

## Cumulative Training Effect in an Annual Training Cycle of Female Competitors in the Long Jump

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### Abstract

This contribution deals with cumulative training effect in two periods of an annual training cycle: 1<sup>st</sup> period - the summer preparatory period and II. summer racing period, 2<sup>nd</sup> period: the winter preparatory and indoor competition period in 16-17 years old female competitors in the long jump. We monitored the changes in the level of reactive strength of the lower limbs using a test of 10 repetitive plyometric jumps on the jump ergometer Myotest PRO. The test was performed at the beginning of each monitored weekly microcycle. We monitored the following parameters: height of the jump, duration of the contact, reactivity and stiffness. The performance of the athletes in monitored parameters had a fluctuating course during the monitored periods. The results have confirmed the correctness of composition of the training. Therefore, the long cumulative training effect positively reflected in an increase of the performance at the schedule time, at the end of monitored period in the indicators of reactive strength. The research has demonstrated the need for ongoing diagnostics of key indicators when manipulating with a training load.

**Keywords:** long jump, training load, microcycle, cumulative training effect, reactive strength.

### Introduction

Athletic jumps are specific group of athletic disciplines of the speed-strength character. The performance depends on many factors, especially the maximum running speed and reactive strength. In the past there were many authors dealing with training for jumping events. But now there is a lot of new information reached by the authors dealing with training for jumping events e.g. Velebil, Krátký, Fišer, Priščák (2002); Bora, Ozimek, Staskiewicz (2005); MacKenzie (2006); Klimczyk (2008); Čillík (2010); Čillík (2011) and others.

Sport training is based on repeating of training stimulations. It is one of the requirements for achieving expected changes in the level of adapting processes. However, the relation between training load - effect cannot be understood mechanically. According to different authors (Neumann, 1993; Dovalil et al., 2002; Volkov, 2002; Moravec and others, 2007 and others) the following division of training effects is distinguished: immediate training effect, delayed training effect, cumulative training effect. The cumulative training effect shows up through the relatively permanent change of the conditions of athletes. Achieving the cumulative effect depends on many factors that characterize the training load (volume and intensity, frequency of stimulations, type of stimulation, sequence of stimuli, variability and others). Training effect also depends on other out-of-training factors that influence the course of recovering processes. The cumulative training effect is divided into short, middle, long. The short cumulative training effect reflects in weekly mezocycle. The middle cumulative effect is evaluated on the basis of changes in the performance in mezocycle. The long cumulative training effect shows up in a longer period of time such as training mezocycle (at least 2 mezocycles), e.g. the period of an annual training cycle, biannual and annual macrocycle, possibly some annual training cycles, e.g. four-year Olympic cycle. The main objective of the training is to reach a cumulative training effect during the most important competitions.

Long-term monitoring of the response to training load is possible on the basis of regularly repeated measurements in a test that reflects some of the important factors of the structure of sport performance in athletic discipline. In this contribution we deal with monitoring the body response to a training load in terms with the cumulative training effect of competitors in the long jump.

### **Purpose**

The main purpose of this thesis was to follow the cumulative training effect during two periods of annual training cycle: 1<sup>st</sup> period: summer preparatory period and II. summer competition period, 2<sup>nd</sup> period: winter preparatory period and indoor competition period. We evaluated the training effect of two competitors in the long jump on the basis of the changes in the level of reactive strenght of the lower limbs always at the beginning of weekly microcycle.

### **Methods**

The characteristic of monitored female competitors:

Two female athletes were monitored:

K.K., 16 years old, body height 172 cm, weight 58-60 kg, sport specialization: the long jump (personal record 522 cm), triple jump (personal record 11.48 m).

E.J., 16 years old, body height 163 cm, weight 51 kg, sport specialization: the long jump (personal record 556 cm), 100 m hurdles (personal record 15.32 s), Heptathlon (personal record 4362 pts).

We used the Myotest PRO device to find out the training effect. The Myotest PRO device is scientifically proven and researched instrument that provides accurate information about the current state of explosive strength of lower limbs, which is detected in our case by plyometric jumps. The authors Bampouras et al. (2010) confirmed the validity and reliability of the Myotest PRO device. Tested athletes performed 10 repetitive plyometric jumps on the jump ergometer Myotes PRO at the beginning of the main part of a training unit after the warm-up, general and specific warm-up. On myotest this test is labeled with the name "Jump - plyometrics".

Plyometrics uses a cycle of stretching and shortening, so called accumulative-recuperation cycle, from English SSC (Slamka, 2000). This principle is used for example even when running and reflections that are critical indicators for the performance in the long jump. Therefore, we consider this test to be appropriate for the detection of the body response to a training load in the level of special preparedness among the female competitors in the long jump. The exercise called repeated take-offs, used in the test, is used by the female competitors as a part of the jumps preparation as so called ankle jumps in the number of jumps 10-20 and volume preparation even more. Therefore, we chose the number of repetitions 10, although the myotest measures an average of 3 best jumps based on the height of the jump.

The aim of the test is to achieve the highest height of the jump ( $h$  - cm), without creasing lower limbs in the knee joint, with a commitment to achieve the shortest possible contact time with the floor ( $t_c$  - ms). The comprehensive indicator is reactivity (index = time of flight / contact time), which expresses the proportion of the height of the jump and duration of the take-off. The fourth examined indicator is stiffness ( $kN.m^{-1}$ ), muscle-tendon stiffness. It expresses the size of the produced strength at the stage of an excentric contraction. It is actually a preparadnes of musculo-tendon apparatus for performing the take-off, so called muscle bias.

We have included all monitored indicators in this contribution: height of the jump –  $h$  (cm), contact time –  $t_c$  (ms), reactivity (index = flight time/contact time), stiffness ( $kN.m^{-1}$ ) ([www.verticaljumping.com](http://www.verticaljumping.com)).

The test was performed always on Monday at the beginning of the 1<sup>st</sup> training unit in a week. Weekly distance between measurements was selected on the basis of the structure of a training divided into microcycles and in an effort to get enough objective ongoing information about the current state during the monitored periods. The measurement was performed during training units in the season 2011/2012, in summer preparatory period and II. summer competition period from 6.8. to 3.10.2012 – 1<sup>st</sup> period, in winter preparatory period and indoor competition period from 29.10.2012 to 3.3.2013 – 2<sup>nd</sup> period.

The structure of monitored training periods:

1<sup>st</sup> monitored period (6.8.– 3.10.2012) 9 microcycles:

6. - 26.8. (3 microcycles) – training period

27.8. - 2.9. (1 microcycle) – competition period  
3. - 16.9. (2 microcycles) – training period  
17.9. - 7.10. (3 microcycles) – competition period, planned peak performance of II. summer competition period – The Slovak Championships of junior teams  
2<sup>nd</sup> monitored period (29.10.2012 – 3.3.2013)  
29.10.2012 – 22.1.2013 (11 microcycles) – training period  
23.1. – 3.3.2013 (6 microcycles) – competition period

## Results

### 1<sup>st</sup> monitored period

The height of the jump of the athlete K.K. has a fluctuating course with a gradually increasing level and the highest value was achieved at the time of planned peak performance (fig. 1). Fluctuation of values is very regular – higher level during one week alternates with lower level during the second week, however, it does not correspond with the graduation of load. The athlete E.J. achieved fluctuating changes in the height of the jump (fig. 1). She achieved the highest values during the last monitored weeks. The lowest value is achieved after the competition week as a result of fatigue caused by big racing load; two races within 3 days. Both athletes achieved similar course of the height of the jump, mainly during the 2<sup>nd</sup> part of monitored period.

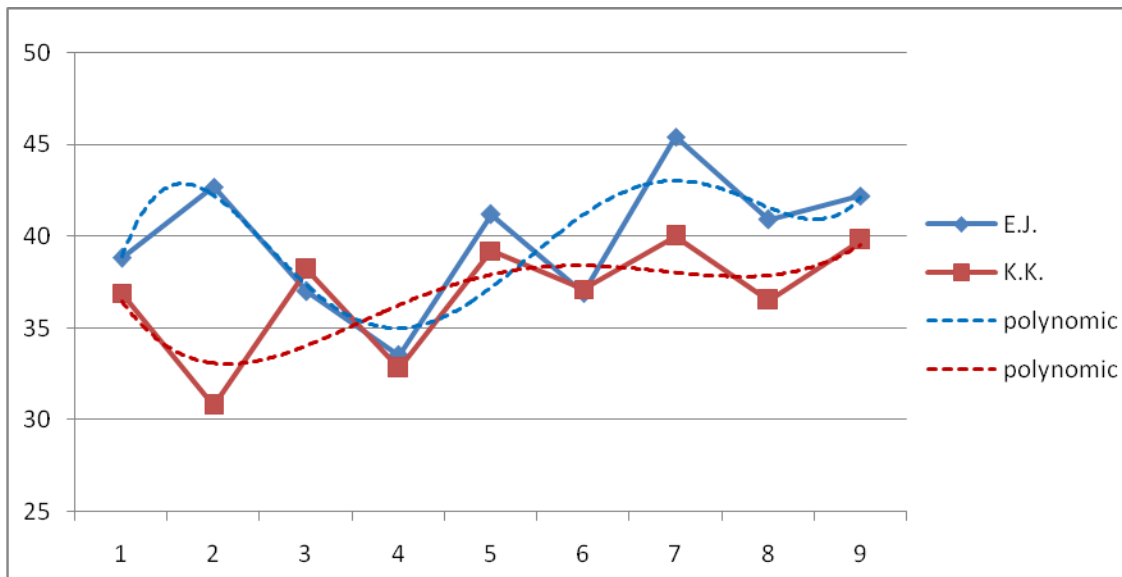


Fig. 1 Height of the jump – 1<sup>st</sup> monitored period

The athlete K.K. achieved the lowest duration of the contact time during a week before the most important competitions (fig. 2) and that is the correct trend. The duration of the contact time significantly extended during the second week of summer preparatory period under the influence of fatigue at the beginning of training, but then a decline occurs in a fluctuating course. The athlete E.J. gradually reduced the duration of the contact time towards the planned peak performance (fig. 2). The course is fluctuating and the shortest time is achieved during the 4<sup>th</sup> and 8<sup>th</sup> week. Both athletes achieved significantly shortest duration of the contact time at the end of the period than at the beginning of summer preparatory period.

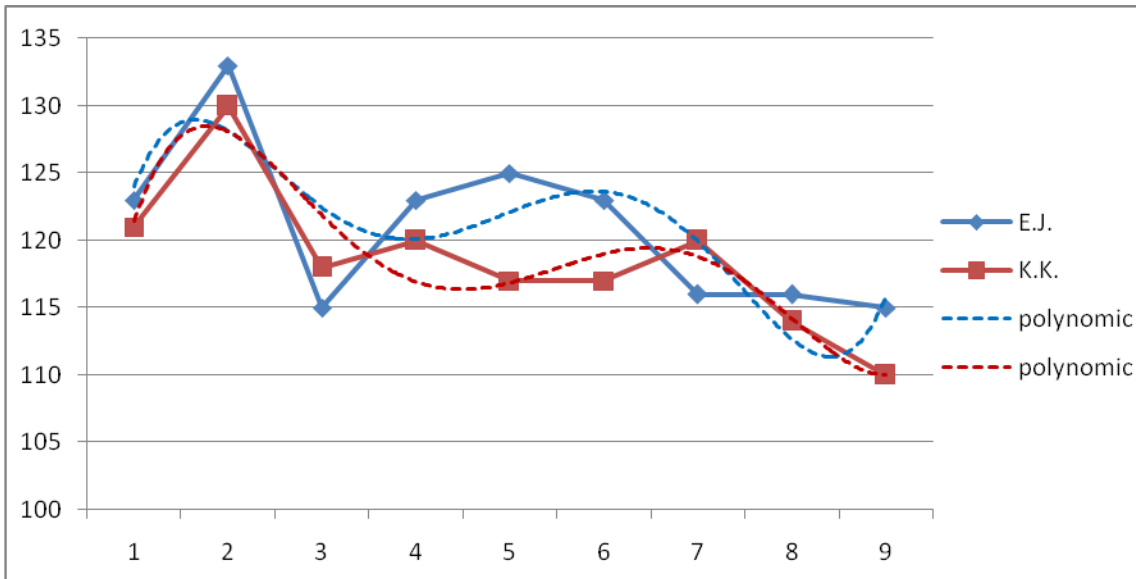


Fig. 2 Duration of the contact time – 1<sup>st</sup> monitored period

Reactivity of the take-off of the athlete K.K. has similar course as the height of the jump – slight rising with a fluctuating course and the highest value during the last week (fig. 3). Decrease in the reactivity during the second week of preparatory period is the result of fatigue from the beginning of training. The athlete E.J. achieved slightly increasing course of reactivity (fig. 3). The changes are fluctuating but the highest values were achieved during the last 3 weeks. Both athletes achieved significantly higher reactivity at the end of monitored period than at the beginning – approximately about 10 %.

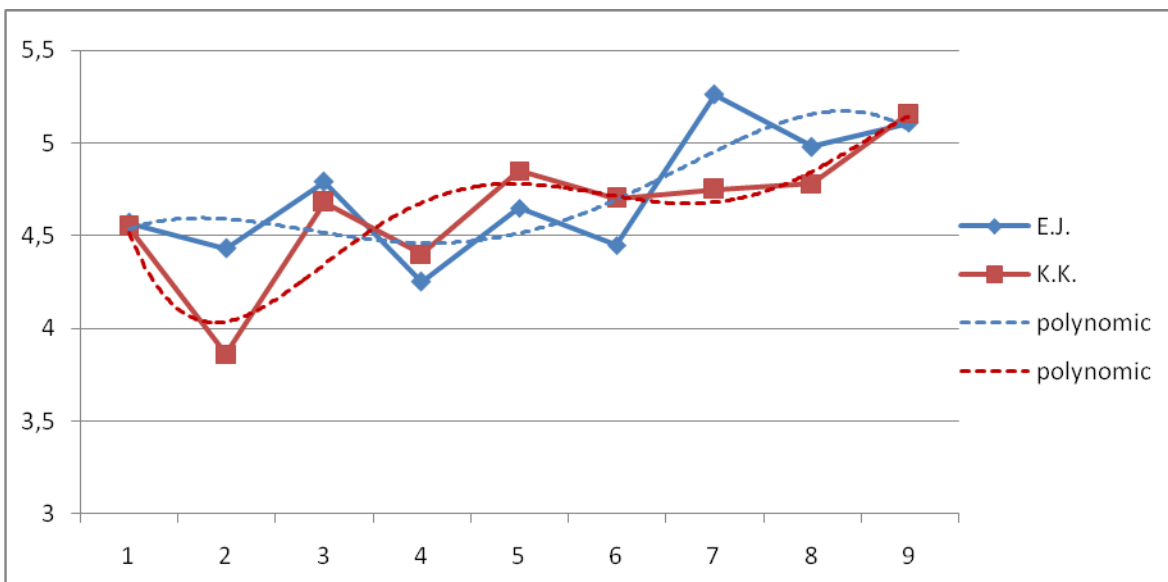


Fig. 3 Reactivity of the take-off – 1<sup>st</sup> monitored period

Also stiffness of the athlete K.K. very slightly increases (fig. 4). More than 50 % of improvement was achieved during the last week; therefore a tuning week had significant immediate effect also cumulative effect on the level of muscle stiffness as a demand for jumps. Stiffness of the athlete E.J. has a fluctuating but slightly increasing course (fig. 4). The values achieved at the end of the period are higher than at the beginning. The most significant decrease was achieved during the second week of the preparatory period due to the influence of fatigue at the beginning of the preparation.

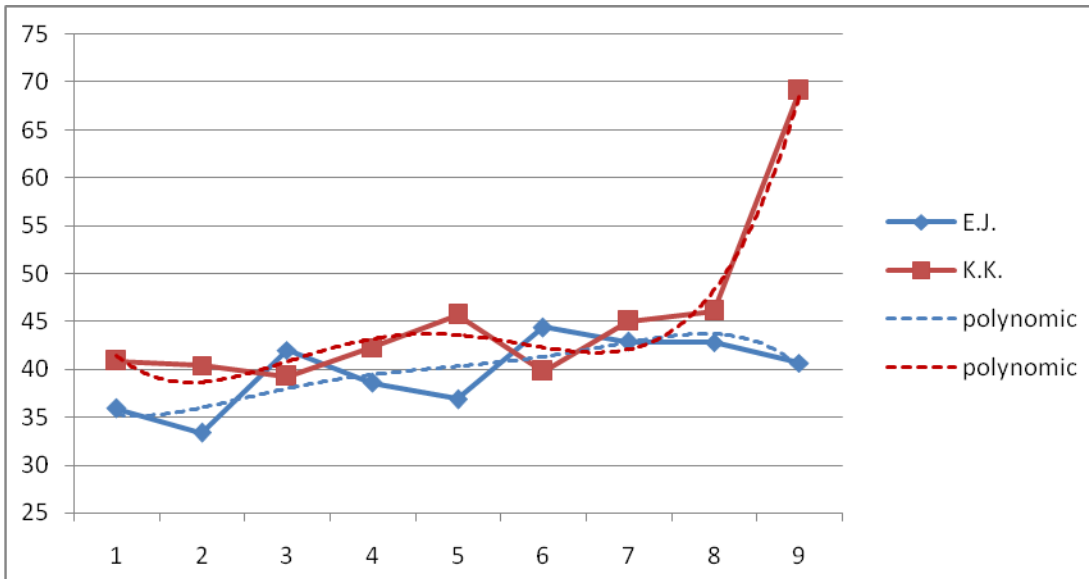


Fig. 4 Stiffness – 1<sup>st</sup> monitored period

#### 2<sup>nd</sup> monitored period

The height of the jump of the athlete K.K. had a fluctuating course with a gradually increasing level and the highest value was achieved a week before the planned peak performance (fig. 5). The athlete E.J. achieved fluctuating changes of the height of the jump (fig. 5). The highest values are achieved during the week of planned peak performance. Both athletes achieved the lowest values during a period of general preparation as a result of fatigue from the training. Considering both athletes, we have observed a positive trend of gradual increasing of the height of the jump.

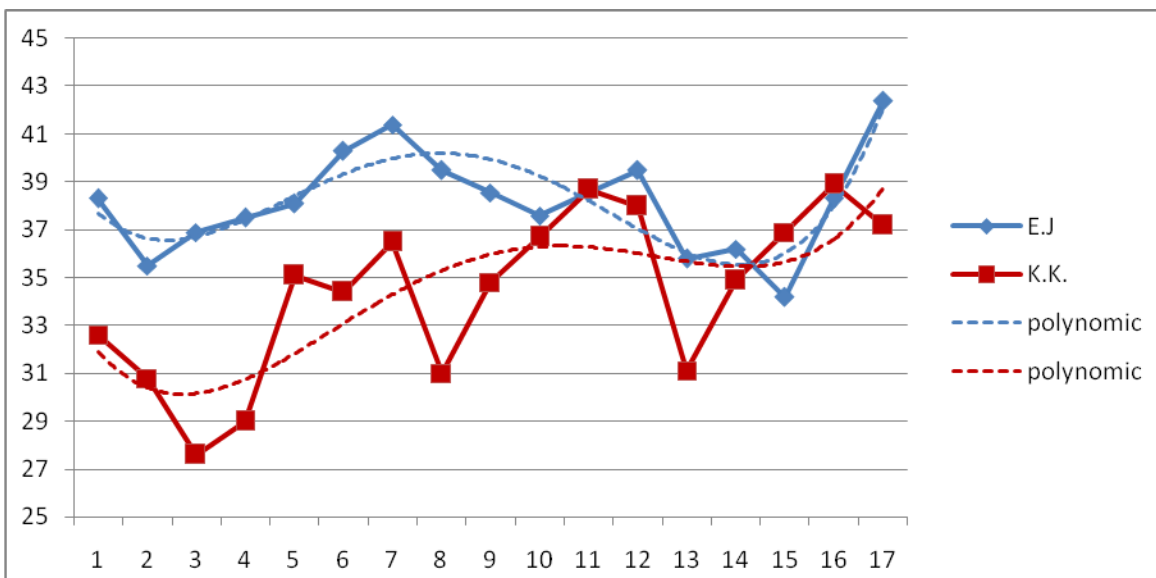


Fig. 5 Height of the jump – 2<sup>nd</sup> monitored period

Length of the take-off of the athlete K.K. was the lowest 2 weeks before the most important competition (fig. 6) and that is the correct trend. The contact time during the take-off significantly extended during the 6<sup>th</sup> week due to the influence of fatigue caused by general preparation but then decreasing occurs in a fluctuating course. The duration of the contact time of the athlete E.J. is

gradually reduced, the shortest time was achieved during the 3<sup>rd</sup> week of the period (fig. 6). Other course is fluctuating and the shortest time is achieved 2 weeks before the planned peak performance. Considering both athletes, the duration of the contact time is slightly shorter at the end of the period than at the beginning of the 2<sup>nd</sup> monitored period.

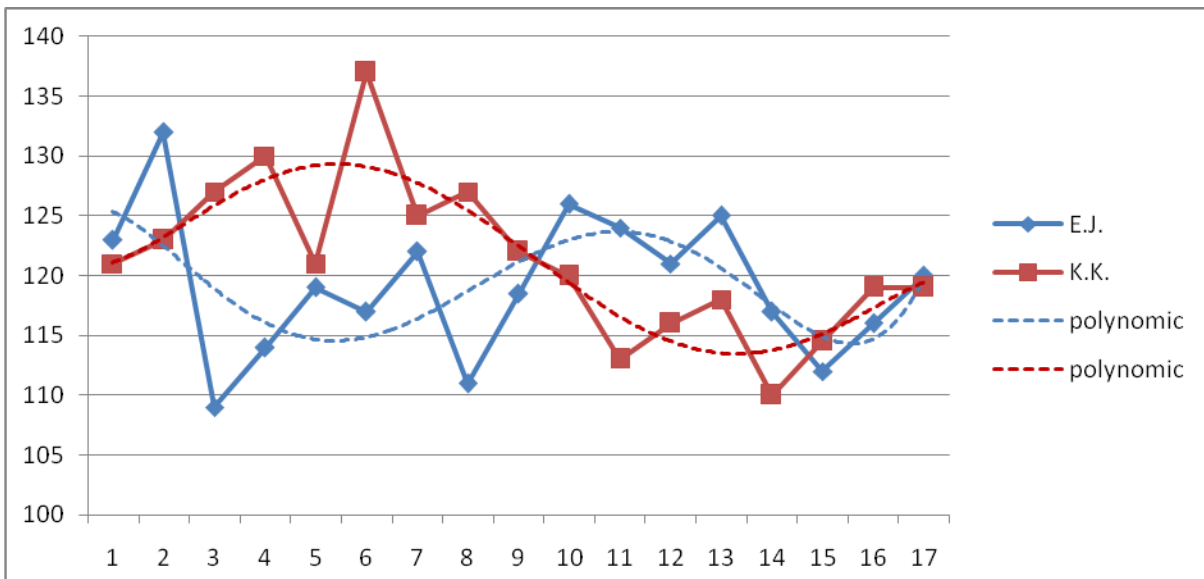


Fig. 6 Duration of the contact time - 2<sup>nd</sup> monitored period

Reactivity of the take-off of the athlete K.K. slightly increases with a fluctuating course and the highest value is achieved at the beginning of the competition period (fig. 7). Reactivity of the athlete E.J. has slightly increasing course (fig. 7). The changes are fluctuating but the highest values were achieved during the period of specific preparation and we have observed an increase at the end of the competition period. Considering both athletes, reactivity is higher at the end of the monitored period than at the beginning – about 10 %.

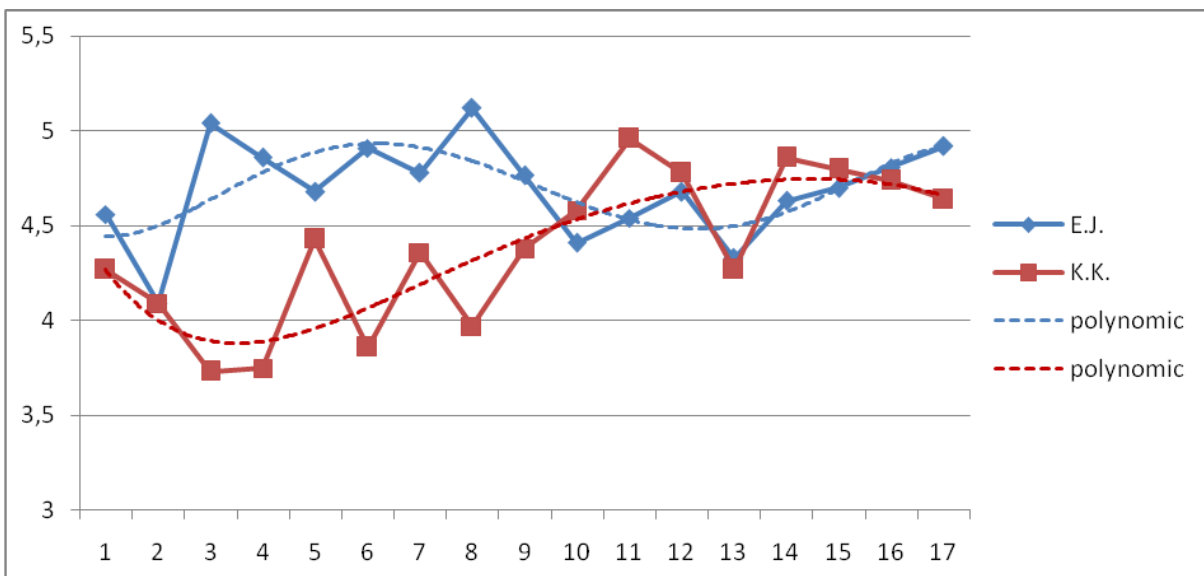


Fig. 7 Reactivity of the take-off – 2<sup>nd</sup> monitored period

Stiffness of the athlete K.K. gradually increases (fig. 8). The highest values are reached at the beginning of a competition period. A decrease was monitored at the end and values were lower than at the beginning of the period. Stiffness of the athlete E.J. has a fluctuating course and the highest values were recorded during the period of specific preparation (fig. 8). The values are higher at the end of the period than at the beginning.

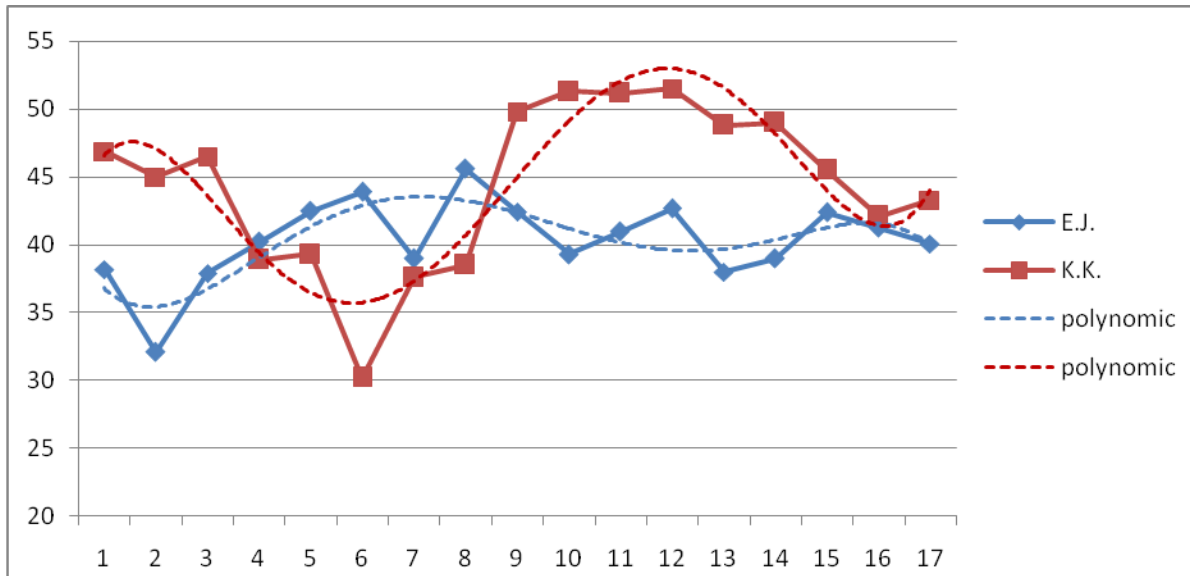


Fig. 8 Stiffness – 2<sup>nd</sup> monitored period

### Discussion

The structure of an annual training cycle depends on several factors. One of the decisive factors is a calendar for competition dates. In the case of the planned second peak performance in the summer competition period is important to include the summer preparatory period as well. Its length depends on the time remaining into the peak season. Individual authors e.g. Suslov (2000); Ter-Ovanesjan (2000); have mentioned 3-5 weeks. Monitoring both athletes, we consider 4-5 weeks long summer preparatory period to be suitable and next 4 weeks focused on the planned peak performance at the end of the II. summer racing period. The athletes were 4 weeks without training in order to have active rest before the monitored period. Considering the age category and the performance of athletes, we consider this to be acceptable. Moreover, the athlete E.J. was longer time without the training due to the injury. Therefore, she was 9 weeks without training. Number of starts during the racing period was also suitable as the authors (e.g. Dovalil et al., 2002) mention 2-4 cumulative starts during the planned peak performance.

In the Slovak athletics the indoor competition period is mostly only the part of the preparatory for the summer competition period. Therefore, winter preparatory period is usually significantly longer than the indoor competition period. In such a case the proportion of general and specific preparation is in the benefit of the general preparation. The preparatory period of monitored competitors was 11 weeks long and the indoor competition period was 6 weeks long. The preparatory period consisted of 6 weeks long general preparation and 5 weeks long specific preparation. It also involved the Christmas period during which the training had been significantly limited for 2 weeks. Longer preparatory period and larger proportion of general preparation would be more suitable for this age category. The athletes took part in 5-6 competition during the competition period. Several authors (e.g. Čillík, 2004 and others) have considered this to be suitable and optimal number for achieving athletic shape and expressing of performance potential in technical disciplines.

Monitoring reactive strenght of the lower limbs is important for these athletes because this indicator is decisive for the long jump. It's appropriate considering the valuation statement, the time but also undemanding energy. So that during the regular testing there is neither significant disruption of training nor the exhaustion of the competitors, which could cause the restriction of the following training. Intensification of training and information about the current condition of



the athletes is positive. The problem was that we investigated only one of the indicators and not also e.g. the level of speed abilities.

Monitoring the effect of a training microcycle at the beginning of the following week is an established procedure. It should be emphasized that there is manifested not only training effect of the previous microcycle but also cumulative effect of training and competition load from the previous microcycles, respectively mezocycles. Therefore, we have observed temporary reduction of the level of individual indicators in the preparatory period, as well as the decisive ones which are a prerequisite for the following supercompensation wave. From this perspective it is important to monitor the changes of states not only in microcycles but also in longer period of time. Achieving the optimal training effect during the competition period is essential for the growth of sports shape, especially during the most important competition. The structure of training of the monitored athletes was in accordance with the generally accepted principles of the training loads, which resulted in a temporary reduction of monitored indicators and their subsequent increase. The course of cumulative training effect was very similar during the 1<sup>st</sup> monitored period as the monitored indicators improved to compare them to the original ones about 5-10 %. More significant improvement was achieved by the athlete K.K. in the indicator of stiffness, due to the efficient tuning before competition. The cumulative training effect showed up through the performance of the athletes during the competition at the end of monitored period when they achieved the results on the level of personal best. The athlete E.J. achieved her personal best in the long jump. The course was similar during the 2<sup>nd</sup> monitored period even though more significant interindividual differences occurred. The course is quite positive but not as clear as in the previous period. The cumulative training effect of the athletes showed up positively through their performance during the competition at the end of monitored period. The female competitors, comparing to the Representative of the Slovak Republic in short distance runs, achieved in the category 1-2 years younger more than average levels of height of the jump, comparable values of the duration of contact time, higher levels of reactivity of the take-off and stiffness (Čillík et al., 2013). Both female competitors reached, at the end of the monitored period in the long jump, the performances at the level of their personal best.

### **Conclusion**

Considering both competitors, we observe a different response to training load. Overall, we conclude a favorable response to training load during the 1<sup>st</sup> monitored period for both athletes. We have recorded an adequate cumulative training effect at the time of planned peak performance – an improvement of indicators of reflective explosiveness about 5-10 % during the 1<sup>st</sup> monitored period. The athlete K.K. gradually improved in all of the monitored indicators of reactive strenght. The immediate effect of a pre-competition microcycle and the cumulative training effect of the preparatory and competition period brought the best values during the last week. This was expressed particularly in the athlete by stiffness. The cumulative training effect of the athlete E.J. positively showed up through an increasing of the performance during the last 3 weeks. This focus showed to be correct when considering her participation in the Slovak Championship in multi-event disciplines – 2 weeks before the end of the monitored period.

2<sup>nd</sup> monitored period did not produce such a clear improvement of the monitored indicators. The course is generally positive but not as clear as during the previous period. Only the height of the jump and reactivity of the take-off improved about 5 - 10 %. Shortening of the contact time was only minimal and only the athlete K.K. achieved an increasing of muscle stiffness. Considering both athletes, the missed training during the Christmas season reflected negatively. Therefore, the compactness of the preparation was disrupted. Ultimately it has brought less significant cumulative effect in the reflective expressiveness and long jump during the competition than during the 1<sup>st</sup> monitored period.

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**References:**

- Bampouras, T. M., Relph, N., Orme, D., Esformes, J.I. (2010). *Validity and reliability Myotest Pro wireless accelerometer*. British Journal of Sports Medicine. 44:i20 doi:10.
- Bora, P., Ozimek, M. & Staskiewicz, R. (2005). *Struktura oraz dynamika obciazen treningu sily w skoku w wzwyż na poziome mistrzowskim*. (Eds. Bora, P.) *Kierunki doskonalenia treningu i walki sportowej – diagnostyka*, tom 2. pp. 44 – 49.
- Čillík, I. (2004). *Športová príprava v atletike*. Banská Bystrica: Fakulta humanitných vied, Univerzita Mateja Bela.
- Čillík, I. (2010). *Okamžitý tréningový efekt po technickom tréningu u pretekárky v skoku do výšky*. In: *Atletika 2010*. pp. 13 – 18. Praha: FTVSUK.
- Čillík, I. (2011). *Tréningový efekt po silovom a technickom tréningu u pretekárky v skoku do výšky*. In: *OŠETROVATEĽSTVO – POHYB – ZDRAVIE*. pp. 245 – 253. Trenčín: TnUAD.
- Dovalil, J. et al. (2002). *Výkon a tréning ve sportu*. Praha: Olympia. .
- Čillík, I. – Pupiš, M. – Ďurják, O. (2013) *Rýchlostné a rýchlostno-silové schopnosti reprezentantiek SR v behoch na krátke vzdialenosti v žiackej kategórii*. (in print)
- Klimczyk, M. (2008). *Kierowanie i kontrola szkolenia sportowego tyczkarzy na etapach – wstepnym i podstatwowym*. Bydgoszcz: Uniwersytet Kazimierza Wielkiego.
- MacKenzie, B. (2006). *Long Jump Training Program* [WWW] Available from: <http://www.brianmac.co.uk/longjump/ljplan.htm> [Accessed 15/10/2012]
- Myotest review. Available from: [http://www.verticaljumping.com%2fmyotest\\_review.html](http://www.verticaljumping.com%2fmyotest_review.html) [Accessed 15/10/2012]
- Moravec, R., Kampmiller, T., Vanderka, M., Laczó, E. (2007). *Teória a didaktika výkonnostného a vrcholového športu*. Bratislava : FTVŠ UK.
- Neumann, G. (1993). *Zum zeitlichen Aspekt der Anpassung beim Ausdauer training*. In: *Leistungssport*, 23, n. 5.
- Velebil, V., Krátký, P., Fišer, V., Priščák, J. (2002). *Atletické skoky*. Praha: Olympia.
- Volkov, L.B. (2002). *Teorija i metodika detskovo i junošeskovosporta*. Kijev: Olimpijskaja literatura.
- Slamka, M.: (2000) *Akumulačno-rekuperáčny cyklus svalovej práce a jeho využitie v športe*. In: *Zborník vedeckých prác katedry atletiky IV, Slovenská vedecká spoločnosť pre TV a šport*, Bratislava, pp. 13-25.
- Suslov, F. (2000). *O strukture podgotovki molodych legkoatletov v godičnom sorevnovateľno – trenirovočnom cikle*. Bulletin RDC IAAF. Moskva: Terra-Sport.
- Ter-Ovanesjan, I. (2000). *Podgotovka legkoatleta: sovremennnyj vzgljad*. Moskva: Terra-Sport.