Kaunas, Lithuania*

INTRODUCTION

The pistol shooters result depends on the physical abilities of the person, technical skills and other factors influencing the overall performance. Sophisticated shooter's training process should be oriented into improvement of hand technique; right posture and physical ability of subject to keep his body in equilibrium. The last feature according to Alto et al. [1] is one of the factors mostly influencing highest performance of the shooter. Human body is kept in equilibrium by several physiological mechanisms what use information obtained by vestibular sensors and the vision. Peripheral and especially central vision has substatious impact on body equilibrium. We investigated the vision information influence on properties of body keeping in equilibrium process and evaluated the correlation of these properties with overall performance of the shooter. Our aim was to reveal the informative estimates of person's ability to keep the body in equilibrium, related with shooter's result. Such estimates could be used for training process control and selection of the athletes.

METHODS

Dynamographic test system MA-1 [3] was used to register body mass center (BMC) position and store the results into computer memory. The tested sportsmen were beginners, advanced and elite National Category Master sportsmen. Their skills evaluated by shooting results were nearly evenly distributed between 175 and 190 points. The test protocol was standing still in 4 postures (1 minute in each). I posture — the foots are compact, the hands let down; II — the foots are spread into shoulders width, the hands let down; III — the shooter's position without pistol; IV — the shooters position with pistol. The tests in the same postures were performed two times: with open eyes and closed eyes. Electrical signals reflecting BMC sway in transversal and sagital directions were digitally processed estimating their frequency parameters and calculating the trace length of body mass center shift during one minute. The special noise-insensitive procedure including wavelet transform for signal decomposition was used to estimate the energy of oscillations in selected frequency ranges of the signal.

RESULTS

Typical electrical signal reflecting BMC position shifts in one direction during open eyes test is shown in Fig.1A. Power spectrum of the signal usually covers frequency range up to 5 Hz. Amplitude of oscillations of BMC signal of advanced shooters was less then the beginner’s one standing in postures III and IV (usual shooter postures) in nearly all range of frequencies. The trace length of BMC position shift during 1-minute test of advanced shooters was also significantly less then the beginner’s one. Comparison of BMC sway during closed-eyes tests versus open-eyes tests revealed the increase of energy of oscillations in frequency range between 0.7 and 1 Hz. Typical BMC position signal of the same tested person in the same posture and direction as in Fig.1A, but during closed-eyes test is shown in Fig.1B. The averaged difference between power spectrum functions of BMC sway during closed-eyes and open-eyes tests is presented in Fig.1C. Difference between BMC sway oscillation energy in this special frequency range between 0.7 and 1 Hz during closed – eyes and open – eyes tests showed a good correlation with overall performance of the shooter. We calculated the correlation of overall performance of the shooters with all possible parameters of BMC sway. The best correlation ($r=-0.99$) was found with the difference between energy of oscillations during closed – eyes and open — eyes tests in sagital direction of posture I.

The five best correlations showing parameters and their correlation coefficient values are presented in Table 1. All these parameters show linear dependence with shooters' results. Three of these parameters in normalized values are plotted against shooters' results in Fig.2. The linear regression lines with model equations and residuals are presented in the same figure 2. Difference between BMC sway oscillation energy in frequency range between 0.7 and 1 Hz during closed – eyes and open – eyes tests have the steepest regression line with comparatively acceptable value of residuals. That for this parameter could be used as informative estimate of person's ability to keep the body in equilibrium.

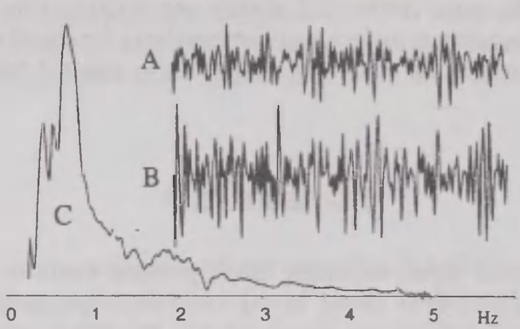


Fig 1. BGCP signal during open-eyes test (A), closed-eyes test (B) and difference between power spectrum functions of both tests (C).

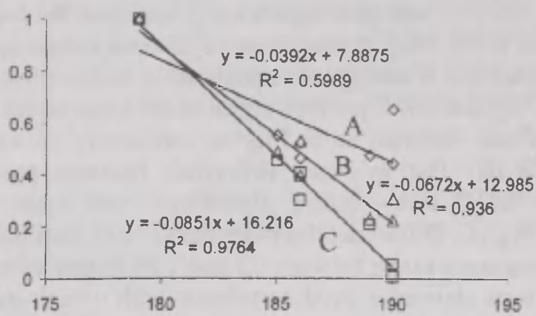


Fig 2. Dependency of trace length of body mass center position (A), sagital oscillations energy (0.7-1Hz) in posture I (B) and difference between sagital oscillations energy (0.7-1Hz) of closed-eyes and open-eyes tests in posture I (C) from shooters result.

Table 1. Correlations with shooters' results

Parametre	Correlation coeff.
Dif. Sagital amp. Closed-Open 0.7–1Hz Posture I	–0.99
Sagital amp. Open 0.7–1Hz Posture I	–0.97
Perpend. Amp. Closed 0.7–1Hz Posture III	–0.97
Dif. Sagital amp. Closed-Open 1–2 Hz Posture I	–0.96
Sagital amp. Open 1-2Hz Posture II	–0.95
Trace Lgth. Open Posture IV	–0.95

DISCUSSION

Subject's ability to keep his body in equilibrium as a special feature of elite class shooters has already been described [1,2]. Body equilibrium control mechanism is based on processing of vestibular, proprioreceptional and visual information. Several authors show the visual information as one of the main parameters in this process. However, it is also possible to keep the body in equilibrium without visual information at all (e.g., standing with closed eyes). Shooter must occupy nearly all his visual information processing for aiming at the target. It is possible that special training process can foster the ability of subject to keep his body in equilibrium with minimal use of visual information. Estimate of visual information impact on total equilibrium keeping process from our results is in high correlation with shooters skills evaluated by shooting result (points). It correlates with the results of other authors. So improvement of training process could be achieved using this estimate for controlling of training process. Also this estimate could help to reveal 'weak points' in shooters skill. There were three subjects in our tests who showed comparatively good condition evaluated by equilibrium keeping estimates, however their shooting results were poor (data not shown). Alternative tests revealed substantious lack in hand technique skills or irregular posture during shooting.

CONCLUSIONS

1. Difference between body mass center position oscillations energy in frequency range between 0.7 and 1 Hz during closed — eyes and open — eyes tests could be sensitive and reliable estimate used for the evaluation of shooters skill during training process and selection of athletes.
2. Special training process can foster the ability of shooter to keep his body in equilibrium with minimal use of visual information, which should be used only for aiming.

ACKNOLEDGEMENT

The work was supported by Lithuanian State Fund for Science and Education (Grant Nr.22133, Contract T-561).

REFERENCES

1. Aalto H, Pyykko I, Ilmarinen R, Kahkonen E, Starck J (1990). Postural stability in shooters. ORL J Otorhinolaryngol Relat Spec 52: 232-238.
2. Era P, Konttinen N, Mehto P, Saarela P, Lyytinen H (1996). Postural stability and skilled performance – a study on top-level and naive rifle shooters. J Biomech 29: 301–306.
3. Muckus K, Danisevicius J, Krisciukaitis A (1999) Computer controlled dynamographic system for investigation of complex psychomotoric reaction. Education, Physical Training and Sport. Selected Papers 1: 51–56.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

ANTHROPOMETRICAL CHARACTERISTICS AND THE FUNCTIONAL STATE OF MUSCULOSKELETAL SYSTEM IN RHYTHM GYMNASTS

T. Kums, A. Vain
University of Tartu, Tartu, Estonia

INTRODUCTION

The demands existing at the present time for top-level athletes force them to intensive training with applying considerable training loads. This situation of athletes increases the probability of reaching the state of over-training, which has clearly expressed clinical symptoms. One of them is the musculo-skeletal system (MSS) overloading, in result of which the number of MSS injuries increases noticeably. Several researchers [4,9,10] state that the frequency of MSS injuries appearing and deepening depends on the increase of body mass and height of athletes. Kibler et al. [2] point out that the decrease of the elasticity of muscle binding apparatus, resulting from overtraining, is one of the major factors in the MSS injuries development mechanism. Taimela et al. [7] established that the lengthening of lower limbs, which results in higher position of body mass centre, is a cause of MSS overload injuries, as the joints must bear higher loads. Loads deform the human MSS, ¾ of the total deformation is applied to the vertebral column, ¼ to the lower limbs. So in comparison to the other MSS segments, the vertebral column is much more elastic element of MSS. On basis of changes in connective tissue structures of vertebral column we can acquire indirect information concerning the functional state of MSS. Changes taking place in the MSS in result of loading are reflected in the dynamics of body height. This parameter allows indirect estimation of the functional state of MSS, including its ability to resist to applied loads [1].

The aim of the present study was to investigate the influence of body height and mass, also the elasticity of vertebral column connective tissue structures on the functional state of the MSS of rhythm gymnasts.

METHODS

The group of subjects involved in the four-year longitudinal monitoring program, performed in the time period 1999–2002 included 32 advanced gymnasts going in for rhythm gymnastics (age 13.2±2.1 years, height 150.7±3.2 cm, body mass 36.4±2.6 kg). The training hours took place on six days every week and lasted 2–3 hours. The gymnasts had gone in for rhythm gymnastics for 6–10 years, total number of performed observations was n=691.

The parameters were determined, which indirectly reflect the functional state of the MSS and its resistance to the training loads. The height change was determined using the Martin anthropometer in supine and upright position (with accuracy ±0.5 mm) immediately before and after applying training loads. For each subject the arithmetical mean of the observation cycle L ksk (in mm) was calculated. Before applying training loads also the subject's height in sitting position was measured (Martin anthropometer), also side-bending of the trunk, to measure the extent of lateral flexion of the thoracic and lumbar spine, with accuracy of ±0.5cm [5], the elasticity of vertebral column connective tissue structures was determined indirectly, using the method by Schoberth [6]. The index of body mass BMI = mass/height (kg/m^2) and the index of body stiffness C = weight/ (l [N/m] were calculated. The subjects were divided into two groups on basis of the mean characteristics of their MSS. In the first group were included the subjects with high resistance to training loads (n=16, n=350 observations, L ksk = 13.5±0.9 mm), in the second group – with low resistance to training loads (n=16, n=341 observations, L ksk 6.1±0.7 mm). The results of observations are presented in Table 1.

The differences are statistically significant according to the ANOVA one-dimensional comparative analysis Fischer criterion.

RESULTS AND DISCUSSION

The subjects with high resistance to training loads (the rhythm gymnasts of the 1st group) had higher BMI values than the gymnasts of the 2nd group ($p<0.002$). The body stiffness index of the gymnasts of the 2nd group is noticeably higher in comparison with the 1st group ($p<0.005$) and the results of the Schoberth test demonstrated that the characteristics of the I and II group reflecting the elasticity of vertebral column connective tissue structures differ significantly ($p<0.02$) (Table 1). The Schoberth test results in the II group were all lower than the norm value (10 cm). In this group 7 girls during the 4 years of observation had pains in the back and spasms in the lumbar region.

Table 1. Comparison of rhythm gymnasts with high and low functionality level of musculo-skeletal system.

	GROUP I MSS high functionality level x±SD n=350	GROUP IIMSS low functionality level x±SD n=341	p
Age (yrs)	13.4±2.1	13.0±2.2	NS
Body mass (kg)	37.24±4.46.	35.95±3.82	NS
Height upright (mm)	1502.4±57.8	1517.9±48.3	NS
Height supine (mm)	1517.3±57.5	1521.8±49.9	NS
Lksk (mm)	13.5±0.9	6.1±0.7	<0.00003
Height sitting (cm)	78.7±6.1	78.9±5.3	NS
BMI (kg/m^2) (body mass index)	16.17±0.74	15.45±0.63	<0.002
Side-bending of the trunk (cm)	28.93±4.08	29.26±3.74	NS
C (N/m) (body stiffness index)	39.97±10.69	97.41±25.23	<0.005
Schoberth test (cm)	11.47±0.64	9.76±0.49	<0.02

The study has shown that the resistance index of MSS — L ksk — is closely related with BMI ($r=0.63$, $p<0.0001$) so depends on the body stoutness. The shorter and heavier a rhythm gymnast, the stronger the resistance to loading of her MSS. The correlation of L ksk with body mass $r=0.58$ ($p<0.0001$), with height in standing position $r=-0.59$ and with height in supine position $r=-0.66$ ($p<0.0001$).

The real situation is completely different, as gymnast is not interested in increasing her body mass. This statement is affirmed by the negative correlation $r = -0.81$ ($p<0.0001$) between the body mass and height.

The BMI increase influences positively the result of Schoberth test $r=0.17$ ($p<0.05$). The index L ksk is also correlated with Schoberth test $r=0.33$ ($p<0.007$) and with side bending of the trunk $r=0.47$ ($p<0.0001$). The given facts seem to demonstrate that the value of L ksk depends on the elasticity of vertebral column connective tissue structures, so the better the elasticity properties of MSS, the higher its ability to resist applied loads.

We can conclude that the better potential abilities of MSS to resist extensive training loads have relatively shorter gymnasts with greater body mass, lower body stiffness and good elasticity properties of vertebral column connective tissue structures.

REFERENCES

1. Corlett E, Eklund J, Reilly T, Troup J (1987) Assessment of workload from measurement of stature. Appl Ergon 18: 65–71.
2. Kibler W, Queen C, Uhl T (1988) Fitness evaluations and fitness findings in competitive junior tennis players. Clin Sports Med 7: 403–416.
3. Laurent G, Sparrow M, Bates P. Milvard D (1978) Collagen content and turnover in cardiac and skeletal muscles of the adult fowl and the changes during stretch-induced growth. Biochem J 176: 419–427.
4. Oja P, Tuxworth B (1995) Eurofit for adults. Assessment of health-related fitness. Tampere, Finland, pp. 59–60.
5. Schoberth H (1972) Die Leistungsprüfungen der Bevegungsorgane. Urban& Schwarzenberg, München- Berlin-Wien.
6. Taimela S, Kujula U, Osterman K (1990) Intrinsic risc factors and athletic injuries. Sports Med 9: 205–215.
7. Vain A (1981) Dynamics of the deformations of the vertebral column and foot of gymnasts. Biomechanics VII -B PWN — Polish Scientific Publishers. Warszawa, pp.566–570.
8. Valliant P (1981) Personality and injury in competitive runners. Perc Mot Skills 53: 251–253.
9. Watson A (1981) Factors predisposing to sports injury in school boy rugby players. J Sports Med Phys Fit 21: 417–422.

SCIENTIFIC DEVELOPMENT AND EVALUATION OF THE POLAR FITNESS TEST™

R. Laukkanen [1], H. Kinnunen [2], P. Virtanen [2]
[1]*Polar Electro Oy, Kempele, University of Oulu, Oulu, Finland*
[2]*Polar Electro Oy, Kempele, Finland*

DEVELOPMENT OF THE TEST

The Polar Fitness Test™ resulting on OwnIndex™ (in Polar M-series heart rate monitors M51 and M52) or $OwnIndex_S$((in Polar S-series heart rate monitors) predicts maximal aerobic power (maximal oxygen uptake, VO_{2max}). The test has been developed using artificial neural network calculation, which is a widely used method in signal processing.

In the test development study, 305 laboratory fitness measurements of 15–65-year-old healthy men and women were performed [6,7]. None of the subjects had any medication. Maximal oxygen uptake was measured with an ergospirometer (Medikro M 909, Kuopio, Finland)) during graded maximal cycle ergometer (Tunturi EL 400, Turku Finland) tests. The fact that each subject reached his or her maximal aerobic power was checked using three criteria: no increase in VO_2 despite load increase, respiratory quotient > 1.1 and blood lactate > 8 mmol/l. Before maximal stress test at least 250 R-R intervals (5 minutes) were recorded from each subject at complete rest in a laying position using Polar R-R Recorder™ (Polar Electro Oy, Kempele, Finland). Measurement errors were removed from R-R intervals using both automatic (Hearts software, Heart Signals Co, Kempele, Finland) and manual methods (visual inspection). Development of the VO_{2max} prediction in the neural network was done in two phases:

firstly 25 subjects were randomly selected as testing (validation) samples. After that the rest of the 305 subjects were used for the teaching of the network. In addition to heart rate and heart rate variability; gender, age and height were used as predictive variables in the neural network analysis. Body weight was used for the calculation of relative VO_{2max} (ml/min/kg).

Correlation coefficient between the laboratory measured VO_{2max} and the artificial neural network prediction was 0.97 and the mean error in the VO_{2max} prediction was 6.5%. The measured maximal aerobic power values in the data varied between 1–6 l/min (25-60 ml/min/kg). In 95% of the cases in the teaching data and in 60 % of the cases in the validation data, the error in the VO_{2max} prediction was less than 0.5 l/min. The mean error of the prediction is good compared to any other predictive tests of maximal aerobic power. Further development of the Polar Fitness Test™ was conducted based on the development study, which was described above. At this stage 119 fitness measurements of healthy American men and women, whose maximal aerobic power was measured in a maximal graded treadmill exercise test, were included in the final development of the neural network. Thus the number of subjects used in the final stage was 424, 381 of which were randomly selected for the teaching of the network and 43 for the validation [2]. The artificial neural network was modified into Polar Fitness Test™.

Polar Fitness Test™ was further developed to result OwnIndex_S, an advanced modification of OwnIndex. In the test development study, 450 laboratory fitness measurements of 15–65-year-old healthy men and women were performed. Correlation coefficient between the laboratory measured VO_{2max} and OwnIndex_S prediction in the data was 0.96 and the mean error in the prediction was 8.2% (3.7 ml/kg/min). In 95% of the cases the error in the prediction was less than 9.4 ml/kg/min. Thus, the accuracy of the OwnIndex_S can be considered good. OwnIndex_S was further validated in studies [3,5] on trained subjects. It was shown that the VO_{2max} prediction associated reasonably highly with VO_{2max} measured in the laboratory in both men and women.

POLAR FITNESS TEST (IN PRACTICE)

Polar Fitness Test™ predicts a person's aerobic fitness from the resting heart rate, heart rate variability, gender, age, height, body weight and self-assessment of the level of long-term physical activity. Polar Fitness Test™

fits best to the follow-up of long-term changes in aerobic fitness. To obtain the measures for heart rate and heart rate variability, 255 heart beats (3–5 min) are measured during the test. In M-series heart rate monitors, physical activity is assessed using a three-level scale (low/middle/high) and in S-series heart rate monitors using a four-level scale (low/middle/high/top). The scale has been modified from NASA/JSC physical activity scale [4] used also in a non-exercise test for maximal aerobic power prediction [1]. The physical activity score should remain the same, if a person's regular exercise habits have not changed during the previous 6 months. It is important to minimize the disturbing effects and standardize the testing conditions in order to achieve accurate and reliable results. However, there is no need to control the effects of breathing to the normal variation of heart rate and heart rate variability during the test. Eating a heavy meal or smoking 2–3 hours prior to the testing should be avoided. Unusually heavy physical effort as well as alcoholic beverages or pharmacological stimulants should be avoided on the test day and the day before.

VALIDITY AND RELIABILITY OF THE TEST

Polar Fitness Test™ has been validated in a study, where 52 healthy 20–60-year-old men were measured before and after an 8-week exercise training [2]. Fifteen men were in the control group. Before the training period the mean error in VO_{2max} prediction by Polar Fitness Test™ was 2.2% and after the training –0.7% compared to the laboratory measurement of maximal aerobic power. The mean deviation in the prediction before and after the training was 4–5 ml/min/kg in all groups. Because this is less than standard deviation of the mean VO_{2max} values within an age group (5–7 ml/min/kg), the validity of Polar Fitness Test™ can be considered good. In this study Polar Fitness Test™ was also validated as a measure of fitness change. The effect of the exercise training was on the average 4.1 ml/min/kg (10 %) when measured in the laboratory. Polar Fitness Test™ predicted this change to be 2.4 ml/min/kg (6 %) on an average. The test thus detected the direction of the change correctly but slightly underestimated the change. The mean deviation in the estimated change of aerobic power was 4.5 ml/min/kg.

The reliability of Polar Fitness Test™ in consecutive tests for the same individual is good. When 11 subjects repeated the test in the morning, in the middle of the day and in the evening during 8 days, in both sitting and laying positions, the average individual standard deviation of the consecutive test results was less than 8 % from the individual mean value. The standard deviations calculated separately for each time of the day were smaller than the standard deviation of all results (Kinnunen et al unpublished). This indicates that the test can be conducted at any time of the day but it should always be repeated at about the same time.

REFERENCES

1. Jackson, Blair, Mahar, Wier, Ross, Stuteville (1990) Prediction of functional aerobic capacity without exercise testing. Med. Sci. Sports Exerc 22: 863–870.
2. Kinnunen, Hautala, Mäkikallio, Tulppo, Nissilä (2000) Artificial neural network in predicting maximal aerobic power. Med. Sci. Sports Exerc 32: 15–35.
3. Peltola, Hannula, Held, Kinnunen, Nissilä, Laukkanen, Marti (2000) Validity of Polar Fitness Test based on heart rate variability in assessing VO_{2max} in trained individuals. Proceedings of 5th Annual Congress of ECSS, Jyväskylä, Finland, 19–23 July, p 565.
4. Ross, Jackson (1990) Exercise concepts, calculations, and computer applications. Carmel, IN, Benchmark Press, pp 95–103,109.
5. Tshopp, Peltola, Held, Kinnunen, Hannula, Laukkanen, Marti (2000) Traditionelle und neue Ansätze zür Schätzung der maximalen Sauerstoffaufnahme in Ruhe. Schweizerische Zeitschrift für Sportmedizin und Sporttraumatologie 48: 58–63.
6. Väinämö, Tulppo, Mäkikallio, Röning. An atrificial neural network for human aerobic fitness approximation. Proceedings of International Conference on Neural Networks (ICNN), Washington DC, June 3–6, 1996, pp 1939–1949.
7. Väinämö, Tulppo, Mäkikallio, Röning (1998) A neuro-fuzzy approach to aerobic fitness classification: a multistucture solution to the context-sentive feature selection problem. Proceedings of ICNN, Anchorage.

REPRODUCIBILITY OF SKINFOLD THICKNESS MEASUREMENTS IN CHILDREN (LONGITUDINAL STUDY)

A. Leppik, T. Jürimäe, T. Sööt
University of Tartu, Tartu, Estonia

INTRODUCTION

The measurement of subcutaneous adipose tissue with skinfold caliper is a routine laboratory and field technique used in the assessment of body composition. Skinfolds represent the measured thickness of a double fold of skin and compressed adipose tissue, and are performed with the use of skinfold calipers, which exert a constant pressure of 10 g/mm^2 [8]. The precision of a measurement of skinfold thickness depends upon the skill of the anthropometrist and the measurement site. In general a precision within 5 % can be attained easily by a properly trained and experienced individual [1]. Normally, interexaminer errors are generally lower than intraexaminer errors for both sets of variables [3]. As a rule, the intraexaminer reliability is higher than r=0.90 both in children [5] and adults [2], or slightly lower [7]. Standardised methodology, including positioning of the instrument and the subject, a well-trained data collector, and practicity until results are constant can increase the reproducibility.

The purpose of this study was to assess the reliability of skinfold thickness measurements on the same children during consecutive three years once per year measured by one investigator.

METHODS

In total, 39 (21 boys and 18 girls) initially 9–12 year-old-children were studied three times with interval of one year (in March-April). Measurements were performed in the morning at school. Nine skinfolds (triceps, subscapular, biceps, iliac crest, supraspinale, abdominal, front thigh, medial calf, mid-axilla) were measured at the right side of the body. Three series of anthropometric measurements were taken and the mean result were used. The measurements were repeated after one-week at the same time on the identical conditions. Skinfold thiknesses were measured using the same Holtain (Crymmych, UK) skinfold caliper during the three year period. All skinfolds were measured according to the protocol recommended by the International Society for Advancement of Kinanthropometry (ISAK) [6]. Skinfold thickness measurements were taken by a trained anthropometrist who had ISAK Level 1 sertificate. Standard statistical methods were used to calculate Spearman correlation coefficients between the first and second measurements.

RESULTS AND DISCUSSION

The reproducibility coefficients during the first, second and third measurement session are presented in Table 1.

Our results indicate that the reproducibility in all three measurement series was very high with correlation coefficients higher than r=0.90, (except in medial calf during the first measurement series in both boys and girls). The differences between measurement series and between sessions were very low. As a rule, the value of correlation coefficient did not depend on the site of a measurement (i.e., on the thickness of skinfold). Our reproducibility coefficients were very similar with the result of Mueller and Malina [5] study in 12 to 17 year old adolescents, where the reproducibility coefficients were in range 0.88–0.90, with an average of 0.91. Age, sex and maturity associated variation in subcutaneous fatness and fat distribution during childhood and adolescence have reasonably well documented. The relative distribution of trunk and extremity subcutaneous fat during childhood is rather stable, and the ratio of trunk to extremety skinfold thicknesses appears to be similar for boys and girls [4]. However, this differences are not influenced measurement reliability if the investigator is highly experienced.

Table 1. The reproducibility coefficients in boys and girls (in brackets) during three measurement sessions.

	First Measurement	Second Measurement	Third Measurement
Triceps	0.963 (0.922)	0.994 (0.996)	0.976 (0.996)
Subscapular	0.991 (0.952)	0.999 (0.998)	0.970 (0.997)
Biceps	0.923 (0.948)	0.956 (0.990)	0.945 (0.964)
Iliac crest	0.908 (0.944)	0.992 (0.999)	0.989 (0.992)
Supraspinale	0.959 (0.986)	0.962 (0.999)	0.986 (0.989)
Abdominal	0.994 (0.908)	0.996 (0.995)	0.988 (0.995)
Front thigh	0.935 (0.959)	0.989 (0.999)	0.973 (0.966)
Medial calf	0.885 (0.892)	0.988 (0.986)	0.952 (0.959)
Mid-axilla	0.965 (0.926)	0.991 (0.992)	0.978 (0.994)

It can be concluded that the reproducibility coefficients of the highly qualified investigator are high and do not depend on the sex, age and time of measurement.

REFERENCES

1. Cameron N (1978) The methods of unxological anthropometry. In: Falkner F, Tanner JM (eds.) Human Growth. 2 Postnatal Growth. New York: Plenum Press, pp. 35–90.
2. Haas JD, Flegal KM (1981) Anthropometric measurements. In: Newell GR and Ellison NM (eds) Nutrition and Cancer: Etiology and Treatment. New York; Raven Press. 123–140.

3. Malina RM, Hamill PVV, Leme Show S (1973) Selected body measurements of children 6–11 years. Unides States. Vital and Health Statistics. Series No 123. Usdhew, Washington, D.C
4. Malina RM, Eugenia Rena Reyes M (1994) Relative fat distribution: Relationship to skeletal maturation, growth status and motor fitness of boys 8–11 years of age. Am J Hum Biol 6: 19–23.
5. Mueller WH, Malina RM (1987) Relative reliability of circumferences and skinfolds as measures of body fat distribution. Am J Phys Anthropol 72: 437–439.
6. Norton KI, Olds TS (1996) Anthropometrica. Sydney UNSW Press, 25–76.
7. Pollock ML, Jackson AS (1984) Research progress in validation of clinical methods of assessing body composition. Med Sci Sports Exerc 16: 606–613.
8. Ward R, Rempel R, Anderson GS (1999) Modeling dynamic skinfold compression. Am J Hum Biol 11: 531–537.

UNDERFOOT PRESSURE DISTRIBUTION OF PATIENTS AFTER TOTAL HIP REPLACEMENT

J. Lorkowski[1,2], A Skawina[1]
[1]*Jagiellonian University, Cracow, Poland,*
[2]*„Zdrowie" Rehabilitation Centre, Cracow, Poland.*

INTRODUCTION

More than one million hip and knee replacement are performed yearly throughout the world [7]. Total hip replacement (THR) is acknowledged as a highly successful procedure that has provided relief of pain, increased mobility, and improved tolerance for activity for thousands of people. Despite the advantages made in the past decade in this field, obvious deficiencies in knowledge remain regarding treatment, patient characteristics, and environmental issues [3,7].

Since the main movement of the trunk takes place around the hip joint and the supportive area are the feet that interact with the ground to introduce impulsive stress into the skeleton the analysis of pressure distribution under the sole could help in evaluation of biomechanical function of hip. Standardized instruments for assessing outcomes need to be developed, validated and introduced into clinical use. The biomechanical analyses could help quantify joint stress and deformation on standing and during gait, and ultimately improve implant design [2,4].

To our knowledge, no previous study that compares the underfoot pressure distribution of patients before and after THR has been published. The purpose of this paper is to estimate the pressure distribution under the sole on the ground of pedobarographic study made before and after THR.

METHODS

We examined 9 patients, both sexes (5 females, 4 males), aged 42–68, who had unilateral THR because of osteoarthritis. Physical and X-ray examinations were carried out to ensure proper hip joint estimation before and after surgery (5–6 months after THR). Each patient had performed underfoot pressure measurements and three tests for each foot were recorded and analysed using computed pedobarography. The pedobarographic apparatus was PEL38 with the capacitance transducers mat. The pressure values were displayed as a conform pattern on a colour graphics display unit and on a printer. The peak pressure, mean pressure and contact areas for the whole foot and for each foot area were obtained before and after surgery. For our analysis 7 areas of interest on each footprint were selected according to Blomgren's classification [1]. The control group consisted of 40 healthy subjects.

In statistical analysis the mean values and standard deviation were calculated and statistical comparisons were performed using t-Student test with 5% level of significance adopted.

RESULTS

In all patients the X-ray pictures made before surgery revealed the degenerative changes of the hip joint. The X-ray tests after operation were made for checking that the stem and acetabulum of prosthesis were in the correct position.

Pedobarographic examination performed preoperatively revealed that the side opposite to the operated was overloaded, except 2 patients with shorter leg because of congenital subluxation of the hip. In these 2 cases the leg on the operated side was overloaded. Underfoot pressure measurements made after surgery, comparing with that made before operation, revealed: in 5 patients increased pressure under T and H region on the operated side, in 2 patients on the operated side decreased pressure under H foot region and increased pressure under MT1 foot region, in 1 patient increased pressure under T region of operated side and increased pressure under MT3 region of non-operated side, in 1 patient decreased pressure under H and increased pressure under MT1 and MT2 foot regions of the operated side.

Preoperative pedobarographic analysis showed significantly ($p<0.05$) greater values of maximal pressure on non-operated side comparing with control group with tendency to decrease after surgery (522 ± 98.3 g/cm^2 vs. 488 ± 87.2 g/cm^2). Postoperative pedobarographic measurements revealed normalisation of the weight-bearing function of the foot as compared to the preoperative results. The foot contact area was bigger before surgery comparing non-operated side with operated but without statistical significance (mean value: 128 ± 27.9 cm^2 vs. 107 ± 16.8 cm^2), and was observed to decrease after operation.

DISCUSSION

Footprints have been utilised for many years to quantify aspects of gait, step length, stride length, base of gait and foot angles [8]. After THR the dynamic methods can produce unrepresentative footprints. During the dynamic measurements the first steps are generally disregarded because they are initiated from a static position, and are therefore not indicative of the individual steps during active locomotion [2,6,8]. At first, it is more sense and more easy to assess deficits statically rather than dynamically.

Our investigation concerned the comparison of the underfoot pressure measured by postural pedobarography before and after THR. The pedobarographic analysis indicated that THR reestabilishes weight-bearing role of the foot. Before operation the "healthy" hip was overloaded as it was shown by increased values of maximal underfoot pressures. Our study revealed that it is difficult to create standard pattern of underfoot pressure distribution in case of coxarthritis. There were some differences between patients, concerning regions in which after operation pressure was changed. It depended on preoperative biomechanical hip disturbances.

Gait analysis suggests that recovery of strength in the musculature about the hip after THR is a prolonged process. Physical activities requiring repetitive impact loading can increase the risk of failure of THR so it is a need for prolonged exercise regimen [5,7]. We think that postural pedobarography is a helpful tool for monitoring recovery process.

The interactions between the forces transmitted by the muscles and bones are the central to understanding of load transmission in the musculoskeletal system. There is a big need to develop tools that will allow to assess biomechanical function of the human body both statically and dynamically. Successful replacement of deteriorated, arthritic, and severely injured hips has contributed to enhanced mobility and comfortable living for many people who would otherwise be substantially disabled [7]. The postural pedobarography is a useful tool to support diagnosis, therapy decision making and therapy control in hip surgery. In conclusion, postural pedobarography allows quantitative evaluation of loading conditions of the hip joint.

REFERENCES

1. Blomgren M, Turan I, Agadir M (1991) Gait analysis in hallux valgus. J Foot Surg 30: 70–71.
2. Genda E, Iwasaki N, Li G, MacWilliams BA, Barrance PJ, Chao EY (2001) Normal hip joint contact pressure distribution in single-leg standing--effect of gender and anatomic parameters. J Biomech 34: 895–905.
3. Gill TJ, Sledge JB, Muller ME (1998) Total hip arthroplasty with use of an acetabular reinforcement ring in patients who have congenital dysplasia of the hip. Results at five to fifteen years. J Bone Joint Surg 80: 969–979.
4. Hughes J (1993) The clinical use of pedobarography. Acta Orthop Belg 59: 10–16.
5. Long WT, Dorr LD, Healy B, Perry J (1993) Functional recovery of noncemented total hip arthroplasty. Clin Orthop Rel Res 288: 73–77.
6. Matjacic Z, Voigt M, Popovic D, Sinkjaer T (2001) Functional postural responses after perturbations in multiple directions in a standing man: a principle of decoupled control. J Biomech 34: 187–196.
7. NIH consensus conference (1995) Total hip replacement. NIH Consensus Development Panel on Total Hip Replacement. Consensus Development Conference, NIH. JAMA 273: 1950–1956.
8. Wilkinson MJ, Menz HB, Raspovic A (1995) Measuring gait parameters from footprints. The Foot 5: 84–90.

PEDOBAROGRAPHIC EVALUATION OF FOOT WITH HALLUX VALGUS DEFORMITY BEFORE AND AFTER KRAMER'S OSTEOTOMY

J. Lorkowski[1,2], D. Zarzycki[3]
[1]*Jagiellonian University, Cracow, Poland,*
[2]*„Zdrowie" Rehabilitation Centre, Cracow, Poland,*
[3]*Jagiellonian University, Zakopane, Poland*

INTRODUCTION

Hallux valgus (hv) deformity commonly occurs in shoe-wearing societies and can lead to pain, blistering and bursal inflammation. Although non-surgical care is always the first option for patients who had hv deformity, hv surgery is among the most common orthopaedic operations in industrialised countries. More than 100 procedures were described for correction of hv [9]. The goal of operative treatment is to correct all pathological elements and yet maintain a biomechanically functional forefoot. It is presumed that the surgery is successful because it reduces the loading point under the foot [6,8]. However, little is known regarding underfoot pressure in case of hv following the operative procedures.

This study aimed to establish the effect of surgical treatment of hv on the underfoot pressure using postural pedobarography.

METHODS

Eight patients (7 females, 1 male, 16 feet) with hv deformity were included in the study (hv angle was 22°–35°, av. 30.2°). Their ages ranged from 32 to 59 (mean 44.1 years). Control group consisted of 40 healthy subjects. The patients were examined clinically with particular reference to their feet and the presence of any musculoskeletal system deformity. Details concerning the history of the foot deformity and degree and site of foot pain were collected. All patients had X-rays and underfoot pressure studies (postural pedobarography) performed preoperatively and postoperatively (6 months after surgery). The surgical technique used was Kramer's procedure that is modification of Mitchell procedure (subcapital osteotomy of I metatarsal bone with incision of a wedge with size of deformation, lateral and inferior translocation of the head of first metatarsal bone, stabilisation with the Kirschner's wire) [3].

The underfoot pressure measuring system was the pedobarograph PEL38. Measurements of the total force, peak pressure and foot contact area are displayed on the monitor immediately after the standing on the sensitive mat, along with the colour-coded pressure pattern. In our study, the footprint data were divided into areas according to classification of Blomgren (seven areas of interest were produced: in the forefoot — MT1, MT2, MT3, MT4, MT5, in the hindfoot — T and H) [2]. Three recordings for each patient were made and the resulting data were collected on computer.

In statistical analysis the mean values and standard deviation were calculated and statistical comparisons were performed using t-Student test with 0.05 level of significance adopted.

RESULTS

The pain in hv group was located in 7 patients at the contact area of head of the I metatarsal bone with shoes on the medial margin of foot, in 5 patients under the head of the II and III metatarsal bone. The X-ray study performed after surgery revealed total correction of hv deformity.

Pedobarographic examination revealed that in the control group and in the group with hv the highest maximum underfoot pressure was in the heel region. The mean value of pressure under H region was in the group with hv before surgery 506 ± 72.3 g/cm^2 and after surgery 459 ± 68 g/cm^2. In the heel region the difference between control group (478±68 g/cm^2) and hv group before surgery was statistically significant ($p<0.05$) and was observed to decrease after surgery. In hv group before surgery the underfoot pressure in forefoot was laterally translocated from central regions of the forefoot to the fifth toe region comparing with healthy subjects. In hv group pressures under MT1 and MT2 regions were decreased and pressures under MT3, MT4 and MT5 foot regions were increased comparing with control group. After operation pedobarography revealed increase of pressure in MT1 and MT2 foot region, no changes in MT3 and decrease of pressure under MT4, MT5 regions but there were no statistically significant differences between measurements obtained before and after surgery. The foot contact area in the group with hv deformity was smaller before surgery than in control group (without statistical significance) and was observed to increased after operation.

DISCUSSION

In our study significant difference was found in the pedobarographic data recorded between measurements made pre and post-operatively in the heel region. Underfoot pressure analysis before surgery has shown that patients with hv had shift in loading away from central part of the forefoot to the lateral side. Similarly, other authors noted that the hv group had significantly greater maximum pressure in small toe region [2]. Pain in the forefoot has been attributed to the functional and structural abnormality resulting from hv deformity, and leads, in turn to abnormal distribution of pressure in the forefoot [2]. Different types of foot surgery give different knowledge about the distribution of underfoot pressure after operation [6,8,9] and affect the distribution of pressure in different way. In case of our study Kramer's procedure allowed positive modification of pressure distribution and helped to recover a proper biomechanical foot function. The expression of that is increasing of pressure under the first metatarsal in postural pedobarography performed after surgery.

The great interest in measurement of the underfoot pressure is shown by the many different methods that have been designed and tested. A number of systems are commercially available, but comparison of the results is complicated by different measurement techniques [4,7]. The results of one system should not generally be compared with another, but there are essential similarities between patterns of underfoot pressure created using different systems. Pressure measurements of bare-foot walking using different systems have been well analysed, but often it is very difficult to perform reliable underfoot pressure measurements during walking. There is some concern that the plantar pressure measurements during walking will vary significantly depending on whole body movements rather than foot structure or deformities. The limited joint mobility has been reported to contribute to high plantar pressure during walking [1,4,7]. It is therefore essential to have some data such as the postural pedobarographic measurements for objectivisation of the force distribution under sole. Our results, together with other published data, showed that pedobarography provides accurate and reproducible measurements of the underfoot pressure distribution. It is difficult to evaluate the pedobarography as a diagnostic tool due to wide range of measurements found in normal subjects [4,5]. However, the equipment is a useful clinical tool to monitor progress, to assess the effect of treatment and to assist in the proper rehabilitation process.

In conclusion, our results suggest that the Kramer's procedure is successful because it transfers the pressure to areas better able to tolerate it and reduces the maximal underfoot pressure. Our study showed that the pressure measurements of the pedobarography could be used to create a connectionist expert systems to monitor progress of treatment of foot pathologies objectively.

REFERENCES

1. Barton JG, Lees A (1996) Comparison of shoe insole materials by neural network analysis. Med Biol Eng Comp 34: 453–459.
2. Blomgren M, Turan I, Agadir M (1991) Gait analysis in hallux valgus. J Foot Surg 30: 70–71.
3. Coughlin MJ (1996) Hallux valgus. J Bone Joint Surg 78: 932–966.
4. Hughes J, Clark P, Linge K, Klenerman L (1993) A comparison of two studies of the pressure distribution under the feet of normal subjects using different equipment. Foot Ankle 14: 514–519.
5. Hughes J (1993) The clinical use of pedobarography. Acta Orthop Belg 59: 10–16.

6. Phillipson A, Dhar S, Linge K, McCabe C, Klenerman L (1994) Forefoot arthroplasty and changes in plantar foot pressures. Foot Ankle Int 15: 595–598.
7. Quaney B, Meyer K, Cornwall MW, McPoil TG (1995) A comparison of the dynamic pedobarograph and EMED systems for measuring dynamic foot pressures. Foot Ankle Int 16: 562–566.
8. Samnegard E, Turan I, Lanshammar H (1991) Postoperative evaluation of Keller's arthroplasty and arthrodesis of the first metatarsophalangeal joint using the EMED gait analysis system. J Foot Surg 30: 373–374.
9. Torkki M, Malmivaara A, Seitsalo S, Hoikka V, Laippala P, Paavolainen P (2001) Surgery vs orthosis vs watchful waiting for hallux valgus: a randomized controlled trial. JAMA 285: 2474–2480.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

ASSESSMENT OF BASIC SOCIAL SKILLS (BASED ON THE DATA OF THE RESEARCH OF ATHLETES)

R. Malinauskas
Lithuanian Academy of Physical Education, Kaunas, Lithuania

INTRODUCTION

In recent years there has been increased attention to defining and assessing individual differences in social abilities and interpersonal skills. Many existing measures of social skills focus on a single, specific type of skill, skill deficit, or skill-related construct such as assertiveness [3], fear of negative evaluation [6], or communication apprehension [2]. The present study is an attempt to develop a general framework for several basic dimension of social skill and to report on the construction of a self-report assessment tool to measure basic social skill dimensions.

Skills in sending and receiving information are presented in the basic social skills of expressivity and sensitivity. The research cited above has dealt primarily with the communication of nonverbal messages, especially the sending and receiving of emotions. Whereas emotional sending and receiving ability represent important components of nonverbal social skills, verbal encoding and decoding abilities are two separate, yet related, social skills. Thus, the first four social skills in our framework are termed: emotional expressivity, emotional sensitivity, social expressivity and social sensitivity. Emotional expressivity involves skill in communicating affect, attitudes and status. Emotional sensitivity is the ability to decode others' emotions, beliefs, or attitudes and cues of status-dominance. Social expressivity includes skill in verbal expression and ability to initiate conversations. Ability to receive and understand verbal messages and concern for social rules and norms are central components of social sensitivity. Two additional skills are concerned with control over communication. The skill of emotional control is the ability to regulate emotional communications and display nonverbal displays. Social control includes role-playing ability and regulation of verbal behavior. In summary, the six basic social skill dimensions considered in the present framework involve skill in sending, receiving and controlling communication in two separate domains, the emotional-nonverbal and the social-verbal domains.

Aim of this work was to develop a much needed general scheme and self report inventory for assessing basic social skill dimensions.

Research objectives were to 1) discuss basic social skills dimensions; and 2) investigate validity and reliability of the Social Skills Inventory.

METHODS

The following research methods were applied: the analysis of literary sources, questioning (Basic social skills inventory) and mathematical statistics (coefficient Cronbach alphas, Pearson correlation coefficient).

Study was conducted in Lithuanian Academy of Physical Education with participation of 139 athletes — students of Lithuanian Academy of Physical Education. The athletes ranged in age from 18 to 19. The investigation was organized in two stages. In April 2000, 139 athletes were tested. In May, the same investigation was repeated. The investigation was provided with the same students. In general, 136 athletes returned back the questionnaires.

The Basic Social Skills Inventory (SSI) contains 24 items, 4 items in each of the six social skills subscales. The response scale for each items is a 5-point scale.

RESULTS

Coefficient alphas for the six SSI scales, which were derived from a sample of 139 athletes, ranged from 0.76 to 0.88 and are shown in Table 1. These coefficients demonstrated the high internal consistency of all the SSI scales, and they compared favorably with other social skill instruments [5]. 136 athletes were administrated the SSI on two occasions one month apart. The test-retest correlations ranged from 0.83 to 0.91 ($p<0.01$) and are presented in Table 1. In summary, the SSI is composed of six scales, each demonstrated high reliability.

Table 1. Norms and reliability coefficients for the SSI.

SSI scale	M	SD	Coefficient alphas (n=139)	Test-retest r (n=136)
Emotional Expressivity	3.76	0.46	0.77	0.83
Emotional Sensitivity	3.79	0.57	0.76	0.89
Emotional Control	2.89	0.52	0.88	0.84
Social Expressivity	3.21	0.71	0.82	0.91
Social Sensitivity	4.02	0.78	0.83	0.87
Social Control	3.79	0.64	0.85	0.88

Having a particular social skill is expected in most cases to be positively intercorrelated with possessing other social skills, because one social skill usually predisposes an individual to develop other skills. For example, the ability to accurately recognize emotional expressions in others may eventually lead to a better ability to express emotions. Thus, we usually speak of certain individuals who are socially skilled (or not socially skilled) on a variety of dimensions. However, the possession of one skill may preclude, in certain cases, having another social skill. For example, a person who is extremely emotionally expressive may be lacking in certain elements of emotional control, as the expression of left emotional states is somewhat spontaneous and, thus, inconsistent with control. Intercorrelations among the six SSI scales are given in Table 2.

Table 2. Norms and reliability coefficients for the SSI.

SSI scale	EE	ES	EC	SE	SS	SC
EE		0.48	–0.29	0.56	0.38	0.61
ES			0.34	0.59	0.31	0.52
EC				–0.48	–0.19	0.26
SE					0.37	0.58
SS						0.48

EE – Emotional Expressivity, ES – Emotional Sensitivity, EC – Emotional Control, SE – Social Expressivity, SS – Social Sensitivity. SC – Social Control.

DISCUSSION

Although there has been several attempts to measure a specific dimension of nonverbal skill [4] and more recently, attempts to assess social skill-related constructs such as empathy and sociability [1], there has been no integrated approach to assessing multiple dimensions of social skill. The SSI represents an initial attempt to provide a general framework for non-verbal and social skill research. It may be the case that individuals who are labeled empathic possess certain combinations of basic social skills that make up these characteristics. Empathy may be composed of skill in emotional sensitivity pared with emotional and social expressivity. The empathy may be a general index of social skills.

Since basic social skills represent learned communication abilities, it seems reasonable that people can develop and enhance these basic skills. Practice and training in basic dimensions of social skills and in the interrelationships of the basic skills should lead to more effective social performance.

In additional, the six basic social skill dimensions considered in the present framework involve skill in sending, receiving and controlling communication in two separate domains, the emotional-nonverbal and the social-verbal domains. The Social Skills Inventory demonstrated internal validity and test-retest reliability. Coefficient alphas for the Social Skills Inventory scales, which were derived from a sample of 139 athletes, ranged from 0.76 to 0.88. The test-retest correlations ranged from 0.83 to 0.91 (all $p<0.01$)

REFERENCES

1. Cheek JM, Buss, AH (1981) Shyness and sociability. J Person Soc Psychol 41: 330–339.
2. Lekavičienė R (1999) Socialinis intelektas: sampratų įvairovė ir pagrindiniai kriterijai. Ugdymo psichologija 2: 23–28 (In Lithuanian).
3. Rathus SA (1973) A 30-item schedule for assessing assertive behavior. BehavTher 4: 78–96.
4. Rose-Krasnor L (1997) The nature of social competence: A theoretical review. Soc Develop 6: 115–135.
5. Snyder M (1974) The self-monitoring of expressive behavior. J Person Soc Psychol 30: 526–537.
6. Watson D, Friend R (1969) Measurement of social–evaluative anxiety. J Person Soc Psychol 33: 448–457.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

CREATINE FOOD SUPPLEMENTS IN THE NUTRITION OF ENDURANCE-TRAINING SPORTSMEN

K. Milašius, M. Pečiukonienė, E. Švedas
Vilnius Pedagogical University, Vilnius, Lithuania

INTRODUCTION

Over the recent years, food supplements, creatine among them, have found a wide application in enhancing the physical performance and functional capacity among sportsmen. Creatine is a natural amino acid endogenously synthesized from glycine, arginine and metionine and in minute quantities received with meat and fish products [1,6,8]. The daily requirement of creatine amounts to 2–3 g. A short-term creatine supplementation (10 to 20 g daily) increases the total creatine in the body by 20–30 per cent. Larger amounts of creatine have been found to support the ATP content under physical exercises of high intensity and to help to restore its concentration at rest [3,4,6]. Thus, creatine has become one of the most popular food supplements among sportsmen. Most researchers emphasise the effect of creatine or its combination with glucose [2] on the sportsmen's organism; however, comprehensive studies on the effect of creatine complexes with other food supplements are lacking. The aim of our study was to elucidate the effect of creatine mono-hydrate and the vitamin MULTI VITA+ complex on the sportsman's body, indices of adaptation to physical loads and blood morphological indices.

METHODS

We examined 20 sportsmen aged 20–24 years. After the first examination when the physical development performance capacity, blood morphological and biochemical indices had been determined, all the subjects were divided into two groups, 10 subjects in each. The food ration of the first (E_1) group was supplemented for five days with creatine monohydrate at a dose 0.3 g/kg body mass. The food ration of the second (E_2) group was supplemented for five days with creatine monohydrate at a dose 0.3 g/kg body mass and one capsule of the MULTI VITA+ (MULTIPOWER) vitamin daily. The study groups consisted of endurance sport representatives (runners, skiers, orientationists, biathlonists). We determined their physical development, single muscular contraction power (SMCP), anaerobic alactic muscular power (AAMP) and according to a 10-second maximum strain work on a veloergometer. The mixed anaerobic alactic — anaerobic glycolytic power was evaluated according to a 30 - second maximum strain work on an ergometer (Wingate test). Anaerobic glycolytic capacity (AGC) was evaluated according to a 60-second work on a veloergometer with the simultaneous measuring of pulse rate and blood pressure. The Roufier index was used to evaluate the aerobic capacity and the functional ability of the circulatory and respiratory systems. We studied the peripheral blood picture, determined the erythrocyte and leucocyte counts, hemoglobin concentration, hematocrite percentage. To assess creatine metabolism in the body, we determined the creatinekinase concentration and creatinine content with the aid of a REFLOTRON biochemical analyzer (Boehringer-Manheim, Germany). The obtained data were processed by mathematical statistics.

RESULTS

The sportsmen's food supplementation with creatine and a combination of creatine with the MULTI VITA+ vitamin was beneficial for their physical development (Table 1).

Table 1. Changes in the physical development and physical performance indices in sportsmen administered creatine and MULTI VITA+ food supplements

Indices	E_1 (Creatine)		E_2 (C+ MULTI VITA+)	
	Before	5 days after	Before	5 days afters
Body mass (kg)	76.70±1.98	77.54±2.07	76.31±3.21	77.42±3.42
Muscle mass (kg)	42.08±1.29	42.95±1.29	41.09±1.80	41.81±1.85
Fat mass (kg)	8.85±0.55	8.74±0.48	8.29±0.76	8.15±0.63
SMCP (kgm/s/kg)	2.42±0.10	2.76±0.10*	2.69±0.11	2.87±0.11
AAMP (kgm/s/kg)	1.60±0.03	1.67±0.03	1.65±0.03	1.69±0.03
AAMP 10s (W)	726.6±27.4	770.2±26.1	746.4±36.5	771.8±33.1
AAMP–AGC 30s (W)	419.2±18.7	455.8±20.6	407.0±12.8	493.8±20.8
AGC (W)	368.3±15.3	388.1±11.6	398.9±19.1	493.8±20.8
Roufier index	3.88±0.78	3.60±0.61	5.10±0.22	4.08±1.08**
Pulse rate at rest	61.2±2.1	60.0±2.4	60.2±3.6	61.8±3.8

Explanations: * – p<0.05, ** – p<0.01, C – creatine

In the group administered the creatine and vitamin combination, the body mass was higher and the fat mass lower than in the group that used creatine alone. Supplementation of the sportsmen's ration with creatine and its complex with the MULTI VITA+ vitamin increased their power in various energy production zones, however, this increase was not statistically significant in either of the groups. The indices of SMCP, AAMP- AGC were higher in the E_1 group administered creatine alone. Functional capacity of the circulatory and respiratory systems during the very short period of our experiment gained more improvement in sportsmen administered creatine with vitamins (Table 1). Changes in the indices of blood morphological composition in the both groups were insignificant. However, leucocyte count was found higher in the group of sportsmen administered creatine with vitamins. This increase occurred mostly at the expense of an increase in lymphocyte and monocyte percentage. Rather great differences were noted in the changes of creatinekinase concentration (Table 2).

Table 2. Blood morphological and biochemical changes in sportsmen administered creatine and MULTI VITA+ food supplements

Indices	E_1 (Creatine)		E_2 (C+ MULTI VITA+)	
	Before	5 days after	Before	5 days after
Erythrocytes x 10^{12}	5.07±0.07	5.18±0.02	4.80±0.09	4.87±0.07
Hemoglobin (g/l)	161.0±2.00	161.0±1.45	150.7±2.15	151.4±2.76
Hematocrit (%)	51.60±0.64	52.60±0.31	48.2±0.79	48.8±0.71
Leucocytes x 10^3	5.32±0.41	5.48±0.40	5.18±0.38	5.69±0.29
bazophils (%)	5.69±0.29	59.4±2.50	55.4±2.74	57.43±3.33
lymphocytes (%)	35.4±2.52	34.8±2.31	33.8±2.71	35.18±3.15
monocytes (%)	4.50±0.93	5.82*±0.39	5.30±1.26	7.34±0.47
Creatinekinase (u/l)	254.6±27.2	337.9±47.8 ***	210.3±45.4	177.5±37.1
Blood creatinine (mmol/l)	67.0±5.4	78.3±1.5*	73.3±2.4	74.8±4.1
Urine creatinine (mmol/l)	15.45±1.29	27.72±1.27 ***	17.09±0.63	27.72±1.82 ***

Explanations: *– p<0.05, **– p<0.01, *** – p<0.001, C – creatine

In the group E_1 members, blood creatinkinase activity increased on average from 254.6 to 337.9 u/l whereas in group E_2 members this index decreased on average from 210.3 to 177.5 u/l. However, these changes were within normal limits. The decreased blood creatinkinase level in E_2 group members shows that performing a load of the same intensity takes less reserves of creatine, its increase in blood and urine is less significant. This implies that the subjects administered creatine in combination with vitamines undergo a less catabolism under physical loads than do the subjects administered creatine alone. These data of our study corroborate the opinion of other authors [5,7].

REFERENCES

1. Balsom P, Söderlund K, Ekblom C (1999) Creatine in humans with special references to creatine supplementation. Sports Med 18: 268–280.
2. Green A, Simpson E, Littlewood J (1996) Carbohydrate ingestion augments creatine retention during creatine feedings in humans. Acta Physiol Scand 158: 195–202.
3. Greenhaff P, Bodin K, Söderlund K, Hultman E (1994) Effect of oral creatine supplementation on the skeletal muscle phosphocreatine resyntesis. Am J Physiol 266: 725–730.
4. Haris R, Söderlund K, Hultman E (1992) Elevation of creatine in resting and exercised muscle of normal subjects by creatine supplementation. Clin Sci 83: 367–374.
5. Hultman E, Bergström J, Spriet L, Söderlund K (1990) Energy metabolism and fatigue. In: Taylor A., Gollnick P, Green H (eds) Biochemistry of exercise VII. Champaign. IL. Human Kinetics, pp. 73–92.
6. Kreider R (1998) Creatine supplementation: analysis of ergogenic value, medical safety, and concerns. J Exerc Phys 1: 1.
7. Lemon P, Boska M, Bredle D (1995) Effect of oral creatine supplementation on energetic during repeated maximal muscle contraction. Med Sci Sports Exerc 27: 204.
8. Schek A (2000) Kreatin-Suplemente für jedermann. Sport Med 2: 58–62.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

AN IMPACT OF CHILDREN COGNITIVE PROCESSES ON EXPECTED OUTCOMES IN PHYSICAL EDUCATION

M. Müür, V. Hein
University of Tartu, Tartu, Estonia

INTRODUCTION

In addition to the traditional focus on motor and physical development, recent curriculum goals in physical education (PE), including health and fitness and the development of positive self-perceptions, social skills, lifelong physically active lifestyle, have been acknowledged and accepted all over the Europe [1]. There are many determinants that influence physically active lifestyle (family support, social influence etc). However, the impact of cognitive processes in PE classes on physically active lifestyle as one of the main objective of contemporary physical education is not studied. Cognitive processes are defined as student thoughts or cognition that impact learning, including their beliefs, perceptions, expectations, levels of attention, motivation, and use of strategies [6]. Cognitive processes play a significant role in many types of learning. It has been established that cognitive variables, such as student's reports of their attention, use of strategies, and motivational levels, impact measures of student engagement, student effort, and achievement in physical education classes [4,5]. Solmon and Lee [3] have developed a questionnaire that assesses the cognitive processes of students in PE classes (CPQPE). The relationship between the CPQPE subscales and measures of goal perspective in PE classes support the notion that this questionnaire provides reliable, valid information about student's cognitive processes in PE lessons. Goal perspective theory [2] has been used as a framework for studying cognitive engagement, and investigations using this construct have supported the notion that student reports of their cognitions are related to the achievement goal orientation they adopt.

The main purpose of this study was to investigate the relationship between student's cognitive processes in PE lessons and the expected outcomes of the PE lessons (physically active lifestyle after graduating the high-school). Secondly, this study examined which part of the cognitive processes (self-regulation, confidence-efficacy, attention-concentration, willingness to engage, strategies) predict the expected outcomes the most.

METHODS

The participants in this study were 944 students (440 boys and 504 girls) at age of 12–18 years from 11 different schools in Estonia. All the students responded the questionnaire in class teacher lessons. Permission to carry out the study was obtained from the headmaster of the school or from the headteacher. Children were assured that their answers will remain confidential. Student's cognitive processes were assessed by the Cognitive Processes Questionnaire in Physical Education (CPQPE) [3]. The CPQPE was developed to assess student's cognitive processes in PE. It included 33 items in five different parts of cognitive processes (self-regulation, confidence-efficacy, attention-concentration, willingness to engage, strategies). The questionnaire was five-point Likert scale, where students had to indicate their level of agreement with statements (from strongly disagree to strongly agree). Additionally six items were designed to measure the physical education outcome and were included to the questionnaire. The items were: I do often sport in my free time; Thanks to the PE, I know the impact of different exercises to my body; I am interested in developing my physical fitness; Outside from the PE lessons I like to do sport; After graduation I would like to take part of sport club training; After graduation I would like to be physically active.

RESULTS

Cronbach alpha coefficients for the subscales of the CPQPE were: self-regulation 0.80, attention-concentration 0.72, willingness to engage 0.78, use of strategies 0.78 and confidence-efficacy 0.61, were three of the items (4,5,7) have excluded. The reliability coefficient for the subscale of outcome was 0.80. Exploratory Factor Analysis (EFA) showed five-factor solution as it was in data reported by Solmon and Lee [3]. Only some of the items were excluded from the analysis as they did not fit in factor (self-regulation 1, 2, 10; confidence-efficacy 4, 5, 7; attention-concentration 5). Factor loadings for each of the items were 0.40. The factor structure and the model fit of the CPQPE was tested by the confirmatory factor analysis (CFA). CFA indexes of fit were similar to data reported by Solmon and Lee [3]: goodness of fit index 0.86, root mean square residual 0.77.

The results of correlation analysis showed correlation between students willingness to engage and their confidence-efficacy (r=0.47). Also the dimension of self-regulation was related to the attention-concentration (r=0.41) and use of strategies (r=0.41). The use of strategies was minimally related to confidence-efficacy (r=0.21) and willingness to practise (r=0.12). Multiple regression procedures were used to determine the dimensions of the cognitive processes, which may predict the outcome of the physical education. The results of multiple regression and means of subscales are presented in Table 1.

Table 1. Summary of Stepwise Regression Analysis, Means, Standard deviations (SD).

Variable	Multiple R	R^2	R^2-change	Beta	Mean	SD
Self-regulation	0.42	0.18	0.18	0.26	40.7	6.3
Willingness to engage	0.47	0.22	0.05	0.28	17.7	4.8
Strategies	0.52	0.27	0.05	0.26	12.2	4.7
Confidence	0.52	0.27	0.004	0.072	21.8	4.3
Attention	0.53	0.28	0.003	0.069	20.2	4.7

DISCUSSION

This study was designed to determine which part of the cognitive processes (self-regulation, confidence-efficacy, attention-concentration, willingness to engage, strategies) predict the expected outcomes the most. To obtain estimates of internal consistency for each subscale of the CPQPE, alpha coefficients were calculated and they were quit consistent with Solmon and Lee [3] research. Only confidence-efficacy had a lower reliability (0.61). Also the subscale of outcome with six items showed a good reliability (0.80). A five- factor solution emerged from the exploratory factor analysis. Some of the items were excluded to get acceptable factor structure. Confirmatory factor analysis indicated the fit of the model. The results of the correlation analysis confirmed the findings of Solmon and Lee [3]. There were a correlation between students willingness to engage and their confidence-efficacy. Also the dimension of self-regulation was related to the attention-concentration as it was in above mentioned study. The results of Solmon and Lee [3] study showed no relation between the dimensions use of strategies and confidence-efficacy, but in this study these were minimally correlated. There were a weak relation between use of strategies and willingness to engage.

The results of the multiple regression showed that self-regulation was the best predictor of the PE outcome, following willingness to engage and using strategies. All the subscales of cognitive processes together allow to predict expected outcomes of physical education only 28 percent. However, there may be other determinants by what could predict the expected outcomes of PE. The results of multiple regression allow to assume that the students will have a long lasting interest in physical activity after graduating the school, when the teachers of physical education emphasise more the self-regulation in teaching process.

REFERENCES

1. Auweele V, Bakker F, Biddle S, Durand M, Seiler R (1999) Psychology for Physical Educators. Human Kinetics, pp. 135–140.
2. Nicholls JG (1984) Conceptions of ability and achievement motivation. Research on motivation in education: Vol. 1. Student motivation: 31–56.

3. Solmon MA, Lee AM (1997) Development of an instrument to assess cognitive processes in physical education. Res Q Exerc Sport 2: 152–160.
4. Solmon MA, Boone J (1993) The impact of student goal orientation in physical education classes. Res Q Exerc Sport 64: 418–424.
5. Solmon MA, Lee AM (1996) Entry characteristics, practice variables, and cognition: Student mediation of instruction. J Teach Phys Educ 15: 135–150.
6. Wittrock MC (1986) Students thought processes. In: Wittrock M C. (ed.), Handbook on research on teaching. Macmillian. Pp. 297–314.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

ON THE POSSIBILITIES OF EVALUATING THE METABOLIC EFFECT OF DIFFERENT TRAINING EXERCISES ON THE BASIS OF OBJECTIVE AND SUBJECTIVE CHARACTERISTICS

A. Nurmekivi, T. Karu, E. Pihl, K. Kaarna, J. Kangasniemi
University of Tartu, Tartu, Estonia

INTRODUCTION

Contemporary training management can be successful only in case there is sufficient information on the process being managed. Many researchers [4,5,6] showed that heart rate (HR) is a very good index of general health and fitness and represents the reactions of the organism to environmental conditions, stress, diseases and fatigue. From the viewpoint of the muscle's metabolic state and recovery, measurements of blood lactate (BLA) concentration and its recovery is of primary importance [2]. The testing of BLA enables to direct better the achievement of good performance. Estimation of perceived exertion [3] is a useful parameter in describing sustainability of exercise in research and sport practice. In comparison with perceptions during exertion, the skill to perceive readiness to being a new activity following recovery during training has not been studied. Our earlier researches [8,9] have established that BLA recovery during rest intervals correlated with statistical significance with perceived readiness ratings (PRR) to begin a new activity.

The aim of this study was to establish to what extent ratings of perceived readiness to start a new exercise are dependent on recovery of

BLA and HR during passive recovery between different activities (strength endurance exercise, running and small football game 4 vs. 4).

METHODS

Ten young male cross-country skiers (17.2±2.2 yr; 174.7±8.6 cm; 62.3±8.7 kg) and 8 young football players (18.5±2.0 yr; 177.5±5.1 cm; 71.3±5.9 kg) were studied. Skiers performed strength endurance exercises complex consisted of 12 exercises in moderate intensity and passed 1500 m run on indoor track. Football players performed a complex load (8 min small game 4 vs. 4 + 8 min run at the anaerobic threshold speed + again a small game of 8 min). Games and running load were separated by 3-min intervals of passive recovery. HR was measured during different activities and recovery using the POLAR VANTAGE SPORT TESTER (Polar Electro OY, Finland). BLA concentration was determined enzymatically after each load and during recovery using the Lange (Germany) analyzer. Ratings of perceived exertion (RPE) were given on the Borg CR 10 scale [4] and PRR on a 5-point scale elaborated by us [7,8].

All data are presented as mean ±SD. Pearson correlation coefficients were used to evaluate the relationships among the variables. Statistical significance was set at $p<0.05$.

RESULTS

Study results are presented in Tables 1 and 2. For the evaluation of strength endurance exercises complex total influence values of HR and BLA concentration after 6th, 10th and 12th exercise were analyzed (Table 1).

Table 2 includes mean objective and subjective characteristics of the effect of the small football games and running load and of recovery.

Table 1. Heart rate (HR) and blood lactate concentration (BLA) indices and their recovery in the evaluation of strength endurance exercises complex influence on young cross-country skiers (M±SD).

Index	M	SD
HR after 6^{th} exercise (beats·min^{-1})	167.9	10.8
HR after 10^{th} exercise (beats·min^{-1})	165.4	14.6
HR after 12^{th} exercise (beats·min^{-1})	156.5	15.1
BLA after 6^{th} exercise (mmol·l^{-1})	5.00	1.05
BLA after 10^{th} exercise (mmol·l^{-1})	6.10	1.25
BLA after 12^{th} exercise (mmol·l^{-1})	5.90	2.70
BLA at 5^{th} recovery minute (mmol·l^{-1})	4.55	2.20
HR at 5^{th} recovery minute (beats·min^{-1})	109.5	11.4
Mean time of 150 m bout (s)	43.4	5.9
Mean HR of 1500 m run (beats·min^{-1})	169.7	3.9
BLA after 1500 m run (mmol·l^{-1})	2.70	0.75
BLA at 5^{th} recovery minute (mmol·l^{-1})	2.15	0.50

Table 2. Objective and subjective indices immediately after exercise and during recovery intervals in young football players (M±SD).

	1^{st} small game	Running load	2^{nd} small game
Mean HR (beats·min^{-1}) after exercise	179.5±13.2	177.6±12.0	181.1±10.7
Mean BLA concentration (mmol·l^{-1})			
after exercise	9.8±4.9	5.6±2.4	7.6±5.0
5^{th} recovery minute			4.9±2.1
10^{th} recovery minute			3.6±1.3
Perceived exertion rating	3.0±0.9	2.9±0.3	3.9±1.3
Perceived readiness ratings			
1^{st} recovery minute	4.1±0.2	4.3±0.7	3.5±1.1
2^{nd} recovery minute	4.6±0.4	4.6±0.5	3.9±0.7
3^{rd} recovery minute	5.0±0.0	5.0±0.0	4.4±0.6
4^{th} recovery minute			4.6±0.5
5^{th} recovery minute			4.8±0.3

DISCUSSION

The most important finding of the young skiers study was that the metabolic reaction on strength endurance exercises complex and on running load at anaerobic threshold level in the same training session is very different. This is confirmed by a quite similar HR-s after the strength exercises and running load (168±11 and 170±4 beats·min^{-1}, respectively) and different BLA concentrations (5.00±1.05 and 2.70±0.75 mmol·l^{-1}, respectively). Consequently, by not evaluating the metabolic state of muscles, which based on BLA concentration, we may get a wrong picture about the influence of different training loads to the organism of young cross-country skiers. The same trend was observed in the study of young football players: at practically equal HR-s (mean HR following the 1st small game 179 beats·min^{-1} and following the running load 177 beats·min^{-1}) the BLA concentration differed considerably (9.8±4.9 mmol·l^{-1} and 5.6±2.4 mmol·l^{-1}, respectively). Therefore, evaluating only HR underestimates muscles metabolic state and excessive intensity in small football game can be planned for the concrete training stage. Evidently running load in even and moderate intensity promoted smaller increase in lactate concentration and is more preferable for developing aerobic endurance basis in young football players. The optimality of this running load was also reflected in the attainment of complete perceived readiness by the 3rd recovery minute in the present study. Following the 2nd small game the effect of the whole set of exercises can be evaluated and it can be estimated as stronger in case of an average game on normal-sized court [1,10], where the majority of activities are conducted in aerobic regimen. Correlation analysis revealed that subjective readiness to begin a new activity is significantly more influenced by BLA concentration and the dynamics of its recovery. The results are in accordance with the results of earlier studies on runners [8,9]. In conclusion, by using objective and subjective indices we can control the distribution of training loads of young sportsmen and better manage the training process.

REFERENCES

1. Bangsbo J (1994) The physiology of football with special reference to intense intermittent exercise. Acta Physiol Scand 151: 1–156.
2. Billat LV (1996) Use of blood lactate measurements for prediction of exercise performance and control of training. Sports Med 22: 157–172.
3. Borg G (2001) Borg's range model and scales. Int J Sport Psychol 32: 110–126.
4. Edwards S (1990) The heart rate monitor book. Sacramento, CA: Fleet Feet Press.
5. Fitz-Clarke JR, Morton RH, Banister EW (1991) Optimizing athletic performance by influence curves. J Appl Physiol 71: 1151–1158.
6. Foster C, Lehmann M (1997) Overtraining syndrome. In: Runnning Injures, Guten GN (ed.). Philadelphia: Saunders, 173–188.
7. Karu T, Nurmekivi A, Lemberg H, Pihl E, Jürimäe T (2000) Relationship between perceived readiness to run and physiological variables during repeated 2000 m bouts in middle-distance runners. Scand J Med Sci Sports 10: 33–36.
8. Nurmekivi A, Karu T, Pihl E, Jürimäe T, Lemberg H (2001) Blood lactate recovery and perceived readiness to start a new run in middle-distance runners during interval training. Perc Motor Skills 93: 397–404.
9. Nurmekivi A, Karu T, Lemberg H, Pihl E, Jürimäe T (2002) Perceived exertion and perceived readiness to begin a new bout during intensive interval training in middle-distance runners. J Hum Mov Stud 42: 441–454.
10. Reilly T (1999) Science and football. Acta Kin Univers Tartuensis 4: 7–26.

PHYSICAL ACTIVITY AND BONE MINERAL DENSITY IN ELDERLY MEN

W. Osinski, R. Szeklicki, R. Stemplewski
University School of Physical Education, Poznan, Poland

INTRODUCTION

Researches of relationships between physical activity (PA) and bone mineral density (BMD) in elderly mostly concern women [2,4,6,7]. Results were diverse but generally positive influence of PA on BMD among older people is indicated.

Blumenthal et al. [1] stated an increase of BMD in men aged 60-83 who made aerobic exercises (3 times a week during 4 months) but only in those with initially low level of BMD. Greendale et al. [3] did not find significant influence of controlled weight training (once a week during 20 weeks) on lumbar BMD (L2–L4) in 58 to 80 years old men.

Aims of this study were to: 1) check if there are differences in BMD in elderly men with different level of PA; 2) estimate the relationship level between PA and BMD; and 3) examine the level of determination of BMD simultaneously by PA, age, height, weight and BMI.

METHODS

96 elderly men (71.8±6.79 years old) living in Poznan (about 600 000 inhabitants) were examined.

The Caltrac accelerometer (Muscle Dynamics, Inc., Torrance, USA) was designed to estimate seven days caloric expenditure related to PA (kcal/week), based on age, sex, weight and height of each subject. The analysis concerned all subjects and also subjects were divided into two groups of different PA level: A – below lower 40% quantile (less than 1500 kcal/week) – 40 men and B – above higher 40% quantile (more than 2000 kcal/week) – 38 men.

BMD (g/cm^2) was estimated by a dual x-ray photon absorptiometry (DEXA), using DPX model (Lunar Radiation, Madison, WI). Radius and ulna bones of non-dominant forearm were measured to estimate BMD. Following locations were used: radius (R-E) and ulna (U-E) distal epiphysis and radius (R-D) and ulna (U-D) diaphysis in 1/3 distance from distal epiphysis.

Age, height and weight were measured and BMI was calculated.

PA results have no normal distribution. Because of this Spearman rank correlation was used. To estimate statistical significance of differences between mean values were counted by t-Student test. Also multiple regression with check of the best subgroup of independent variables was employed.

RESULTS

Comparison of BMD between groups showed significantly higher ($p \leq 0.05$) values of U-E and U-D in more active men. There were no significant differences in R-E and R-D values (Table 1).

Table 1. BMD values in groups with different PA (kcal/week)

BMD [g/cm^2]	Group A n=40	Group B n=38	t-Student test
R-E	0.359±0.068	0.390±0.066	1.98^{NS}
U-E	0.244±0.055	0.272±0.059	2.12*
R-D	0.658±0.110	0.685±0.061	1.33^{NS}
U-D	0.648±0.090	0.688±0.068	2.18*

^{NS}- no significant difference, * $p \leq 0.05$

Estimated correlations between PA and BMD values for all subjects were significant ($p \leq 0.05$) only for epiphysis (U-E) and diaphysis (U-D) of ulna (Table 2).

Table 2. Values of Spearman rank correlation coefficients between PA and BMD for all subjects (n=96)

	BMD [g/cm^2]			
	R-E	U-E	R-D	U-D
PA [kcal/week]	0.199 p=0.051^{NS}	0.226 p=0.026*	0.102 p=0.319^{NS}	0.201 p=0.048*

^{NS}-no significant correlation, *- $p \leq 0.05$

Because the level of PA might be simultaneously correlated with other variables, multiple regression analysis was also employed. Multiply regression analysis with check of the best subgroup of independent variables included estimation of dependent variable (BMD) by five independent variables: age, height, weight, BMI and PA. Coefficients of determination (D%) and numbers of the most significant independent variables (composition of three-, two- or one — variable) for BMD are shown in Table 3.

Table 3. Coefficients of determination (D%) and the most significant independent variables for BMD for all subjects (n=96)

BMD [g/cm^2]	D% – 3 variables	D% – 2 variables	D% – 1 variable
R-E	15.39% – 4. 1. 5	13.37% – 4. 1	10.45% – 4
U-E	9.0% – 5. 1. 4	8.07% – 5. 1	4.67% – 5
R-D	16.02% – 4. 1.5	15.61% – 4. 1	9.61% – 4
U-D	16.81% – 1. 4. 5	13.81% – 1. 4	8.59% – 1

1-age, 4-BMI, 5-PA

From five independent variables used in multiple regression analysis, the most significant for BMD were age, BMI and PA. BMI had the highest influence for R-E and R-D. U-E was mostly determined by PA, and U-D by age. Height and weight did not exist in any model of composition of three, two and one most significant independent variables.

DISCUSSION

The analysis of results (t-Student test, Spearman rank correlation and multiple regression analysis with check of the best subgroup of independent variables) did not allow to reject hypothesis about the beneficial influence of PA on BMD. In our study comparison of BMD between groups with low and relatively high PA showed significantly higher ($p<0.05$) U-E and U-D values in more active men. We received a significant rank correlation ($p<0.05$) between BMD and PA (for U-E $r=0.23$ and for U-D $r=0.20$). Michel et al. [5] obtained similar results. They found higher BMD of spine in 70 years and older men who exercise 200 and more minutes per week in comparison to less active. Blumenthal et al. [1] showed similar relationships only in men (63–80 years old) with low initial level of BMD. Positive influence of habitual PA in premenopausal women was also described by Stillman et al. [8].

Our analysis showed that the interpretation of relationships between PA and BMD from cross sectional study can lead to simplification from biological point of view. The multiple regression proved that the level of BMD correlated not only with PA but simultaneously with other variables, (i.e. age and BMI).

The reasons of differences in forearm bone BMD between groups of different PA level can also be suspected in the level of past PA. Persons with actual higher PA were probably more active in the past and obtained higher peak bone mass. Suominen [9] found higher values of BMD in men engaged in sport in comparison to not trained.

REFERENCES

1. Blumenthal JA, Emery CF, Madden DJ, George LK, Coleman RE, Riddle MW, McKee DC, Reasoner J, Williams RS (1989) Cardiovascular and behavioral effects of aerobic exercise training in healthy older men and women. J Gerontol 44: M147–M157.

2. Drinkwater BL (1994) Physical activity, fitness and osteoporosis. In: Bouchard C, Shephard RJ, Stephens T (eds.) Physical activity, fitness and health. International Proceedings and Consensus Statement. Champaign, Human Kinetics Publishers, pp 724–736.
3. Greendale GA, Hirsch SH, Hahn TJ (1993) The effects of a weighted vest on perceived health status and bone density in older persons. Quality Life Res 2: 141–152.
4. Kemper HCG, Wolff I, Croonenburg JJ, Twisk JWR, Kostense PJ (1999) Can exercise prevent osteoporosis? Meta – analysis of (randomized) controlled trials in pre- and postmenopausal women. Med Sportiva 3: S37–S59.
5. Michel BA, Bloch DA, Fries JF (1989) Weight — bearing exercise, over exercise, and lumbar bone density over age fifty. Arch Int Med 149: 2325–2329.
6. Shephard RJ (1997) Aging, Physical Activity and Health. Human Kinetics.
7. Spirduso WW (1995) Physical Dimensions of Aging. Human Kinetics.
8. Stillman RJ, Lohman TG, Slaughter MH, Massey BH (1986) Physical activity and bone mineral content in women aged 30 to 85 years. Med Sci Sports Exerc 18: 576–580.
9. Suominen H (1993) Bone mineral density and long term exercise. An overview of cross – sectional athlete studies. Sports Med 16: 316–330.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

MOTOR PERFORMANCE TESTING IN ELDERLY WOMEN

M. Pääsuke, J. Ereline, H. Gapeyeva, M. Proosa, K. Joost, K. Mõttus, P. Taba
University of Tartu, Tartu, Estonia

INTRODUCTION

Extension of the leg is an important movement involved in many activities in daily life, one of them being rising from a chair that is difficult to perform without the use of the hands for many elderly people. Elderly subjects with Parkinson's disease (PD) often have difficulties with this movement. The inability to perform chair rising, especially quickly, has been associated with increased risk of falling [3,6]. Rising from a chair is a challenging task that requires relatively high leg extensor muscle strength, joint ranges of motion and balance control [1,2]. Several investigations stress the importance of knee extensor muscle strength in older persons for the successful chair rising performance [1,2,4,5]. However, the differences in force preparation and production capacity of the knee extensor muscles, and chair rising performance between patients with PD and healthy elderly subjects is not clear. The aim of this study was to compare chair-rise performance and leg extensor muscle isometric strength in elderly women with mild-to-moderate Parkinson's disease and age- and gender matched healthy women.

METHODS

Twenty eight elderly (68–90-year-old) women participated in this study. The subjects were divided into two groups: patients with mild-to-moderate PD (with mean ±SE age 74.3±2.0 yrs, height 157.4±1.7 cm, body mass 64.8±2.0 kg and body mass index 26.2±0.7 $kg.m^{-2}$, n=12) and healthy women (with mean±SE age 71.7±1.1 yrs, height 157.6±1.5 cm, body mass 65.3±2.0 kg and body mass index 26.3±0.7 $kg.m^{-2}$, n=16). All subjects were able to perform rising from a chair independently without using their upper limbs. Inclusion criteria for patients was a diagnosis of idiopathic PD with a disease severity rating of stage I to III (mild to moderate PD) on the Hoehn and Yahr's scale. The PD duration ranged from 3 to 18 years. All patients were medicated with ordinary anti-PD drugs and they were measured during the stable "on" period.

Chair-rise movement was performed from standard height chair at normal and fast speed. Force plate mounted in the floor measured vertical ground reaction force (VGRF) during chair-rise. The arms were folded, with hands grasping the elbows and kept against the chest. Subjects performed rising from a chair at first at a self-paced, comfortable speed and then as fast as possible. The following force-time characteristics were calculated while rising from a chair for each leg: maximal VGRF and maximal rate of vertical ground reaction force development (VGRFD). Chair rising time was calculated by electrogoniogram from initial knee flexion to the time at which full extension of the knee was first reached.

Leg extensor muscle strength was measured during unilateral (UL) and bilateral (BL) isometric contractions using a specially designed dynamometric chair. The subjects were tested on seated position and the feet were placed on a foot-plate mounted on a steel bar held in ball-bearings on the frame. During testing isometric maximal force (MF) the subjects were instructed to push the foot-plate as forcefully as possible for 2–3 s in three cases: 1) UL contraction of the right leg, 2) UL contraction of the left leg and 3) BL contraction in random order. Bilateral force deficit (BL_{def}) was calculated by the formula: $BL_{def} = 100 - (BL/UL_R + UL_L) \cdot 100\%$, where BL – MF during bilateral contraction, UL_R – MF of the right leg during unilateral contraction, UL_L – MF of the left leg during unilateral contraction. During testing force-time characteristics of fast voluntary BL contraction and relaxation the subjects were instructed to react to the light signal as quickly and forcefully as possible by pushing feet on the foot-plate, maintain maximal effort as long as the signal was on (2 s) and relax the muscles after the disappearance of the signal. Isometric rate of force development (RFD) and half-relaxation time (HRT) were recorded. Data are means and standard errors (±SE). One-way analysis of variance followed by Tukey post hoc comparisons were used to test for differences between groups. A level of $p<0.05$ was selected to indicate statistical significance.

RESULTS

Maximal VGRF and rate of VGRF development, and chair rise time while rising from a chair with comfortable speed did not differ significantly ($p>0.05$) in PD patients and healthy women (Fig. 1). Healthy women had shorter ($p<0.05$) chair rise time while rising from a chair with maximal speed compared with PD patients. However, no significant differences ($p>0.05$) in maximal VGRF and rate of VGRF development while rising from a chair with maximal speed were observed between the measured groups. Healthy women had greater ($p<0.05$) MF and RFD of the leg extensor muscles during BL contraction and MF during UL contraction of the right leg than PD patients (Fig. 2). No significant differences ($p>0.05$) in isometric MF during UL contraction of the left leg, BL force deficit and HRT during fast relaxation after maximal BL contraction were observed between measured groups.

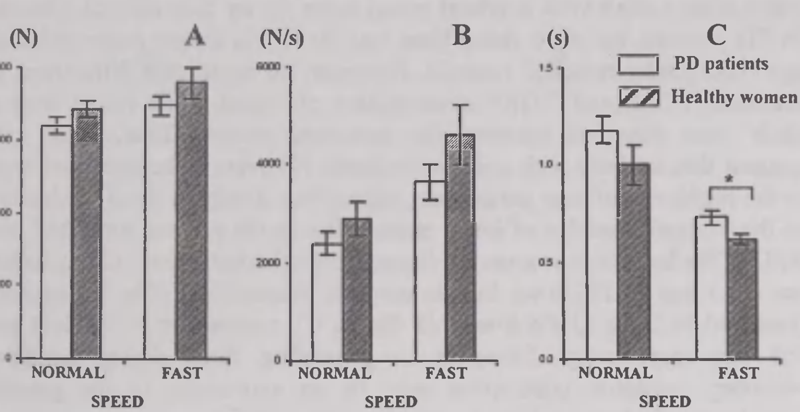


Fig. 1. Maximal vertical ground reaction force (VGRF) (A), rate of VGRF development (B) while rising from a chair and chair rise time (C) in PD patients and healthy women (mean ±SE). * $p<0.05$.

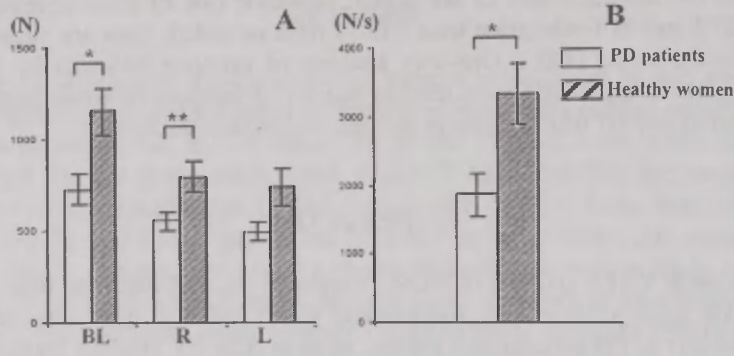


Fig. 2. Maximal isometric force of the leg extensor muscles during bilateral (BL) contraction and unilateral (UL) contraction of the right (R) and left (L) leg (A), and maximal rate of force development (B) during BL contraction in PD patients and healthy women (mean ±SE).
* p<0.05; ** p<0.01.

DISCUSSION

The results of the present study indicated that the PD patients performed rising from a chair with maximal speed more slowly than control subjects. In PD patients, the chair rising time was by 16.1% longer compared with age- and gender-matched controls. However, no significant differences in maximal VGRF and VGRF development produced while rising from a chair were observed between the measured groups. Thus, these data suggest that subjects with mild to moderate PD seem to be more deficient in the regulation of time parameters, rather than simply in force production of the extensor muscles of lower extremities. In the present study MF and RFD of the leg extensor muscles during bilateral contraction in PD patients was 37.3 and 44.1% lower than in controls, respectively. The PD patients produced 30.5 and 33.4% lower MF during UL contraction of the right and left leg, respectively. Slowness in generating force during maximal voluntary isometric contraction may be an expression of the general bradykinetic features and more variable motor unit firing.

REFERENCES

1. Gross MM, Stevenson PJ, Charette SL, Pyka G, Marcus R (1998) Effect of muscle strength and movement speed on the biomechanics of rising from a chair in healthy elderly and young women. Gait Posture 8: 175–185.
2. Hughes MA, Myes BS, Schenkman ML (1996) The role of strength in rising from a chair in the functionally impaired elderly. J Biomech 29: 1509–1513.
3. Nevitt MC, Cummings SR, Kidd S, Black D (1989) Risk factors for recurrent nonsyncopal falls. A prospective study. J Am Med Assoc 261: 2663–2668.
4. Pääsuke M, Mõttus K, Ereline J, Gapeyeva H, Taba P (2002) Lower extremity performance in older female patients with Parkinson's disease. Aging Clin Exp Res (Accepted).
5. Schenkman M, Hughes MA, Samsa G, Studenski S (1996) The relative importance of strength and balance in chair rise by functionally impaired older individuals. Am J Geriatr Soc 44: 1441–1446.
6. Tinetti ME, Speechley M, Ginter SF (1988) Risk factors from falls among the elderly persons living in the community. New Engl J Med 319: 1701–1707.

EXPERIMENT IN DIDACTICS OF PHYSICAL EDUCATION

D. Rajtmajer, M. Vehovar
University of Maribor, Maribor, Slovenia

INTRODUCTION

According to Tos Hafner-Fink, an experiment is more than a basic data collecting technique; it is a research procedure [6]. Frenchman La Place was one of the most deserving in the field of introducing an experiment in sociological studies. He introduced the theory of probabilities and established the significance of a constant factor in experimental situation. He also realised the importance of the sample expanse and the usefulness of parallel groups (experimental and control group) [1]. An experimental method makes it possible to get an insight look into causal relation between two or more variables [1]. At the same time we can examine their exactness and incorrectness respectively. This was confirmed also by Yule and Kendall [8] who emphasised that an observer of social phenomena could not experiment. He/she can only observe the circumstances as they are (without controlling them). Therefore, it is not possible to simplify the observing factors. This is just contrary to physical and chemical experiments where an observer has to deal with extremely complicated examples of multiple causality, nevertheless the result can be the consequence of any alternative causes or consequences. In the field of pedagogical experiment, Meumann and his teacher Wundt distinguished experimental and other methods of research observation. They defined the basic criteria. They believe that the methods differ in the degree of influence that a researcher exerts on the course of phenomena and processes he/she examines [4]. Meumann categorically affirms that a researcher can have a great ascendancy over the experiment proceedings. He/she intervenes in them, causes them systematically and varies the degree of their effect on the entities. In the main, experiments in pedagogical practice should systematically examine the effects of educational actions, affirms Schmidt [5], who exerted a great influence upon its usage. In this way we can investigate the causal relations between teaching and educational steps and their results [5]. However, we should not forget that the effect of individual factors in the field of education depends on different phenomena. This problem can not be solved simply by random sampling. A low variability of factors should be provided. If this is not possible, they should be eliminated. The accuracy of an experiment should therefore depend on a sufficient number of samples and on equalisation of parallel groups. The application of an experiment in didactics and pedagogical processes is logical if the basic technical and theoretical information about the subject-matter is known. This basic data has been achieved by means of descriptive methods (for this purpose we attended PE lessons and carried out more than 1200 demonstrations during the 10-week period). We tested motor abilities of 1600 children from 5.5 to 6.5 years of age [3]. We also used the results of other authors [9]. We were examining the effects of organised psycho-motor learning in physical education in pre-school. We wanted to define the differences between initial and final knowledge of children and the difference between experimental and control group. The testing was done in different disciplines. The aim of the experiment was to teach the children the basic elements of a long jump, somersaults (on the ground) and controlling, throwing and catching the ball. For this purpose, the preliminary testing of 94 children was carried out in eight kindergartens [7]. The didactical approach of the research project resulted in improvement of motor abilities and motor knowledge of all children [7]. During the research project we also verified several hypothesis. First of all (1), we wanted to prove that the progress is of statistical importance. The other hypothesis were: (2) efficiency of teachers is insufficient, (3) the contents of practice would be adequate, (4) there would be no significant differences regarding gender and (5) the organisation of practice would be adequate as well. The analytical stage of the research project was planned to be a complex of partial studies. Above all, we were orientated towards effective testing of initial and final condition. At the same time we have also tried to verify the adequacy of contents and qualification of teachers to perform this exacting program.

METHODS

The children from 5.5 to 6.5 years of age were organised in an experimental (180 children) and control (180 children) groups. They were chosen at random and equalised with parallel groups after initial testing. They were all in good health and capable of performing the program. The testing samples were made up of four tests: somersaults (forwards, on the ground), long jump, controlling a ball, throwing and catching the ball. Three examiners on the previously defined criteria evaluated the knowledge. They assessed the performance of children in points from 2 to 9. The whole experiment (training process and testing) lasted 10 weeks. The procedures of testing (the selection of children and examiners, testing and evaluation, data control and defining of parallel groups) were equalised. For young children from 5.5 to 6.5 years of age, the exercises of the experimental program represent highly exacting tasks that require a long-continued learning, It is a well-known fact that they have to do the same or modified movement over a hundred times if we want to form motion stereotypes with automatic regulation of movement. A lengthy training can lessen the motivation. Therefore, adequate methods for children at this age should be used. Data processing included descriptive statistics by groups and gender. Subtracting the initial results of final results of experimental and control group defined acceleration progress. We also defined statistical importance of progress by means of T-test and regulated the tables and graphs showing results.

RESULTS AND DISCUSSION

The complete project is supposed to be finished in June 2002. Therefore, at this point, the quantitative analysis is based on random sampling of four parallel groups (one for each discipline). After having subtracted the results of the control group, the final result (improvement of knowledge) of the experimental group is: 1.70 in testing long jump, 1.2 in throwing and catching the ball, 1.1 in controlling the ball and 2.5 in testing the somersaults forwards on the ground. The final situation of all groups will certainly be different. However, the difference between parallel groups is evident. The fact is that there was a statistical importance of great improvement of knowledge in all experimental groups. That confirms the first hypothesis.

Verifying the second hypothesis, we have found out that the efficiency of teachers is insufficient. The progress of children could be greater if trained PE teachers performed the teaching of motor knowledge. However, this is not necessarily true because they are usually qualified to work with children over age of 11. The best solution to the problem would certainly be teaching "in tandem" — a PE teacher and counsellor. We believe that the program was adequate. However, to confirm the third hypothesis, a precise analysis of 300 lesson plans should be done, the same holds true for the last two hypothesis. There were the least problems in organising the initial and final testing (evaluation in points from 2 to 9), which was performed by 90 examiners. Nevertheless, the reliability of assessing is questionable — it is a well-known fact that "internal" evaluation always inclines to overestimation.

CONCLUSIONS

The successfulness of the experiment is incontestable because the knowledge of all groups has improved. This was the very first research project with young children (other authors in the field of sports didactics and pedagogics worked with older children). We have learn a lot and come to important conclusions. There is absolutely no doubt that at this age the control of psycho-motor learning is needed. The research project contributed a great deal to the treasury storing the knowledge about motor learning of young children.

REFERENCES

1. Muzic V (1973) Methodology of Pedagogical Research. Sarajevo, pp. 73–111.
2. Rajtmajer D (1991) Methodology of Physical Education II. Maribor: Pedagoska fakulteta, pp. 21–46.
3. Rajtmajer D (1997) Diagnostic-prognostic Value of Norms of some Motor Abilities of Younger Children, monography. Maribor: PF.
4. Sagadin J (1993) The Chapters from Pedagogic Research Methodology. Ljubljana: ZRSS, pp. 6–12.

5. Schmidt V (1960) An Introduction into Pedagogic Methodology. Ljubljana: ZRSS, pp. 77–87.
6. Tos N, Hafner-Fink M (1998) The Methods of Social-science Research. Ljubljana: FDV, pp. 155–175.
7. Vehovar M (2001) Development of some Complex Motor Structures of Young Children by Effect of Didactic Process. Ljubljana: FS, pp. 385–365.
8. Yule G, Kendall VMG (1950) An Introduction to the Theory of Statistics. Ljubljana: ZRSS, pp. 6–14.
9. Zimmer R, Volkamer M (1984) Test of Motor Abilities for 6 Year Old Children. Weinheim, Manuel.

DEVICE FOR MOVEMENT COORDINATION MEASUREMENT AND TRAINING

G. Schalow, M. Pääsuke, J. Ereline, H. Gapeyeva
University of Tartu, Tartu, Estonia

INTRODUCTION

The optimisation of central nervous system (CNS) functioning to improve neuromuscular performance has not received sufficient attention. This is astonishing since the CNS regulates the motor program for muscle activation, the co-operation of motor units in a muscle for enhancing muscle strength as well as breathing and blood circulation. In patients with CNS injury coordination dynamic therapy has been shown to improve neuromuscular performance and physical fitness [2–7]. If the functioning of the injured CNS of patients can be improved by motor learning then this should also be possible in the CNS of healthy subjects. Especially the improvement of phase and frequency coordination in the premotor neural networks for high load will give rise to (1) more coordinated firing of motor units with the consequence of increased muscle strength; (2) better functioning of the autonomic nervous system including the improvement of the cardiovascular circulation and breathing; and (3) improvement of the higher mental functions [2]. The aim of this study was to measure the changes in movement coordination and leg extensor muscle isometric strength characteristics in healthy young women after coordination training using a special coordination dynamic device.

METHODS

Six healthy females (with mean±SE age 20.0±1.0 yrs, height 167.3±2.3 cm, body mass 58.9±2.7 kg and body mass index 21.0±0.5 $kg \cdot m^{-2}$) participated in a two-week coordination training on a special coordination dynamic device (Fig. 1A). The subjects exercised 5 times per week and 2 hours per day (~10,000 integrative coordinated movements per day). The CNS organization and its functional improvement was measured by the coordination dynamics (Δ (df/dt)/f; f = frequency) between arm and leg movements (Fig.1B, C) [2,3]. The exactness of the coordination between arms and legs for different coordinations between pace (P) and trot gait (K) reflects the quality of CNS self-organization materialised by relative phase and frequency coordination between the firings of neurones and neural assemblies of its neural networks. Maximal force (MF) of the leg extensor muscles was measured during unilateral (UL) and bilateral (BL) isometric contractions using a specially designed dynamometric chair [1]. The subjects were tested in seated position, the feet placed on a foot-plate mounted on a steel bar held in ball-bearings on the frame. During testing the subjects were instructed to push the foot-plate as forcefully as possible for 2–3 s in three cases: 1) UL contraction of the right leg; 2) UL contraction of the left leg; and 3) BL contraction in random order. Bilateral deficit (BL_{def}) was calculated by the formula: $BL_{def} = 100 - (BL/UL_R + UL_L) \cdot 100\%$, where BL – MF during bilateral contraction, UL_R – MF of the right leg during unilateral contraction, UL_L – MF of the left leg during unilateral contraction. The movement coordination and muscle strength characteristics were recorded before and after the 2-week training, and after 3 months.

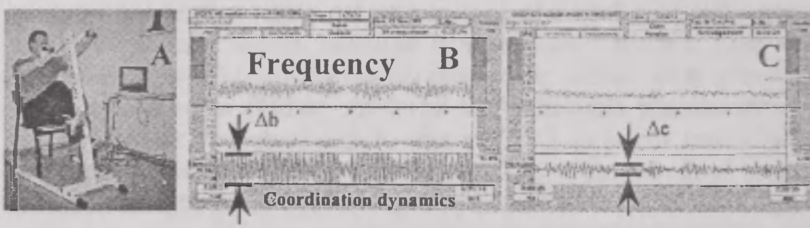


Fig. 1. A special coordination dynamic training and measuring device (A) and movement coordination recording at the beginning (Δb, B) and end of training (Δe, C). P – pace gait; K – trot ga

Data are means and standard errors (±SE). Two-way analysis of variance followed by Tukey post hoc comparisons were used to test changes in measured characteristics after training. A level of $p<0.05$ was selected to indicate statistical significance

RESULTS

Coordination between arms and legs before and after 2 weeks of training. After 2 weeks of training the coordination dynamics between arms and legs improved on average for a low load of 20N for forward turning by 17% ($p>0.05$) and for backward turning by 55% ($p<0.05$) (Fig. 2). For a high load of 200N the coordination dynamics improved by 57% ($p< 0.05$).

Motor learning time course. The coordination dynamics for low-load and high-load backward turning were plotted against the days of training to get more information on physical performance and fitness. The coordination dynamics improved (the arrhythmicity of turning decreased) with ongoing training for all trained movements. For low-load forward and backward turning the coordination dynamics seemed to reach a certain static level (Fig. 2A,B), whereas for high-load exercising the coordination dynamics further improved towards the end of training (Fig. 2C).

Motor memory. Three months after the training the low-load and high-load coordination dynamics were measured again to see how permanent by the improved coordination between arms and legs was learned (Fig. 2). Low-load and high-load coordination dynamics had changed only slightly from the improved level. The improved coordination between arms and legs for low and high load went therefore into the long-term memory.

Leg extensor muscle strength. MF of the leg extensors increased after 2-week training as compared to the initial level before training during BL contractions and UL contractions of the right and left leg 12.8, 13.6 and 1.1%, respectively ($p>0.05$) (Fig. 3). After training BL deficiency was decreased by 34.6% (from 14.8 to 9.7%) as compared to the level before training ($p>0.05$).

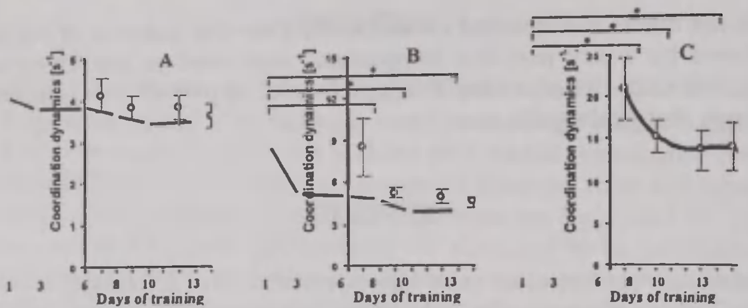


Fig 2. Coordination between arms and legs (quantified by the arrhythmicity of turning) for low-load forward turning (A), low-load backward turning (B) and high-load forward turning (C) with ongoing training. Coordination dynamics. $\Delta(df/dt)/f$, f– frequency; * $p<0.05$.

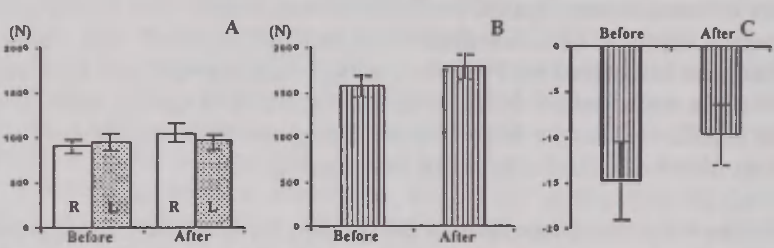


Fig. 3. Maximal force of the leg extensor muscles during unilateral (A) and bilateral (B) isometric contractions and bilateral deficit (C) before and after training.

DISCUSSION

We have shown that the coordination between arm and leg movements improved substantially during 2 weeks of training. Unexpected was that the learned improved coordination was not forgotten by the CNS after 3 months. The exact coordination between arm and leg movements is very important for physical performance. Following 3 months of no therapy the low-load coordination dynamics worsened by 10% in patients with CNS injury [7]. The motor memory is therefore better in healthy subjects. The improvement of the coordination between arm and leg movements for high load showed between the 5^{th} and 8^{th} day a plateau or even a small decrease (increase in the arrhythmicity of turning again; Fig. 2C) which may be due to exhaustion. Between the 8^{th} and 13^{th} day the coordination improved then strongly again. The significant improvement of the coordination between arms and legs especially for high load indicates therefore improvement of physical performance and fitness.

It is concluded that the extremely exact coordination training especially for high load and the non-invasive, on-line measurement of the coordination dynamics is an efficient training and measuring method for increasing and measuring physical performance and fitness in healthy subjects.

REFERENCES

1. Raudsepp L, Pääsuke M (1995) Gender differences in fundamental movement patterns, motor performances and strength measurements of prepubertal children. Ped Exerc Sci 7: 294–304.
2. Schalow G, Zäch GA (2000) Reorganization of the human CNS. Gen Physiol Biophys 19: S1–S244.
3. Schalow G (2001) On-line measurement of human CNS organization. Electromyogr Clin Neurophysiol 41: 225–242.
4. Schalow G (2001) Time axis calibration in human CNS organization for judging dysfunction. Electromyogr Clin Neurophysiol 41: 485–505.
5. Schalow G (2002) Stroke recovery induced by coordination dynamic therapy and quantified by the coordination dynamic recording method. Electromyogr Clin Neurophysiol 42: 85–104.
6. Schalow G (2002) Improvement after traumatic brain injury achieved by coordination dynamic therapy. Electromyogr Clin Neurophysiol (In press).
7. Schalow G (2002) Spinal cord recovery achieved by 3 months of coordination dynamic therapy. Electromyogr Clin Neurophysiol (in press).

SUBJECTIVELY EVALUATED PHYSICAL ACTIVITY AND OBJECTIVELY TESTED PHYSICAL CAPACITY AMONG STUDENTS

L. Siupsinskas, A. Vainoras, G. Pilkauskaite
Kaunas University of Medicine, Kaunas, Lithuania

INTRODUCTION

The main task was to compare objectively tested physical capacity with subjectively evaluated physical activity among students of Kaunas University of Medicine.

METHODS

Were evaluated 134 forth year students (96 females and 42 males) of the Faculty of Medicine of Kaunas University of Medicine. All the students performed Eurofit tests of physical fitness [1]. This set of tests consists of nine tests. In this research, we have used these tests of physical fitness: endurance shuttle run for the evaluation of cardio — respiratory endurance, hand grip for the evaluation of static strength of the hand, standing broad jump for the evaluation of explosive power of the leg's muscles, sit — ups for the evaluation of the trunk strength, shuttle run: 10 x 5 meters for the evaluation of running speed — agility, plate tapping for the evaluation of speed of the limb movement, sit-and-reach for the evaluation of the flexibility of the trunk, Flamingo balance test for the evaluation of the total body balance. All the students were evaluated at the same hour and by the same testator during the semester. In order to supplement Eurofit tests for better reflection of the functionality of the organism we used other tests and calculations. Two parameters were calculated: body mass index (BMI): BMI = Weight (kg) / Height ^{2} (m) and respiratory index (RI): RI = V_{max} (ml) / Weight (kg), where V_{max} – maximal volume of the lungs. Anthropometric measures were estimated for every student. We have analyzed relative, percentage amount of the muscles and fat tissue for each person according common body mass. Heart rate, systolic and diastolic blood pressure at rest, power of squats and respiration (Schtange and Henche tests) parameters were also estimated. All the students filled special compiled questionnaire about their health status and physical capacity level, physical and sports activity. We have divided data into four groups according to the averages (less and more) of BMI and RI indexes (separately males and females). Objectively tested physical fitness (all the tests) and subjectively evaluated physical activity (according to the questionnaire) were analyzed in each group. In order to compare the data between groups we have had to normalize research results according to the average and dispersion of each group.

RESULTS

Normalized Eurofit and other tests measures were divided into four groups (A,B,C,D) for each gender according to the averages of BMI and RI indexes:

A group: BMI>average, RI<average,
B group: BMI>average, RI>average,
C group: BMI<average, RI<average,
D group: BMI<average, RI>average.

Analyzed results showed that the highest objectively tested physical capacity was in group B with high BMI and RI for both genders. Lowest results had group C of males with low BMI and RI and group D of females with low BMI and high RI. We have decided to analyze questionnaire results and to compare objectively tested physical fitness and subjectively evaluated physical activity between these two groups of both genders. five questions from questionnaire were selected and analyzed: “How will You describe Your level of physical capacity?”; “How often You are physical active during the day at least 30 minutes?”; “Do You think that You have supposed to be more physical active?"; "Did You went in for sports before studies at the university?"; and "Are You going in for sports now?". Analyzing answers to question about own described physical capacity, we found that all the male students of "best" group B described own physical capacity as "good". Only 42.8 % of male students of "worse" group C stated that their physical capacity is good ($p<0.05$). No differences between answers to this question were observed among females. All the male students of "best" group claimed that they are "often" physical active during the day at least 30 min, unfortunately only 57.1% of "worsen" group answered the same. Statistically significant ($p<0.05$) bigger number (90.8%) of female students of "best" group answered that there are physical active "often" than "worsen" group of females (56.6%). Only 33.3% of male students of "best" group stated that their should be more physical active, even 85.7% of male students of "worsen" group thought that they should be more active. Opposite situation was observed among females. 81.8% of female students of "best" and 73.3% of "worse" group claimed that they should be more physical active. All the male students of "best" group and 57.1% male students of "worsen" group stated that they went in for sports before studies at the university and going in for sports now. The same number of female students of "best" group answered than they went in for sports before studies at the university and going in for sports now. Number of female students of "worsen" group (73.3%) which went in for sports before studies at the university fell down to 36.7% which are going in for sports now.

DISCUSSION

According to the results we can come to conclusion that subjectively evaluated physical activity proved objectively tested physical capacity level with some differences according to gender.

REFERENCES

1. Committee of experts on sports research (1993) EUROFIT Hand book for the EUROFIT tests of Physical Fitness. Second edition, Strasbourg.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

TESTING OF ESTONIAN YOUNG FEMALE VOLLEYBALLERS' (AGED 13–16) PHYSICAL ABILITIES CONSIDERING THEIR BODY BUILD

R. Stamm[1], M. Stamm[2], S. Koskel[1], H. Kaarma[1]
[1]*University of Tartu, Tartu, Estonia*
[2]*Tallinn Pedagogical University, Tallinn, Estonia*

INTRODUCTION

To improve adolescents' volleyball coaching in Estonia, along with other information, we need objective data on young female volleyballers' physical abilities and body build. The aim of the present study was to collect and analyse such data in order to draw up a testing programme, which could be used by coaches all over Estonia.

METHODS

The sample consisted of 46 young female volleyball players aged 13–16 years (average age 14.6), who belonged to six training groups. All of them practised volleyball regularly and participated in young female volleyballers' championships in the age group of up to 16 year olds. Anthropometric measuring and testing of physical abilities were carried out during the same session. The same researchers examined all the teams.

Physical ability tests

All the subjects passed the following seven validated tests of physical fitness. Jumping ability was measured by two vertical jump performance tests [10] — standing vertical jump and reach (PA_1) and running vertical jump and reach (PA_2). Maximum aerobic endurance was measured by 20 m shuttle run (PA_3) [8]. Trunk strength (PA_4) was measured using a sit-up test [1]. The flexibility test (PA_5) measured the extent of bending forward from sitting position [7]. Deftness and speed of movement were measured by a zigzag run test (PA_6) [6]. Upper body and arms strength was measured by the medicine ball throwing test (PA_7) [9].

Anthropometric testing

The girls were healthy and their sexual development corresponded to Tanner's stages III–IV. The methodology of the anthropometric study relied on the long-term research carried out on many populations at the Centre for Physical Anthropology, University of Tartu [3, 4]. The girls were measured according to the classical methods of Martin [5]. Measuring of skinfolds followed the methodology provided by Knussman [5]. Lower extremity length was measured according to Jatsuta's method [2] and skinfolds with Holtain skinfold callipers. A total of 43 body measurements, including 11 skinfolds, were taken. The measurements included body weight and height, nine length measurements and six breadth-depth measurements. Thickness of limb bones (femur, ankle, humerus and wrist breadth), 15 circumferences and 11 skinfolds were measured. Statistical analysis was made using the SAS system.

RESULTS

Results of physical ability tests and their dependence on age are presented in Table 1. As the results showed great variability, we divided the data on the basis of $\overline{X}$ and SD into five classes and calculated, considering all the test results, the average score of points for each girl. By their anthropometric characteristics — height and weight — the girls surpassed the Estonian average for their age group (average height: 13 years — 163.19 cm; 14 years — 164.08 cm; 15 years — 168.43 cm; 16 years — 169.60 cm; average weight: 13 years — 54.48 kg; 14 years — 52.55 kg; 15 years — 58.26 kg; 16 years — 60.46 kg). Study of the anthropometric structure of the body as a whole revealed that the latter was determined by statistically significantly related individual characteristics. The leading characteristics in the whole system were height and weight, which determined 20–90% of the variability of each characteristic. The existence of such a system suggests that all individual characteristics represent not only a concrete body measurement but partially also the body as a whole. Consequently, one might suppose that, equally with height and weight, all other characteristics can be used for establishing the impact of body build on test results. All the tests of physical abilities except that of stomach muscles strength (PA_4) and flexibility (PA_5) showed correlation with individual anthropometric characteristics. Thus, jump tests correlated with all the measured variables except indicators of body fat content (BMI, skinfolds, amount of subcutaneous adipose tissue in kilograms and its percentage of body weight). Medicine ball throwing test (PA_7) correlated with the general size of the body, upper extremities' length, bone-muscle strength of the trunk and extremities (extremities' circumferences, extremities' bones thicknesses); there was, however, no correlation with body fat content. Endurance test (PA_3) showed negative correlations with all body characteristics, and better results were achieved by smaller girls. The results of the speed test (PA_6) were worse in volleyballers with higher body fat content. Dependence of physical ability tests results on body build could be predicted by multiple regression analysis (Table 2). We applied two parallel models. In the first one, the arguments included only age, height and weight; the second model contained a combination of 3–4 other variables that had revealed significant correlation with the test studied. We found that, although the first model was significant in the case of all the tests, determining their variability within 24–75%, the second model predicted physical ability test results with greater precision (42–89%).

Table 1. Basic statistics of young female volleyballers physical fitness tests results and their correlation with age

No	Variable	$\bar{x}$	SD	Min	Max	Statistically significant correlation with age
1.	Test of highest jump and reach standing (PA_1) (cm)	252.98	10.01	237.00	275.00	0.38
2.	Test of highest jump and reach running (PA_2) (cm)	256.98	10.08	243.00	284.00	0.37
3.	Endurance test (Eurofit, PA_3) (sec)	375.78	84.70	135.00	545.00	–
4.	Test of strength of stomach muscles (PA_4) (sec)	169.68	59.56	85.00	300.00	–
5.	Test of flexibility (PA_5) (cm)	16.63	6.53	4.00	32.50	–
6.	Test of speed measuring (PA_6) (sec)	27.70	1.48	24.70	33.00	–
7.	Medicine ball throwing test (PA_7) (cm)	300.37	44.35	210.00	400.00	–

DISCUSSION

The results of our study showed the great variability of young female volleyballers' body build and physical abilities, and correlations between them. This confirms the need for considering constitutional peculiarities in volleyball coaching. The seven physical ability tests used by us and the 21 body measurements that belonged to the regression models could be used for drawing up testing programmes. We would get the best overview of adolescent female volleyballers' abilities and performance if we used the teams results at competitions in combination with testing at championship games once a year. Entering the data into a database that is being created would enable us to carry out regular complex longitudinal assessment of Estonian young volleyballers' performance.

REFERENCES

1. Brewer J, Davis J (1993) Abdominal curl conditioning test. Leeds: The National Coaching Foundation.
2. Jatsuta KZ (1923) Ob izmerenii nizhnei konechnosti na zhivom. Rus Antrop 12: 3–4 (In Russian).
3. Kaarma H (1995) Complex characterization of women's body measurements. Anthrop Anz 3: 239–244.
4. Kaarma H, Veldre G, Stamm R, Lintsi M, Kasmel J, Maiste E, Koskel S (2001) Regularities of body build structure of Estonian girls and youths. Morphology (Arch Anat Hist Embr) 6: 80–82 (In Russian).
5. Knussman R (1988) Anthropologie: Handbuch der vergleichenden Biologie des Menschen. Vol 1: Wesen und Methoden der Anthropologie. Stuttgart: Gustav Fischer Verlag.
6. Kuramsin JF, Persin AN, Popovski AN (1985) Otbor i prognozirovaniye potentsialnykh vozmozhnostey voleibolistov na etape nachalnoy podgotovki, 20. (In Russian).
7. Larson LA (1974) Fitness, health and work capacity. International standards for assessment. New York, NY: Macmillan.
8. Leger L, Mercier D, Gadoury C, Lambert J (1988) The multistage 20 metre shuttle run test for aerobic fitness. J Sport Sci 6: 93–101.
9. Viitasalo J (1988) Evaluation of explosive strength for young and adult athletes. Res Quart Exerc Sport 59: 9–13.
10. Young W, MacDonald C, Hegger T, Fitzpatrick J (1997) An evaluation of the specificity, validity and reliability of jumping tests. J Sport Med Phys Fitness 37: 240–245.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

MORPHOLOGICAL AGE OF SCHOOL-AGED INDIVIDUALS WITH DIFFERENT LEVELS OF MOTOR PERFORMANCE

A. Suchomel
Technical University, Liberec, Czech Republic

INTRODUCTION

In some age periods, there can be significant disproportion between the biological age and chronological age. As for pre-pubescent and pubescent individuals, it is not surprising to find disproportion bigger than 2 years. As for men, these differences gradually disappear between the age of 17 and 20 (for women, it happens 2 years earlier). According to analysis of the published findings, it is obvious that the motor performance of biologically accelerated individuals is usually better than the motor performance of biologically average or retarded individuals, which is valid especially for pubescent boys. Biologically accelerated individuals have better motor performance in test of speed and strength abilities [2,5]. The aim of the paper was to determine the morphological age (growth age, proportional age) of school-aged boys and girls (8-9 and 12-13 years old) with low and high motor performance in the test battery UNIFITTEST (6-60).

METHODS

Method of selecting subjects

We used the test battery of UNIFITTEST (6-60) for evaluation of motor performance of school-aged children. It contains four motor tests: standing broad jump, sit-ups 60 seconds, endurance shuttle run 20 m and shuttle run 4 x 10 m [4].

The representative sample consisted of 253 boys and 267 girls aged 8–9.99, 247 boys and 262 girls aged 12–13.99. On the basis of motor testing, we selected: a) individuals with a low motor performance, their test scores were over 1.5 standard deviation below the average value — four samples contained 19–25 children; b) individuals with a high motor performance, their test scores were over 1.5 standard deviation above the average value — four samples contained 17–23 children.

Methods of data analysis

The growth age was processed with the use of percentile growth charts [3]. We determined the so-called height bands (considering the chronological age, they are: I. very tall, II. tall, III. medium height, IV. short, V. very short) and the so-called height-weight proportionality (A – obese, B – robust, C – proportional, D – slim, E – very thin figure). Due to the significant influence of the genetic factor on body height, we used population nomograms to evaluate the participants' heights via the medium height of their parents [3].

The biological proportional age was processed with the use of the KEI values [1]. Then we converted the KEI values to years. We used estimating equations, which are classified according to decimal age and sex [5]. The last stage in this procedure was determination of the differences between the chronological and biological age. We calculated the KEI values by the anthropologic software ANTROPO version 98.1.

RESULTS AND DISCUSSION

Legend – abbreviations used in this chapter. M = prepubescent individuals (aged 8 – 9); S = pubescent individuals (aged 12 –13); D = girls; CH = boys; N = low level of motor performance; V = high level of motor performance; K-W test = the Kruskal-Wallis test; $\chi^2_{0.01;7}$ = chi-square (the 0.01 significance level; 7 degrees of freedom).

Distribution of the selected individuals into the 25 categories according to the percentile growth charts indicated in accordance with our presumption that the average height band (III) is the most frequent. Considering the height-weight proportionality of the V individuals, we can find out that with the exception of 2 MCHV individuals, all the children belong to either the C band (a proportional figure) or the D band (a slim figure). As for the N groups, the prepubescent individuals have rather proportional figures, but the pubescent N individuals have more robust and more obese figures. Most of the SDN individuals belong to the B band (robust figures). Most of the SCHN individuals belong to the A band (obese figures). The results show that the N and V individuals' age does not influence their inclusion to the normative height bands. On the contrary, considering the height-weight proportionality the pubescent individuals have relatively bigger body weight than prepubescent ones of the same sex and motor performance.

We evaluated body height of selected individuals via the medium height of both the biological parents. We found out that the median values of percentile differences between the population nomograms and the percentile growth graphs do not significantly differ from zero, which is valid for all the groups. The explored N and V individuals have been growing up proportionately to their hereditary predisposition. There is a tendency to a higher variability in the female groups.

On the basis of the K-W test ($95.92 > \chi^2_{0,01;7}$) with subsequent pair comparison of the selected groups, we found out in accordance with presumption significant differences between the pre-pubescent and the pubescent groups at the 0.01 level, but we did not find any significant differences in the relation to motor performance. The results of differences between the biological and chronological age (Table 1) show big ranges in the selected groups. The range in the prepubescent N samples and all pubescent samples was more than 3 years. The values of the range and interquartile range indicated higher variability in the N groups, where maximal positive differences were recorded. A SCHN boy's biological acceleration was equal to 3.1 years. A SDN girl's acceleration was equal to 3.6 years. Both the individuals were obese and it was difficult to localise anthropometric points on their bodies. The minimal values are in the V groups (a SCHV boy – 1.9 years; a SDV girl – 2.4 years). These spans approximately correspond to the findings in an average child population [2,5].

Table 1. Differences between the biological and chronological age of the selected individuals (years).

n	MCHN	MCHV	SCHN	SCHV	SCHN	SCHV	SDN	SDV
	19	23	24	18	22	20	25	17
x_{max}	2.10	1.00	2.50	1.10	3.10	2.00	3.60	0.80
x_{Me}	0.30	0.10	0.50	–0.20	0.70	0.05	0.65	-0.40
x_{min}	–0.90	–1.30	–1.00	–1.50	–1.00	-1.90	-1.10	-2.40
R_q	1.00	0.70	1.20	0.50	2.20	1.45	2.60	1.00
R	3.00	2.30	3.50	2.60	4.10	3.90	4.70	3.20

M = pre-pubescent individuals; S = pubescent individuals; CH = boys; D = girls; N = low level of motor performance; V = high level of motor performance; n = number of subjects; x_{max} = maximal score; x_{Me} = median; x_{min} = minimal score; R_q = interquartile (middle) range; R = range.

CONCLUSIONS

The growth age results in the selected groups indicated that classification of the individuals into normative height bands was in no relation to their age, sex or level of motor performance. Considering the height-weight proportionality, we found out that the pubescent individuals had the relatively higher values of body weight than prepubescent ones of the same sex and motor performance. The selected individuals have been growing up proportionately to their hereditary predisposition. We did not find any significant differences among KEI values in the relations to motor performance. The range of differences between the biological and chronological age in the prepubescent samples with low motor performance and all pubescent samples was more than 3 years. The values of the interquartile range of differences show higher variability in the samples with low motor performance. The results of differences between the biological and chronological age approximately correspond to the findings in an average child population.

REFERENCES

1. Brauer BM (1982) Die Bestimmung des biologischen Alters in der sport- und jugendärzlichen Praxis mit neuen anthropometrischen Methoden. Ärztl Jugend 73: 94–100.
2. Hirtz P, Sharma KD (1995) Relationship between biological age and motor-performance of primary school children. In Komandel L. (ed.) Physical Education and sports of Children and Youth. Bratislava: Komenský University, pp. 162–166.
3. Lhotská L, Bláha P, Vignerová J, Roth Z, Prokopec M (1993) V. Celostátmí antropologický výzkum dětí a mládeže 1991 (české země) : Antropometrické charakteristiky [Vth Nation-wide Anthropological Survey of Children and Adolescents (Czech Republic): Anthropometric characteristics]. Praha: Státní zdravotmí ústav.
4. Měkota K, Kovář R (1995) UNIFITTEST (6-60) Tests and norms of motor performance and physical fitness in youth and in adult age. Acta Universitatis Palackianae Olomucensis Gymnica 1: S3-S108.
5. Šelingerová M (1992) Stanovenie biologického veku a jeho uplatnenie v športě (Determination of biological age and its using in sport). Doctoral dissertation. Bratislava: Komenský Univerzity.

ANTHROPOMETRIC SOMATOTYPE OF CHILDREN WITH LOW AND HIGH MOTOR PERFORMANCE

A. Suchomel
Technical University, Liberec, Czech Republic

INTRODUCTION

Summarizing the results of the studies of the relation between somatotype and motor performance of children we can state that the value of the ectomorphy is usually in a positive relation to the performances in motor tests. No significant relation between mesomorphy and the results of the children in motor performance tests has been proved. In most cases, the endomorphy has a significantly negative relation to the results of the children in motor performance tests. The best results in the tests have been reached by ectomorphic mesomorphs while the worst results were reached by endomorphs, with no inter-sexual differences.

The aim of the paper was to determine the anthropometric somatotype of school-aged boys and girls (8–9 and 12–13 years old) who have considerably above-average and considerably below-average test score in the test battery UNIFITTEST (6–60).

METHODS

Method of selecting subjects

We used the test battery of UNIFITTEST (6–60) for evaluation of motor performance of school-aged children. It contains four motor tests:

standing broad jump, sit-ups 60 seconds, endurance shuttle run 20 m and shuttle run 4 x 10 m [4].

The representative sample consisted of 253 boys and 267 girls aged 8–9.99, 247 boys and 262 girls aged 12–13.99. On the basis of motor testing, we selected: a) individuals with low motor performance, their test scores were over 1.5 standard deviation below the average value — four samples contained 19–25 children; b) individuals with high motor performance, their test scores were over 1.5 standard deviation above the average value – four samples contained 17–23 children.

Methods of data analysis

To determine the anthropometric somatotype we used a modified Sheldon method according to Heath and Carter [3]. To assess somatotypes of the selected samples, we classified median somatotypes into 13 categories according to the dominance of the individual components and their correlation [1]. We analyzed the dispersion of somatotypes by means of calculating the indices of somatotype dispersion: in two-dimensional expression SDI [5] and in three-dimensional expression SAM [2]. Somatotype components were processed with the use of software ANTROPO 98.1.

RESULTS AND DISCUSSION

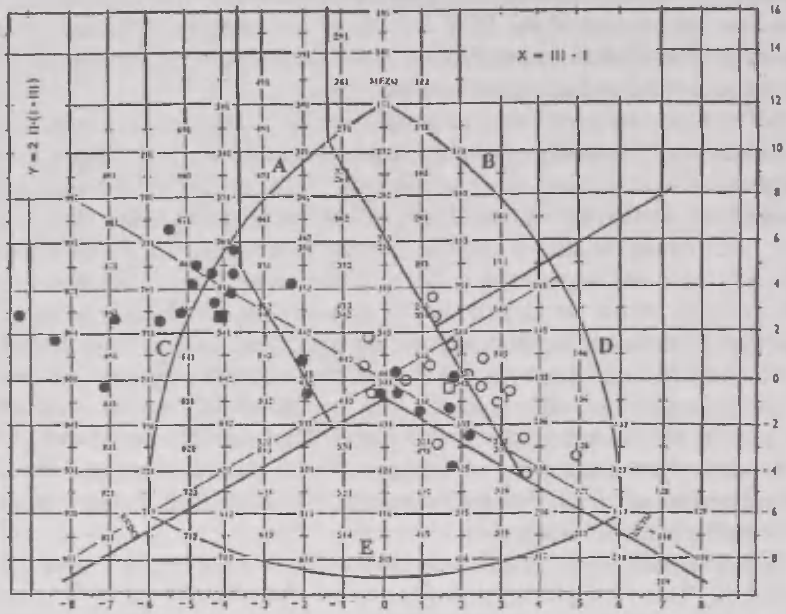
Legend — abbreviations used in this chapter: M = pre-pubescent individuals (aged 8–9); S = pubescent individuals (aged 12–13); CH = boys; D = girls; V = high level of motor performance; N = low level of motor performance.

We used the calculated medians of the individual components to determine median somatotypes of the selected samples. We found the following median somatotypes: the MCHN sample 3.50 – 4.75 – 2.80; the MCHV sample 1.75 – 4.10 – 4.10; the MDN sample 4.30 – 4.30 – 3.30; the MDV sample 2.40 – 3.50 – 4.70; the SCHN sample 6.10 – 6.15 – 1.50; the SCHV sample 2.60 – 4.45 – 3.95; the SDN sample 5.75 – 5.10 – 1.70 and the SDV sample 2.70 – 3.20 – 4.30.

The higher the age of the individuals and the lower the motor performance of the samples are, the more they move in the endomorphic-mesomorphic direction. Using the categories described by Carter [1], the median somatotypes of the MCHV and SCHV samples belong to the category of mesomorphs-ectomorphs, the median somatotypes of the MDV sample to the neighbouring category of mesomorphic ectomorphs and the median somatotype of the SDV sample to the category of balanced ectomorphs. The median somatotypes of the N samples belong to the category of mesomorphs-endomorphs in all the cases.

The high values of the mesomorphy in the N samples are a question to be discussed. Generally, the mesomorphy is considered a predisposition to high sports performance, which was not fully confirmed by the results mentioned above. The contradiction could be caused by using the method of determining so-called anthropometric somatotype in obese children (in our case the significant number of the obese individuals was in the N groups). When we determine the mesomorphy of obese children, the recorded values are too high and do not correspond with reality. We found out contradictions between the visual characteristics of the individuals (round proportions, short limbs, great amount of fat) and the calculated values of mesomorphy exceeding 5 points. So the problem probably lies in the method of determining somatotype, which calculates the mesomorphy from width and circumference parameters which are high above average in the case of obese children.

The somatotypes of all pubescent girls are shown in somatograph (Fig. 1). This example have clearly shown great differences in the dispersion of the somatotypes between the N and V samples. In order to analyze the dispersion of the somatotypes in detail, we calculated indices of the somatotype dispersion — SDI and SAM (Table 1). We found out that in all the cases the result values were more homogenous in the V samples than in the N samples. In both performance groups, the result values were more homogenous in the prepubescent samples of both sexes than in the pubescent samples.



• = girls with low motor performance; ○ = girls with high motor performance.

Fig. 1. Somatotypes of pubescent girls

Table 1. Results of SDI and SAM.

	MCHN	MCHV	MDN	MDV	SCHN	SCHV	SDN	SDV
SDI	5.08	2.11	4.05	2.19	5.42	2.33	6.20	2.98
SAM	2.19	0.95	1.89	1.04	2.35	1.05	2.48	1.30

M = pre-pubescent; S = pubescent; CH = boys; D = girls; N = low level of motor performance; V = high level of motor performance.

CONCLUSIONS

The samples with high motor performance were somatically very similar, characterized by mesomorphic ectomorphy or ectomorphic mesomorphy with low level of endomorphy. On the contrary, the samples with low level of motor performance were difficult to characterize due to high values of the indices of the somatotype dispersion. In these samples, mesomorphs-endomorphs, endomorphic mesomorphs and medium somatotypes slightly prevailed. The results confirmed the necessity of somatic parameter determination in the selection of sports talented children. On the other side they showed us a tendency to ambiguous relation between the basic somatic characteristics and the low level of motor performance.

REFERENCES

1. Carter JEL (1975) The Heath — Carter somatotype method. San Diego: State University.
2. Duquet W, Hebbelinck M (1977) Application on the somatotype attitudinal distance to the study of group and individual somatotype status and relations. Growth and Develop. Physique Symp Biol Hung 20: 377.
3. Heath BH, Carter JEL (1967) A modified somatotype method. Am J Phys Anthrop 27: 57–74.
4. Měkota K, Kovář R (1995) UNIFITTEST (6–60) Tests and norms of motor performance and physical fitness in youth and in adult age. Acta Univ Pal Olom Gymn Suppl 1: 1–108.
5. Ross WD, Wilson BD (1973) A somatotype dispersion index. Res Quart 44: 372–374.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

DEVELOPMENTALLY ENHANCE PROCESS IN PHYSICAL ACTIVITY OF YOUNG CHILDREN

K. Tantiphlachiva
Srinakharinwirot University, Bangkok, Thailand

Developmentally enhance process is a teaching tool was established for early childhood teacher. A systematic thought process is essential to a profession, as it assists the professional in meeting the needs of a student. Developmentally enhance process (DEP) is the framework for the practice of early childhood teacher. It is a method of problem identification and problem solving that describes what the teacher actually does for the young children. The five-step model accepted as the process of developmentally enhancement for the young children, including assessment, teaching diagnosis, planning, teaching intervention and evaluation. The process can be envisioned as a continuous cycle. The teacher assesses the child's behaviors and compares the gathered information with growth and developmental level. Based on the assessment, the teacher identifies actual developmental problems. These are formulated into diagnosis. A plan of developmental enhancement is devised and then intervened through the child's activity. When evaluation is performed, developmental status is reassessed and a new cycle begins with modifications instituted as needed to achieve the desired outcome.

Assessment

Assessment is the first stage of DEP. It is a continuous process, an operation at all phases of developmental enhancement and the foundation for decision making. It consists of the purposeful collection, classification, and analysis of data from behaviors and communication of young children.

To ensure an accurate and comprehensive assessment, the teacher must consider information about the child's health, age and maturity. The two steps of assessment can involve: (1) gathering children information about physical, emotional, social and cognitive development during the activity; and (2) classified and analyzing the data for identified special needs for developmental enhancement.

Teaching diagnosis

Diagnosis is a teaching judgement about individual or group of children responses to learning situation or activity that inform the teacher to know the student's need for learning enhancement. Teaching diagnosis provided the basis for selection of teaching intervention to achieve outcomes for which the teacher is accountable. The criteria for diagnosis in young children stressed on developmental levels as opposed to chronological level. The precise diagnosis can helps teacher develop appropriate lesson plan and program.

Planning

Teachers' plan is usually based on regular observation and assessment of children's activities, interests, needs involvement and abilities. Now we change to use teaching diagnosis instead. Once the teaching diagnosis has been identified, a plan of teaching is developed and outcomes or goals are established. The outcome is the expected change in a child development or behaviors that occur after teaching interventions are instituted. The ultimate goal of teaching is to convert the teaching diagnosis into a desired developmental potential. The plan must be formulated before the interventions are developed and implemented. The end point of the planning phase is the development of the teaching plan in developmental enhancement.

Teaching intervention

Teachers take an active role in stimulating and supporting children's involvement in physical activity, providing them with conversation, time and ideas for how to make activity increasingly complex. The phase of intervention begins when the teacher put the selected intervention into action and accumulated feedback regarding its effects. The feedback returns in the form of observation and communication and provides a data base on which to evaluate the outcome of the teaching intervention throughout the intervention stage, the children are remained in their activity with comfort and free.

Evaluation

Evaluation is the last step in the DEP. With it purpose, it can be used to describe the current behavior of a child and what she knows, and if the evaluation is repeated, it can show the child performance has changed over a period of time [4]. The teacher gathers, sorts and analyzes data to determine if (1) the goal has been met, (2) the plan requires modification, or (3) another alternative should be considered. Observation guidelines are necessary to identify methods of evaluation whether the goal or outcome is achieved. The evaluation stage either completes the DEP or serves as the basis for selection of other alternatives for intervention in solving the specific problem. Evaluation requires inquiry, appraisal and assessment. The result of evaluation helps in making decision, and to be effective, must be continuous and ongoing. The evaluation is a process where by information is obtained in order to assess the efficiency and effectiveness of teaching,

Background of DEP

DEP is based on the premise that all children have right to grow up effectively and that is the mission of early childhood teachers who response these function. Teachers had to function as facilitators as well as instructors stimulating and expanding on learning possibility inactivity and responding to children's indications of interest and ability. Teachers understand their roles in actively collaborating with young children involved in learning activities, and place a high premium on children's activity [3]. At anywhere and any time, teachers must response to improve student learning and to develop continuing failure in school systems has been changed by understanding teachers. Child-centered take significant roles for learning reform.

DEP is the way for helping, step by step. The five-step of DEP can help the teacher to know how to help the children, like an action research and integrative concept. Teachers know the problem and know how to treat and know the thing was happened after treat. An appropriate lesson plan and program promotes physical, social, emotional, and cognitive developmental needs of children. It means that the teacher does a quality teaching program.

DEP and physical activity

DEP is a teaching process. It is appropriate for active learning. Physical activity is an active learning which teacher can use DEP easily. It comprised of body movement produced by the skeletal muscles that results and increase energy expenditure such as sport, vocational work, recreation activity and chores [1]. The young children should be actively involved in activities that enable them to use their bodies to learn and develop feelings of purpose and competence. Their growing confidence and physical skills are reflected in game of running, chasing and kicking. A nearly university characteristic of children in this period is their almost constant physical activity. The primary years are thus a time to use and test developing motor skills [6]. Teachers can detect the developmental level of each child and promote their abilities with DEP.

Play is one of the most physical activities of young child. It is the heart of children activities. Children can play and learn at the same time. Moreover, play is intrinsically motivated attention and requiring active engagement. Children learn societal roles and values, and learn to adapt to their environment. Teachers know action of children reflect the level of their development [2]

At that time, the teacher can assess their competencies and abilities. And then we can know the weak or strength point of the children's development and plan how to enhance them for fruitfully development. Authentic assessment practices directly measure actual performance. The child ability and performance more fully and accurately and to provide teachers with information that help them develop strategies that will be helpful to the real needs of individual children [2].

The interested aspects for enhancement

Physical activity is an activity over taken all day life. Children love to play, move and communicate their ideas through the activity. There are at least five aspects due to develop need enhancement in physical activity. There are motor development, social development, emotional development and cognitive development. The cognitive development divide into two aspects, such as creativity and problem solving.

The development of motor skill competency is important because it enables children to perform everyday tasks for growing older for school, general living, work, sport, recreation and leisure [2]. Physical activity play a large part in the development and maturing of the capacities of the ego and the ego operates through the use of intellectual powers. The role of physical activity is very important to interact with an exploration of the environment that the child learns to master reality.

Problem solving in any content area rests on thinking skills can be taught directly through process strategies. The mechanism of emotion, creative and problem solving always appear during the physical activity especially the game. DEP needs more information from young children activity. The advocate of performance assessment would have children demonstrate that they could perform particular tasks, especially in real situation for clear identify needs, behavior or development of the young child.

CONCLUSION

Developmentally enhance process is composed of assessment, diagnosis, planning, intervention and evaluation. It is start to analyze situation, make reasonable judgement and solve the problem. Planning an interesting method for enhancement and then evaluation, and come back again to reassessment. Physical activity is the young child's activity that easy to access the developmentally enhance process.

REFERENCES

1. Curtis DE, Russell SJ (1997) Physical Activity in Human Experiences: Interdisciplinary Perspectives. Illinois: Human Kinetics.
2. Darling-Hummond L, Ancess J, Falk B (1995). Authentic Assessment in Action: Studies of Schools and Students at Work. New York: Teachers College, Columbia University Press.
3. Gestwicki C (1999) Developmentally Appropriate Practice: Curriculum and Development in Early Childhood Education. Albany: Delmar Publishers.
4. Hendrick J (1991). Total Learning: Developmental Curriculum for the Young Child. New York: Merrill.
5. Lifter K (2000) Linking Assessment to Intervention for Children with Developmental Disabilities or At-risk for Developmental Delay: The Developmental Play Assessment (DPA) Instrument. In Gitlin-Weiner

K, et al. (eds.) Play Diagnosis and Assessment. Canada: John Wiley & Sons, Inc.

6. Morrison GS (1998) Early Children Education Today. New Jersey: Merrill, Prentice Hall.
7. O' Brein C (1994) Motor Development and Learning in Children. In Boulton-Larvis G, Catherwood D (eds.) The Early Years: Developmental, Learning and Teaching. Victoria: The Australian Council for Educational Research, Ltd.

SPORTS DROPOUT IN THE ADOLESCENTS OF THE PROVINCE OF VICENZA (ITALY)

G. C. Trentin[1], F. Viviani[2]
[1]*ISEF of Padua and CONI of Vicenza, Italy*
[2]*University of Padua, Padua, Italy*

INTRODUCTION

Several studies have called into question whether the term dropout is accurate and precise to identify individuals who discontinue sport involvement, because children and adolescents participate in number of physical activities ranging from recreational to highly structurated and competitive, it could happen that a dropout could be a dropout in a programme but a complier in another programme [5]. In a case 68% of the children who withdrew from competitive swimming aimed to return to the fray in the following year or were active in other sporting activities [3]. The reasons for discontinuing differ from younger (lower that 10 years old) to older children and are various: conflicts of interests, the desire to be involved in other activities, injuries, lack of fun and novelty, dislike for the coach, competitive stress and so on [6]. The role of significant others is then neglected in dropout research, and little is known about the motivation and attrition processes in sport sessions. A number of surveys is dedicated to sport dropout, especially qualitative, but they usually offer a cross-section of a particular area or situation. Only in few cases reflexions helping research are uttered in relevant literature, so the problem remains circumscribed [4].

METHODS

In 52 junior high (J) and high (H) schools of Vicenza and province (North-Eastern Italy), to 4676 adolescents (2392 males and 2284 females) a 54-items questionnaire was administered respectively to 2217 J and 2459 H students whose informed consent was previously asked. The aims were to collect observational and qualitative data on sports dropout in this province, and to understand which factors are crucial in promoting motor practice and those eventually provoking dropout in sports. The present paper reports the statistical analysis of Vicenza and Schio only, carried out on the basis of the criteria gender, J vs. H, main town vs. province.

RESULTS

Regarding the whole sample, 58.4% of the interviewed declared to be involved in some sporting activity (males=65.4%, females=52.2%). Among those who declared to practice agonistic activity, students who were involved at a "amateur" level (spontaneous groups), were 26.6% of the males and 46.3% of the females. Most part of the males practiced soccer (74.2%), females volleyball (35.3%), declaring an high satisfaction for the sporting practice undertaken. A decline in sport involvement was found from J to H school, with differences in the sample. Girls always practiced in a smaller number with respect to males and both in Vicenza and in the province their participation dropped from J to H school (Vicenza: J=26.4% vs. H=20.8%; province: J=38.0% vs. H=22.9%). Girls always showed an average higher percentage of unpracticing subjects (around two thirds vs. around half of the males). Both sexes tendency towards a dropping in sport participation during H school was clear in all groups. On the whole, students who abandoned a previous sporting activity were 50.4% of the males and 62.4% of the females. Regarding the comparison Vicenza/Schio, the males who withdrew in the main town were 49.3% vs. 62.3% of the females (χ^2=14.0; df=1; p<0.01) in H schools; in J schools they were, respectively 35.3% and 48.3% (χ^2=17.3; df=1; p<0.01). In Schio, boys and girls showed a similar trend. H=58.7% vs. 74.4% (χ^2=24.1; df=1; p<.001); J=55.0% vs. 68.6% (χ^2=9.8; df=1; p<.01). Between the main city and Schio, males abandoned in Vicenza in 49.3% of the cases vs. 58.7% of Schio (χ^2=7.8; df=1; p<0.01) in H schools; 35.3% vs. 55.90% in J schools (χ^2=26.6; df=1; p<0.001). In H schools girls quit a sporting activity in 62.3 % of the cases in Vicenza vs. 74.4% of the cases in Schio (χ^2=14.0; df=1; p<0.01). The rate was higher in J schools: Vicenza 48.3% of the cases vs. Schio 68.6% (χ^2=28.1; df=1; p<0.0001).

The critical ages were, for both sexes, 10–11 years for J schools and 13 and 14 for H schools and the main reasons were: study-connected problems (with percentages ranging from 20 to 35% in H schools and from 10 to 20% in J schools, with females showing the highest percentages), and other unspecified reasons, not connected with their family or the teenager groups they belonged to. H school girls declared in 10% of the cases that they quit for "affective" reasons vs. 2% of their male counterpart. Doubts where expressed, in percentages ranging from 65% to 85%, about the sensitiveness and technical competence of their coaches.

DISCUSSION

Sport dropout is a multifaceted problem highlighting awkwardness and disappointed expectations in youngsters, especially in those ages in which boys and girls face school changes and decisions regarding their future life. The age at risk in the present survey, were, in fact, those linked with school changes, which imply a reorganization of ordinary duty schedules, a change in the reference pairs, and reduction of leisure time. The trend found is congruent with the European one [8] and with a research carried out in the nearby province of Rovigo [7]. Girls participation was lower than that of males and this could be due to surviving stereotypes on female "weakness". The technical and emotional competence of coaches is essential in avoiding sports dropout. Studies on coaches show that the preferences for coaches who show high levels of supportive behavior and who exhibit an autocratic leadership, linearly increase with the age and level of competition of their subordinates [1,2]. Then, males tend to prefer an autocratic coaching style, while females prefer more democratic attitudes [9]. In the last decades democratization of sport occurred worlwide [8] and this not only permitted the participation of lower socio-economic classes in what used to be the more "elite" sports, but caused a different sensitivity in youngsters and parents. Many times, the main aim of a coach is to acquire results, without caring the growth of a child as a person. The psycho-social development of a child, however, requires a wide spectrum of experiences and sports practice is essential as it helps socialization and can improve the cooperation with pairs, the programming of short- and long-term objectives, the coping with stress and anxiety, and so on. Not always, then, a sporting practice alone can statisfy the needs of innovation and the desire to tackle novelties from all their nuances, typical of a growing individual. So coaches should be first of all recipients of a good emotional intelligence, in order to cope with the conflicting desires and aspirations of a growing person. Other reasons could explain sports dropout. Sport has developed more and more into commercial products. Traditional sports and sport clubs are becoming "out-marketed" by commercially oriented, privatized sport organizations. Another reason could be the dominance of TV and that of computer games which enhanced the demand for spectator sports, sometimes "gladiatorial" and violent. The present observational survey, therefore, investigated only on some aspects of sports dropout. In order to thoroughly delve the problem, a multidisciplinary approach is needed. As example of battery of tests and evaluations to be performed to understand in detail sports dropout in young promising athletes could be as follows: a) a revision of the previous physical activity, focusing on the competitive activity; b) a deep historical revision of the past injuries and diseases; c) a nutritional profile; d) a psychological profile; e) tests of motor performance; f) anthropometric measures; f) a radiographic examination of the wrist; g) blood samples; h) live shootings of the kinematic chain subduing the pace; i) neurological (motor) examinations; j) analysis of biosignals in motion; k) analysis of the social context and of the practices inside the sporting context, to record if they are sexists, racists, homophobics and so on, and l) other, depending on the context.

REFERENCES

1. Chelledurai P (1990) Leadership in sports: a review. Int J Sport Psychol 21: 328–354.
2. Chelledurai P, Carron A (1983) Athletic maturity and preferred leadership. J Sport Psychol 5: 371–383.
3. Gould D, Feltz D, Horn T, Weiss M (1982) Reasons for attrition in competitive young swimming. J Sport Behav 13: 155–165.
4. Horn TS (1992) Advances in Sport Psychology. Champaign: Human Kinetics Publishers, pp. 212–213.

5. Klint KA, Weiss MR (1992) Dropping in and dropping out: Participation motives for current and former youth gymnasts. Can J Appl Sport Sci 11: 106–114.
6. Lewko JH, Greendorfer SL (1988) Family influences in sport socialization of children and adolescents. In: Smoll F, Magill R, Ash M (eds.) Children in Sport. Champaign IL: Human Kinetics, pp 287–300.
7. Pellai A, Marzorati P, Brizzi L (2000) Pratica e abbandono dell'attività sportiva in età evolutiva nella provincia di Rovigo. It J Sport Sci 7: 49–55.
8. Riordon J (1999) Young People and Sport in Europe in the 21st Century. Hong Kong. J Sports Med Sports Sci 9: 77-80.
9. Salminen S, Likkonen J (1993) Coach-athlete relationship and coach's behaviour in training sessions. In Paula-Brito A, Alves J (eds.) Proceedings of the 8th World Congress Sport Psychology: An Integrated Approach, Lisbon, pp 886–889.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

THE ETHOLOGY OF TRIUMPH BEHAVIOR IN SPORT: CONSIDERATIONS ON OBSERVATIONAL RESEARCH APPLIED TO MOVEMENT SCIENCE

F. Viviani, V. Rizzo
University of Padua, Padua, Italy.

INTRODUCTION

An action embraces a number of movements varying from locomotion, specie-specific schemes (such as courtship, care rituals and gestures) and acquired abilities [6]. In ethology, the traditional dichotomy innate/acquired showed to be a mistaken opinion, as both the terms belong to a neuronal matrix that cannot develop if both genetical information and environmental stimuli are lacking [1]. Regarding triumph behavior (TB), ethological data show that animals display a variety of forms, ranging from vocalizations (parrots) to display of genitals (primates) [5]. Psychoanalysis claims that a "triumphing" individual needs unconscious identification with the loser, in order to narcissistically express gratifying identifications controlled by unconscious symbolic patterns. After a clear triumph, changes in the endocrine system were found both in all primates [4]. TB in sport varies from a private gesture of joy to a public ceremony, and the individual gestures are externalized in various ways: from a controlled exhibition of mock modesty to a savage jump of joy. Depending on the context and the achievement reached, the gestures and actions underlying a victory show a series of behaviors that are related to sex, age, sporting activity, ethnic and cultural background, and the surrounding audience. Movements and actions can be analyzed and measured in a precise way, using high speed photographs and video recordings. These are invaluable instruments, as the resercher can directly observe a behavior in real time.

METHODS

To investigate on TB in sport, a preliminary survey was carried out on 50 individual gestures of exultation, chosen in 19 male volleyball high level videotape recorded matches that were deconstructed in this way: the matches were seen and TG were selected, chosing the most significant TB gestures. Every body district was then thorougly analyzed and canons of behavior (CB) were identified. The first and the second CB of the upper arms (1UACB, 2UACB) and the trunk (1TCB, 2TCB) were defined, verifying their symmetry/asymmetry, looking for the existence of common canons. The hand gestural expressiveness (palms and fingers) was analysed, and the temporal relation between the canons of the various parts was also checked. The presence/absence of self incitement or shouts of joy was checked, together with the temporal sequence canons/shouts of joy. So it was done for other signals.

RESULTS

In general, a TG usually begins as being an individual movement and ends as being collective. The individual exultation is characterised by a shout of joy, the elevation of upper arms, clenched fists. The jubilation with a pair is characterised by a hand by hand twack and group exultance, while the latter is usually characterized by embraces. Table 1 shows the gestures accompanying TB displayed by volleyplayers.

From the observation of data, the following synthesis is possible: the first body district activated is the hand (98.0% of the cases), which is followed by the upper arms (in 96.0% of the cases), the face (shout of joy, 40.0%), the lower arms (16.0%) and the trunk (6.0%). In 68.0% of the cases 1UACB was recognized. It implies the raising of the upper arms outwards (76.5%) with flexed forearms (96.1% of the cases). The 2UACB was performed mainly by extending the upper arms (74.0%) directed upwards (91.9% of the cases) with extended forearms (79.5%), and palms inwards (85.0%) with clenched fists (56.0%). The direction of the first and the second UACB showed that in 73.0% of the cases the movements were ascending, in 21.0% descending, and in 6.0% "neutral". The gestures were then classified as being symmetric (with both arms) or asymmetric (with one arm only). In 70.0% of the cases the movements of the 1UACB were symmetric, and in the other 30.0% asymmetric; while in the 2UACB, the symmetry was found in 60.0% of the cases. The combination shout of joy/1UACB, showed that the 1UACB was displayed first, followed by the cry (56.0%), while they happened simultaneously in 44.0% of the cases. Between cry/2UACB the simultaneity prevailed (68.1%). The interaction with team-mates showed that the first contact mostly happened with one team-mate only (63.8%) and in 80.0% of the cases it was displayed extending the upper arms upwards with open hands, the palms inwards and the shake the pairs' palms. The playground center was the area where this contact occurred in 78.7% of the cases. The symmetrical technical gesture (wall) elicited mostly a symmetric TG (eliciting also an higher TG), while an asymmetric technical gesture (attack), increased asymmetry.

Table 1. Gestures accompanying exultance in 50 individual TB. An athletes can perform one or more than one of them.

INDIVIDUAL GESTURES PERFORMED	N of times	%
The athlete: raises upper arms	35	19.7
Yells out	30	17.8
Hits his hands or companions hands upwards	26	14.6
Clenches his fists	25	14
Embraces his companions	20	11.2
Urges his companions	20	11.2
Shake hands	8	4.4
Spreads out and bends rapidly and repeatedly the upper arms, clenching his fists	8	4.4
Tenses the forearms, blocking the upper arm press-up, clenching his fists	5	2.7
TOTAL	177	100

DISCUSSION

TB has been reported in ethological studies in both human and non human primates [2]. The main variations with respect to the main gestures with respect to this main gesture are the shaking of the upper arm clenched in fists and the gesture imitating the culmination of a sexual act. Methodologically, the real conundrum in this field is how to score and evaluate the gathered observations. The continual recording method (or narrative) involves recording in a series of sentences the occurrences the researcher observes when they happen. The frequency counting method (or tallying) involves the researcher recording each time a certain behavior occurs. The first method is slow and not very efficient; the second is constrained by time but more efficient. Apart from these methodological quandaries, our observations on TB strongly support the idea that fixed patterns of behavior are recognizable in TB, as in the first and second UACB and TCB, the same movements are exhibited in percentages ranging from 75 to 98% of the cases. During the last two decades studies on cortical motor system showed that, far from being unitary, it appears to be constituted by a constellation of different areas each of these endowed with specifical properties and linked by reciprocal connections, with parietal cortex [3,7]. This implies that the motor system not only executes movements, but internally represents them. The discovery of the "mirror" neurons widened the horizons. They are located in at least three brain areas, they involve several brain areas and are probably at the basis of action recognition (as they show activity in relation both to specific actions performed by the self and the matching actions performed by others — therefore providing a potential bridge between minds) [6]. In fact, they permit not only to imitate movements, but they are probably at the basis of other social cognitive functions, such as empathy. The present survey, then, opens a wide field of study and the next steps will be: a) to look for differences, analogies/omologies in very young and young volleyball athletes; to check differences by sex and level of performance, and to extend the search to other sporting activities; b) to check individual psychophysiological changes in various "triumphing" athletes; c) to check whether the audience and the opponents influence or not TB expressions; and d) to check whether TB is a team determinant or not. Only in this way TB will be better understood in many of its elusive aspects.

REFERENCES

1. Alcock J (1989) Animal Behavior. It. Edition. Etologia. Bologna: Zanichelli.
2. Eibl-Eibesfeldt (1976) I fondamenti dell'etologia. Milan: Adelphi.
3. Kiehn O, Harris-Warrick RM, Jordan LM, Hultbon H, Kudo N (1998) Neuronal Mechanisms for Generating Locomotor Activity. Ann NY Acad Sci. Vol. 860. New York: New York Academy of Sciences.
4. Mazur A, Lamb TA (1980) Testosterone, status, and mood in human males. Horm Behav 14: 236–246.
5. Morris D (1977) L'uomo e i suoi gesti. Milan: Mondadori.
6. Rizzolatti G, Fadiga L, Fogassi L, Gallese V (1999) Resonance bahaviors and mirror neurons. Arch It Biol 137: 85–100.
7. Rosembaum DA (1991) Human Motor Control. San Diego: Academic Press.

EFFICIENCY OF CLASS CLIMATE ON THE PHYSICAL SELF-EDUCATION OF GIRLS

V. Volbekiene
Lithuanian Academy of Physical Education, Kaunas, Lithuania

INTRODUCTION

One of the ways that may enable physical activity to become an indispensable part of children's lifestyle is the creation of productive class climate stimulating students' physical self-education. Our paper focuses on the importance of the student as well as the teacher and their interactive communication. We regard them as central and active elements of educational system whereby the educational environment created by these elements in a feedback manner affects other components of the system, assists in goal-realization, and promotes the students' self-education. The aim of the study was to establish the efficiency of class climate on the girls' physical education.

METHODS

The research data are presented on senior high-school girls aged 15–17 (n=141). The participants were divided into two groups: experimental (E) and control (C). The duration of the experiment was one year. In the E group, emphasis was placed on the creation of effective physical education class climate. The teacher of physical education had to select the style of communication and didactic principles of the experimental methods ensuring the students' self-education. In this way, an interaction between students and teachers based on a cooperation of partnership was achieved whereby the traditional authority-based teacher-student relationship was rejected. For the C group, the objectives included those commonly associated with the subject of physical education. The girls of E and C groups participated in two compulsory physical education classes per week.

Physical activity was determined using a standard questionnaire by measuring energy consumption (in METs) per day. Physical fitness was estimated according to Eurofit tests. Statistical data analysis was carried out using SAS statistical analysis package.

RESULTS

Changes in physical activity (PA) over the experimental period are presented in Table 1. Results indicated that over the one-year period of the experiment duration PA in the experimental group increased ($p<0.001$), while in the control group it decreased ($p<0.05$).

Table 1. Changes in the students' PA before (I) and after (II) the experiment (kcal/1 kg weight consumption)

Group	I	II	p
Experimental	37.06±4.64	41.34±5.62	<0.001
Control	37.72±5.62	33.58±4.94	<0.05

In the E group, the girls' PA increased in 84.8%, exhibited zero changes in 2.7%, and decreased in 12.5% cases. In the C group, the girls' PA increased only by 13.8% and demonstrated negative changes in 86.2% cases.

During the experiment period, the girls' fitness increased in both groups. Reliable changes manifested in the both groups confirm the efficiency of the program of the enhanced physical self-education in leisure time applied to the E group in a motivating environment (Table 2).

Physical fitness data demonstrated that in the E group, all indices of physical fitness manifested significant positive changes over the experiment period (plate tapping, 10x5 m shuttle-run, sit and reach, standing broad jump, bent arm hang, and 20 m shuttle-run). In the C group, statistically reliable improved result average after the experiment was achieved for the plate-tapping test ($p<0.05$). Data of other tests manifested positive changes though statistical reliability was not detected.

Table 2. Results of the girls physical fitness before (I) and after (II) the experiment

EUROFIT test	Experimental group		
	I	II	P
Plate tapping (ms)	115.27±10.87	103.06±8.74	<0.001
Shuttle run 10x5 m (ms)	216.18±10.98	202.80±9.31	<0.01
Sit and reach (cm)	27.57±4.90	30.71±4.13	<0.001
Standing broad jump (cm)	174.15±14.02	186.32±14.06	<0.001
Sit-ups (n/30 s)	23.61±3.48	28.27±18.15	<0.01
Bent arm hang (ms)	101.08±76.61	174.94±109.2	<0.001
Weight (kg)	56.78±5.95	56.49±6.13	>0.05
	Control group		
Plate tapping (ms)	114.59±8.13	109.38±8.34	<0.05
Shuttle run 10x5 m (ms)	199.20±13.50	178.89±55.87	>0.05
Sit and reach (cm)	29.81±5.50	35.88±29.98	>0.05
Standing broad jump (cm)	171.79±13.76	172.66±13.13	>0.05
Sit-ups (n/30 s)	24.28±3.26	23.76±2.86	>0.05
Bent arm hang (ms)	120.14±67.05	102.83±68.12	>0.05
Weight (kg)	56.00±4.55	57.00±4.48	>0.05

DISCUSSION

The research data confirmed the efficiency of positive class climate on the girls' PA and fitness resulting from the effects of physical self-education. [4]

The results of our study are in accordance with the view that the success of teaching goals depends on the teacher's ability to evoke the students' positive feelings by combining the type and content of activities with the ultimate goals [3]. The frequently used model of physical education based on strict, heavy physical exercises, involving immense physical and mental efforts, develops negative physical training motivation and is doomed to failure. The students' physical education may be defined as efficient when the joy of movement experienced in the classes of physical education triggers the life-long need for physical activity, that is, PA becomes a lifestyle. The target of physical education classes should therefore be joy of movement [2]. With these goals in mind emphasis is placed not on the process in-progress (training for high performance) and the control of its result, but on the ultimate result of physical education at school (the formation of healthy behavior and the intrinsic motivation for PA after graduation. Our results on fitness are in accordance with the results obtained by other scholars who claim that the increase of PA directly affects changes in fitness. In the E group, a significant increase of PA over the experiment period resulted in a statistically reliable increase of all fitness components while in the control group, negative changes in PA yielded a negligible improvement of the majority of fitness components ($p>0.05$). The daily increase of PA rather than direct emphasis on fitness produces more effective fitness training results [1].

It was conducted that class climate based on the stimulation of physical self-education is effective in increasing senior high-school girls' leisure PA and fitness. We thereby conclude that class climate has cumulative effect on the students' physical self-education.

REFERENCES

1. Blair S, Kohl H, Gordon N (1992) Physical Activity and Health: A Lifestyle Approach, Blackwell Scientific Publ.
2. Feingold RSC, Barrete GT (1991) Strategies for school fitness curriculum modifications: an integrative model utilizing the superordinate goal theory. In: Williams T et al. (eds.) Sport and Physical Activity, E & FN Spon, London.
3. Rowland TW (1990) Exercise and Children's Health. Champaign, IL: Human Kinetics.
4. Volbekienė V (1997) Physical Education. Health. Continuing Self-education. A Resource Book for Teachers of Physical Education. Vilnius, pp. 53–59.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

CHANGES IN HEALTH RELATED FITNESS OF 16–18 YEAR OLD STUDENTS

V. Volbekiene, R. Baubliene
Lithuanian Academy of Physical Education, Kaunas, Lithuania

INTRODUCTION

Efficiency of physical education and changes in its results are usually established by estimating students' fitness. According to fitness results and their changes physical education teachers can regulate students' physical education process. According to growth and maturity regularities students should reach maturity of their physical development just after leaving school. Health related fitness results should grow until adulthood. Breach of such regularities is indicative of the gaps in the peoples' lifestyle, physical education included [3].

The aim of the study was to establish changes in health related fitness in respect to age and chronology.

METHODS

The study was carried out in the spring of 1992 and 2002. 274 and 251 boys as well as 354 and 304 girls respectively (aged 16–18 years) from five largest cities of Lithuania participated in testing. A random choice of schools and students was made. Health related fitness was established by Eurofit tests: sit ups (n/30 s), sit-and-reach (cm), 20 m shuttle run (min). Height (cm) and body mass (kg) were also measured. All measurements were performed according to standard requirements.

Statistical data analysis was carried out using SAS statistical analysis package. Students' t-test was used for comparing physical fitness results. Statistical significance was set at $p<0.05$.

RESULTS

The results about height, body mass, sit-ups, sit and reach and 20m shuttle runs of 16–18 years old Lithuanian students are presented in Table 1. Height and body mass results among boys increased until 18 years ($p<0.05$) while they did not change among girls ($p>0.05$). However, body mass of 18 year — old girls was greater than that of 16–17 year-old girls ($p<0.05$). Results of sit-ups, sit-and-reach and 20 m shuttle run of 16–18 year old boys and girls did not differ significantly, except for the sit-ups results of 16 year old boys that are worse than those of 17 and 18 year old boys ($p<0.05$). Results of 17 year — old boys' 20 m shuttle runs were lower than in the other 16 and 18 age groups.

Table 1. Health related physical fitness results of 16–18 year — old Lithuanian students

Age	Sex	N	Height (cm)	Body mass (kg)	Sit-ups (n/sec)	Sit-and-reach (cm)	20m sh/run (min)
16	Male	100	176 ±0.1	61.3± 8.7	26.8± 7.7	22.6± 8.1	7.3± 2.8
	Female	103	166 ±0.1	55.8± 7.5	24.7± 3.5	24.2± 7.4	4.0± 1.5
17	Male	58	179± 0.1*	66.5± 10.6*	29.9± 3.6*	22.5± 6.5	6.0± 2.4*
	Female	101	168± 0.1	56.3± 8.1	24.4± 3.6	24.2± 7.1	4.0± 1.9
18	Male	93	181± 0.1*	71.3± 10.5*	29.5± 3.7	24.6± 6.8	7.2± 1.7*
	Female	100	169± 0.1	57.7± 6.8	24.9± 3.3	25.9± 6.7	4.1± 1.5
18	Male	100	183± 0.1	71.9± 8.6	28.6± 4.1	24.7± 7.7	7.4± 2.1
	Female	91	168± 0.1	59.1± 8.6	25.2± 3.7	25.4± 7.0	4.2± 1.4

* – $p < 0.05$ (difference in 1 year junior age group is marked by asterisk)

After comparing the 1992 and 2002 students' health related fitness results (Table 2) according to Eurofit program, it has been established that virtually there were no differences among 16–18 year old students in respect to height, body mass and sit ups results ($p>0.05$). A tendency to lower sit-and-reach test results was observed in 2002 ($p>0.05$). In 2002, boys and girls 20m shuttle run results were worse in all age groups ($p< 0.05$).

Table 2. The health related fitness results of 16–18 years old Lithuanian students in 1992 and 2002 year.

Age	Year	N	Heigh (cm)	Body mass (kg)	Sit ups (n/sec)	Sit-and-reach (cm)	20m sh/r (min)
Males							
16	1992	107	175± 6.4	61.5± 9.7	27.6± 3.4	25.1± 8.0	9.3± 1.5
	2002	100	176 ±0.1	61.3± 8.7	26.8± 7.7	22.6± 8.1	7.3±* 2.8
17	1992	101	180± 5.8	66.6± 9.7	28.3± 2.8	27.3± 7.9	9.0± 1.5
	2002	58	179± 0.1	66.5± 10.6	29.9± 3.6	22.5± 6.5	6.0±* 2.4
18	1992	66	178± 5,8	67.5± 7.4	29.0± 3.6	30.7± 7.6	10.0± 1.3
	2002	93	181± 0.1	71.3± 10.5	29.5± 3.7	24.6± 6.8	7.2±* 1.7
Females							
16	1992	130	166± 6.0	54.8± 6.3	23.2± 4.0	28.5± 5.4	5.8± 1.3
	2002	103	166± 0.1	55.8± 7.5	24.7± 3.5	24.2± 7.4	4.0±* 1.5
17	1992	131	167± 5.4	58.0± 6.5	23.4± 3.5	30.3± 6.2	5.5± 1.5
	2002	101	168± 0.1	56.3± 8.1	24.4± 3.6	24.2± 7.1	4.0±* 1.9
18	1992	93	169± 5.2	57.6± 5.4	24.0± 3.0	30.0± 5.4	5.6± 1.5
	2002	100	169± 0.1	57.7± 6.8	24.9± 3.3	25.9± 6.7	4.1±* 1.5

* – $p < 0.001$ (differences between results of 1992 and 2002)

DISCUSSION

It has been established that there is an early stabilization of fitness results and a negative change of cardiorespiratory fitness during the last 10 years. Schoolchildren of senior grades in Lithuania schools have two physical education lessons per week, the aim of which is to form sport skills and raise skill related physical fitness. Lately, programs of physical education have been aimed at motivation of everyday physical activity and formation its skills. Unfortunately, they have not been implemented to the full [4]. Physical education aimed at fostering physical activity of students and forming their physical literacy contribute to a much greater degree to developing physical capacity of pupils than lessons straightly directed at high motor performance [1, 2]. This assertion has been proved by our study and has shown that physical education inherited from the Soviet system according to the badge "Ready for Work and Defense" principles is inefficient [4].

In conclusion, early stabilization of health related fitness results has been established. It has been ascertained that height, body mass, sit ups, sit and reach, 20 m shuttle run results of 16–18 year old boys and girls virtually did not change. During the last decade negative changes in cardiorespiratory fitness as well as a tendency towards poorer flexibility have been observed.

REFERENCES

1. Feingold RSC, Barrete GT (1991) Strategies for school fitness curricular modifications: an integrative model utilizing the superordinate goal theory. In: Williams, T., et al. (eds.) Sport and Physical Activity, E & FN Spon, London.
2. Iverson DC (1985) The promotion of physical activity in the United States: the status of programs in medical, worksite, community and school settings. Publ Health Rep 100: 212–224.
3. Simmons-Morton B (1987) Children and fitness: a public health perspective. Res Quart 58: 295–302.
4. Volbekienė V (1998) Facing the Future: The Objectives of Students' Physical Education and Ways to Realization. Sports. – 1997: Conference Proceedings. Kaunas, pp. 44.

Acta Kinesiologiae Universitatis Tartuensis, 2002, Vol. 7 (Supplement)

COMPUTER TRACKING OF PLAYERS AT SQUASH MATCHES

G. Vučković, B. Dežman, F. Erčulj, S. Kovačič, J. Perš
University of Ljubljana, Ljubljana, Slovenia

INTRODUCTION

Squash is a poly-structural acyclic sport played by individuals or doubles. The small court, high velocity of the ball and numerous exchanges of strikes require suitable movement of the players in the court. The players most often perform acyclic movements, which include short accelerations, brakings and changes of direction [2].

Data on external loading (modes, intensity and amount of movement) represent an important basis for planning and determining loadings in training. Many researchers have studied the nature of external loading of players in different sports because of this, using different methodology of data acquisition [1, 3]. It is precisely this difference in methodology that most often causes the great variability of the results in various studies of the same team sport [5].

In squash, external loading was studied by Hughes and Franks [3]. The two authors studied the differences between winners and losers in the travelled distance in lateral and longitudinal movements and in the average velocity of the movements of four groups of squash players differing in quality. They used the average values of the last ten seconds of each individual point in the first three sets played. The average velocities of movements for the individual groups were from $1.47 ms^{-1}$ for the worst players to $1.98 ms^{-1}$ for the best. They found that the average velocity of the losers in three groups was statistically significantly higher than that of the winners. The distance travelled in longitudinal movements of the losers was also statistically significantly higher in all the groups than that of the winners.

Since this area is rather poorly researched in squash, we wished in this study to determine some indicators of external loading on a sample of the best squash players in Slovenia. At the same time we attempted to find if statistically significant differences exist between winners and losers in these indicators.

METHODS

The sample of players includes four top squash players in Slovenia, who played in the quarter-final, semi-final and final matches at the 2001 National Championship of Slovenia. Ten sets were played all together. In each one of the players was the winner and the other the loser.

The variable sample included the distance covered and the average velocity of movement of the winner and loser in the individual sets. The data on the distance covered is a summation of all the distances covered in the set, while the data on the average movement velocities of the players was obtained only from the active phase of each set.

The data was obtained by a computerised system for tracking squash players at a match and at training SAGIT/SQUASH, based on the technology of computer vision and developed at the Faculty of Electrical Engineering of the University of Ljubljana [4].

The data acquisition procedure was as follows. The matches were filmed on a squash court with a video SVHS camera fixed to the ceiling, with a lens that enabled it to cover the entire court area. All the matches (sets) were recorded on video tape with a SVHS video-recorder. The images were then transferred into a computer, digitised and processed with the SAGIT/SQUASH software (Fig. 1).

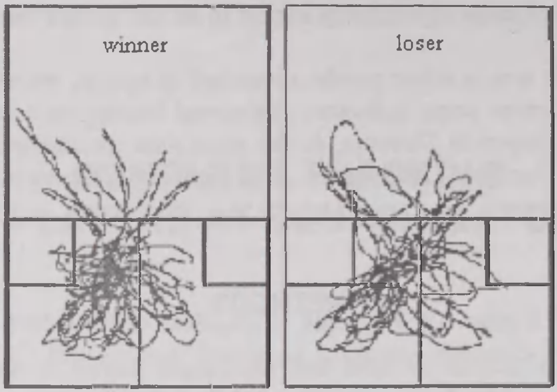


Fig. 1. Computer printout of movements of a winner and a loser in the longest point

The obtained data was analysed with the Excel and SPSS for Windows programmes. One-way analysis of variance was used to find the differences between the winners and losers in the individual sets.

RESULTS AND DISCUSSION

The distance covered by the players in an individual match and set varies greatly (Table 1). At matches it varies from 2702 m to 3418 m, in sets from 591 m to 1368 m. Since the distance covered by the players at a match does not always depend on the absolute playing time, we suppose that it is more dependent on the duration of the active phase in the individual point and on the way the players play (their tactical model). We suppose that the distance covered will be longer also when two equal players meet, since the duration of the individual points in the set will be longer.

The results in Table 2 show that the winners in individual sets covered a longer distance. Their average velocity of movement is also higher. However, these differences are statistically non-significant at the 0.05 error level and are close to the specified precision of our tracking system. These results are quite surprising in light of those obtained in the cited reference [3]. The results can be found in the specificity of our sample. Since the same player won almost all the sets (nine out of ten), it is possible that the obtained results are the consequence of the specific movement pattern of this player or because of the larger number of serves and final strikes. These suppositions need to be validated in further studies. Even if we did not obtain statistically significant differences between the winners and losers of sets, the coaches in squash can still use this data as an orientation for planning the conditional preparation of their players.

Table 1. Distance of all player movements in individual sets at all matches

match	quarterfinals distance (m)		semi-finals distance (m)		finals distance (m)	
player	W	L	W	L	W	L
1.set	825	793	1207	1130	850	875
2.set	972	1018	843	811	744	680
3.set	905	946	1368	1350	606	603
4.set	/	/	/	/	637	591
sum	2702	2757	3418	3291	2837	2749
set average	900	919	1139	1097	709	687
match duration (sec.)	2060		2711		2399	

Legend: W – winner, L – loser.

Table 2. Results of descriptive statistics and analysis of variance

Variable	Winners				Losers					
	xa	s.d.	min.	max.	xa	s.d.	min.	max.	F	P(F)
Distance (m)	895.7	237.95	606	1368	879.6	240.23	591	1350	0.023	0.882
Vel. (ms^{-1})	1.573	0.1	1.38	1.72	1.509	0.07	1.43	1.64	2.513	0.130
Result	9	0	9	9	2.7	1.82	0	6	118.67	0

Legend: vel. – velocity, xa – mean, s.d. – standard deviation, min. – minimal result, max. – maximal result

We also found that this new tracking technology gives a good record of the distance, velocity and direction of movement of the objects being tracked, as well as subsequent processing of the recorded data.

REFERENCES

1. Bon M, Perš J, Kovačič S, Dežman B, Šibila M (2001) Computer vision system for tracking players during the handball match. In Mester J, King G, Strüder H, Tsolakidis E, Osterburg A (eds.) Book of abstracts: 6th Annual Congress of the European College of Sport Science, Cologne: Sport und Buch Strauss, pp. 549.
2. Eubank C, Messenger N (2000) Dynamic moves and stepping patterns typical to the game of squash. J Sports Sci 18: 471–472.
3. Hughes M, Franks IM (1994) Dynamic patterns of movement of squash players of different standards in winning and losing rallies. Ergonomics 1: 23–29.
4. Perš J, Vučković G, Kovačič S, Dežman B (2001) A low-cost real-time tracker of live sport events. In Lončarić S, Babić H (eds.), Proceedings of ISPA 2001, Croatia, University Computing Centre, University of Zagreb, pp. 362–365.
5. Reilly T (1996) Science and Soccer. Liverpool John Moores University, Liverpool.

SWING FOOT REGULATION FOLLOWING OBSTACLE CLEARANCE: EFFECTS OF APPROACH VELOCITY AND OBSTACLE HEIGHT

Y. Wang, K. Watanabe
Hiroshima University, Hiroshima, Japan

INTRODUCTION

In the real world, our path is usually obstructed. People are confronted with a course consisting of undulations or obstacles during locomotion. For obstacle avoidance, stepping over obstacles places great demands on the locomotor system and poses great risks.

To date, the effects of approach velocity and obstacle height on the swing foot regulation have not been well defined. However, in the everyday environment, the precise and consistent regulation of the swing foot while negotiating obstacle is undertaken across a range of gait mode. Thus, the purpose of this study was to investigate the gait temporal-distance characteristics during the crossing stride.

METHODS

Five healthy males participated in the study (age: 21.8±0.8 years; height: 1.72±0.06 m; body mass: 69.7±8.2 kg). Subjects were free of any known gait abnormalities and visual impairment. All of them were right hand dominant. A sagittal view of the left side of the body was obtained for all trials using a CCD video camera with a standard sampling frequency of

60 Hz. Retro-reflective hemispherical markers, 20 mm in diameter, were attached to the toe (anterior border of the first metatarsal) and heel (posterior aspect of the calcaneus) of both feet.

Subjects walked barefoot on a walkway about 10 meters long and 1 meter wide. Four sets of experiments were performed. In experiment 1, the subjects were asked to walk on the walkway, without obstacles, in their self-selected walking speed, fast walking speed and self-selected jogging speed. In experiment 2, 3, 4, the subjects were instructed to walk along walkway, step over the obstacle with their right feet first and their left feet second, and then continue walking to the end of the walkway. The obstacle height and approach velocity were randomly selected for each trial. Three trials were performed for each task.

The means and standard deviations were calculated and compared for all variables. Two-way repeated measures ANOVA was performed to examine the effects of approach velocity when stepping over obstacles of different heights.

RESULTS

The crossing velocity increased linearly ($p=0.000$) when approach velocity increased. The crossing stride time decreased linearly ($p= 0.001$) as approach velocity increased. For the crossing stride length, it increased linearly ($p=0.002$) while approach velocity increased. As can be seen in Fig. 1, the crossing stride length was independent of obstacle height.

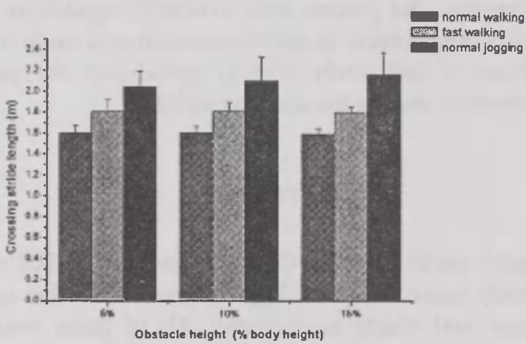


Fig. 1. Crossing stride length of each approach velocity and obstacle height

Toe-obstacle distance of the trailing foot was found to be influenced by approach velocity. It was increased linearly (p=0.016) when approach velocity increased. Also, increasing approach velocity resulted in heel-obstacle distance of leading foot increasing linearly (p=0.013). More important, however, both the toe-obstacle distance and heel-obstacle distance were not affected by obstacle height.

Of considerable interest was the leading foot clearance did not change with the approach velocity and obstacle height. It was constant for leading foot when stepping over obstacles from 5% to 15% body height with self-selected manners. The trailing foot clearance, however, was affected by approach velocity (linear trend, p=0.001). In addition, the toe clearance variability of trailing foot was greater than that of the leading foot (Fig. 2).

A clear profile of gait mode and obstacle height effects can also be seen when looking at the time from the trailing foot toe off to when it was directly over the obstacle. The time from toe off to obstacle increased linearly (p=0.002) when obstacle height increased. Also, it was dependent of approach velocity (p=0.035).

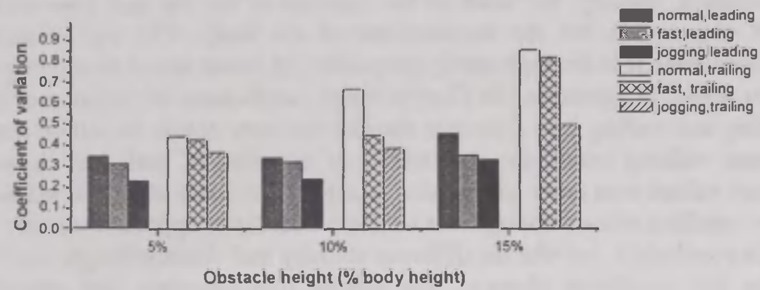


Fig. 2. Coefficients of variation for the foot clearance of each gait mode and obstacle height.

DISCUSSION

Consistent with Sparrow et al. [1], when stepping over an obstacle in a self-selected manner, the crossing stride length remained invariant with change in obstacle height. For obstacle avoidance, kinesthesis is critical for providing information about the position and movement of the limbs through space. That is, information determined from the relative joint angles of the leading and trailing limbs provide knowledge about the location of the limb to ensure obstacle clearance. Therefore, it is reasonable to think that stride length is regulated precisely when negotiating obstacles in order to maintain an invariant crossing position of the trailing foot.

The vertical clearance of leading foot was not affected by the gait mode and obstacle height. This measured toe-obstacle clearances were similar to the results reported by Chou et al. [2] and Patla [3]: toe-obstacle clearance is relatively constant for the leading foot in a self-selected manner. The leading foot can be visually guided when stepping over obstacle. Cognitive influence is applied to finer adjustment related to the height of the obstacle. This makes it possible not only to produce quick and precise adjustment for placing the leading foot in a specific location, but also to establish the whole body's stability.

For the vertical clearance of trailing foot, however, it was affected by gait mode. In addition, the toe clearance variability was greater than that of the leading foot. Chen et al. [4] demonstrated that with increasing locomotion velocity, the work of the muscles at the hip and knee joints were responsible for the acceleration of the body. The calf muscles changed their role from primarily propulsion at lower speed to stability at faster speed. In agreement on Chen's report, coefficients of variation of the leading and trailing foot clearance showed the same result. In self-selected normal walking speed, the coefficients of variation of both feet showed greater values than other gait modes. It suggests the calf muscle acted as a joint stabilizer when stepping over obstacle with faster approach velocity.

In conclusion, introducing different velocity and obstacle height elicited swing foot regulation changes. The leading foot clearance kept constant margin for safety strategy when approach velocity and obstacle height changed, while the clearance distance of the trailing foot showed greater variability. The crossing stride velocity and stride length increased as approach velocity increased, while they were independent of obstacle height. These results suggest that the higher approach velocity poses greater demands on locomotor system when negotiating obstacle.

REFERENCES

1. Sparrow WA, Shinkfield AJ, Chow S, Begg RK (1996) Characteristics of gait in stepping over obstacles. Hum Mov Sci 15: 605–622.
2. Chou LS, Kaufman KR, Robert HB, Draganich LF (2001) Motion of the whole body's center of mass when stepping over obstacles of different heights. Gait Post 13: 17–26.
3. Patla AE (1997) Understanding the roles of vision in the control of human locomotion. Gait Post 5: 54–69.
4. Chen IH, Kuo KN, Andriacchi TP (1997) The influence of walking speed on mechanical joint power during gait. Gait Post 6: 171–176.

INSTRUCTION TO AUTHORS

Acta kinesiologiae Universitatis Tartuensis is a multidisciplinary (publishing papers on diverse subjects from sports and exercise sciences) annual publication.

Manuscripts are accepted for consideration with the understanding that their contents have not been published elsewhere. Manuscripts are read through by the editor and by two reviewers in blind review process, which takes 8–10 weeks.

Manuscripts are to be submitted in English. Submit three clear copies of the manuscript to the editor. Maximum volume of text is 10 pages, maximum total volume is 15 pages. Type the manuscript double-spaced on one side of A4 paper with margin of 3 cm on the left side.

The manuscript should be arranged as following

1. Title page

Title of the article in capital letters, names of authors, authors institution, name and address of the principal author, up to 5 key words. For blind review, a second title page is needed that contains only the title.

2. Abstract (up to 200 words, separate sheets).
3. Text

The text should contain the following sections: Introduction, Materials and Methods, Results, Discussion, References, Acknowledgements if any. Tables and Figures should be presented on separate sheets. Figures should be professional in appearance and have clean, crisp lines. Identify each Figure by marking lightly on the back, indicating, Figure number, top side and abbreviated title of manuscript. Legends for the Figures should be submitted on a separate sheet. Tables should be double-spaced on separate sheets and include a brief title. The SI units should be used in presenting results.

Each citation in the text must be noted by number in parenthesis and must appear in the reference list as well. Each entry in the reference list must be double-spaced, arranged alphabetically and numbered serially by author with only one reference per number. Non-english papers should be cited in the original language.

Entries in the reference list should be as follows:

1. Sarna S., Kaprio J. (1994) Life expectancy of former elite athletes. Sports Med. 17 (3): 149–151
2. Gurpide E. (1975) Tracer methods in hormone research. Springer Verlag, New York
3. Morgan W. P., Borg G. (1976) Perception of effort in the prescription of physical activity. In: The humanistic and mental health aspects of sports, exercise, and recreation, T. Craig (ed). Chicago: Am. Med. Assoc. 256–259
4. Paoletti R. (1994) Future directions in drug treatment of atherosclerosis. 8th Int. Dresden Symp. on Lipoproteins and Atherosclerosis. Abstracts. Dresden, June 10–12, 1994, 22.

Page proofs will be sent to the author for marking of printer's errors. Ten reprints will be sent, free of charge, to the principal author.
Subscription rate: 20 USD (+postage) send to the editor.

ISSN 1406–9822