Developmental Trend Of Talented Pupils' Performance in Orienteering – Longitudinal Research 1997–2020 in the East Bohemia Region of the Czech Republic

Ivan Růžička[1], Adam Křehký[1], Petr Scholz[2], Kamila Růžičková[1], Jan Suk[1], Adrián Agricola[1]

[1]Faculty of Education, University of Hradec Králové, Hradec Králové, Czech Republic
[2]College of Polytechnics, Jihlava, Czech Republic

ABSTRACT

The article presents the findings of a longitudinal testing of talented youth in orienteering in the Czech Republic. Young talented orienteers participate in the testing of motor skills by standardized tests. The results and conclusions of the 3 km and 5 km cross-country running measurements (according to age category) point to a regressive state of endurance abilities in young athletes between 1997 and 2020, describe possible reasons and suggest possible remedies. A total of 300 girls and 445 boys aged 12-14 years participated in the research investigation in the East Bohemian Region of the Czech Republic, who are divided into performance categories HD12 and HD14 in the context of organised Czech orienteering competition. The aim of the evaluation of the longitudinal testing was to determine the trends in performance in endurance cross-country running as a key performance parameter of talented orienteering athletes over the period 1997 to 2020. The resulting data indicate that performance in all the studied categories in the given field test has a consistently decreasing trend. The results are also related to the conclusions of foreign and domestic observations of the state of motor fitness of children and youth of the corresponding period and indicate that the level of aerobic ability of young talented runners generally follows the current state of the level of endurance ability found in the national testing of school youth under the auspices of the Czech School Inspectorate (CSI, 2023), and thus the alarming society-wide situation in the field of motor fitness of children and youth in the Czech Republic.

Keywords: motor testing, talented children and youth, longitudinal research, orienteering, aerobic fitness

INTRODUCTION

Lehnert et al. (2014, p. 13) define talent as "a complex of aptitudes covering the requirements placed on an athlete to achieve high sport performance." The identification of talent is an integral part of organized sports, especially in the process of sports training for children and youth. The process of talent identification should ideally start at the very beginning of a sport career on the basis of the child's discovered movement abilities in the family or in the process of school physical education (Bailey & Morley, 2006). The complex process of identification is closely linked to the requirements of a specific sports discipline and also includes monitoring the potential for the development of relevant motor skills (Agricola et al, 2022). One of the possible ways of talent identification is the use of motor testing as a means of mapping the current state of the given prerequisites of young athletes, while the results of repeated measurements allow to predict with a certain degree of caution the possible development of performance growth of a young athlete (Perič, & Suchý, 2010; Morrow et al., 2023). The process typically takes place during the specialized training (depending on the sector, from about the age of 11) and lasts for several years. In this stage of child and youth development, individuals are closely monitored, and sport and motor performance tends to be assessed based on regular testing and measurement of relevant predictors.

Orienteering is a sport that combines self-movement with orientation in unfamiliar terrain. Competitors move under their own power through arbitrary terrain with the aim of completing a designated race course using a map and a compass in the shortest possible time (CSOS, 2018). Soulek (1991, p. 5) discusses that "...performance is limited by a certain percentage of special running endurance and a certain percentage of orienteering qualities...and is assumed to vary with age, with the proportion of running performance in overall performance being predominant in elite runners." Langer's (1991) structure of performance in adult athletes consists of 54% fitness, 24% somatotype and running technique, 12% orienteering technique, 8% load capacity and 2% are other factors, clearly indicating that endurance ability demonstrated in running performance has the greatest influence on orienteering performance. According to Hnízdil and Kirchner (2005), performance in the schoolchildren's categories, running performance still determines 30% running performance and 70% orienteering technique. However, in the younger age group (12-14 years) this ratio is balanced to 50:50 and gradually the role of running fitness becomes more and more pronounced in experienced competitors (up to 70:30).

The relationship between endurance level, running technique and competitive performance in orienteering has been studied abroad by Saltin (1972), Adams & Saltin (1980), Ranucci, Grassi & Miserocchi (1986), Kolb, Sobotka & Werner (1987), Fach (1989), Moser et al. (1995), Jensen, Johansen & Kärkkäinen (1999), Larsson et al. (2002), Millet et al. (2010) and others. Then, Batista et al. (2020), by analysing 469 studies, demonstrated that the main physiological requirement required for performance in orienteering is a high level of fitness in alternating aerobic and anaerobic loaded terrain running. Thus, it supports the findings of Soulek (1991) directly targeting the young orienteering category, who demonstrated that there are significant differences in the level of physical fitness in orienteering athletes at the age of 15 years, which in practice underlines the need for systematic cross-country training of young orienteers before the age of 15 years.

Thus, monitoring the parameter of running performance rightly has a prominent place in the identification and work with young talent in orienteering. The area of support for talented pupils in orienteering in the Czech Republic has been dealt with by a number of authors (Soulek & Škop, 1975; Weber, 1981; Růžička, 2009; Cahel, Košárek & Novotný, 2015) and the selection of talents has long been implemented within individual clubs, training centres and regions. In the East Bohemian region, the process involves the annual entrance testing of young athletes, which defines the membership base of the Youth Training Center. Athletes aged 12-14 who placed in the top 10 in the overall annual ranking races of the previous season are nominated for testing. This applies to both DH12 (girls and boys up to 12 years) and DH14 (up to 14 years) categories. The process includes tests of motor readiness in selected areas of motor skills, a key part of the testing of young talented orienteers is a test of special physical readiness, which is running in forest terrain called cross-country running.

METHODS

The aim of our research was to determine the developmental trend of performance in young talented orienteers from the East Bohemian region of the Czech Republic based on the results of longitudinal motor testing conducted between 1997 and 2020. A total of 745 young orienteers (300 girls and 445 boys) from the East Bohemian region aged 12-14 years participated in the research. The survey does not include data from 2001, when the testing did not take place. The results of this testing present a long-term trend in the level of physical preparedness in the area of endurance skills, which is dominantly related to the quality of competitive performance of orienteers. The monitored item is a key component of the performance of young talented orienteers - a test of special physical preparedness: cross-country running. The girls from the D12 and D14 categories and the boys from the H12 category will run a three-kilometre course, while the oldest boys' category, H14, will run a five-kilometre course. Cross-country testing is conducted annually in Hradec Králové near the Biřička pond in the local part of Nový Hradec Králové on a consistent one-kilometer circuit, partially along forest paths and partially in open terrain with an elevation gain of 20 meters. The test is performed after thorough warm-up and always under the supervision of trained regional coaches dedicated to the activities of the Youth Training Center and assistants from the ranks of coaches of selected clubs in the named region. The measurement is carried out by hand stopwatches with accuracy to the second.

Statistical data was processed and evaluated in MS Excel 2016 using descriptive method with arithmetic mean, percentage values and standard deviation which shows us the average deviation from the mean of the category. To optimize the evaluation, we normalize the observed performance results into "standard scores" that show us by how many standard deviations a test result is better or worse than the arithmetic mean

$$z = \frac{x - \overline{X}}{s}$$

and convert to T-scores

$$T = 50 + 10z$$

Legend:

X - total arithmetic average

x - tested result

s - standard deviation

T - values of arithmetic averages of individual years converted to T-scores

where the average performance corresponds to 50 points and the standard deviation equals 10 points (Měkota & Blahuš, 1983).

$$T = 60 - 10*z$$

The results are presented using a graphical method employing line graphs that depict the linear trend, along with logical methods for interpretation and drawing conclusions.

RESULTS

The presented results of special physical fitness testing (cross-country) utilize values of arithmetic averages for each year, recalculated to T-scores based on the specified age categories, along with indicating the linear performance trend in the respective running test.

Results of category boys H12 and girls D12

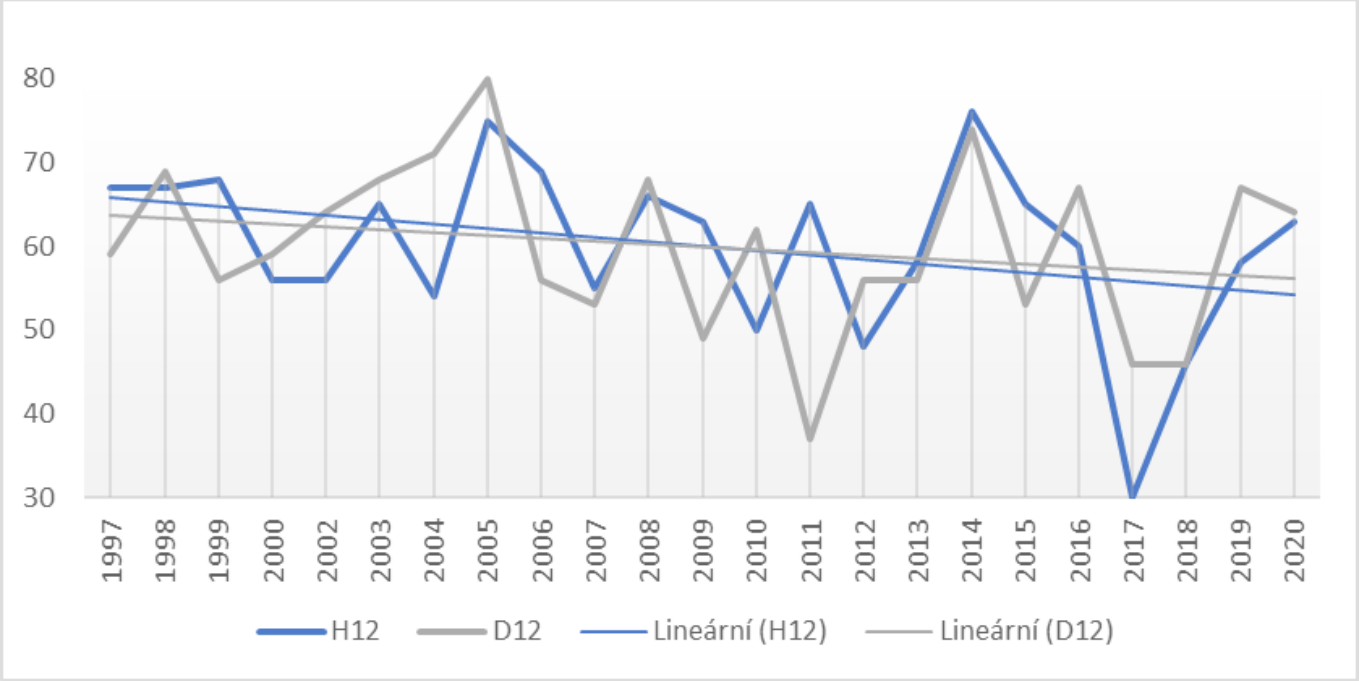

Figure 1. Values of performance in the cross-country running test for the categories of girls D12 and boys H12 (both cat. 3 km) in T-scores in the observed period 1997-2020 with expressed linear trend of performance.

Results of boys H14 and girls D14

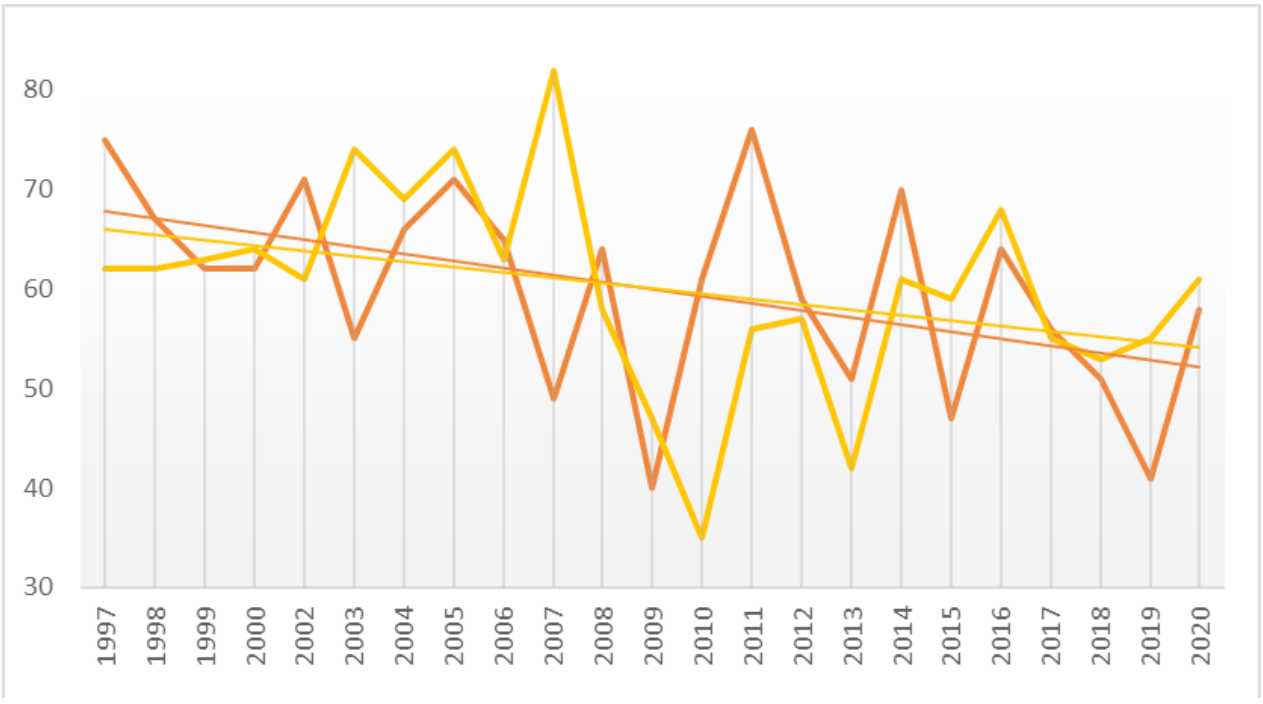

Figure 2. Performance values in the cross-country running test for the categories girls D14 (3 km) and boys H14 (5 km) in T-scores in the period 1997-2020 with a linear trend in performance.

DISCUSSION

The results of special physical fitness (cross) testing of young talented orienteers in all categories of orienteering tracked between 1997 and 2020 indicate a gradual deterioration in endurance performance. The regression of this key predictor of quality performance in orienteering is presented by linear trend graphics for the younger boy H12 and girl D12 categories tested and both older categories H14 and D14, with the most pronounced regression for the oldest categories tested. The results of our study indicate the longitudinal nature of the observed negative linear trend. Although there are differences in the average performances from year to year, using the expression of the linear trend we can clearly observe the unfavourable state of the long-term development of the level of endurance abilities of young athletes. This fact confirms the continuously alarming general regression of the state of these motor prerequisites in children and youth manifested in the world since the mid-1970s (Tomkinson, 2007). It also adds topicality to the results of long-term observations of physical fitness levels in children and youth based on research in 27 countries conducted on all continents between 1958 and 2003 (Tomkinson et al., 2003; Olds et al, 2006; et al.) Similar and important findings from international empirical or meta-analytic studies of the last decades include those of Tomkinson (2007, 2019), Aubert et al. (2022), and the very recent findings of the FitBack project (Ortega et al., 2023). These directly point to a trend of long-term decline in both strength abilities and, in particular, cardiorespiratory fitness (aerobic capacity) in children and young people. The alarming situation is consistent with the findings of a number of measurements conducted among school youth in the Czech Republic over the last 25 years, i.e. covering the same period as our evaluation (Bunc, 2000; Gajda & Měkota, 2000; Rubín et al., 2014; Suchomel & Rubín, 2017; Růžička et al., 2022, etc.). Thus, the results of our longitudinal monitoring and the identified negative performance trends complete the picture of the generally deteriorating situation in the level of physical fitness of children and youth in our country. Moreover, they draw attention to the fact that the given regression does not only affect school youth in general, but also affects the performance sphere, specifically the area of work with talented young orienteers.

One of the key reasons for the negative trend can be seen in the wrong exercise regime of children and youth in the Czech Republic, which is then reflected in the performance trends of young talents. As documented by Kalman et al. (2010), a large proportion of school children are insufficiently physically active. The decline in the fitness of boys and girls in grades 3 and 7 of primary school is evidenced by a 2013 study on a sample of primary schools in the Pilsen region, which targeted muscular performance as one of the components of fitness. The data present more than double the prevalence, with 74% of children classified as below average to significantly below average in 2013 compared to 31% in 1986 (Müllerová et al., 2015). In a pilot survey by the Czech School Inspectorate in the 2015/2016 school year (CSI, 2016), the decline in physical fitness of pupils in primary and secondary schools over the last 10 years was perceived by three-quarters of physical education teachers. A negative conclusion was also expressed when comparing the results of the measurement of school youth, which was carried out as part of the Sazka Olympic multi-sport project, with the results of a national survey from 1966 (Adamec, 2021). Gába et al. (2022) in the National Report on Physical Activity of Czech Children and Youth summarise by

concluding that Czech girls and especially boys are currently below average in terms of aerobic fitness levels compared to international standards. Finally, based on an assessment of trends based on our longitudinal monitoring, we can also draw a parallel with the picture that complements the results of the nationwide motor fitness testing of school youth (Agricola et al., 2020) in the autumn of 2022. The conclusions of the CSI (2023) demonstrate that girls and boys generally fall within the "critical zone" of fitness. The most pronounced deterioration in performance occurred in comparison to the mean of the Unifittest battery of test norms (Kovář & Měkota, 1995) specifically in the cardiorespiratory fitness test (endurance shuttle run), regardless of gender. The results for 7th grade elementary school students showed a 27% and 33% decline in performance between 1996 and 2022 for boys and girls, respectively, which is approximately equivalent to the normative Unifittest performance of 3rd grade elementary school students. Thus, even our tracking results dealing with talented pupils - that is, highly active performance-oriented and motivated individuals - do not break out of the negative societal trend in the area.

The evaluation methodology we have developed will allow us to process and interpret the results in future years and continue to monitor the long-term trend in the performance of talented pupils in orienteering as a basis for systematic work with children and youth. The given conclusions emphasize the need for increased attention of coaches of children and youth in the field of development of endurance abilities in orienteering. The results can also be used to compare the results of talented pupils in the area of endurance skills with other areas, talented youth centres or clubs. Alternatively, they may allow comparison of performance trends with international competitors, for individuals, the results can then predict the further development of sporting talent and its potential outcomes. Awareness of the identified negative trends in performance can significantly strengthen the need for coaches of children and youth to focus on effective fitness training of their trainees, especially in the area of endurance skills development as a key prerequisite for sport performance in orienteering. This corresponds to the current strong international emphasis on conditioning in orienteering already in the youth categories (Larsson et al., 2002; Türkmen & Biçer, 2022 and especially the meta-analytical study by Batista et al, 2020, etc.), in the Czech context agrees with the view of Cahela et al. (2015), Růžička (2009) and Soulek (1991), who, based on laboratory and field motor testing, recommended the provision of systematic endurance training before the age of 15.

CONCLUSION

The results of the longitudinal testing and its evaluation show that the performance of talented children and youth in orienteering in the East Bohemia region of the Czech Republic is deteriorating. The linear trend of performance in the discipline of cross-country running shows a negative tendency in all the studied categories of younger and older pupils/students in the period 1997-2020. The smallest degree of deterioration can be observed in the tested category D12, and the largest regression in the category H14. In general, both older categories DH14 show a steeper negative trend in performance, which may indicate a lack of attention of coaches of pupils in the field of development of endurance skills before this age. It also demonstrates some connection with

the society-wide regression of motor fitness of Czech children by comparing the findings of Kovář & Měkota (1995) and CSI (2023) affecting essentially the same period as our observation. The evaluated measurement data and conclusions can significantly contribute to the construction of systematic training of young talents in orienteering, which will adequately respond to the identified long-term negative trend, as well as the society-wide regression in the field of motor fitness level.

REFERENCES

Adamec, R., Brtna, M., Bžezina, J., Dvořák, T., Gardošíková, D., Janáček, Š., … Zavřel, R. (2021). *Bílá kniha. Analýzy a data o zdatnosti dětí v* ČR [The white book. Analyzes and data about children's fitness in the Czech Republic]. Praha: Český olympijský výbor.

Adams, D., & Saltin, B. (1980). Physical work capacity in orienteering (II). *IOF-Report 2/1980.*

Agricola, A., Cacek, J., Cuberek, R., Čepička, L., Flemr, L., Hnízdil, J., … Zvonař, M. (2020). *Monitoring tělesné zdatnosti a pohybové aktivity žáků v České republice* [Monitoring physical fitness and physical activity of pupils in the Czech Republic]. Praha: Vysokoškolské sportovní centrum MŠMT.

Agricola, A., Bozděch, M., Válek, T., Nykodým, J., & Zháněl, J. (2022). The RAE in WJTF 2012-16: A 5-Years Longitudinal Study. *Conference Sport and Quality of Life* (pp. 43). Brno: Masaryk University.

Aubert, S., Barnes, J. D., Demchenko, I., Hawthrone, M., Abdeta, C., Nader, P. A., … Tremblay, M. S. (2022). Global Matrix 4.0 Physical Activity Report Card grades for children and adolescents: Results and analyses from 57 countries. *Journal of Physical Activity and Health, 19*(11), 700–728.

Bailey, R., & Morley, D. (2006). Towards a model of talent development in physical education. *Sport, Education and Society, 11*, 211–230.

Batista, M. M., Paludo, A. C., Gula, J. N., Pauli, P. H., & Tartaruga, M. P. (2020). Physiological and cognitive demands of orienteering: a systematic review. *Sport Sciences for Health, 16,* 591–600.

Bunc, V. et al. (2000). Školní mládež na konci dvacátého století. (Závěrečná zpráva projektu MŠMT/VS 97131) [School youth at the end of the twentieth century]. Prague: FTVS UK

Cahel, M., Košárek, P., & Novotný, R. (2015). *Koncepce práce s talentovanou mládeží* [The concept of work with talented youth]. http://www.orientacnibeh.cz/upload/dokumenty/sekce-ob/koncepce-mladez.pdf

Český svaz orientační sportů. (2018). *Pravidla orientačního běhu* [The rules of orienteering running]. http://www.orientacnibeh.cz/upload/dokumenty/sekce-ob/pravidlaob-18.pdf

Česká školní inspekce (2016). *Vzdělávání v tělesné výchově, podpora rozvoje tělesné zdatnosti a pohybových dovedností* [Education in physical education, promoting the development of physical fitness and movement skills]. Prague: ČŠI.

Česká školní inspekce (2023). Tělesná zdatnost žáků na základních a středních školách – tematická zpráva [Physical fitness of pupils in primary and secondary schools – thematic report]. Prague: ČŠI.

Fach, H. (1989). Performance diagnosis and training control in endurance sport – what might be useful for orienteers? *Scientific Journal of Orienteering, 5*, 3–11.

Hnízdil, J., & Kirchner, J. (2005). *Orientační sporty* [Orienteering]. Prague: Grada.

Gába, A., Baďura, P., Dygrýn, J., Hamřík, Z., Kudláček, M., Rubín, L., Sigmund, E., Sigmundová, D., Vašíčková, J., & Vorlíček, M. (2022). *Národní zpráva o pohybové aktivitě českých dětí a mládeže 2022* [National Report on Physical Activity of Czech Children and Youth 2022]. Olomouc: Active Healthy Kids Czech Republic.

Gajda, V., & Měkota, K. (2000). Stav základní motorické výkonnosti mládeže mladšího školního věku v ostravském regionu. In M. Turek (Ed.), *Zborník z medzinárodnej vedeckej konferencie „Motorika detí predškolského a mladšieho školského veku"* pp. 121–130 [Proceedings of the International Scientific Conference Prešov – „Motorics of preschool and younger school-age children"]. Prešov: SVS.

Jensen, K., Johansen, L., & Kärkkäinen, O. P. (1999). Economy in track runners and orienteers during path and terrain running. *Journal of Sports Sciences*, *17,* 945–950.

Kalman, M., Sigmund, E., Sigmundová, D., Hamřík, Z., Beneš, L., Benešová, D., & Csémy, L. (2010). *Národní zpráva o zdraví a životním stylu dětí a školáků: na základě mezinárodního výzkumu uskutečněného v roce 2010 v rámci mezinárodního projektu Health Behaviour in School-aged Children: WHO Collaborative Cross-National study (HBSC)* [National report on the health and lifestyle of children and schoolchildren: based on international research

conducted in 2010 as part of the international project Health Behaviour in School-aged Children: WHO Collaborative Cross-National study (HBSC)]. Olomouc: Palacký University Olomouc.

Kolb, H., Sobotka, R., & Werner, R. (1987). A model of performance-determining components in orienteering. *Scientific Journal of Orienteering, 3,* 71–81.

Kovář. R., & Měkota, K. (1995). *Unifittest (6-60) test and norms of motor performance and physical fitness in youth and in adult age.* Olomouc: Palacký University Olomouc.

Langr, J. (1991). *Struktura výkonu v orientačním běhu* [Structure of performance in orienteering]. (Master´s thesis, University of Hradec Králové).

Larsson, P., Burlin, L., Jakobsson, E., & Henriksson-Larsén, K. (2002). Analysis of performance in orienteering with treadmill tests and physiological field tests using a differential global positioning system. *Scientific Journal of Orienteering, 20,* 529–535.

Lehnert, M., Kudláček, M., Háp, P., Bělka, J., Neuls, F., Ješina, O., … Štastný, P. (2014). Sportovní trénink I [Sports training I]. Olomouc: Palacký University Olomouc.

Měkota, K., & Blahuš, P. (1983). *Motorické testy v tělesné výchově* [Motor tests in physical education]. Prague: Státní pedagogické nakladatelství.

Millet, G. Y., Divert, C., Banizette, M., & Jean-Benoit, M. (2010). Changes in running pattern due to fatigue and cognitive load in orienteering. *Journal of Sports Sciences, 28*, 153–160.

Morrow, J. R., Mood, D. P., Zhu, W., & Kang, M. (2023). *Measurement and Evaluation in Human Performance*. Champaign: Human Kinetics.

Moser, T., Gjerset, A., Johansen, E., & Vadder, L. (1995). Aerobic and anaerobic demands in orienteering. *Scientific Journal of Orienteering, 11,* 3–30.

Müllerová, D., Langmajerová, J., Sedláček, P., Dvořáková, J., Hirschner, T., Weber, Z., … Derflerová Brázdová, Z. (2015). Dramatic decrease in muscular fitness in Czech schoolchildren over the last 20 years. *Central European Journal of Public Health*, 23, 9–13.

Olds, T. S., Tomkinson, G. R., Leger, L. A., & Cazorla, G. (2006). Worldwide variation in the performance of children and adolescents: an analysis of 109 studies of the 20-m shuttle run test in 37 countries. *Journal of Sports Sciences*, *24*(10), 1025–1038.

Ortega, F. B., Leskošek, B., Blagus, R., Gil-Cosano, J. J., Mäestu, J., Tomkinson, G. R., … Jurak, G. (2023). European fitness landscape for children and adolescents: updated reference values, fitness maps and country rankings based on nearly 8 million test results from 34 countries gathered by the FitBack network. *British Journal of Sports Medicine, 57*, 299–310.

Perič, T. & Suchý, J. (2010). *Identifikace sportovních talentů* [Identification of sports talents]. Prague: Karolinum.

Ranucci, M., Grassi, G., & Miserocchi, G. (1986). Anaerobic threshold in orienteers as an index of the aerobic-anaerobic relative contributions to the total power output—a comparison with other endurance sports. *Scientific Journal of Orienteering, 3*, 124–133.

Rubín, L., Suchomel, A., & Kupr, J. (2014). Aktuální možnosti hodnocení tělesné zdatnosti u jedinců školního věku [Current possibilities of physical fitness assessment in school-age individuals]. Česká *kinantropologie* [Czech Kinanthropology], *18*(1), 11–22.

Růžička, I. (2009). Identifikace talentů a práce s nimi [Identifying talents and working with them]. *Orientační běh* [Orientation running], *5, 9–10.*

Růžička, I., Křehký, A., Dostálová, R., Růžičková, K., Nalevanko, V., Walterová, S., & Agricola, A. (2022). Diagnostics of Motor Abilities in Primary School Pupils in the Hradec Králové and Pardubice Regions. *Studia Sportiva, 16*(2), 144–157.

Saltin, B. (1972). *Orienteringsträning* [Orienteering training]. Rapport no. 10, Stockholm.

Soulek, V. (1991). *Teorie a praxe tréninku orientačních běžců* (I. díl) [Theory and practice of orienteering training (Volume I)]. Prague: ČSOB.

Soulek, V., & Škop, V. (1975). *Výběr talentované mládeže pro orientační běh* [Selection of talented youth for orienteering]. Prague: ÚV ČSTV.

Suchomel, A., & Rubín, L. (2017). Úroveň tělesné zdatnosti u dětí z libereckého regionu v mezinárodním kontextu [The level of physical fitness of children from the Liberec region in the international context]. *Studia Kinanthropologica, XVIII*(1), 41–53.

Tomkinson, G. R. (2007). Global changes in anaerobic fitness test performance of children and adolescents (1958–2003). *Scandinavian journal of medicine & science in sports, 17*(5), 497–507.

Tomkinson, G. R., Lang, J. J., & Tremblay, M. S. (2019). Temporal trends in the cardiorespiratory fitness of children and adolescents representing 19 high-income and upper middle-income countries between 1981 and 2014. *British journal of sports medicine*, *53*(8), 478–486.

Tomkinson, G. R., Léger, L. A., Olds, T. S., & Cazorla, G. (2003). Secular Trends in the Performance of Children and Adolescents (1980-2000): An Analysis of 55 Studies of the 20m Shuttle Run Test in 11 Countries. *Sports Medicine, 33,* 285–300.

Türkmen, Ö, & Biçer, B. (2022). Effects of 8-Week Orienteering Training on Physical Fitness Parameters among Adolescents Aged 14-18 Years. *Biomed Research International.*

Contact Information:

Adrián Agricola,
Faculty of Education, University of Hradec Králové
Rokitanského 62, Hradec Králové
500 03, Czech Republic
adrian.agricola@gmail.com