

ACTA UNIVERSITATIS CAROLINAE
KINANTHROPOLOGICA, Vol. 55, 1 – 2019

Charles University
Karolinum Press

AUC Kinanthropologica is licensed under a Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

<http://www.karolinum.cz/journals/kinanthropologica>

© Charles University, 2019

MK ČR E 18584

ISSN 1212-1428 (Print)

ISSN 2336-6052 (Online)

CONTENTS

Original Articles

- 5 WAIC, M.
Looking back at the quarter century of Kinanthropology.
Unde venis et quo vadis Kinanthropology
- 10 HASSMANNOVÁ, K., PAVLŮ, D., NOVÁKOVÁ, T.
Most common injuries of the musculoskeletal system among children
of elementary school age who engage in gymnastic sports
(aerobics, artistic or rhythmic gymnastics) at an elite level
- 21 MANDROUKAS, A., HELLER, J.
Maximal oxygen uptake and concentric isokinetic muscle strength in pubertal
football trained and untrained boys of the same biological age
- 32 ČÁSLAVOVÁ, E., VIŠNĚVSKÝ, A.
Effect of long-term sponsorship of the Škoda Auto brand
and international sport events on congruence of brand personality
- 49 ŠTĚDRONĚ, B.
Experiments with the Lichtman forecasting procedure in the sport segment

Looking back at the quarter century of Kinanthropology. Unde venis et quo vadis Kinanthropology

Marek Waic

Department of Kinanthropology and Humanities, Faculty of Physical Education and Sport,
Charles University, Prague, Czech Republic
waic@ftvs.cuni.cz

ABSTRACT

The study is aimed at dealing with the development of kinanthropology as a science discipline, and scientific beginnings related to the area of movement at the end of the 19th century. In addition, the study reminds us of the contributions of František Smotlacha to the development of these sciences. Further, it is devoted to the 90's of the last century when kinanthropology was established as a discipline of postgraduate studies and an associated habilitation discipline.

KEYWORDS

kinesis; anthropos; human movement studies; Charles University; physical education

DOI

10.14712/23366052.2019.1

INTRODUCTION

In the first issue of the Journal of Physical Education of Youth in 1992, we find a short entry titled “Kinanthropology has Entered the World.” This entry reflected the fact that Kinanthropology was accredited as a postgraduate course at the Faculty of Physical Education and Sport (FTVS) at Charles University in 1991 and subsequently became a field for habilitation.

In this report we read: “The word kinanthropology is the etymological combination of three Greek words kinesis (to move), anthropos (human) and logos (word). The term logos is usually the second part of a composite of words describing an expert in the area that is expressed in the first part” (*Physical Education of the Youth*, 1992, 58(1), p. 1). Kinanthropology and kinanthropologists were born.

Kinanthropology, however, did not rise out of nothing. Still, its conception was a significant milestone in the evolution of the study of human movement in the Czech lands. Finding the starting point is not easy. If kinanthropology was born at Charles University, then let’s focus on academia. In February 1882, the Charles-Ferdinand University¹ was divided into Czech and German parts, or rather, into Czech and German universities. Ten years later, by the decree of Ministry of Cultus and Instruction, Czech and German Educational Courses for Physical Education Teachers of Secondary Schools and Teachers’ Institutions were established. In 1906, the Czech course was affiliated with the Institute of Anatomy of the Czech Medical Faculty. Prof. Dr. Jan Jánošík,² who was replaced by prof. Dr. Karel Weigner³ in 1927, was appointed the course director. A tradition was maintained that the courses was headed by a professor of anatomy and a director of the Institute of Anatomy of the Medical Faculty of Charles University. The lectures and seminars were conducted in three areas: 1. Practical physical education, 2. Theory, history, assignments, tools and system of physical education, 3. Anatomy, physiology, basics of health and nutrition sciences.⁴ Even before the First World War, the lectures could easily be divided into three specific fields of social-sciences, biomedical sciences and sport. The mission of the course was primarily educational, but the lectures were led by the best specialists in these fields who draw upon the latest scientific knowledge of the times and applied them to human movement.

¹ The Austrian Emperor Ferdinand III participated in the reform of the university after he took Carolinum from the Jesuits in 1638 and restored independent law and medical studies under the imperial protector. In 1654, the emperor enacted the agreement of all parties to create one Charles-Ferdinand University with four faculties, while the Faculty of Philosophy and Theology remained in the administration of the Jesuits; the Archbishop was confirmed as Chancellor, although the role was in practice performed by the rector. The Prague university bore the abovementioned name until the establishment of Czechoslovakia.

² Prof. Dr. Jan Jánošík (1856–1927), a founder of the Czech anatomy; between 1910 and 1911 a rector of Charles-Ferdinand University.

³ Prof. Dr. Karel Weigner (1874–1937), a pupil of professor Jánošík, who replaced him in the role of the director of the Institute of Anatomy; between 1936 and 1937 a rector of Charles University.

⁴ *Dějiny Univerzity Karlovy*, IV, 1918–1990. Prague: Karolinum, 543 p.

The next step in the emancipation of the study of movement was the habilitation of František Smotlacha. František Smotlacha was a graduate of the course and studied Natural Sciences at the Faculty of Philosophy.⁵ In 1907, he passed a state exam from “physical education for secondary schools” and, in 1909 and 1910, from mathematics, physics and natural science. In 1911, František Smotlacha defended his dissertation thesis on mycology and passed a rigorous examination in zoology, botany and philosophy and became a Doctor of Philosophy. In July 1914, Dr. Smotlacha received the “Voluntary Supplement to First Approbation,” by passing an exam (according to the new exam rules) in swimming, first aid, fencing, games and track and field. In 1924, Smotlacha was authorized to establish an Institute of Physical Education and Sport for the students of Charles University which was affiliated with the Faculty of Science. In 1930, Dr. Smotlacha presented his thesis on “Biological basis of humans interest in climbing and hanging” before the faculty of the Faculty of Science of Charles University and became an associate professor in the field of “methodology and systems of physical education” (Waic, 2011, p. 54). By this, the study of movement had been de facto recognized at Charles University.

In 1927, František Smotlacha started publishing a magazine called *New Physical Education, a Journal for Physical Education, Games, Sports, Scouting and Research*. It was the first periodical in the Czech lands which had an ambition to publish a variety of scientific research from various fields of study on human movement, to popularize them and thus enrich the teaching of physical education at secondary schools. The pages of *New Physical Education* provided new space for discussion on the further direction of physical education sciences:

The direction of the journal is defined by the progress of physical education and education as such and the progress of sports, scouting as well as gainful physical work. It will discuss questions from the field of study of human as a subject of physical education, or as a practitioner of physical education, sports, scouting and gainful employment, i.e. biology (anthropology), psychology (pedopsychology) and sociology, as well as from the field of study of education: hygiene, eugenics, economics, logic, ethics and aesthetics. These sciences determine the direction of education, and hence physical education, and are also important sciences for the appreciation of physical education, sports, games, scouting, gainful employment and all their methods (*Nová tělesná výchova*, 1927, 1(1), p. 1).

On November 17, 1939, the Nazi occupiers closed the doors of Czech universities. After the liberation of Czechoslovakia in 1945, the Institute for the Education of Physical Education Teachers at Charles University was established, replacing the Educational Course, but the modest conditions in which it operated and frequent organizational changes that accompanied the physical education courses, did not favour the development of the study of human movement.

The Government Decree from 7 April 1953 established the Institute of Physical Education and Sport (ITVS) and the Research Institute of Physical Education and the Centre of Physical Education began to be created within the ITVS. The institutional establishment of the Research Institute of Physical Education had certainly been a sig-

⁵ An independent Faculty of Science was established in 1920.

nificant contribution to the development of the study of human movement. The actual benefit to this development is difficult to evaluate, and its assessment would require a deeper analysis, in which it would be necessary to separate the powerful ideological ballast from rational knowledge in the professional publications of that time.

The gradual loosening of the Communist nomenclature control over all areas of society, including the study of movement, created an environment in which it was possible to discuss the constitution of an independent study of human movement and its exit from the field of physical education pedagogy. In 1967, Professor Stanislav Čelikovský (from 1962 to 1973 Vice-Dean for Science of FTVS) initiated an international conference at the Faculty of Physical Education and Sport of Charles University, where participants discussed the establishment of the scientific discipline of human movement. Although they were not successful in their venture, Stanislav Čelikovský and his pupils Rudolf Kovář and Petr Blahuš managed to establish one of the fundamental disciplines of the study of movement – anthropomotrics. The normalization had put a stop to the establishment of an independent study of human movement. But that did not mean the research stopped too. The Communist normalizers focused mainly on sport humanities, but in other disciplines several empirical researches and experiments were carried out and yielded many interesting results. It is not for the historian to assess whether some of them have been wrongly forgotten, but I dare to say that literature and periodicals from the 1970s and 1980s should not be forgotten, so that we do not discover what was already discovered, which is a phenomenon that is not unknown in the history of science.

The fall of the communist regime in Czechoslovakia brought new opportunity to the Faculty of Physical Education and Sport at Charles University to freely discuss the establishment of a field of study that would focus on movement. In this discussion, a generation of experts who received the highest scientific accolades, spoke the loudest. These were Petr Blahuš, Václav Hošek, Rudolf Kovář and Pavel Slepíčka who were appointed professors at the turn of the 1980s and the first half of the 1990s. It was this “strong generation” that stood at the birth of the science of Kinanthropology.

In the early 1990s, the Department of Fundamentals of Kinanthropology was established at FTVS, headed by prof. PhDr. Zdeněk Teplý, DrSc. In October 1991, the Kinanthropology was accredited by the Accreditation Commission as a postgraduate doctoral degree program and subsequently as the field of habilitation. A Kinanthropological Scientific Society was established at the conference on Kinanthropology, held during the celebrations of the 40th anniversary of the Institute of Physical Education and Sport (Blahuš, 1993).

The new field of study was given an institutional framework, but its content had to be clarified, which the participants of the conference attempted. The first definitions of the discipline also emerged. Also applicable to the present is the one from Petr Blahuš: “The subject of Kinanthropology is human intentional physical activity and its relation to the development of man as a biopsychosocial individual” (Blahuš, Česká kinantropologická společnost. Not dated).

In his contribution at the “founding” conference Lubomír Dobrý said that Kinanthropology: “implicitly contains requirement to specify in each individual field of the broad kinanthropological spectrum what is presented here in a general form, and thus to express a relation of the particular and special to the general” (Dobrý, 1992, p. 2).

He thus initiated a discussion on the structure of sub-fields of Kinanthropology, a discussion which is still alive to this day.

We may ask ourselves a somewhat heretical question whether the “kinanthropological” journey that started at the beginning of the 1990s is really the right one, or whether, for the area where our research and educational efforts are directed, we should not have chosen a different collective label, such as studies of sport. But it would remain only hypothetical because it is too late to return. Kinanthropology as a term describing the study of human movement has already been established and is generally accepted not only by the professional kinanthropological community but also by experts from other fields of science. In the institutional framework of education and pedagogical-scientific qualifications, Kinanthropology has also been already firmly established. This process was completed by the definition of educational areas in the amendment to the Higher Education Act of 2016, which included Physical Education – Kinanthropology, and within which the first study programs were accredited to our Faculty. Also, Biomedical and Social Science Kinanthropology were included in the system of internal evaluation of various disciplines fostered at Charles University.

The current assessment of the academic performance of academic institutions is based on the evaluation of atomized disciplines. Kinanthropology is an exception in this respect, which makes it unique, because it seeks to explore human movement in its interdependence and complexity. For example, the growing deficit in population’s physical activity, especially in rich countries with developed infrastructure (including the Czech Republic), has mainly social causes with far-reaching health consequences. The kinanthropologists have tools to examine all the components of the process throughout the chain of mutually affecting causes and consequences and to look for ways to reverse this negative trend.

The only thing remaining is to wish Kinanthropology that it will avoid any pitfalls on its future path and to all researchers, who devote their time to this science, not only enough placements in the “top” science observed in the “quartiles,” but above all, a lot of ingenuity in finding research topics which would bring them joy and which would actually develop knowledge of the human movement.

REFERENCES

- Bečvář, J., Havránek, J., & Pousta, Z. (1998). *Dějiny Univerzity Karlovy*. Prague: Karolinum.
- Blahuš, P. (1993). Kinantropologie na Univerzitě Karlově. *Tělesná výchova mládeže*, 59(7), 17–23.
- Dobrá, L. (1992). Potřeba kinantropologie. *Tělesná výchova mládeže*, 58(1), 1–4.
- Nová tělesná výchova: list pro tělesnou výchovu, tělocvik, sport, hry, skauting a vědecké studium těchto oborů* (1927). 1(1). Prague: Ústav tělesné výchovy, tělocviku a sportu.
- Tělesná výchova mládeže: nezávislý list pro učitelstvo všech druhů škol, kandidáty učitelství, tělocvičné a sportovní spolky, cvičitele a vychovatele mládeže* (1992). Brno: Melantrich.
- Waic, M. (2011). Zrození českého akademického sportu a František Smotlacha. *Česká kinantropologie*, 15(2), 49–58.

Most common injuries of the musculoskeletal system among children of elementary school age who engage in gymnastic sports (aerobics, artistic or rhythmic gymnastics) at an elite level

Kristina Hassmannová*, Dagmar Pavlů, Tereza Nováková

Department of Physiotherapy, Faculty of Physical Education and Sport,
Charles University, Prague, Czech Republic

* Corresponding author: hassmannova.kristina@gmail.com

This study was developed within the Charles University PROGRESS Programme Q41.

ABSTRACT

Background. The main objective was to find out which musculoskeletal system problems (pain and/or injuries) are the most common among girls of elementary school age who engage in gymnastic sports at an elite level. We were also interested in the influence of the success of girls in gymnastics competitions on problems of the musculoskeletal system. In connection with the pain and injuries of the musculoskeletal system, we asked whether the gymnasts were monitored professionally on the medical side, whether they regularly engaged in primary or secondary physiotherapeutic care.

Methods. The data were obtained by combining qualitative and quantitative research in the form of a structured interview and a questionnaire. Retrospective data were collected. The research group consisted of 58 girls (average age 13.5 years) engaging in gymnastic sports at an elite level.

Results. A musculoskeletal system problem occurred in 98% female gymnasts during their elementary school age. Their lower limbs, specifically the knees and ankles, appeared to be the most susceptible parts of the musculoskeletal system. Multiple musculoskeletal system problems were more frequent than single isolated problems. As far as the correlation between the incidence of pain/injury and the girls' individual performance level is concerned, gymnasts assuming non-medal positions had a higher incidence of pain and injuries than the medal-winning gymnasts. The higher incidence of injuries in non-medal gymnasts compared to medal gymnasts was confirmed by statistical analysis. Physiotherapeutic prevention, whether primary or secondary, was given a minimum number of gymnasts.

Conclusion. The results of this study demonstrate a high susceptibility to painful conditions and injuries especially of lower limbs of elite level gymnasts at their younger school age. It also proved statistically significant that gymnasts who are worse off with performance always have a higher incidence of problems with the musculoskeletal system. These results are also probably due to the fact that most of the interviewed gymnasts are not in physiotherapy or other professional care.

KEYWORDS

gymnastic sports; musculoskeletal system; pain and injuries; hyper mobility

DOI

10.14712/23366052.2019.2

INTRODUCTION

Gymnastic sports, presumably due to their difficulty, are specific in that a large number of injuries already occur in childhood. The hazard of injury in gymnastic sports is very high because of the high demands put on the gymnast's performance, both on movement and on the intensity of training. Another risk factor is also the start of a very intense early age (Bradshaw, 2010; Lowry et al., 1982).

The children start their sports career at an age of 3–4 in preparatory courses taking place once or twice a week. The number of training units is increased step by step to reach 6–9 units a week (which can amount to more than 20 hours weekly) at the children's younger school age (Kolar, 2017).

Functional overloading of the musculoskeletal system due to a burden that is inadequately high with respect to the children's age and to a training intensity that is too high for the children to be able to cope with constitutes the highest health risk in children sporting at a competition level (Kučera et al., 2011).

In childhood, we often encounter problems with the musculoskeletal system in the form of microtraumas, manifest as pain or minor injuries, which are often not even given sufficient importance. Micro-traumas, which may have fatal consequences for the child's sports career, must be taken into account in children (Keller, 2009). Chronic damage suffered by the children during their growth does not attract much interest either because, owing to the children's high adaptive and regenerative capacity, the consequences of the inadequately high load and insufficient regeneration are not immediately apparent, but they create preconditions for musculoskeletal system problems at a higher age (Karantanas, 2010).

This study is based on an already published study (Hassmannová et al., 2018) where we focused on the deficiencies in physiotherapeutic care in connection with musculoskeletal problems in younger school age girls who are engaged in elite gymnastics sports. In this article, we will focus on the most common musculoskeletal problems of these gymnasts and their possible causes.

OBJECTIVES AND METHODS

The aim of this work was to map musculoskeletal system problems – painful conditions and injuries – in younger school age girls practising gymnastic sports at an elite level. Furthermore, we wanted to identify those parts of the musculoskeletal system that are most prone to causing pain and to injuries and find whether – and if so, then to what extent – pain or injury affect the gymnast's performance, and also how this issue is addressed from the physiotherapeutic aspect.

The research group comprised girls from Prague sports clubs of artistic and rhythmic gymnastics and gymnastic aerobic who have been practicing their sports at an elite level. Specifically, the group included 58 girls from 10 artistic gymnastics clubs, 22 girls from rhythmic gymnastics clubs and 26 girls from gymnastic aerobic clubs. The mean study subject age was $x_{\text{mean}} = 13.52 \pm 1.24$ years. The following criteria, in addition to availability, were applied to the selection of the participants: girl at a younger school age, i.e. not younger than 12 years and not older than 15 years, prac-

tising a gymnastic sport since her age of 3–4 years (in a preparatory course) and now, at her younger school age, at a high competition level.

The research combined the qualitative and quantitative approaches by using a controlled structured interview and a questionnaire. The structured interview was made with children towards or after the end of their younger school age and one of their parents was present. The data collection concept was retrospective, information from the younger school age period was recorded. The interview structure was set by a fixed questionnaire which was filled in step by step by the researcher during the interview.

Data were collected during December 2017 and January 2018. As mentioned above, one of the parents as a legal representative was present during the interview and the information gained was recorded in the questionnaire. Before starting the interview, the researcher made the study subject and her parent familiar with the interviewing procedure and information processing method, and both of them expressed their consent by signing copies of the informed consent form approved by the Ethics Committee of the Faculty of Physical Education and Sport, Charles University (Hassmannová, 2018).

Data analysis was based on the following questionnaire items:

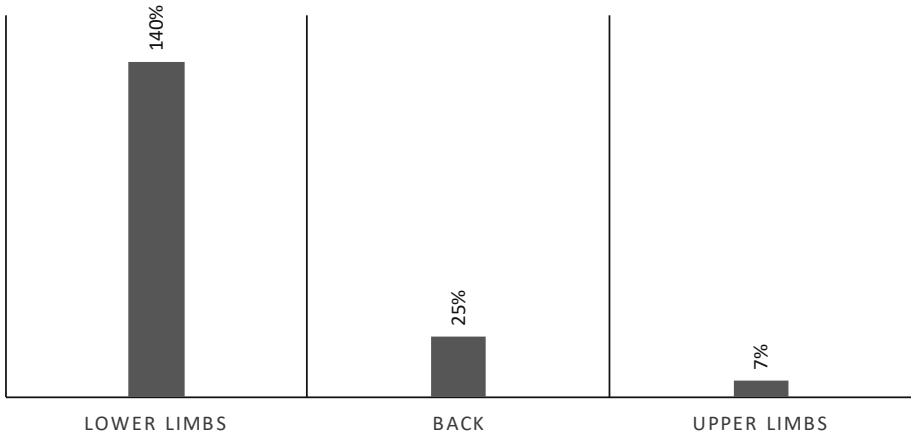
- Training intensity (categories: ≤ 5 hours per week, 5–10 hours per week, > 10 hours per week).
- Sport achievements (“Medal position” means that the child often participated in competitions and won a medal in one-half of them or more).
- Other motion activities in addition to the gymnastics trainings (“Yes” means that the girl practises some motion activity other than gymnastic training at least once a week during her younger school age).
- Sports training-related pain and/or musculoskeletal system injuries (pain was defined as such musculoskeletal system pain as the child perceives regularly, is located in a defined body area and limits the child during training but does not preclude the child’s participation in it; musculoskeletal system injury was defined as a condition due to which the child was unable to practise sports activity).
- Approach to the child’s musculoskeletal system problems (“Professional attention” means that the girl visited a doctor or physiotherapist immediately after the problem appeared; “Prevention” means primary physiotherapeutic prevention where the child attended physiotherapeutic sessions periodically even though they had no acute problem; and “follow-up prevention” means secondary physiotherapeutic prevention where the child attended physiotherapeutic sessions periodically because of an existing or past problem).

The data were processed in the Microsoft Excel spreadsheet application. The double sample t-test method was used for statistical data processing.

RESULTS

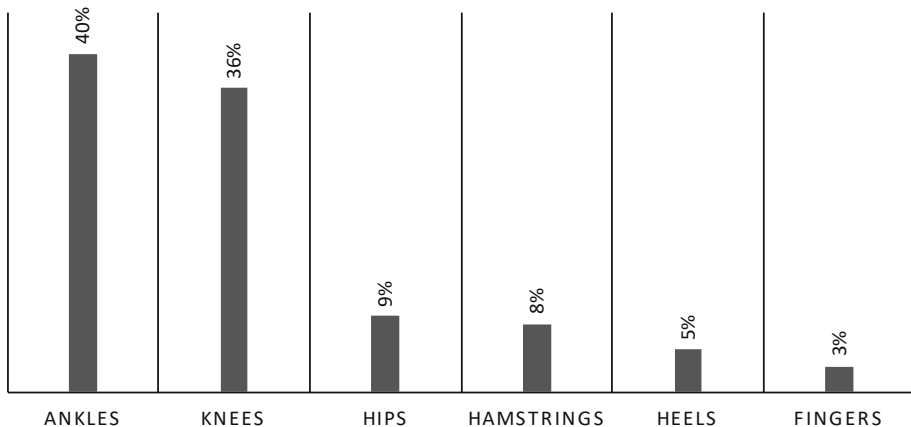
One or more sport training-related musculoskeletal system problems of any type occurred in 57 (98%) gymnasts at their younger school age. In other words, only one girl in the research group reported no pain or injury in relation to her sporting activity.

The prevailing problems concerned the girls' lower limbs, back and upper limbs. The frequency of lower limb problems was up to 140% (a figure over 100% means that some girls perceived more than one problem of that type) (Graph 1).



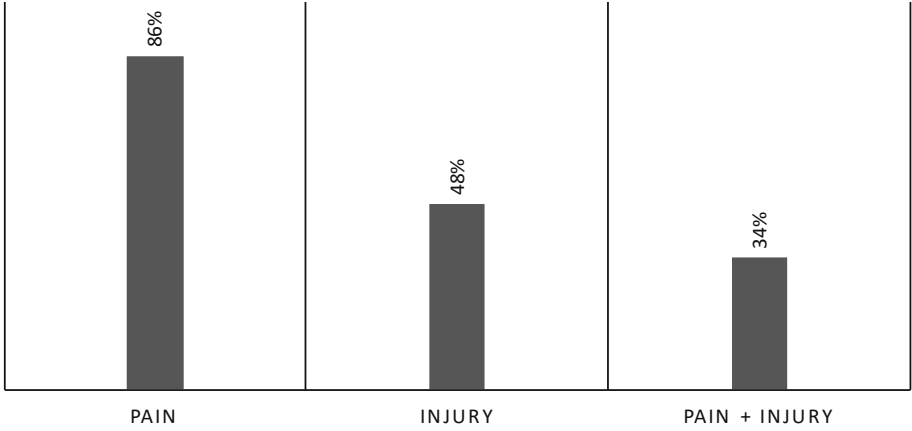
Graph 1 Problematic areas of musculoskeletal system of gymnasts of young school age

Most prone to injury in this respect were the ankles and knees. In the subgroup of girls with lower limb problems, ankle problems were reported by 40% girls, problems with knees, by 36% girls. Back pain or injury was reported by 25% girls whereas upper limb problems were reported by mere 7% girls. The following graph shows the percentage of problems on different parts of the lower limb (Graph 2).



Graph 2 Pain and injuries of lower limbs in young school age gymnasts

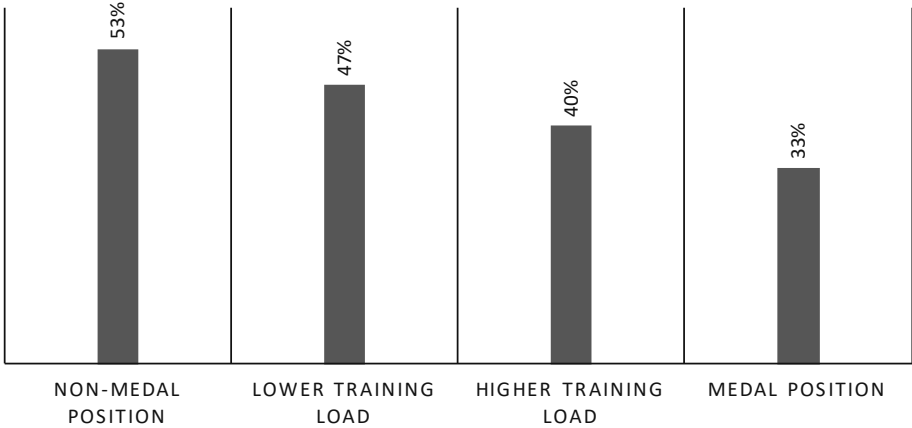
Musculoskeletal system pain was reported more frequently than musculoskeletal system injuries. Specifically, musculoskeletal system pain was reported by 86% gymnasts at their younger school age, which is an alarming figure. Musculoskeletal system injury was reported by 48% girls, combination of pain and injury was reported by 34% girls (Graph 3).



Graph 3 The occurrence of pain and injuries of the musculoskeletal system in younger school age gymnasts

Relations between musculoskeletal system pain and training load/sports achievements

As to the pain-training load relationship, the incidence of musculoskeletal system pain was paradoxically higher in gymnasts who had a lower training load. And as to the pain-sports achievements relationship, pain was reported more by gymnasts who normally attained non-medal positions than by girls who frequently won a medal at competitions (Graph 4).

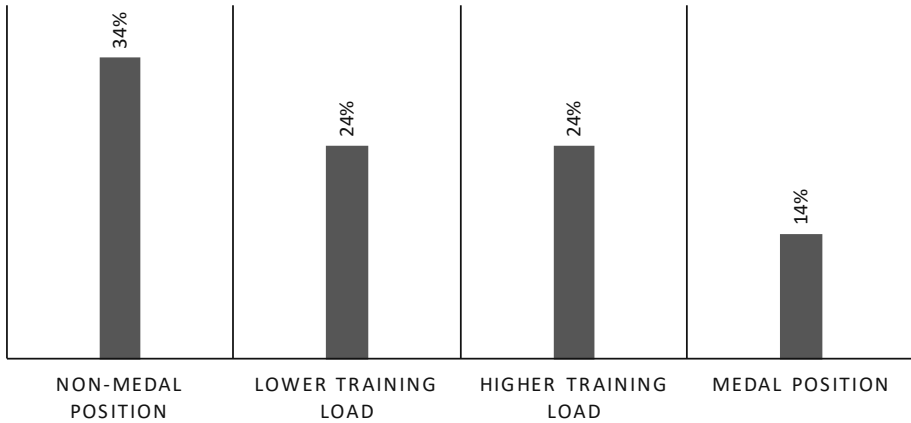


Graph 4 Pain of the musculoskeletal system in younger school age gymnasts

Relations between musculoskeletal system injuries and the training load/sports achievements

The occurrence of musculoskeletal system injuries was uniform with respect to the training load intensity. The injury-sports achievements relationship was similar to the pain-sports achievements relationship: injuries were reported more by gymnasts who normally attained non-medal positions than by girls who frequently won a medal at competitions (Graph 5).

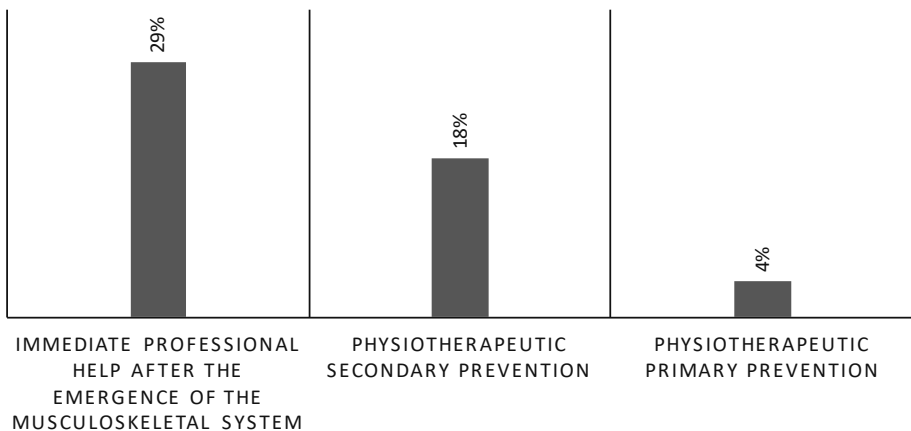
Statistical processing gave evidence that this fact is statistically significant, $p = 0.049$ (i.e., $p < 0.05$).



Graph 5 Injuries of the musculoskeletal system in younger school age gymnasts

Professional treatment of musculoskeletal system problems

The research results demonstrate that fewer than 29% gymnasts who experienced a musculoskeletal system problem saw a doctor or physiotherapist immediately after the problem appeared. Mere 4% gymnasts followed a physiotherapeutic prevention program. Physiotherapeutic prevention because of a present or past musculoskeletal system problem was practised by fewer than 18% gymnasts (Graph 6).



Graph 6 Professional solutions and prevention of problems of musculoskeletal system in young school age gymnasts

DISCUSSION

The high injury rates in elite gymnasts are ascribed to the high training intensity, to the high demands for performance and also to external effects (effects of the environment, family, trainers, medical care level). Caine et al. (1989) have studied a group of elite gymnasts (female & male) during a one-year period. One research group consisting of 50 female gymnasts reported 147 injuries, which is a 294% rate. The other group examined consisted of 31 female gymnasts and the number of injuries was 48, i.e. 155%, which agrees with the results of our study. Lowry and Leveau (1982) examined a group of 370 elite female gymnasts and recorded 260 musculoskeletal system injuries, which implies a 70% injury rate. Other 2 studies made during the same period of time did not support a high injury risk rate of gymnastics: Goodway et al. (4) examined a group of 725 gymnasts (male & female) and recorded 93 injuries (13% injury rate), and Pettrone and Ricciardelli (1897) examined a group of 542 gymnasts (male & female) and recorded 62 injuries, which provides an injury rate of mere 5%. Presumably, the high differences between the data are due to different injury assessment methodologies applied. The studies indicate that the higher the gymnast's performance, the higher the injury risk (Lowry et al., 1982). Most prone to injury in gymnasts are their lower limbs, depending on the nature of the performance expected of the gymnast (Kirialanis et al., 2003). This is confirmed by the results of our study. In comparison of the occurrence of pain and injuries, there was a much greater occurrence of musculoskeletal system pains, which represents tiny microtrauma and functional problems of the musculoskeletal system. This result is consistent with that of Keller (2009), which describes the occurrence of microtraumas in young gymnasts. These microtraumas, due to functional disorders of the musculoskeletal system, are the basis for more serious injuries in later life and endangering the entire sports career. The most common functional disorders of the musculoskeletal system are muscle imbalance arising from the specifics of gymnastic sports. Muscle imbalances disrupts the balance between agonists and antagonists and disrupts the smooth coordinated movement. Movement becomes physiologically ineffective, affects muscular and joint apparatus, and is only a matter of time before serious structural changes occur (Kolář, 1988).

Frequent injuries to lower limbs in gymnasts can explain typical muscle imbalances for gymnastics described by Kolář (1988). Muscles that bind to the lower limbs and have a tendency to weaken in gymnastics are *m. gluteus maximus* and *m. vastus medialis*. Weakening of the large gluteal muscle causes overloading of the hamstrings and paravertebral muscles in the lumbar region. It causes a loose and internally rotating position in the hip joint and a valgus position of the knee and ankle joint (Liebenson, 2007).

Muscles that bind to the lower limbs and have a tendency to shorten in gymnastics are *m. iliopsoas*, *tensor fasciae latae*, *m. rectus femoris*. Shortening of *m. iliopsoas* causes lower cross syndrome. The shortening of *tensor fasciae latae* causes the proximal end of the tibia, the valgus of the knee joint, and the weakness of the *m. vastus medialis*, which weakens the stability of the knee joint. Shortening of *tensor fasciae latae* is one of the causes of functional disorders of the knee joint (Kolář, 1988; Liebenson, 2007).

Given the results regarding the professional treatment of musculoskeletal system problems, we also attribute the frequent occurrence of problems with musculoskeletal system to gymnasts with minimal professional health care, as rehabilitation medicine or physical therapy. Frequent occurrences of problems in the lower limbs may have a negative impact on the entire musculoskeletal system without additional physiotherapeutic intervention and cause further injury. The incidence of injuries to more parts of the musculoskeletal system is already beginning to appear at a young age, as shown by the results of our study. We assume that with increasing age of gymnasts and increasing training intensity the problems of the musculoskeletal apparatus will be even worse. Physiotherapeutic prevention can prevent the development of functional problems of the musculoskeletal system described above and thus reduce the risk of injury in gymnastic sports overall.

Surprisingly, when studying our group of high training intensity gymnasts, we recorded a higher incidence of musculoskeletal system pain and injuries in gymnasts exposed to a lower training intensity and attaining poorer results in competitions than in gymnasts who had a higher training intensity and attained better achievements. We conclude that gymnasts in non-medal positions will always exhibit a higher injury rate than gymnasts winning medal positions. What remains to be clarified is whether this inverse relation between the injury rate and the gymnast's ability to attain a medal position is associated with some innate disposition and motion formulas, whether innate or acquired by optimal training. We conclude that even though their training is equally intensive and proceeds under the same leadership, the gymnasts assuming non-medal positions are unable to attain the same level of performance as their more successful colleagues and their risk of injury is higher. All this shows that some individuals are successful, are able cope with high training loads and have good achievements whereas other individuals are not that successful, have more musculoskeletal system problems and the suitability this type of sport for them is questionable. Hence, the selection of a suitable sport for a child is an issue of crucial importance.

Hypermobility is a major risk factor in the gymnast's proneness to musculoskeletal system pain and injury. Hypermobility (acquired or congenital) is found in nearly all female gymnasts. Enhanced connective tissue and ligament laxity results in repeated motions exceeding the physiological barrier, which are actually supported by the gymnastic sports, whereby the risk of premature occurrence of degenerative changes is enhanced. Individuals with diagnosed constitutional hypermobility are more prone to the development of a defective body posture and the associated musculoskeletal system problems, which are amplified by sports training (Grabara, 2010; Satrapová & Nováková, 2012).

The child's immature brain is unable to rationally assess the consequences of starting fatigue and lower achievements, whereupon the risk of injury increases, and it is the trainer's or parent's responsibility to watch the child's fatigue, maintain it in tolerable limits and prevent its transition into pathology (Balyi & Stafford, 2005). It is a false belief that the child's body is more resistant to fatigue. In fact, children are only unable to perceive their body so well as adults. We feel that children are less prone to tiredness because the child's body tone is shifted more to the stimulated sympathetic nervous system, with a relatively attenuated parasympathetic system also during a relative rest (Kučera et al., 2011).

CONCLUSION

The study showed a high incidence of musculoskeletal problems among younger school-age girls engaged in gymnastics at an elite level. The most susceptible are the lower limbs, namely the ankle and knee joints. Problems of the musculoskeletal system are also frequently encountered, the most frequent being the ankle and knee joints.

There are several reasons for the frequent occurrence of pain and injury at such a low age. The main reasons are the high level of sport, the high training intensity and the absence of professional, physiotherapeutic care for gymnasts from childhood. Insufficient physiotherapeutic care compared to the incidence of musculoskeletal problems was confirmed in our study.

Injury prevention in gymnastic sports requires an interdisciplinary and multi-sided approach of all professionals and the child's family who wish to responsibly contribute to the preparation of gymnasts from the very beginning as far as the elite level.

REFERENCES

- Balyi, I., & Stafford, I. (2005). *Coaching for Long-Term Athlete Development*. Leeds: Coachwise UK.
- Bradshaw, E. J. (2010). Performance and health concepts in artistic gymnastics. *International Symposium on Biomechanics in Sports: Conference Proceedings Archive*, 28, 51–55.
- Caine, O. J., et al. (1989). An epidemiologic investigation of injuries affecting young competitive female gymnasts. *American Journal of Sports Medicine*, 17(6), 811–820.
- Goodway, J., et al. (1989). *The distribution of injuries among young female gymnasts in relation to selected training and environmental factors*. Abstract. Paediatric Work Physiology, Symposium, Leuven.
- Grabara, M. (2010). Postural variables in girls practicing sport gymnastics. *Biomedical Human Kinetics*, 2, 74–77.
- Hassmannová, K. (2018). *Nejčastější zranění pohybového aparátu u dětí mladšího školního věku, které se věnují vrcholově gymnastickému aerobiku, sportovní nebo moderní gymnastice*. Master's thesis. Prague: UK FTVS.
- Hassmannová, K., Nováková, T., Satrapová, L., & Pavlů, D. (2018). Nedostatky ve fyzioterapeutické péči v souvislosti se zraněními pohybového aparátu u dětí školního věku, které se věnují vrcholově gymnastickým sportům (gymnastickému aerobiku, sportovní nebo moderní gymnastice). *Rehabilitace a fyzikální lékařství*, 25(4), 165–170.
- Karantanas, A. H. (2010). *Sports injuries in children and adolescents*. New York: Springer.
- Keller, M. S. (2009). Gymnastics injuries and imaging in children. *Pediatric Radiology*, 39(12), 1299.
- Kirialanis, P., Malliou, P., Beneka, A., Giannakopoulos, K. (2003). Occurrence of acute lower limb injuries in artistic gymnasts in relation to event and exercise phase. *British Journal of Sports Medicine*, 37(2), 137–139.
- Kolar, E., Pavletič, M. S., Smrdu, M., & Atikovič, A. (2017). Athletes' perception of the causes of injury in gymnastics. *The Journal of Sports Medicine and Physical Fitness*, 57(5), 703–710.
- Kolář, P. (1988). *Fyziologie hybnosti, relaxace a kompenzační cvičení ve sportovní gymnastice*. Prague: ČO ČSTV.
- Kučera, M., Kolář, P., & Dylevský, I. (2011). *Dítě, sport a zdraví*. Prague: Galén.
- Liebenson, C. (2007). *Rehabilitation of the spine: a practitioner's manual*. 2nd ed. Philadelphia: Lippincott Williams.

- Lowry, C. B., & Leveau, B. F. (1982). A retrospective study of gymnastic injuries to competitors and noncompetitors in private clubs. *American Journal of Sports Medicine*, 10(4), 237–239.
- Meeusen, R., & Borms, J. (1992). Gymnastic Injuries. *Sports Medicine*, 13(5), 337–356.
- Pettrone, F. A., & Ricciardelli, E. (1987). Gymnastic injuries: the Virginia experience 1982–1983. *American Journal of Sports Medicine*, 15(1), 59–62.
- Sands, W. A. (2000). Injury Prevention in Women's Gymnastics. *Sports Medicine*, 30(5), 359–373.
- Satrapová, L., & Nováková, T. (2012). Hypermobilita ve sportu. *Rehabilitace a fyzikální lékařství*, 19(4), 199–202.
- Stošić, D., Milenković, S., & Živković, D. (2011). The influence of sport on the development of postural disorders in athletes. *Facta Universitatis*, 9(4), 375–384.

Maximal oxygen uptake and concentric isokinetic muscle strength in pubertal football trained and untrained boys of the same biological age

Athanasios Mandroukas*, Jan Heller

Faculty of Physical Education and Sport, Charles University, Prague, Czech Republic

* Corresponding author: thanmandrou@hotmail.com

ABSTRACT

The purpose of the present study was to examine the effects of long term (prolonged) football training on maximal oxygen uptake ($\dot{V}O_2$) and isokinetic muscle strength in young football players and untrained boys of the same biological age. Twenty football competitive boys (mean age 14 ± 0 yrs; height 165.5 ± 8.5 cm; weight 59.9 ± 9.5 kg; years of training 7 ± 3) and eighteen untrained school boys (mean age 14 ± 0 ; height 168.22 ± 10.46 cm; weight 59.3 ± 9.9 kg) of the same biological age volunteered to participate in the study. Sexual maturation classified according to Tanner's stage 3. The football players participated both in their school's physical education program and in their football team training program while the untrained group participated only in their school's physical education program (2–3 times per week for 40 min). All subjects were tested for maximal oxygen uptake ($\dot{V}O_2$) and respiratory exchange ratio (RER) on the treadmill using an open circuit spirometry. The isokinetic peak torque values of quadriceps (Q) and hamstrings (H) as well as the H : Q strength ratios were recorded. $H_{con} : Q_{con}$ was calculated as the ratio of the peak concentric torque of H to the peak concentric torque of the Q. Results showed that the trained group had significantly lower heart rate in rest ($p < 0.001$), higher RER ($p < 0.001$), maximal blood lactate (BL_{max}) ($p < 0.001$) and higher ($\dot{V}O_2$) max in both relative and absolute values ($p < 0.001$) compared to the untrained group. At angular velocities of $60^\circ s^{-1}$ and $180^\circ s^{-1}$ the relative peak torque of Q and H were significantly higher ($Q = p < 0.01$; $H = p < 0.01$). However, the absolute values of Q and H as well as the H : Q ratios at all angular velocities did not differ significantly between the two groups. The results suggest that systematic football training (intensity and duration) has a positive effect in metabolic capacity, cardiorespiratory system and neuromuscular function.

KEYWORDS

muscle strength; hamstrings; quadriceps; H : Q strength ratio; biological age; football players; puberty; maximal oxygen uptake

DOI

10.14712/23366052.2019.3

INTRODUCTION

Today, children start serious athletic training at earlier ages than ever before. Both in young and adults, football is one of the most popular team sports in the world. It is commonly accepted that the physical activities of football have a positive impact in spiritual, psychological and bodily health (Hagger et al., 2001) and contributes to the maintenance of a physically active lifestyle (Krustrup et al., 2010). Regular football training, two to three times a week, caused significant cardiovascular and muscular adaptation (Nadeau et al., 2011; Krustrup et al., 2010). The aerobic capacity and the muscle strength in prepubertal and pubertal children have been a matter of long-lasting controversy (Vamvakoudis et al., 2007). Some studies demonstrated an improvement in $\dot{V}O_2$ (Eriksson & Koch, 1973; Máček et al., 1976; Lussier & Buskirk, 1977; Savage et al., 1986; Baxter-Jones et al., 1993), while other investigations (Kobayashi et al., 1978; Bar-Or, 1983; Mirwald & Bailey, 1984; Williams & Reilly, 2000) have shown little or no improvement. During puberty (13–16 years of age) occur difference in body size, aerobic power, muscle strength and performance between boys of contrasting maturity status, e.g. early versus late maturity of the same age (Malina et al., 2004). Complicating factors in this controversy has been mainly the different experimental design of the studies in this area as well as the chronological ages of the subjects (Armstrong, 1997). Most of these studies have been cross-sectional and therefore the effects of growth, development and heredity aspects may have been greater than those brought about by training (Mirwald et al., 1981; Vamvakoudis et al., 2001).

Training during childhood (prepubertal – pubertal) continues to be a subject of interest. However the results of training with children of different chronological age are difficult to separate the effects of training from these of growth. Although the isokinetic muscle strength as well as the aerobic power has been studied extensively there is no information on these variables throughout the same biological age in trained and in normal untrained children who had only the physical activities in the school. More specifically, little is known about the alteration that may occur in $\dot{V}O_{2max}$ and muscle strength in trained and untrained children. To our knowledge the present study is the first to provide information about the aerobic power and concentric isokinetic strength of knee extensors and flexors in trained and untrained (non-athletic) boys of the same biological age. Thus, the purpose of this study was to examine and compare the difference in aerobic power and isokinetic concentric peak torque of the knee flexor and knee extensor muscles as well as the ratios between already trained and untrained pubertal boys of the same biological age.

MATERIALS AND METHODS

Participants

A total of thirty eight (mean \pm SD, N = 38, 20 football players and 18 untrained boys, age = 14 ± 0) subjects volunteered to participate in this study. The participants were divided into two groups: a) football players as trained group, b) untrained boys. The physical characteristics of the subjects are shown in Table 1. All subjects and their parents were informed of the nature, purpose, and the possible risks involved in the study before giving their voluntary written consent for participation. All subjects

completed a questionnaire that included their relevant medical and physical history. The exclusion criteria were: recent history of muscle injury of the lower limbs, present complaint of thigh and leg pain and any other medical problems contraindicated for experimental testing. Also, overweight boys were excluded from the untrained group. None of the subjects had been doing progressive resistive exercise 24 hours before the testing. All players in the study came from three football academies (clubs) which followed a specific training program, while the untrained came from four different schools of the same region (area). The untrained group participated only in their normal physical education program in their school and did not take part in any other sport activities. The trained group participated both in their schools physical education program and in the national championship competition games. They were a highly selective group with regard to skills, performance, size, anthropometric characteristics and physical condition. Boys of both groups were born on the first 6 months of the same year. Pubertal staging, by examination of pubic hair, penile and testicular development was performed by an experience paediatric physician, experienced in the assessment of secondary sex characteristics, state of pubic hair based on the criteria of Tanner (1962). So, the classification for the sexual maturity for both groups were in Tanner stage three. The participants visited the laboratory in order to be informed about the experimental procedures and familiarised with equipment. Leg dominance was determined by asking the boys the limb that they preferred to use when they kick the ball. The height and body weight were measured using an electronic digital scale (Seca 220e, Hamburg, Germany). Resting heart rate (HR) and resting systolic and diastolic blood pressures (sBP, dBP) were recorded before the testing. Tests were performed in a temperature – controlled laboratory (20 °C to 21 °C; ~ 50% relative humidity). The study was performed in accordance with the local university Ethics Committee guidelines and ethical standards of the Sports Medicine research.

Football training program

The football training protocol focused on the development of technical and tactical skills and on the improvement of game – related fitness. The duration of the training season was 41 weeks per year. They participated in 3 to 4 training sessions of 90 min each, per week for at least 7 years. Also, they competed in 1 game per week throughout the season. More specifically *football* training consisted of jogging, stretching, and calisthenics of approximately 45–50% of the maximal heart rate, followed by alternating 75–85% for 5–8 minutes and light 50–65% for 40–45 minutes. This period included running with and without the ball. Also, jumping and sprinting exercises were a regular part of their practice. The intensity of the session registered by telemetry (Sport Tester, Finland).

Untrained group

The school physical education program consisted of 2–3 training sessions per week and every session was lasted for 40 minutes. The content of this program consisted of ball games (e.g. football, basketball, volleyball, handball and some calisthenics). The intensity was estimated by telemetry (Sport Tester, Finland). Both the duration and the intensity of the training in this group were much less than the specific training

program of the football players. Subjects reported no musculoskeletal injuries of the lower limbs that would affect them from performing maximal isokinetic contraction.

Measurement of the isokinetic strength

Prior to testing, each subject underwent a 5-minute warm-up period on a bicycle ergometer (Monark, Varberg, Sweden) followed by 5 minute of stretching of the hamstrings and quadriceps as previous described by Mandroukas et al. (2014). The subject was then seated on the dynamometer in an adjustable chair; the upper body was stabilised with straps secured diagonally across the chest and the hips. Prior to maximal testing a series of submaximal concentric contractions were performed. Maximal isokinetic strength was recorded as the torque of the quadriceps and hamstrings muscles throughout the whole range of motion, at angular velocities of 60, 180, 300 ° s⁻¹. Peak torque was measured using a speed-controlled isokinetic dynamometer (Cybex II, Lumex Inc., Ronkonkoma, NY) with a specially designed program which included torque comparison adjusted to the weight of the leg. The knee to be tested was positioned at 90° of flexion, (0° = fully extended knee), in order to align the axis of the dynamometer lever arm with the distal point of the lateral femoral condyle. Gravity correction was performed for the tested leg. The length of the level arm was individually determined and the resistance pad placed proximal to the medial malleolus. The non-tested leg was hanging freely. Knee extension started when the knee positioned at 90° of the flexion while the knee flexion started when the knee was in full extension (0°). Subjects were instructed to cross their arms over their chest and to kick the leg as hard and as fast they could through a complete range of motion. Three repetitions were carried out at each angular velocity and the best torque was used for the reanalysis. A 30 sec rest period was taken between each trial and a 60 sec rest period between each velocity measurement. During these procedures, subjects always performed maximal voluntary contractions, in which verbal encouragements was given to the subjects throughout the contractions. The concentric strength ratio between the knee flexors and the knee extensors (H : Q ratio) was expressed as the ratio between the peak values at each velocity. The conventional H : Q ratio determined as maximal hamstrings strength divided by maximal quadriceps strength.

Determination of maximum oxygen uptake

$\dot{V}O_{2max}$ was performed on a motorised treadmill (Jaeger LE 6000, Wurzburg, Germany) after a five-minute warm-up and stretching of the lower limbs. Subjects exercised to exhaustion according to a maximal incremental continuous exercise protocol consisting of ten 1-minute stages. The initial grade and speed were set at 0% at 8 and 10 km/h, respectively, and followed by an increase in speed of 1 km/h per stage with 2% stable grade. $\dot{V}O_{2max}$ values and cardiorespiratory indices were measured via an ergospirometric device based on breath by breath automated pulmonary/metabolic gas exchange system (Oxycon Pro-Jaeger, Wurzburg, Germany) using a tight face mask specially designed for children. The heart rate (HR) was recorded by means of a 12-lead electrocardiogram (Viasys) connected to the ergospirometric apparatus. Subsequently, the following additional cardiorespiratory indices were determined during the test: the exercise duration; the respiratory exchange ratio (RER); the maximal heart

rate (HR_{max}). $\dot{V}O_{2max}$ was assumed when three of the four following criteria were met: a) the HR during the last minute exceeded 95% of the expected maximal HR predicted 220-age; b) a respiratory exchange ratio ($\dot{V}CO_2/\dot{V}O_2$) at or higher than 1.1 was reached; c) $\dot{V}O_2$ reached a plateau and/or signs of subjective exhaustion were present and were no longer to run despite verbal encouragement; d) level of concentration of blood lactate higher than 6 mmol l⁻¹. Blood samples were obtained from a warmed fingertip and the concentration of blood lactate was determined in the 5th min of recovery using a lactate photometer analyser (Accusport, Boehringer Mannheim, Germany).

Statistical analysis

All data are expressed as mean \pm standard deviation (\pm SD). Independent sample T-test analysis was used to determine the differences among young football players and untrained boys. The statistical analysis was performed via the Statistical Package for Social Sciences (SPSS, version 22.0, Chicago, Illinois). The level of significance was set at $p < 0.05$.

RESULTS

The physical and anthropometric characteristics of the subjects are demonstrated in Table 1. No significant differences were found between the two groups regarding the age, height, weight, BSA and BMI. The results of the cardiorespiratory exercise testing are shown in Table 2. HR_{max} , resting systolic blood pressure (sBP_{rest}) and diastolic blood pressure (dBp_{rest}) showed no significant difference between the groups. However, the resting heart rate (HR_{rest}) was significantly lower in the trained group compared to untrained group ($p < 0.01$). Moreover, the trained group presented significantly higher RER ($p < 0.01$) and BL_{max} values ($p < 0.001$). The relative peak torque values of knee extensors and knee flexors were significantly different between the two groups as presented in Figure 1. At angular velocities of 60° s⁻¹ and 180° s⁻¹ the trained group had significantly higher peak torque value compared to untrained group ($p < 0.01$ and $p < 0.05$ respectively). However, no significant difference was found between groups in the fast angular velocity of 300° s⁻¹. Figure 2 shows no significant difference in absolute peak torque of the knee extensors and knee flexors between the two groups

Table 1 Physical and anthropometric characteristics of the subjects (mean \pm SD)

	Trained group (n = 20)	Untrained group (n = 18)
Age (years)	14 \pm 0	14 \pm 0
Experience (years)	7 \pm 3	
Height (cm)	165.5 \pm 8.5	168.2 \pm 10.5
Weight (kg)	56.9 \pm 9.5	59.3 \pm 9.9
BMI (kg m ⁻²)	20.5 \pm 2.4	20.9 \pm 2.4
BSA (m ²)	1.6 \pm 0.2	1.7 \pm 0.2

BMI = Body Mass Index; BSA = Body Surface Area

at all angular velocities (60, 180, 300 ° s⁻¹). Likewise, the H/Q peak torque ratio did not differ between the trained and the untrained group as presented in Figure 3. In figure 4 presented the $\dot{V}O_{2max}$ in absolute (ml O₂ min⁻¹) and relative (ml O₂ min⁻¹ kg⁻¹) values. The trained group showed significantly higher values in comparison with the untrained group ($p < 0.001$).

Table 2 Cardiorespiratory and metabolic values of the subjects

	Trained group (n = 20)	Untrained group (n = 18)
HR _{rest} (b min ⁻¹)	65 ± 3 **	73.1 ± 9
sBP _{rest} (mmHg)	112.9 ± 5	118.6 ± 6.8
dBp _{rest} (mmHg)	63.6 ± 5.4	62.2 ± 4.3
HR _{max} (b min ⁻¹)	197.8 ± 4.5	198 ± 5.6
Respiratory exchange ratio (RER)	1.2 ± 0.2 **	1.0 ± 0.1
BLa _{max} (mmol l ⁻¹)	8.7 ± 1.8 ***	6.4 ± 1.2

** $p < 0.01$, Trained group vs Untrained group; *** $p < 0.001$, Trained group vs Untrained group

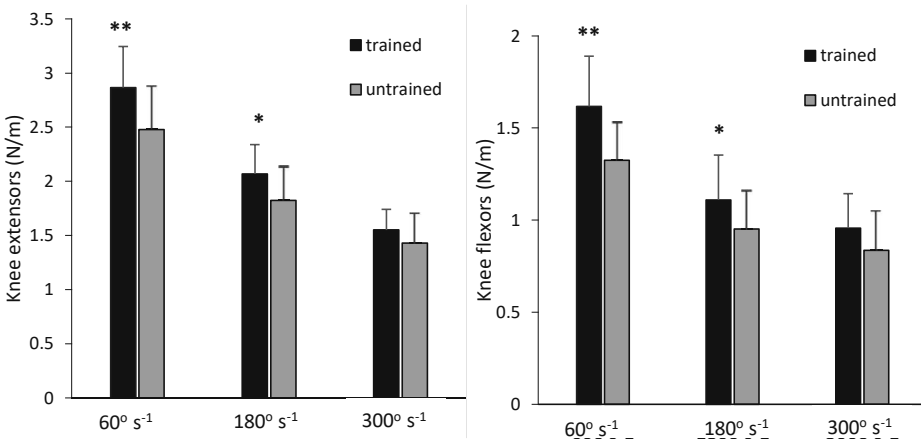


Figure 1 Relative Peak torque of knee extensors and flexors for trained and untrained group at different angular velocities. The values are expressed as means ± SD

* $p < 0.05$, Trained vs Untrained; ** $p < 0.01$, Trained vs Untrained

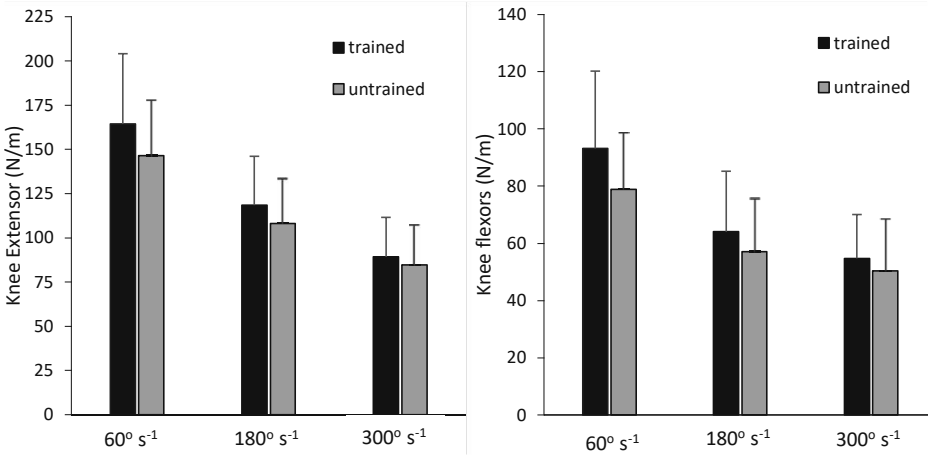


Figure 2 Absolute Peak torque of knee extensors and flexors for trained and untrained group at different angular velocities. The values are expressed as means ± SD

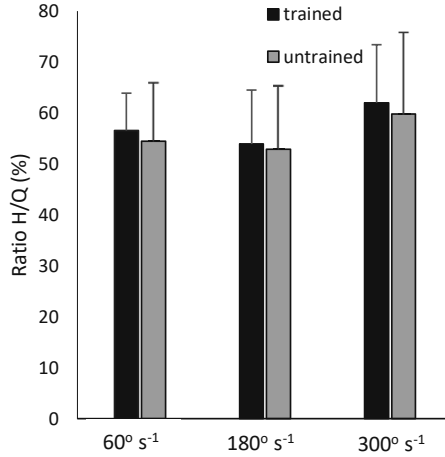


Figure 3 Peak torque rations of H/Q at 3 angular velocities for the determination of peak torque. Values represent means ± SD. H/Q ratio values presented no significant differences between the groups

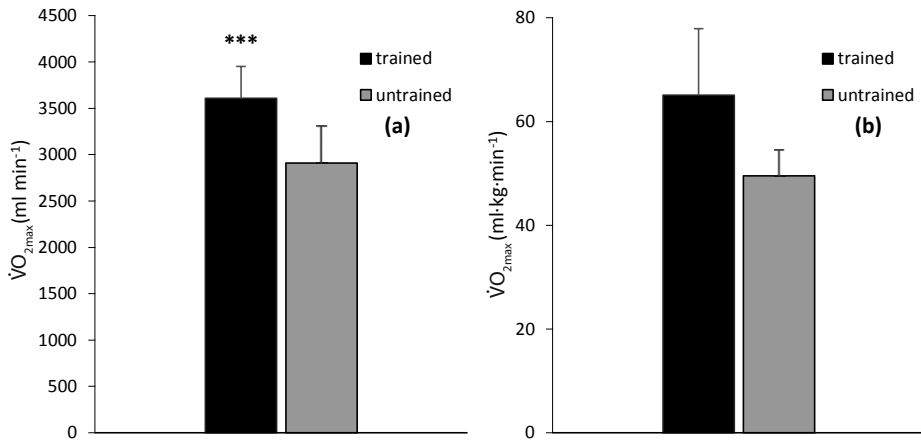


Figure 4 Absolute (a) and Relative (b) maximal aerobic power values during the maximal running test.

Values represent mean \pm SD

*** $p < 0.001$, Trained vs Untrained

DISCUSSION

The purpose of this study was to examine and compare the aerobic power and the concentric isokinetic muscle strength between trained and untrained boys of the same biological age. The results of the present study showed that the $\dot{V}O_{2max}$ both in absolute and relative values were higher in the trained group compared to untrained group. Football training during previous years has showed to have effects in aerobic power. The higher aerobic capacity that was found in the trained group may be attributed not to training only, but to hereditary endowment. In football as in all sport, young athletes constitute a highly select group chosen on the basis of size and technical skills. Football training improve the running economy, the neuromuscular function and the adaptations resulting from the higher training intensity. While significant difference were found in relative muscle peak torque, no significant difference were observed across absolute muscle strength between the two groups. The torque – velocity relationship in both groups showed a similar, adult-like pattern, namely as angular velocity increased peak torque decreased. Quadriceps strength is greater than hamstrings strength at all angular velocities. However, it is interesting to note that the absolute strength of quadriceps and hamstrings was similar in the two groups. Our results are in agreement with other studies for young football players (Berg et al., 1985; Capranica et al., 1992) who have documented no difference in isokinetic strength of the lower limbs in preadolescent boys compared to no athletes and in disagreement with all previous studies that have investigated the quadriceps and hamstrings strength in isokinetic dynamometer between groups with various chronological age. The differences in relative muscle strength were observed in slow (60° s^{-1}) and moderate (180° s^{-1}) angular velocities. The non-significant difference that was found at fast angular velocity of 300° s^{-1} may be due to the fact that boys in this age are insufficient to develop maximum torque in relation to time. It is known that in normal children the aerobic

power, eccentric and concentric peak torque of the knee joint increase during growth and development. Blimkie (1989) suggested that a complex interaction of factors may contribute to the development of isokinetic leg strength during growth and maturation. Cross-sectional studies have indicated strong relationships between stature, body mass and isokinetic leg strength (De Ste Croix et al., 1999; Housh et al., 1995). Some studies (Alexander & Molnar, 1973; Kanehisa et al., 1995; Pääsuke et al., 2001) showed an increase in muscle strength of quadriceps and hamstrings in untrained children during growth and developments. Children in biological age of 14 years occur during a period of transition to adolescent (adulthood) that is often viewed within the context of sexual maturation and stature growth. The biological events that occur are complex and include changes to the nervous and endocrine system (Beunen & Malina, 1988). The trained group undergo a more systematic strength and endurance training with high frequency, intensity and durations. Despite not measuring serum testosterone in our study, our results would agree with Hansen et al. (1999) and Zakas et al. (1994) who indicated that training and age lead to hormonal and metabolic adaptations. Zakas et al. (1994) showed that training can be a stimulus for increased growth hormone and testosterone in pubertal but not in prepubertal (10 years) boys. The term muscular imbalance usually refers to the strength relationship between hamstrings to quadriceps muscles. The kinetic characteristics in football such as starting, jumping, feints and directional and speed changes place greater stress of the lower limbs. Our results showed no significant differences in H : Q strength ratio between the groups in all angular velocities. The strength of quadriceps and hamstrings in this age seems to have a parallel increase. The data of H : Q strength ratio produced in the present study may be useful but, at least at young ages, it is doubtful whether these data can provide a definitive answer on how to develop a tool for preventing hamstrings or quadriceps muscle injuries. It must be pointed out that the relationship of function between hamstrings and quadriceps muscles in terms of the strength and muscle balance in practice plays a key role in the movement of the knee joint, which is why it is of great interest and is given special attention both in sport medicine as well as in the rehabilitation settings. The results of the present study indicate that football training has a positive effect in metabolic capacity, cardiorespiratory system and muscle strength of the lower limbs. In summary, the results suggest that football training improved $\dot{V}O_{2\max}$ and muscle strength of knee extensor and flexor muscles more than the expected increases which were attributed to age and corresponding physical growth and maturation. Our findings may have been influenced by genetic factors, the selection of young subjects for specific sport and adaptations caused by training. However, the current study could indicate further research regarding the effects of age, training and their combination on muscle strength and performance in pubertal trained and untrained boys.

ACKNOWLEDGEMENTS

We would like to thank all participants and research support staff involved in this study for their committed participation. No external financial support was received for this investigation.

REFERENCES

- Alexander, J., & Molnar, G. E. (1973). Muscular strength in children: preliminary report on objective standards. *Archives of Physical Medicine and Rehabilitation*, 54(9), 424–427.
- Armstrong, N. (1997). *Young people and physical activity*. Oxford University Press, USA.
- Bar-Or, O. (1983). Physiologic responses to exercise of the healthy child. In: *Pediatric Sports Medicine for the Practitioner* (pp. 1–65). New York, NY: Springer.
- Baxter-Jones, A., Goldstein, H., & Helms, P. (1993). The development of aerobic power in young athletes. *Journal of Applied Physiology*, 75(3), 1160–1167.
- Berg, K. E., LaVoie, J. C., & Latin, R. W. (1985). Physiological training effects of playing youth soccer. *Medicine and Science in Sports and Exercise*, 17(6), 656–660.
- Beunen, G., & Malina, R. M. (1988). Growth and physical performance relative to the timing of the adolescent spurt. In: Pandolf, K. B. (Ed.), *Exercise and Sport Sciences Reviews*, 16(1), 503–540. New York: Mcmillan Publishing Company.
- Blimkie, C. J., Ebbesen, B., MacDougall, D., Bar-Or, O., & Sale, D. (1989). Voluntary and electrically evoked strength characteristics of obese and nonobese preadolescent boys. *Human Biology*, Aug 1, 515–532.
- Capranica, L., Cama, G., Fanton, F., Tessitore, A., & Figura, F. (1992). Force and power of preferred and non-preferred leg in young soccer players. *The Journal of Sports Medicine and Physical Fitness*, 32(4), 358–363.
- De Ste Croix, M. B. A., Armstrong, N., & Weisman, J. R. (1999). Concentric isokinetic leg strength in pre-teen, teenage and adult males and females. *Biology of Sport*, 16(2), 75–86.
- Eriksson, B. O., & Koch, G. (1973). Effect of physical training on hemodynamic response during submaximal and maximal exercise in 11–13-year old boys. *Acta Physiologica Scandinavica*, 87(1), 27–39.
- Hagger, M. S., Chatzisarantis, N., & Biddle, S. J. (2001). The influence of self-efficacy and past behaviour on the physical activity intentions of young people. *Journal of Sports Sciences*, 19(9), 711–725.
- Hansen, L., Bangsbo, J., Twisk, J., & Klausen, K. (1999). Development of muscle strength in relation to training level and testosterone in young male soccer players. *Journal of Applied Physiology*, 87(3), 1141–1147.
- Housh, D. J., Housh, T. J., Weir, J. P., Weir, L. L., Johnson, G. O., & Stout, J. R. (1995). Anthropometric estimation of thigh muscle cross-sectional area. *Medicine & Science in Sports and Exercise*, 27(5), 784–791.
- Kanehisa, H., Yata, H., Ikegawa, S., & Fukunaga, T. (1995). A cross-sectional study of the size and strength of the lower leg muscles during growth. *European Journal of Applied Physiology and Occupational Physiology*, 72(1–2), 150–156.
- Kobayashi, K., Kitamura, K. I., Miura, M. O., Sodeyama, H. I., Murase, Y. U., Miyashita, M. I., & Matsui, H. I. (1978). Aerobic power as related to body growth and training in Japanese boys: a longitudinal study. *Journal of Applied Physiology*, 44(5), 666–672.
- Krustrup, P., Dvorak, J., Junge, A., & Bangsbo, J. (2010). Executive summary: The health and fitness benefits of regular participation in small-sided football games. *Scandinavian Journal of Medicine & Science in Sports*, 20(s1), 132–135.

- Lussier, L., & Buskirk, E. R. (1977). Effects of an endurance training regimen on assessment of work capacity in prepubertal children. *Annals of the New York Academy of Sciences*, 301(1), 734–747.
- Máček, M., Vavra, J., & Novosadova, J. (1976). Prolonged exercise in prepubertal boys. *European journal of Applied Physiology and Occupational Physiology*, 35(4), 291–298.
- Malina, R. M., Eisenmann, J. C., Cumming, S. P., Ribeiro, B., & Aroso, J. (2004). Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13–15 years. *European Journal of Applied Physiology*, 91(5–6), 555–562.
- Mandroukas, A., Vamvakoudis, E., Metaxas, T., Papadopoulos, P., Kotoglou, K., Stefanidis, P., & Mandroukas, K. (2014). Acute partial passive stretching increases range of motion and muscle strength. *The Journal of Sports Medicine and Physical Fitness*, 54(3), 289–297.
- Mirwald, R. L., & Bailey, D. A. (1984). Longitudinal comparison of aerobic power and heart rate responses at submaximal and maximal workloads in active and inactive boys aged 8 to 16 years. In: *Human Growth and Development*. Borms, J., Hauspie, J., Sand, A., Suzanne, C., & Hebbelinck, M. (Eds.), pp. 561–569. New York: Plenum.
- Mirwald, R. L., Bailey, D. A., Cameron, N., & Rasmussen, R. L. (1981). Longitudinal comparison of aerobic power in active and inactive boys aged 7-0 to 17-0 years. *Annals of Human Biology*, 8(5), 405–414.
- Nadeau, K. J., Maahs, D. M., Daniels, S. R., & Eckel, R. H. (2011). Childhood obesity and cardiovascular disease: links and prevention strategies. *Nature Reviews Cardiology*, 8(9), 513–525.
- Pääsuke, M., Ereline, J., & Gapeyeva, H. (2001). Knee extensor muscle strength and vertical jumping performance characteristics in pre-and post-pubertal boys. *Pediatric Exercise Science*, 13(1), 60–69.
- Savage, M. P., Petratis, M. M., Thomson, W. H., Berg, K., Smith, J. L., & Sady, S. P. (1986). Exercise training effects on serum lipids of prepubescent boys and adult men. *Medicine and Science in Sports and Exercise*, 18(2), 197–204.
- Tanner, J. M. (1962). *Growth at Adolescence*. 2nd ed. Oxford: Blackwell Scientific Publications.
- Vamvakoudis, E., Dalkiranis, A., Vrabas, I. S., Christoulas, K., & Mandroukas, K. (2001). The effects of physical training on the basic components of physical fitness in pubertal boys. *Journal of Human Movement Studies*, 41(3), 209–224.
- Vamvakoudis, E., Vrabas, I. S., Galazoulas, C., Stefanidis, P., Metaxas, T. I., & Mandroukas, K. (2007). Effects of basketball training on maximal oxygen uptake, muscle strength, and joint mobility in young basketball players. *The Journal of Strength & Conditioning Research*, 21(3), 930–936.
- Williams, A. M., & Reilly, T. (2000). Talent identification and development in soccer. *Journal of Sports Sciences*, 18(9), 657–667.
- Zakas, A., Mandroukas, K., Karamouzis, G., & Panagiotopoulou, G. (1994). Physical training, growth hormone and testosterone levels and blood pressure in prepubertal, pubertal and adolescent boys. *Scandinavian Journal of Medicine & Science in Sports*, 4(2), 113–118.

Effect of long-term sponsorship of the Škoda Auto brand and international sport events on congruence of brand personality

Eva Čáslavová*, Andrej Višněvský

Department of Sport Management, Faculty of Physical Education and Sport,
Charles University, Prague, Czech Republic

* Corresponding author: caslavova@ftvs.cuni.cz

ABSTRACT

The research examines the influence of long-term sponsorship on congruence (perceived consensus) of personal characteristics between Škoda Auto and sponsored international sport events such as the Ice Hockey World Championship and Tour de France. To identify personalities of these three subjects' brands we used a standardised personality scale created by Geuens, Weijters and De Wulf in 2009, which was developed to measure brands of various product categories. To measure personality congruence we used the absolute differentiation method (Gwinner & Eaton, 1999). Data were collected via online questionnaires in January and February 2015. The research file formed a quote sample of 250 Prague respondents. Personal characteristics were evaluated via a seven-point Likert's scale expressing a degree of agreement or disagreement. The results show that the Škoda Auto brand is mostly characterized by the Responsibility dimension, whereas the brands of international sport events such as the Ice Hockey World Championship and Tour de France are mostly characterized by the Activity dimension. Respondents marked Aggressivity and Emotionality as undescriptive dimensions of Škoda Auto, and Simplicity and Emotionality as undescriptive dimensions of international sport events.

KEYWORDS

sponsorship; brand personality transfer; sport marketing; brand strategy; Ice Hockey World Championship; Tour de France

DOI

10.14712/23366052.2019.4

INTRODUCTION

Sponsorship, aside from traditional advertising, is no longer an alternative way of brand promotion, but has become a full-fledged form of marketing communication. Despite the global economic crisis in 2008, total worldwide expenditures on sponsorship continue to grow. Global spending on sponsorship grew by 30.7% between 2009 and 2015, according to IEG (2016). In 2015, global spending on sponsorship totalled USD 57.5 billion, of which sport sponsorship accounted for 70% (IEG, 2015). On the other hand, with the ever-growing popularity of sponsorship it is getting more and more difficult to provide brands with the required market differentiation through sponsorship. It has become commonplace to see business and sport managers endeavouring to come up with unique sponsorship projects and replaced the traditional display of logos at sports grounds. For example, sponsor's brand products are interlinked with a sport event, but are these projects more efficient considering the sponsorship objectives? Can such interlinking of a brand with a sport event be strong enough to trigger a positive image transfer from the sport event to the brand? Research of sponsorship suggests that there are numerous factors that may affect the efficiency of image transfer in sponsorship. Woisetschläger, Haselhoff and Backhaus (2013), for example, found that the efficiency of sponsorship might be impaired by the fans' aversion to changes in names of sponsors, mainly in clubs strongly influenced by tradition. Still, Neijens, Smit and Moorman (2009) pointed out a positive effect of image transfer in sponsorship even three months after the end of a sport event. Chanavat, Martinet and Ferrand (2010) identified lower efficiency of such transfer in a brand involved in sponsorship of multiple sports entities simultaneously. The studies referred to above indicate that although global spending on sponsorship continues to grow, sponsorship is a complex topic deserving deeper investigation.

Image congruence (or perceived congruity) between a sports entity brand and a sponsor's brand (Lee & Cho, 2009) is one of the image transfer measures. Congruence means a degree of both direct and indirect relevance between the sponsor and the event (McDonald, 1991; Musante & Milne, 1999). When investigated, congruence can be measured as a whole or as congruence of selected image components that are classified by Keller (2008) as brand attributes and benefits, typical user, brand heritage, and brand personality. In recent years, the attention has moved toward the brand personality concept. Schade, Piehler and Burmann (2014) emphasize the importance of the brand personality in its function of behavioural relevance. Thus, the brand personality becomes a key element affecting the overall image of the brand. These are the reasons why the congruence of personalities of the international sport events brands and their sponsor's brand are dealt with in this paper.

When it comes to huge international sport events like the Ice Hockey World Championship or Tour de France, companies tend to focus on long-term strategic sponsorship agreements that are regularly renewed based on assessment of previous cooperation. It is quite common to extend cooperation unless the sponsor or the sponsee wish to significantly change their image and marketing strategy. Suppose that the longer the sponsorship, the better the association of the brand with the sport event in the customer's mind and sponsorship, thus, becomes more efficient. The purpose of this paper is to find out if long-term sponsorship positively contributes to a higher degree

of brand personality congruence between an international sport event and its sponsor. This was exactly why we chose Škoda Auto, a brand holding the Guinness record in the duration of sponsorship provided to the Ice Hockey World Championship. Škoda Auto has been a sponsor of this international sport event since 1992. For comparison, another major sport event that has been sponsored by Škoda Auto since 2004, the Tour de France, was selected.

METHODS

The first step to achieve the goal of the research is the selection of a suitable brand personality scale. There are universal scales to measure the personality of various product categories (Aaker, 1997; Geuens, Weijters, & De Wulf, 2009), and specific scales designed for a specific product category (Lee & Cho, 2012; Sung, Choi, Ahn, & Song, 2015). Personality characteristics of universally applicable scales are set to allow identification of brand personalities on a general level while making it possible to mutually compare more brands of various product categories. On the other hand, specific scales comprise specific personality characteristics that are typical for one product category only. The higher the universality of a scale, or its ability to apply the measurement on a larger number of product categories, the lower the quality of a unique personality description in one product category. For this particular reason marketing experts have recently recommended applying specific scales designed in the context of brand product uniqueness if brands of one product category are investigated (Ross, 2008). The goal set for this research is to compare brands of various product categories (automotive industry and international sport events) and, therefore, our attention was focused on the group of universal scales.

In 1997, J. F. Aaker designed the first standardized universal scale for brand personality measurement within various product categories. Aaker proceeded from her definition of brand personality: "The set of human characteristics associated with brand" (Aaker, 1997, p. 347). The scale contains 42 personality traits and has been applied in research (Lee & Cho, 2009; Grohmann, Giese, & Parkman, 2013). Enormous attention given to this scale stirred a discussion among experts about its pros and cons. The main criticism was directed against the general definition of brand personality, high number of personality characteristics and insufficient applicability of the scale in different cultural environments (Geuens et al., 2009). Azoulay and Kapferer (2003, p. 151) suggested a new definition of brand personality and they describe it as "the set of human personality traits that are both applicable to and relevant for brands." Even though they use psychological science to describe human personality, this definition does not allow for a scale with personal traits that cannot be applied in marketing for a brand entity. Based on the definition by Azoulay and Kapferer, a new standardized universal scale of brand personality was created by Belgian authors Geuens et al. (2009). Tested in the U.S.A. and nine European countries (Geuens et al., 2009), the scale is limited to as few as 12 personality characteristics. No other recognized universal scale has been designed for brand personality since 2010. Instead, specific scales to measure specific product categories are being developed, e.g. nation brand personality scale (Kim, Shim, & Dinnie, 2013), luxury brand personality scale (Sung et al., 2015), and for sports there are sport club personality scale (Schade, Piehler, & Burmann,

2014) and sport event personality scale (Lee & Cho, 2012). Analysis of the available standardized universal scales implied that the scale by Geuens et al. (2009) in Figure 1 is the most suitable scale for our research since it was created in the European cultural environment, it contains a low number of personality traits and, moreover, it is based on the strictly defined brand personality according Azoulay and Kapferer (2003).

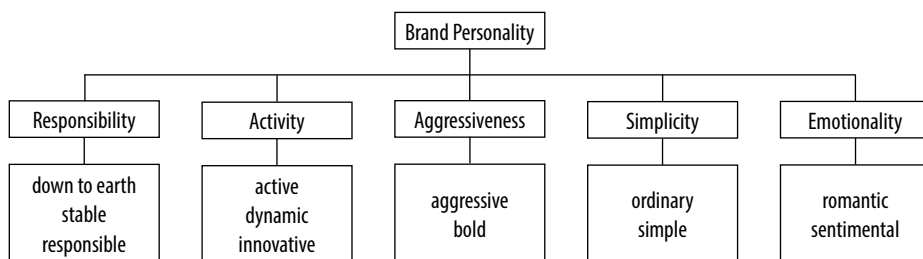


Figure 1 Brand personality according Geuens, Weijters, and De Wulf (2009)

Our research is a follow-up to a number of previous brand research projects focused on sports (Čáslavová & Petrářková, 2011; Čáslavová & Višněvský, 2016) that have been performed at the Department of Sport Management, Faculty of Physical Education and Sports, Charles University, since 2000.⁶

The basic research sample – relevant target group of people in the population was determined in view of the research objectives and the type of the investigated brands. Some brand personality research projects performed abroad resorted to homogeneous cohorts of students (Ambroise, Ferrandi, Merunka, & Valette-Florence, 2005; Lee & Cho, 2012), while some other surveys used panels to collect representative data (Aaker, 1997; Geuens et al., 2009; Schade et al., 2014). International sport events appeal to a wide range of persons in the society and homogeneous groups of students, therefore, are not relevant for our research. We decided to measure the brand personality on the Prague population. Being aware of how difficult it would be to perform a random selection from all people living in Prague, we opted for quota sampling of respondents. Two basic demographic quotas, gender and age, were applied. It was decided not to include any other demographic variables as it would have been impossible for us to control them in research. Median, a survey agency specializing in pre-election

Table 1 Quotas of the capital city of Prague

Gender	Male	48%
	Female	52%
Age	18–29 years	18%
	30–44 years	32%
	45–59 years	21%
	60 years and older	29%

⁶ The study is part of the Progress Q19 research programme.

public opinion surveys in the Czech Republic, provided statistics regarding the current structure of Prague inhabitants. Making use of Median's information on the structure of Prague's inhabitants from September to October 2014, we obtained a sample of 250 respondents representing Prague population by gender and age.

The intention was to collect data during a period when neither of the investigated international sport event takes place in order to avoid any influence on the perception of brand personality from publicity. It was decided to collect data in January and February 2015. We compiled a questionnaire in both printed and electronic versions. The printed version was used mainly by respondents of older age groups. Respondents were asked to evaluate personality traits on a Likert scale ranging from 1 to 7. Each value corresponded to a degree of agreement with the listed traits and to what extent the traits describe or fail to describe the brand. Value 1 equals absolutely not describing while value 7 equals perfectly describing.

The data analysis consists of two parts. In the first part, the personality of three brands, Škoda Auto, Ice Hockey World Championship, and Tour de France, was identified through the mean, standard deviation, and mode. Higher values of mean dimensions and traits indicated a higher degree of agreement with an item characterizing the brand. The standard deviation quantified the amount of dispersion of respondents' responses on the Likert scale. Thus, a lower value of the standard deviation suggested a rather unified opinion of respondents on the given dimension or trait. Representing the mean of the measured standard deviations lying in the interval (1.32; 2.07), the boundary value of standard deviation was set to 1.7. The mode indicated the most frequently occurring responses on the Likert scale regarding the traits. In the second part, congruence of brand personality between Škoda Auto and the sport events was measured. Absolute difference statistics by Gwinner and Eaton (1999) was applied to quantify congruence. For a Likert scale, it is calculated as an absolute difference in values on a scale between two measured brands and, in cases of a seven-point scale, the resulting value falls within the interval (0; 6). If the difference in personality perception between two brands is small, the absolute difference will be close to 0. Only if there is absolute congruence of a respondent's answers between two brands, would the number equal 0. The smaller the absolute difference between two brands, the more congruent their personality.

RESULTS

Identification of the Škoda Auto brand personality

The respondents rated Škoda Auto as a responsible, active, and simple brand. Aggressiveness and Emotionality were rejected as not matching dimensions.

Huge differences in the rating of traits included in the Responsibility dimension ($N = 4.99$; $SD = 1.51$) were observed. Stable and Responsible are the two best describing characteristics of the Škoda Auto brand. These items earned the most unambiguous expression of the respondents' opinion in the whole questionnaire. Stable and Responsible were considered to be describing (values 5 to 7 on the Likert scale) by 81% and 73% of respondents, respectively. This manifested in high values of the mean and, at the same time, low values of the standard deviation as shown in Table 2. Down to Earth was considered as not describing.

Active and Dynamic within the Activity dimension ($N = 4.84$; $SD = 1.45$) were marked as the best matching traits. Active and Dynamic were considered to be describing by 66% and 62% of respondents, respectively. Again, Table 2 shows a positive perception of both these items on the values of the mean and standard deviation. The trait Innovative was rated within the positive range of values 5 to 7 by 52% of respondents. Nevertheless, the neutral value of 4 (partly describing) was the most frequent response to the question about Innovative. This implies that Škoda Auto is not unambiguously perceived as being innovative.

Simplicity ($N = 4.54$; $SD = 1.62$) is the last dimension of the Škoda Auto brand that is positively rated by respondents as describing. First and foremost, Simple was marked as describing by 57% of respondents, but only 9% of respondents assigned this trait with 7, the highest value on the Likert scale (perfectly describing). Table 2 shows a low standard value for this item, which indicates alignment of respondents' opinions. Ordinary was also marked as describing by more than a half of respondents (51%). In this case, the opinions are diverse due to the high standard deviation.

The trait Aggressive within the Aggressiveness dimension ($N = 3.40$; $SD = 1.64$) achieved a low mean and a relatively higher standard deviation as shown in Table 2. In total, 62% of respondents marked this characteristic as not describing (values 1 to 3 on the Likert scale). Almost not describing (2) was the most frequent response. Marked as not describing by 48% of respondents, a slightly less negative response was observed for the trait Bold. The Škoda Auto brand is perceived as neither aggressive nor bold.

Respondents expressed the highest degree of disagreement when asked about the Emotionality dimension ($N = 2.92$; $SD = 1.71$). The high value of standard deviation found in both characteristics indicates a lack of unity of their opinions. Romantic and Sentimental were marked as not describing by 71% and 61% of respondents, respectively. The lowest value 1 on the Likert scale (absolutely not describing) was the most frequent response for both these traits.

Identification of the Ice Hockey World Championship brand personality

The Ice Hockey World Championship was rated as an active, partly responsible and aggressive brand. Compared to the Škoda Auto brand, the mean values of the dimensions are lower, while the standard deviations of the dimensions are higher and this indicates less aligned opinions regarding the brand personality.

Activity ($N = 4.86$; $SD = 1.62$) is the highest rated dimension of this brand. The mean of the dimension is significantly affected by the low mean of the trait Innovative, which strongly differs from the remaining characteristics: Active and Dynamic. These traits were marked as describing (values 5 to 7) by 70% and 67% of respondents, respectively. The positive rating is proven by the highest values of the mean shown in Table 2. In addition, more than 25% of respondents chose the highest value 7 (perfectly describing) for both these traits. The Ice Hockey World Championship is, therefore, strongly perceived as an active and dynamic brand.

Responsibility ($N = 4.22$; $SD = 1.65$) is considered to be the second best matching dimension of the Ice Hockey World Championship brand personality. Stable is the highest rated characteristic within this dimension. In total, 51% of respondents marked this item on the Likert scale as describing. As shown in Table 2, opinions of

respondents are not aligned due to the high standard deviation. The Down to Earth characteristic received the lowest mean within the dimension. A big number of respondents (39%) marked this trait as not describing. It can be concluded that the Ice Hockey World Championship is considered to be a stable and responsible brand.

Aggressiveness ($N = 4.10$; $SD = 1.76$) was rated as a partly matching dimension. Compared to the results achieved by the other investigated brands, the Ice Hockey World Championship is perceived as the most aggressive brand. The trait Aggressive is considered to be describing by 41% of respondents and the same percentage of respondents perceives the trait as not describing. This is the reason why this trait also received a high standard deviation in Table 2. The trait Bold achieved a similar rating, 45% of respondents marked this trait as describing and this revealed itself in the higher mean. Still, the inconsistency of responses remains high due to higher standard deviation.

Simplicity ($N = 3.72$; $SD = 1.64$) was marked as a dimension that does not match the Ice Hockey World Championship brand personality. 49% of respondents perceive Ordinary as not describing. Table 2 shows that the mean was below the neutral value of 4. The lower standard deviation indicates a relatively high alignment of opinions. The trait Simple ended up with a less clear answer. Although respondents continue to perceive it as a trait that does not match the Ice Hockey World Championship, their responses are more dispersed across the Likert scale. Still, 44% of respondents lean towards the option that this trait does not describe the brand.

As for Emotionality ($N = 3.00$; $SD = 1.94$), the trait Romantic achieved the lowest mean of all traits measured and summarized in Table 2. In total, 71% of respondents marked this trait as not describing. On the other hand, the second trait included in this dimension, Sentimental, achieved the highest standard deviation in the whole survey, which shows evidence of significantly different individual opinions of respondents. The Mode statistics in Table 2 makes it obvious that these two characteristics mostly received value 1 on the Likert scale (absolutely not describing). This rating was selected by 36% of respondents for Romantic and by 29% of respondents for Sentimental.

Identification of the Tour de France brand personality

Tour de France is depicted as an active and partly responsible brand. The means and standard deviations of the dimensions are similar to those achieved by the Ice Hockey World Championship brand. However, there are differences in the characteristics assigned to the Tour de France brand.

Activity ($N = 4.87$; $SD = 1.66$) was marked as the best matching dimension. The scores of traits within this dimension vary greatly. According to the mean values listed in Table 2, 69% of respondents agreed with Active as the best describing trait of Tour de France. The high rating of this trait is emphasized by the fact that the highest possible value on the Likert scale became the most frequently chosen response. The percentage of positive responses indicates that respondents marked Dynamic as the best matching item. As many as 71% of respondents chose this trait as describing and, moreover, responses with the highest value on the Likert scale occurred most often. It should also be stressed that, while expressing how consistent or dispersed the responses are, the standard deviation achieved higher values compared to the previously analysed brands. Only 47% of respondents marked Innovative as a matching trait. The

rating of this trait, thus, differs significantly from the remaining items included in this dimension.

Responsibility (N = 4.16; SD = 1.69) was marked as a partly describing dimension. The inconsistency of results achieved in each of the characteristics within this dimension is also quite obvious. Stable was marked as describing by 56% of respondents. Table 2 shows a significantly high value of the standard deviation, which shows evidence of a lack of alignment of opinions. Down to Earth received an opposite rating, 46% of respondents marked this item as not describing. Again, the responses for this trait were rather dispersed. The trait Responsible was rated as partly describing. It was marked as describing by 39% of respondents and as partly describing by 29% of respondents. The standard deviation shown in Table 2 was low and this means that respondents shared a common opinion on this trait.

Based on the statistical result, the Aggressiveness dimension (N = 4.04; SD = 1.69) can be considered as partly describing. If we look at the traits in more detail, we notice that 46% of respondents marked Aggressive as not describing, while 47% respondents perceived Bold as describing. If anything, this dimension contains two characteristics that received different rating from respondents.

Simplicity (N = 3.74; SD = 1.62) was marked as not describing. Compared to the standard deviations of the other dimensions shown in Table 2, the value of this dimension of the Tour de France brand personality scored the lowest. The statistics of the traits within this dimension do not differ significantly. The trait Ordinary is considered to be less matching. It was marked as not describing by 45% of respondents. Simple scored closer to the neutral value of 4 (partly describing) as only 38% and 29% of respondents marked it as not describing and partly describing, respectively.

Having the Tour de France brand in mind, the Emotionality dimension (N = 3.23; SD = 1.80) was rated as not describing by the respondents. As with the Ice Hockey World Championship, the opinions are rather dispersed, which is demonstrated by the high standard deviations in the traits shown in Table 2. Romantic was marked as not describing by 58% of respondents. One quarter of respondents rated this trait as absolutely not describing (the lowest value on the Likert scale). A slightly less negative opinion was recorded for Sentimental, 51% marked this trait as not describing.

Table 2 Identification of the Škoda Auto, Ice Hockey World Championship, Tour de France brand personality

Dimension	Škoda Auto					
	Mean	SD	Characteristics	Mean	SD	Mode
Responsibility	4.99	1.51	down to earth	4.44	1.61	5
			stable	5.50	1.40	6
			responsible	5.05	1.32	5
Activity	4.84	1.45	active	4.98	1.34	5
			dynamic	4.89	1.49	5
			innovative	4.66	1.50	4
Aggressiveness	3.40	1.64	aggressive	3.08	1.58	2
			bold	3.72	1.63	3

Simplicity	4.54	1.62	ordinary	4.46	1.71	4
			simple	4.62	1.51	5
Emotionality	2.92	1.71	romantic	2.73	1.63	1
			sentimental	3.11	1.77	1
Ice Hockey World Championship						
Responsibility	4.22	1.65	down to earth	3.86	1.66	4
			stable	4.47	1.69	6
			responsible	4.32	1.53	5
Activity	4.86	1.62	active	5.15	1.52	5
			dynamic	5.12	1.61	7
			innovative	4.30	1.59	4
Aggressiveness	4.10	1.76	aggressive	4.02	1.75	5
			bold	4.19	1.76	4
Simplicity	3.72	1.64	ordinary	3.59	1.58	4
			simple	3.85	1.68	4
Emotionality	3.00	1.94	romantic	2.63	1.72	1
			sentimental	3.37	2.07	1
Tour de France						
Responsibility	4.16	1.69	down to earth	3.76	1.70	4
			stable	4.61	1.73	6
			responsible	4.12	1.51	4
Activity	4.87	1.66	active	5.14	1.63	7
			dynamic	5.12	1.68	7
			innovative	4.36	1.55	4
Aggressiveness	4.04	1.69	aggressive	3.71	1.62	3
			bold	4.36	1.69	4
Simplicity	3.74	1.62	ordinary	3.59	1.57	4
			simple	3.89	1.65	4
Emotionality	3.23	1.80	romantic	3.11	1.74	1
			sentimental	3.36	1.85	1

Congruence of brand personality between Škoda Auto and international sport events

To measure the congruence between the Škoda Auto brand and the international sport events, the first step was to identify their personalities. Now, we have to assess the extent to which the resulting personalities of the three brands cohere on the Likert scale. It is assumed that the duration of sponsorship between the Škoda Auto brand and the sponsored sport events can affect the personality congruence of their brands. The sponsorship of the Ice Hockey World Championship has lasted 24 years and the sponsorship of Tour de France dates back 12 years.

The congruence in traits within the dimensions was measured with the help of absolute difference. Table 3 quantifies the arithmetic mean of the absolute difference values between the following pairs: Škoda Auto vs. Ice Hockey World Championship and Škoda Auto vs. Tour de France. The arithmetic mean of the absolute difference values provides information about the magnitude of the average difference in rating of each pair of brands. As shown in Table 3, it lay within the interval (1.20; 1.88). Table 3 thus shows that Škoda Auto vs. Ice Hockey World Championship is the pair of brands that has a lower average of absolute difference in most traits. This pair is more congruent in the following characteristics: Down to Earth, Responsible, Active, Bold, Ordinary, Romantic, and Sentimental. The second pair of brands, Škoda Auto vs. Tour de France, shows higher congruence in the remaining traits: Stable, Dynamic, Innovative, Aggressive, and Simple.

The values of the mean absolute difference do not provide any information about whether the congruent trait is both matching and not matching for the analysed brands. This is the reason why it is essential to interpret the values of the mean absolute difference in the context of the identified brand personality and according to the mean trait values. First, we set the boundary values for the mean and for the mean absolute difference. The value of 4 was set for the mean, i.e. the neutral position on the Likert scale, and the value of 1.54 was set for the mean absolute difference, this denotes the middle point of the interval within which the mean absolute differences of traits occurred. Next, we generated a chart where the midpoint of the axis is at the boundary values of both the statistics, coordinates (1.54; 4), and we had four quadrants. Quadrant I is the most interesting for us as the traits contained there are congruent and, at the same time, describe the personality of both the brands. Chart 1 shows the location of traits identified for the first pair of brands, Škoda Auto and Ice Hockey World Championship. Active, Responsible, and Down to Earth are considered to be both congruent and describing the personality traits. Chart 2 illustrates the second pair of brands, Škoda Auto and Tour de France, where only Active was found in the first quadrant. The trait Dynamic is at the very boundary of congruence.

By comparing Charts 1 and 2, it can be concluded that the Škoda Auto brand is more congruent with the international sport event brand of the Ice Hockey World Championship than with the Tour de France brand. Congruence between the Škoda Auto and Ice Hockey World Championship brands was identified in three traits that were, moreover, marked by the respondents as describing. Only one trait marked by the respondents as describing showed congruence between the Škoda Auto and Tour de France brands. Our assumption that the duration of sponsorship positively affects the personality congruence of international sport events and sponsor's brands has been confirmed.

DISCUSSION

Identification of brand personality

Identification of the brand personality with the help of the mean value and standard deviation on the Likert scale makes it possible to recognize personality traits and determine to what extent a certain trait matches the brand (mean) and what is the prevailing opinion (standard deviation). For a brand manager, therefore, it would be ideal

if, for the desired personality traits, the mean is as high as possible and the standard deviation remains as low as possible. This would represent a strong and unified opinion expressed by respondents. The identification of personalities of the Škoda Auto, Ice Hockey World Championship, and Tour de France brands indicated that the Škoda Auto brand received the best values of mean and standard deviation. The international sport event brands, on the other hand, achieved less distinctive results. It can be assumed that this outcome is partly impacted by the product category of the brands. Škoda Auto has a clearly defined tangible product, while the Ice Hockey World Championship and Tour de France render absolutely unique and comprehensive sport products.

Table 3 Mean absolute difference of responses on the seven-point Likert scale

Characteristics	Škoda Auto vs. Ice Hockey World Championship	Škoda auto vs. Tour de France
Down to earth	1.52	1.57
Stable	1.76	1.70
Responsible	1.49	1.59
Active	1.39	1.48
Dynamic	1.71	1.54
Innovative	1.58	1.57
Aggressive	1.78	1.54
Bold	1.66	1.73
Ordinary	1.76	1.88
Simple	1.72	1.58
Romantic	1.20	1.48
Sentimental	1.59	1.71

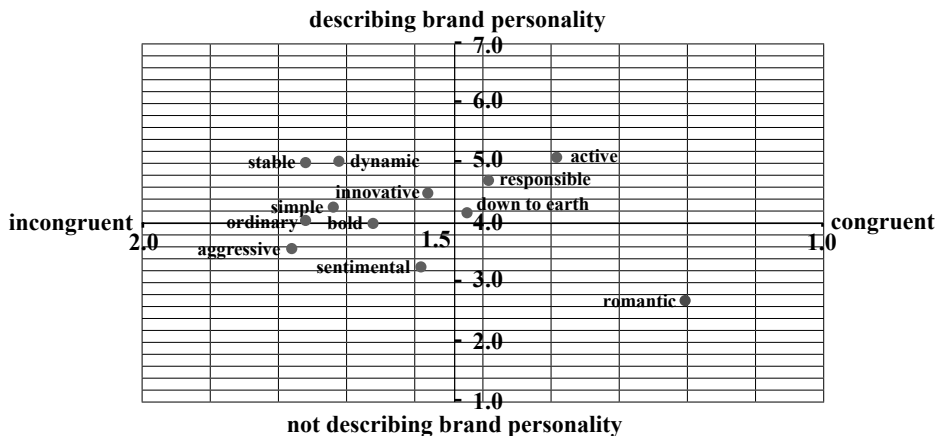


Chart 1 Congruence and mean values of the pair of brands: Škoda Auto and Ice Hockey World Championship

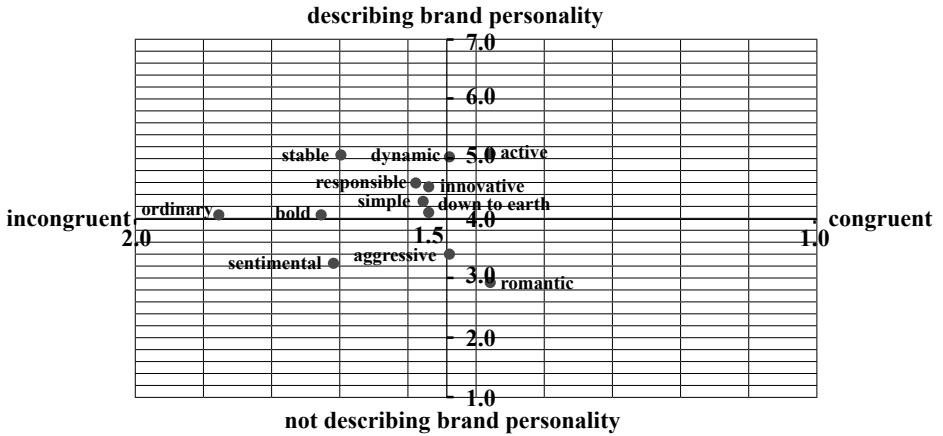


Chart 2 Congruence and mean values of the pair of brands: Škoda Auto and Tour de France

It is for this specific reason that applying a generally standardized brand personality scale to measure just brands in sports is deemed to be less appropriate, unless they are compared to brands of other product categories. A general brand personality scale is considered to be a well-suited measuring tool whenever brands of different product categories have to be compared, e.g. to measure the personality congruence as was the case in our study.

Škoda Auto

It was assumed that the Škoda Auto brand would be characterized by Responsibility and Simplicity. The assumption was based on our knowledge of the long-term publicity campaign where Škoda Auto highlights these traits. Putting the emphasis on responsibility is a widespread phenomenon in marketing communication of car brands, while emphasis on simplicity is a unique marketing communication of the Škoda Auto brand and “Simply Clever,” the brand’s motto, is a proof of that. The results confirmed the assumed ranking of these two dimensions. Additionally, the Activity dimension was also rated very positively. This result might indicate a transfer of the personality trait due to long-term sponsorship as this dimension also received high rating in the international sport events.

We consider Aggressiveness to be an undesirable dimension for the Škoda Auto brand. We are not certain if the management of Škoda Auto share our opinion and whether this characteristic is also considered undesirable as a certain degree of aggressiveness is a natural characteristic for ice hockey. Linking Škoda Auto with ice hockey could result in the transfer of this trait to the sponsor’s brand. Moreover, the brand may be perceived as aggressive if an aggressive advertising campaign is waged against competitors. In the Czech Republic, this sort of campaign occurred between Škoda Auto and Hyundai.

Perceived by the respondents as a not describing dimension, the rating of Emotionality is deemed surprising. Emotions are extremely important for brands involved in sponsorship, and even more so if it is sponsorship of sports. In sponsorship, brands

are presented to target groups of potential customers during their entertainment and leisure time. Emotions in sport are supposed to boost the public's attachment to the brand and enhance customer-brand relationships. For this reason, we were surprised to see that Škoda Auto is not perceived by the respondents as a brand that radiates emotions.

Ice Hockey World Championship

Variation over time, individual liking of the brand, and a narrower target group of customers are believed to be the factors making the rating of the Ice Hockey World Championship brand personality less distinctive. The variation over time results from the yearly rotation of countries hosting the Ice Hockey World Championship. Differences in the style and national traditions impact the image and perception of the international sport event's personality. Individual liking of the brand causes significant variation in the values on the Likert scale.

It was assumed that the Ice Hockey World Championship would predominantly be depicted by the Activity and Aggressiveness dimensions. As the Aggressiveness dimension was marked as only partly describing, our assumption was found to be only partly proved. Still, the mean of this dimension was higher in the Ice Hockey World Championship than in the remaining two brands. Naturally, ice hockey shows a higher degree of aggressiveness resulting from the game. Of course, it depends on the organizers and their ability to exploit this feature for the benefit of the brand.

Responsibility was rated as a matching dimension, which is considered to be an interesting outcome. For the whole duration of its existence, the Ice Hockey World Championship has never experienced any unfortunate scandals that could have impaired the brand's image. It was quite surprising for us to find that Emotionality was rated as not describing. It was expected that Emotionality would be one of the core characteristics of international sport event brands, but in fact this was the least matching dimension of the brand personality. The difficulty lies in the traits representing this dimension: Romantic and Sentimental. In our opinion, these two traits do not describe emotionality typical for the sports environment.

Tour de France

As for the identification of the brand personality of Tour de France, we were quite curious to see how the personality of this brand would be affected by the frequent doping scandals that, unfortunately, are rather typical for road cycling. It was slightly surprising for us to find that the results of the survey were quite similar to the brand identification of the Ice Hockey World Championship. Being strongly dependent on TV transmission, the way of presentation of this sport event can be another significant factor affecting the personality of Tour de France. Cycling is predominantly a TV sport. The image of Tour de France can be improved through television and, to achieve this, shots of historical places and high-mountain nature are widely used.

Slight differences as against the brand identification of the Ice Hockey World Championship were identified in Responsibility, Aggressiveness and Emotionality. Compared to the other measured brands, Tour de France is perceived as less responsible, which could be a consequence of the doping scandals. Yet, the difference is not too large. Similarly, this brand is perceived as less aggressive compared to the Ice Hockey

World Championship. Although a more positive result was measured for Emotionality, the difference is very small and has no influence on the overall identification of the brand personalities.

Congruence of brand personalities in sponsorship

Each corporation deciding to enter into sponsorship pursues different marketing goals, based on which sponsorship planning is derived. In the Czech Republic, Škoda Auto belongs to the most successful Czech brands in the international market. Therefore, the marketing activities must have a global impact. Sponsorship of international sport events is an ideal opportunity to enhance the brand awareness abroad and build its global image. In our opinion, Škoda Auto adopted a strategically effective behaviour as its sponsorship of the Ice Hockey World Championship and Tour de France focuses on different regions and different target groups in the population. Involved in sponsorship of the Ice Hockey World Championship, Škoda Auto approaches the European market, particularly its Northern and Central European regions, and the Russian market. Sponsorship of Tour de France, on the other hand, puts the main emphasis on Southern European countries and the USA. Different duration of sponsorship with the international sport events was the decisive factor when selecting this brand for the survey. We were looking for a brand that has been involved in sponsorship of sport events for at least ten years to see the impact of the duration on the congruence of personality. The second condition was that there should be a sufficient difference between the duration of sponsorship of the first sport event and the sponsorship of the second sport event.

In case that the transfer (congruence) of the brand personality has been perfectly accomplished between the sport event and the sponsor, the values of absolute difference would be low in all twelve personality characteristics. In real sponsorship, however, only partial congruence is achieved in certain traits. To know which traits have shown congruence can be of key importance in achieving the transfer of image. It is desirable for both the sponsor and the international sport event that the traits be congruent in the high values of the mean. If the sponsor achieved congruence with the sport event in traits showing a low value of the mean (traits that do not match the brand), the transfer of image would not be efficient. The brands would then differ in what defines them. Conversely, the transfer of image would work well if a degree of congruence is achieved in traits showing a high value of the mean (traits that match the brand). The brands would be linked by what defines them. These were the reasons why we selected charts comparing mean absolute differences in quadrants and mean values on the Likert scale to demonstrate the results.

Active, Responsible and Down to Earth interlink the brands of Škoda Auto and Ice Hockey World Championship most of all, while the pair consisting of Škoda Auto and Tour de France share only Active. The survey, however, does not determine whether the transfer of image occurs in one direction only, from the sport event to the sponsor's brand, or also in the opposite direction, from the sponsor's brand to the sport event. It can be assumed that Responsible, the trait that is more typical for the Škoda Auto brand, could transfer to the Ice Hockey World Championship due to long-term sponsorship. Another question suggests itself: can all congruent traits be assigned to the factor of long-term sponsorship? A situation may occur that certain personality

traits are typical for both brands irrespective of sponsorship. In that case, it makes no difference whether the transfer of image and brand personality is considered to be the goal of sponsorship. Then, the congruence of image becomes a prerequisite and not a mere consequence of sponsorship. Providing it is a sufficiently strong player in the market, the international sport event can choose a sponsor whose traits are perceived by the public in a similar way and enter into a sponsorship agreement with such sponsor.

To investigate the factors of image transfer in sponsorship more thoroughly and precisely in the future, it would be advisable to focus on the context of environment and motivation of corporations to enter into sponsorship. Each international sport event is confronted with different natural, technical, and political challenges. These factors of the environment affect implementation of sponsorship. On the other hand, each company entering into sponsorship has its specific products and specific marketing communication of its brand. Sponsorship is a considerable investment and, as such, it is often designed to match specific needs of companies. For this reason, it is impossible to draw generally applicable conclusions from surveys examining sponsorship. In the future, research should focus on specific cases of sponsorship.

CONCLUSION

The research of congruence of the Škoda Auto, Ice Hockey World Championship and Tour de France brands showed that the duration of sponsorship may influence the brand personality. Partial congruence of certain personality traits was proved. Škoda Auto was identified as a responsible, active, and simple brand. Ice Hockey World Championship was identified as an active, responsible, and aggressive brand. Tour de France was identified as an active and partly also responsible brand. The identification of brand personalities thus indicated a potentially higher degree of congruence of personality traits between Škoda Auto and the Ice Hockey World Championship. Subsequent analysis of personality congruence was performed with the help of the absolute difference method developed by Gwinner and Eaton (1999). The values of the mean absolute difference prove that there is a higher degree of congruence between the brands of Škoda Auto and Ice Hockey World Championship than between Škoda Auto and Tour de France. Specifically, this applies to the following seven traits: Down to Earth, Responsible, Active, Bold, Ordinary, Romantic, and Sentimental. The remaining five traits showed a higher degree of congruence with Tour de France. After comparing the results of congruence with the results of personality identification, it was found that the Škoda Auto brand achieved congruence with the Ice Hockey World Championship in three traits that describe both brands: Active, Responsible, and Down to Earth. Only one congruent trait, Active, describes concurrently the Škoda Auto and Tour de France brands.

REFERENCES

- Aaker, J. L. (1997). Dimensions of brand personality. *Journal of Marketing Research*, 34(3), 347–357.
- Ambroise, L., Ferrandi, J. M., Merunka, D., & Vallette-Florence, P. (2005). How Well Does Brand Personality Predict Brand Choice? A Measurement Scale and Analysis Using Binary Regression Models. *Asia Pacific Advances In Consumer Research*, 6(1), 30–38.
- Azoulay, A., & Kapferer, J. N. (2003). Do brand personality scales really measure brand personality? *Brand Management*, 11(2), 143–155.
- Chanavat, N., Martinent, G., & Ferrand, A. (2010). Brand images causal relationships in a multiple sport event sponsorship context: Developing brand value through association with sponsees. *European Sport Management Quarterly*, 10(1), 49–74.
- Čáslavová, E., & Petráčková, J. (2011). The brand personality of large sport events. *Kinesiologie*, 43(1), 91–106.
- Čáslavová, E., & Višněvský, A. (2016). Identification of Ice Hockey world Championship International sport Event through Brand personality. In: *Conference proceeding World Academy of science, engineering and technology*. Amsterdam The Netherlands Aug. 04–05. 18 (8), Part I, pp. 8–15.
- Geuens, M., Weijters, B., & De Wulf, K. (2009). A new measure of brand personality. *International Journal of Research in Marketing*, 26(2), 97–107.
- Grohmann, B., Giese, J. L., & Parkman, I. D. (2013). Using type font characteristics to communicate brand personality of new brands. *Journal of Brand Management*, 20(5), 389–403.
- Gwinner, K. P., & Eaton, J. (1999). Building Brand Image Through Event Sponsorship: The Role of Image Transfer. *Journal of Advertising*, 28(4), 47–57.
- Gwinner, K., & Bennett, G. (2008). The Impact of Brand Cohesiveness and Sport Identification on Brand Fit in a Sponsorship Context. *Journal of Sport Management*, 22(4), 410–426.
- IEG (2016). *As Sponsorship Borders Fall, Spending Rises*. Available online at: <http://www.sponsorship.com> (accessed 1 December 2016).
- Keller, K. L. (2013). *Strategic brand management: building, measuring and managing brand equity* (4th ed.). Upper Saddle River: Pearson Prentice Hall.
- Kim, Y. K., Shim, S. W., & Dinnie, K. (2013). The Dimensions of Nation Brand Personality: A Study of Nine Countries. *Corporate Reputation Review*, 16(1), 34–47.
- Lee, H. S., & Cho, C. H. (2009). The matching effect of brand and sporting event personality: Sponsorship implications. *Journal of Sport Management*, 23(1), 41–64.
- Lee, H. S., & Cho, C. H. (2012). Sporting event personality: scale development and sponsorship implications. *International Journal of Sports Marketing & Sponsorship*, 14(1), 51–68.
- Lee, E. J. (2013). A Prototype of Multicomponent Brand Personality Structure: A Consumption Symbolism Approach. *Psychology & Marketing*, 30(2), 173–186.
- McDonald, C. (1991). Sponsorship and the image of the sponsor. *European Journal of Marketing*, 25(11), 31–38.
- Macintosh, E., Nadeau, J., Seguin, B., O'Reilly, N., Bradish, C. L., & Legg, D. (2012). The Role of Mega-sports Event Interest in Sponsorship and Ambush Marketing Attitudes. *Sport Marketing Quarterly*, 21(1), 43–52.
- Musante, M., & Milne, G. R. (1999). Sport Sponsorship: Evaluating the Sport and Brand Image Match. *International Journal of Sports Marketing and Sponsorship*, 1(1), 32–47.
- Neijens, P., Smit, E., & Moorman, M. (2009). Taking up an event: brand image transfer during the FIFA World Cup. *International Journal of Market Research*, 51(5), 579–591.
- Plumer, J. T. (1985). How personality makes a differences. *Journal of Advertising Research*, 24(6), 27–31.
- Ross, S. D. (2008). Assessing the use of the brand personality scale in team sport. *International Journal of Sport Management*, 3(1/2), 23–38.

- Schade, M., Piehler, R., & Burmann, C. (2014). Sport club brand personality scale (SCBPS): A new brand personality scale for sport clubs. *Journal of Brand Management*, 21(7–8), 650–663.
- Stipp, H. (1998). The impact of Olympic sponsorship on corporate image. *International Journal of Advertising*, 17(1), 75–87.
- Sung, Y., Choi, S. M., Ahn, H., & Song, Y.-A. (2015). Dimensions of Luxury Brand Personality: Scale Development and Validation. *Psychology & Marketing*, 32(1), 121–132.
- Woisetschläger, D. M., Haselhoff, V., & Backhaus, C. (2014). Fans' resistance to naming right sponsorships. *European Journal of Marketing*, 48(7/8), 1487–1510.
- Woisetschläger, D. M., & Manuel, M. (2012) Sponsorship congruence and brand image. A pre-post event analysis, *European Journal of Marketing*, 46(3/4), 509–523.

Experiments with the Lichtman forecasting procedure in the sport segment

Bohumír Štědroň

Department of Sport Management, Faculty of Physical Education and Sport,
Charles University, Prague, Czech Republic
stedron@ftvs.cuni.cz

This paper was completed with the support of Charles University programme Progres Q19: Social Science Aspects of the Study of Human Movement II.

ABSTRACT

This article deals with predicting the results of sport games in the selected sports segments. The Potůček (2006) quantitative and qualitative predicting methods (Štědroň, 2012, 2014, 2015) offer many procedures and models. The method of Allan Lichtman, which was tested in the USA during the presidential election, was chosen for our experiment. The method was modified for the sports segment. Preliminary results demonstrate that the analysed method can become a basis for forecasting in sports.

KEYWORDS

prediction; result of a sport game; A. Lichtman's 13 keys model

DOI

10.14712/23366052.2019.5

INTRODUCTION

Professor Allan Lichtman is an American political historian who teaches at the American University in Washington, D. C. He is a co-author of a model (Lichtman, 2008, 2016) called “Thirteen Keys.” Based on a system of statements, this procedure has correctly predicted every American presidential election winner since 1984 and succeeded in making the correct predictions several months or years prior to the elections. The election victory of Republican presidential candidate Donald Trump was the most recent prediction that proved correct. Throughout his U.S. career professor Lichtman has been awarded many acknowledgements and honours such as his appointment as distinguished professor of history in 2011.

At present, prognostic methods are analysed in numerous publications by Štědroň (2012, 2014, 2015), Potůček (2006), Šíma, Bartošek (2016), Šíma, Ruda, Omcirk (2015), Šíma, Omcirk, Ruda (2015).

The Lichtman method was modified for the sports segment by means of brainstorming and application of the Occam’s razor principle.

OBJECTIVE

The purpose of this paper is to propose a modified approach that is based on the Lichtman procedure and can be applied to predict results of sport events. The strategic objective of the study is to initiate a discussion on forecasting methods and receive funding for UK FTVS from international projects.

METHODOLOGY

The methodology applied in this paper is based on the Occam’s razor and Brainstorming methodologies (Štědroň, 2015; Fotr & Švecová, 2016).

William of Occam was born in England in 1280. He became a Franciscan friar and studied at the University of Oxford. Known as a creative philosopher, he is appreciated as the author of studies that were far ahead of the modern theory of the state. The term Occam’s razor refers to the methodological and philosophical principle suggesting that arguments, or entities (particulars), are not to be multiplied without necessity in order to explain a certain phenomenon. Pointless entities should be eliminated. Therefore, this method is also known as the law of parsimony or the principle of minimalism. This approach was commonly applied in medieval philosophy and can even be traced back to Aristotle (Šuleř, 2009).

The term Occam’s razor is still used but in a broader, more varied sense. According to the original concept all definitions should be devoid of all useless, auxiliary arguments, however, Occam’s method is now also used to assess the correctness of models, e.g. as an arbiter between two or more theories. According this interpretation of Occam’s razor, the simpler theory is correct. Occam’s razor can also be applied to analyse the causes of individual phenomena and measured data. The simpler, or more probable, of two competing models is more acceptable.

Occam's principle does not say that the simpler explanation is correct, but it says that the probability of correctness is high and the simpler explanation should be preferred unless evidence to the contrary is available.

Brainstorming, on the other hand, is a significantly younger method. Brainstorming was introduced in the 1930s by Alex Osborn who presented the method as "How to Think Up." Later, it became known as Brainstorming and this method remains the most popular way to stimulate creative thinking.

The recommended format consists of three parts:

- preparatory phase,
- creative discussion of experts specializing in various domains to extract innovative ideas and approaches,
- evaluation and implementation of outcomes.

Professor Lichtman's method is based on an analysis encompassing all U.S. presidential elections from 1860. He developed the methodology in collaboration with Vladimir Keilis-Borok (founder of the International Institute of Earthquake Prediction Theory and Mathematical Geophysics). Lichtman described the algorithm (Lichtman, 2008, 2016) in two publications. His heuristic model consists of thirteen statements that can be assigned a true/false value. Each true statement favours the re-election of the incumbent party. When six or more are false, the challenging party wins. For the D. Trump vs. H. Clinton election battle the thirteen statements were phrased as follows:

1. Party mandate: After the most recent mid-term elections, the incumbent party holds more seats in the House of Representatives. (FALSE)
2. Nomination contest: There is no serious contest for the incumbent party nomination. (TRUE)
3. Incumbency: The incumbent party candidate is the sitting president. (FALSE)
4. Third party: There is no significant third-party candidate (other than Democratic or Republican) or independent campaign. (TRUE)
5. Short-term economy: The economy is not in recession during the term. (TRUE)
6. Long-term economy: Real economic growth during the term equals or exceeds mean growth during the previous two terms. (TRUE)
7. Policy change: The incumbent administration effects major changes in national policy. (FALSE)
8. Social unrest: There is no sustained social unrest during the term. (TRUE)
9. Scandal: The incumbent administration is untainted by major scandal. (TRUE)
10. Foreign/military failure: The incumbent administration suffers no major failure in foreign policy or military affairs. (TRUE)
11. Foreign/military success: The incumbent administration achieves a major success in foreign policy or military affairs. (FALSE)
12. Incumbent charisma: The incumbent party candidate is charismatic or a national hero. (According to Lichtman, Hillary Clinton is short of these attributes, FALSE)
13. Challenger charisma: The challenging party candidate is not charismatic or a national hero. (Neither Trump was assigned with these attributes, TRUE)

The true and false values in the brackets refer to the values of the 2016 United States presidential election. Lichtman's method identified five false statements and eight true statements. The result is that Donald Trump was the winner. This means that, again

in the 2016 United States presidential election, the Lichtman algorithm proved to be effective.

Failure of Lichtman's method can be demonstrated in the prediction of the 2017 presidential election in France. The opinion poll of voters performed on 9 March showed that Marine Le Pen, chairperson of the National Front party and the European Parliament, was a clear favourite who was expected to advance to the second round while Emmanuel Macron, minister of economy who resigned from his position to concentrate on the presidential election, was supposed to be Le Pen's rival.

ELECTION CAMPAIGN 1

Marine Le Pen unveiled her presidential platform to voters in Lyon. The manifesto included 144 points mainly dealing with migration and tax policy, France's position in the European Union and the country's security. If Le Pen had become the next president, the attitude towards the European Union would have radically changed in France. Le Pen refused the single currency and called for re-establishment of the national borders. Should the neighbouring countries have denied their consent to restore border crossings, she was determined to hold a referendum, or to pursue the withdrawal of France from the European Union – Frexit. Fighting for making the issuance of French passports more restrictive and deportations of immigrants faster, the immigration policy is the core political concept of the National Front political party. Concerned with the terrorist attacks afflicting France in the recent years, Le Pen intended to recruit 15,000 new police officers in order to increase the size of the security forces. Moreover, she wished to reintroduce the death penalty. Le Pen's main goal was to give France liberty and security, and provide the French with the choice of decision-making.

ELECTION CAMPAIGN 2

Emmanuel Macron is the head of the En marche political movement with its slogan "France on the move." Politically, he is a social liberal. Macron is an advocate of the "open door" policy towards all migrants and refugees. His campaign was founded on the migration policy that is perceived positively and regarded as an economic tool. He went as far as to challenge France to make a public apology for the French involvement in the Algerian War of 1954–1962. Macron expressed his intent to support business and ease the tax burden for entrepreneurs. Additionally, he encouraged all scientists, economists and entrepreneurs living in the USA, who disagree with Trump's policies, to move to France.

THIRTEEN KEYS FOR FRANCE

Now, Lichtman's Thirteen Keys algorithm can be used in an attempt to predict the next president of France. Marine Le Pen was chosen to represent the incumbent party while Emmanuel Macron represented the challenging party. The following conclusion was reached:

1. After the most recent elections, the incumbent party holds more seats in the House of Representatives. (TRUE)
2. There is no serious contest for the incumbent party nomination. (FALSE)
3. The incumbent party candidate is the sitting president. (FALSE)
4. There is no significant independent candidate campaign. (TRUE)
5. The economy is not in recession during the campaign. (TRUE)
6. Real economic growth per capita during the term equals or exceeds mean growth during the previous two terms. (TRUE)
7. The incumbent administration effects major changes in national policy. (FALSE)
8. There is no sustained social unrest during the term. (TRUE)
9. The incumbent administration is untainted by major scandal. (FALSE)
10. The incumbent administration suffers no major failure in foreign policy or military affairs. (TRUE)
11. The incumbent administration achieves a major success in foreign policy or military affairs. (FALSE)
12. The incumbent party candidate is charismatic or a national hero. (TRUE)
13. The challenging party candidate is not charismatic or a national hero. (TRUE)

Five false statements could be identified after applying the thirteen keys algorithm. According the Lichtman procedure, the incumbent party candidate – Marine Le Pen – should have been the winner, but that was not the case.

Understandably, a modified version of professor Lichtman's method must be applied for the sports segment. A modified system of statements was established by means of brainstorming and Occam's razor. Additionally, the system of 0 and 1 as in propositional calculus or Boolean algebra will be applied.

APPLICATION IN THE SPORTS SEGMENT

Applied in the modified version and based on both a brainstorming session and Occam's razor, Lichtman's method was used to predict if Real Madrid would successfully defend the UEFA Champions League title in 2019. The following predicates were formulated:

- There are no significant changes in the club's management.
- Less than three players were replaced in the incumbent champion's previous year winning line-up.
- The incumbent champion is in great shape and proved this in recent games.
- There is no rival in the contest that is capable of defeating the incumbent champion.
- There is no rival in the contest that is in better shape than the incumbent champion.
- There is no rival in the contest that has a better team than the incumbent champion.
- The incumbent rival ranks among the top three in the Continental League.
- The defending club is untainted by major scandal.
- The incumbent champion is charismatic (high attendance).
- The basic line-up did not change in recent games.
- Not more than one player left the team during the current season.

Results obtained for previous cases:

- AC Milan, incumbent champion in 1989/1990

- The result (true : false) was 10 : 1
- AC Milan defended the UEFA Champions League title
- AC Milan, incumbent champion in 1990/1991
 - The result was 5 : 6
 - AC Milan did not defend the UEFA Champions League title
- Real Madrid, incumbent champion in 2016/2017
 - The result of prediction was 8 : 3
 - Real Madrid dominated the UEFA CL
- Real Madrid, incumbent champion in 2017/2018
 - The result of prediction was 7 : 4
 - Again, Real Madrid defended the UEFA CL title

To apply the heuristic procedure to the current situation, i.e. Real Madrid in 2018/2019, the following list of predicates is determined:

- There are no significant changes in the club's management (0)
- Less than three players were replaced in the incumbent champion's previous year winning line-up (0)
- The incumbent champion is in great shape and proved this in recent games (1)
- There is no rival in the contest that is capable of defeating the incumbent champion (0)
- There is no rival in the contest that is in better shape than the incumbent champion (0)
- There is no rival in the contest that has a better team than the incumbent champion (0)
- The incumbent rival ranks among the top three in the Continental League (0)
- The defending club is untainted by major scandal (1)
- The incumbent champion is charismatic (high attendance) (1)
- The basic line-up did not change in recent games (1)
- Not more than one player left the team during the current season (0)

The results above (7 : 4) indicate that Real Madrid will fail in the future game.

For the purposes of predicting the result of an Ice Hockey World Championship game, the following thirteen keys were defined:

1. The defending club won most games in the previous World Championship.
2. More than one third of the defending club's basic line-up remained the same as in the previous World Championship.
3. The economy is not in recession during the season.
4. Real economic growth equals or exceeds growth during the previous two seasons.
5. There is no change in the defending club's management during the current season.
6. There is no social unrest during the season.
7. The defending club is untainted by major scandal.
8. The defending club reached the quarter-finals in the previous World Championship.
9. The rival did not reach the quarter-finals in the previous World Championship.
10. The defending club is charismatic (high attendance of matches).
11. The rival is not charismatic (poor attendance of matches).

12. The defending club won the previous game of these two teams.
13. The defending club became the world champion in the recent three years.

The statements listed above can be used to predict the result of the match. The first step consists of determining which team of the selected game is the defending team and which team is the rival team. Thirteen statements are generated after determining the teams, or countries, and years. Each statement is marked as P_i . There are thirteen statements and, therefore, the variable ranges from 1 to 13.

$$i \in \{1; 2; 3; \dots; 13\}$$

In the next step, the veracity of the statements is assessed. Two values are used to express the veracity of the statements.

$$v(P_i) = \{0; 1\}$$

Any statement can be either true or false. Function $v(P_i)$ assigns 1 to each true statement. False statements are assigned with 0. After assessing the veracity of the statements, each is assigned either with 0 or with 1. These values must be then summed up.

$$S = \sum_{i=0}^{13} v(P_i)$$

The sum S determines the number of true statements. It can range from 0 (if neither of the thirteen statements is true) to 13 (if all statements are true).

$$S \in \{0; 1; 2; \dots; 13\}$$

At the end of the whole procedure the value of the sum S makes it possible to predict the result of the selected game. If most of the statements are true, in other words the value of the sum is at least 7 ($S \geq 7$), the incumbent team will win. If, on the other hand, most statements appear to be false and the value of the sum S is 6 or lower ($s \leq 6$), the rival team will be the winner.

TESTING

The method was tested on several ice hockey games played at the Ice Hockey World Championships in 2016, 2017, and 2018. The first game of Slovakia and the first game of the United States in each of the years were used as the testing sample.

To assess the selected games, data comprising results from previous years, team line-ups, names of coaches, gross domestic product figures, and changes in these figures were collected. Then, the veracity of each statement was assessed. The outcome of the assessment is shown in Table 1.

Table 1 Veracity of statements for games played by the US and Slovak teams

	$v(P_i)$					
	Canada vs. USA (2016)	Slovakia vs. Hungary (2016)	USA vs. Germany (2017)	Slovakia vs. Italy (2017)	Canada vs. USA (2018)	Czech Rep. vs. Slovakia (2018)
1	1	0	0	0	1	1
2	0	1	0	0	0	1
3	1	1	1	1	0	1
4	0	1	0	0	0	0
5	0	0	1	1	0	1
6	1	1	1	1	1	1
7	1	1	1	1	1	1
8	1	0	1	0	1	1
9	0	1	0	1	0	1
10	1	1	1	1	1	1
11	0	0	0	0	0	0
12	0	1	0	1	1	1
13	1	0	0	0	1	0

The sum of true statements was calculated for each game and it was determined which of the teams would, according to the method, be the winner. The result obtained was compared with the actual result of the game. The table below shows that the method was successful in determining the winners of all games with the only exception being the game between Canada and the United States of America in 2018. These teams belong among the best in the whole history of the Ice Hockey World Championship. The game was very close and remained tied (4 : 4) after overtime. This meant that a shootout had to be played – it was very close again (1 : 2) and the final score was 4 : 5. Considering these circumstances, this case was accepted.

Table 2 Method testing

Game	$S = \sum_{i=1}^{13} v(P_i)$	Winner prediction	Actual result	Validity of method
Canada vs. USA (2016)	7	incumbent	5 : 1	valid
Slovakia vs. Hungary (2016)	8	incumbent	4 : 1	valid
USA vs. Germany (2017)	6	rival	1 : 2	valid
Slovakia vs. Italy (2017)	7	incumbent	3 : 2	valid
Canada vs. USA (2018)	7	incumbent	4 : 5	not valid
Czech Rep. vs. Slovakia (2018)	10	incumbent	3 : 2	valid

PREDICTION

The defined and tested predicates were used to predict the result of the match between Slovakia and the United States of America that is scheduled for 10 May 2019 at the 2019 Ice Hockey World Championship in Slovakia. Table 3 shows the statements regarding the game that have to be assessed as true or false. The United States of America were marked as the incumbent team.

Table 3 Statements applicable to the match USA vs. Slovakia at IIHF WC 2019

<i>i</i>	P_i	$v(P_i)$
1	USA won most games at IIHF WC 2018.	1
2	More than one third of the basic line-up remained the same as at IIHF WC 2018.	0
3	The economy is not in recession during the season.	1
4	Real economic growth equals or exceeds growth during the previous two seasons.	1
5	There is no change in the US team management during the current season.	1
6	There is no social unrest during the season.	1
7	The US team is untainted by major scandal.	1
8	The US team reached the quarter-finals at IIHF WC 2018.	1
9	Slovakia did not reach the quarter-finals at IIHF WC 2018.	1
10	The US team is charismatic (high attendance of matches).	1
11	The Slovak team is not charismatic (poor attendance of matches).	0
12	The US team won the previous game of these two teams.	1
13	The US team became the world champion in the recent three years (2016–2018).	0

The prediction is regarding a game that will be played in May and, therefore, it is impossible to determine whether all the statements are true or false. The values highlighted in light gray are already clear and will not change with the passage of time. These are statements regarding historical results. In total, there are seven of them. Values highlighted in dark gray may potentially change. They comprise statements the validity of which depends on the future development and situation during the coming season. There are six unclear statements.

$$S = \sum_{i=0}^{13} v(P_i) = 10$$

The veracity of statements highlighted in orange was determined based on currently available data, current economic situation, and previous years' practice. If all 13 statements are taken into consideration, the number of true statements is 10. This implies that the US team should win this game. It is worth noting, however, that it would be desirable to repeat the whole procedure when the date of the game gets closer to verify the veracity of the statements and, by doing that, to verify the prediction of the result.

Lichtman's method dealing with the American presidential elections was modified for a completely different domain – the Ice Hockey World Championship. The original statements were adjusted to apply to an ice hockey team and to allow prediction of a result of an ice hockey match. Tested on historical data, the method was proved to be applicable and can be used. The prediction regarding the game between Slovakia and the United States of America at the next World Championship is that Slovakia will fail.

CONCLUSION

The analysis showed that the interpretation of predicates is a heuristic approach that comprises many scenarios. In the prediction of the most recent presidential election made by professor Lichtman, for example, a change in the assessment of only one statement would change the whole prediction (Hillary Clinton would be the winner).

The results obtained show that the modified Lichtman method is applicable to the sports segment even though the difference between the political and sports environments is so significant (Štědron, 2015) that Lichtman's heuristic approach cannot be applied in the sports environment without major modifications. To make the prediction more feasible, the keys would have to contain a dynamic comparison of the rivals (sinusoidal pattern of a player or team's performance) rather than remain limited to the defending team. To define such keys, many studies investigating the patterns of sport preparation, training, social links within the team, and the performance sinusoidal pattern would be needed, which would exceed the scope of this study. The brainstorming also indicated that, compared to the number of predicates used in the analysed cases, more than five times more predicates would be necessary to model the sport reality more precisely.

While the application of the Lichtman method on the sports segment is in the early stages of development, the main trend will probably be towards computer systems (instead of Business Intelligence) and "SPORT INTELLIGENCE" applications. It is worth mentioning in connection with the development of artificial intelligence, that Alpha GO, a self-learning computer program defeated Lee Se-dol, Korean GO world champion, in 2016. The future "SPORT INTELLIGENCE" system will also be a self-learning system capable of adding predicates in its database autonomously.

REFERENCES

- Fotr, J., Švecová, L. (2016). *Manažerské rozhodování: postupy, metody a nástroje*. Prague: Ekopress.
- Lichtman, A. (2016). *Predicting the Next President: The Keys to the White House*. Rowman & Littlefield Publishers.
- Lichtman, A. (2008). *The Keys to the White House: A Surefire Guide to Predicting the Next President*. Rowman & Littlefield Publishers.
- Potůček, M. (2006). *Manuál prognostických metod*. Prague: Slon.
- Šíma, J., Bartošek, D. (2016). Závislost velikosti tržních hodnot účastníků Mistrovství Evropy ve fotbale 2016 na dosaženém výsledku. *Acta Academica Karviniensia*, 18(3), 50–61.
- Šíma, J., Omcirk, V., Ruda, T. (2015). Mistrovství světa ve fotbale 2014 v kontextu tržní hodnoty týmů a jejich umístění. *Česká kinantropologie*, 19(2), 96–108.
- Šíma, J., Ruda, T., Omcirk, V. (2015). Dependency of Market Value of a Team on the Result Achieved at the FIFA World Cup 2014 in Brazil. *Studia Sportiva*, 9(1), 267–273.

- Šíma, J., Ruda, T., Omcirk, V. (2013). Dependence of the Overall National Team Market Value on its Success at UEFA EURO 2012. *Acta Universitatis Carolinae. Kinanthropologica*, 49(2), 32–42.
- Štědroň, B., Čáslavová, E., et al. (2015). *Manažerské rozhodování v praxi*. Prague: C. H. BECK.
- Štědroň, B., Kocour, V. (2014). *Technologické prognózy a telekomunikace*. Prague: Sdělovací technika.
- Štědroň, B., Potůček, M., et al. (2012). *Prognostické metody jejich aplikace*. Prague: C. H. BECK.
- Šuleř, O. (2009). *100 klíčových manažerských technik: komunikování, vedení lidí, rozhodování a organizování*. Brno: Computer Press.

INTERNET SOURCES

- FC Viktoria Plzeň. *Úspěchy* [online]. Available at: <<http://www.fcviktoria.cz/zobraz.asp?t=historie-uspechy>> Belorussia – Czechia/online broadcasting
- Isport* [online]. [cit. 2017-05-10]. Available at: <https://isport.blesk.cz/hokej/ms-v-hokeji-nemecko-a-francie-2017/belorusko-cesko/online-prenos?match=259342>
- 2016 Ice-Hockey World Cup. *Wikipedie* [online]. [cit. 2017-05-10]. Available at: https://cs.wikipedia.org/wiki/Mistrovstv%C3%AD_sv%C4%9Bta_v_ledn%C3%ADm_hokeji_2016
- <https://www.chapters.indigo.ca/en-ca/books/contributor/author/allan-j.-lichtman>
- <https://techcrunch.com/2017/05/27/googles-alphago-ai-is-retiring>

ACTA UNIVERSITATIS CAROLINAE
KINANTHROPOLOGICA, Vol. 55, 1 – 2019

Published by Charles University,
Karolinum Press, Ovocný trh 560/5, 116 36 Prague 1
www.karolinum.cz
Prague 2019

Typeset by Karolinum Press
Printed by Karolinum Press

Address correspondence to the Faculty of Physical Education and Sports,
Charles University, José Martího 31, 162 52 Prague 6 – Veleslavín, Czech Republic
e-mail: auc-k@ftvs.cuni.cz

Full text is available at:
<http://www.karolinum.cz/journals/kinanthropologica>