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# APPLICATION OF THE DNS METHOD FOR IMPROVING RUNNING TECHNIQUE

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***Abstract***
*This paper focuses on the use of the DNS method for improving technique in hobby runners and cross-country skiers. DNS is a neurophysiological concept based on the principles of developmental kinesiology, Prof. Kolář has extended these principles with an exercise and rehabilitation approach. This method uses both theoretical knowledge in diagnosis (examination, testing, movement analysis) and practical skills in subsequent treatment, correction and training of movement stereotypes. The main objective was the application of DNS to improve the running technique. Several sub-tasks were related to this goal, verifying the expected postural improvement in probands and checking whether the results were better in males or females. Several methods were used to obtain the data. The main method to determine running technique was diagnostics in the Salming RunLab. This was followed by a DNS test, which was followed by a DNS method exercise. The six-month plan was followed by a comparison of running technique through observation. Statistical results were processed using a two-sample paired t-test for the mean. The statistical results showed that there was no improvement in running technique, but when the running technique was compared before and after the DNS method exercise, there was an improvement, and the exercise also contributed to improved posture and a better feeling of running. Although the results are not clearly measurable, the DNS method has an effect on running technique, women are more disciplined in relation to exercising at home and enjoy the DNS method more than men. The DNS method has produced results not only in terms of sport but also in terms of improving the probands' sense of well-being when performing daily activities, leading to an improvement in their quality of life.*

***Keywords***
*Running; running technique; diaphragm; dynamic neuromuscular stabilization; posture; stabilization; developmental kinesiology.*

## 1 INTRODUCTION

The article focuses on the use of the DNS method according to Prof. Kolář to improve the running technique. The aim of improving running style is not only to prevent injuries but also to make the runner feel comfortable during the activity and enjoy the movement. The Dynamic Neuromuscular Stabilization (DNS) method according to Prof. Kolář was chosen for implementation. DNS is a neurophysiological concept based on the principles of developmental kinesiology, Prof. Kolář extended these principles with an exercise and rehabilitation approach.

This method uses both theoretical knowledge in diagnosis (examination, testing, movement analysis) and practical skills in subsequent treatment, correction and practice of movement stereotypes (Kolář, Kobesová, 2017). Examination according to the DNS concept uses a functional assessment of postural-locomotor patterns, which compares with developmental patterns to define ideal physiological muscle coordination. Based on this comparison, it defines then divergences in the function of individual muscles and in the centration of individual segments. One part of this examination is the assessment of postural stabilization of the trunk (Chramosta, Truc, 2020). Postural stabilization, which is defined as an active posture controlled by the central nervous system against the action of the gravitational field (Máček, Radvanský,

2011). If there is an unbalanced activity of the stabilization muscles, it leads to the decentration of a certain segment (Kolář, Kobesová, 2017). The way to better running results is through running, but there are cases when running needs to be supplemented with other specific training to improve performance and running technique (Humphrey, 2012).

The research was based on the demonstration of improved running technique based on input data from the Salming RunLab diagnostics and the application of DNS method exercises for a period of 6 months, after which a follow-up evaluation will be performed using the observational method. Follow-up data was evaluated using a two-sample paired t-test for the mean.

## 2 AIM AND HYPOTHESES

The aim was the application of dynamic neuromuscular stabilization according to Prof. Kolář for the improvement of running technique. Several subtasks are related to this goal. If the DNS method can improve trunk stabilization and can teach proper use of the diaphragm and pelvic floor, posture should improve in those individuals where it is not ideal. Since the group of test subjects consisted of males and females, it is possible to compare the groups in terms of success rates.

Hypotheses

- H 1: DNS exercise affects running technique
- H 2: DNS exercise affects runner's performance
- H 3: DNS exercise has an effect on the pace
- H 4: DNS exercise affects cadence
- H 5: Exercise affects the vertical oscillation
- H 6: Exercise affects stride length
- H 7: DNS exercise affects ground contact time

## 3 METHODS

### 3.1 Characteristics of the research group

The study group consisted of 16 probands, 9 males and 6 females aged between 30 and 45 years who regularly run 2-3 times per week, performance was not differentiated as it was not standardized.

The main assumption was to improve the running technique of hobby female runners and hobby male runners using dynamic neuromuscular stabilization according to Prof. Kolar. Furthermore, it was assumed that women would perform better than men due to greater discipline and goal orientation. Lastly, it was assumed that not only running technique would improve, but overall body posture improves due to trunk stabilization exercises and proper engagement of the diaphragm and pelvic floor. However, there was also an assumption that one method is not enough to improve running technique; if a runner has shortened muscles, they need to be stretched in a targeted manner and it is not enough to just address the involvement of the diaphragm and pelvic floor muscles.

### 3.2 Organisation of the research investigation

The first step was to reach out to probands, specifically hobby runners, which wasn't difficult due to my years of being a runner. Once the group of hobby runners was complete, it was necessary to obtain information about their baseline, the state of their running style. This was possible thanks to the arranged cooperation with the brand of sports equipment and clothing Salming Praha Pankrác, where they have the so-called RunLab running laboratory.

During December 2019 - February 2020, probands were tested in the Salming RunLab.

At the end of February 2020, 13 probands passed the diagnostics, 8 males and 5 females, the group was reduced by 3 probands.

The first joint training session had the aim to test all probands using DNS tests and based on these results, everyone was given their homework.

In the next joint training session, the probands demonstrated their ability to breathe correctly and were then given the first set of exercises, which were also available in written form. Next, their discipline mattered, as they were given the task of practising at home every other day; the actual practice session was about 20 minutes long.

After six to seven weeks, i.e. in mid-July 2020, another exercise was conducted. First, the previous exercise was checked to see if everyone had mastered the exercises, and then they were given another collection of exercises, which were again given in the written form, and one exercise was also videotaped. In September, one proband left the group due to a fractured lower limb.

The last exercise, which took place in November 2020, was conducted in an online-only format, with an exercise video along with written instructions to all runners. At this point there was a kind of laxity and reluctance to exercise in the group, motivation was lost and some admitted that they were no longer exercising as intensively as in previous months.

October was marked by a further loss of probands, one of whom suffered a prolapsed intervertebral disc at L5-S1 while working in the garden. At the end of January 2021, two more probands, who had been "extra" at the beginning, wanted to be part of the group on their own initiative, ended their cooperation. This was due to recurrent viral illnesses, dislike of physical activity and a generally negative attitude towards everything. In the end, a total of 9 probands remained 4 men and 5 women.

The final process was to be an exit retest of the running style in RunLab, between January and February 2021. Unfortunately, this diagnosis could not be made and the outlook for the next period was not favourable, so an alternative procedure was established. This involved making a detailed video recording of each proband and their running styles and then comparing this with the previous RunLab diagnosis, from which a conclusion was drawn.

### 3.3 Diagnostics

A mixed research strategy was adopted in processing the results. In one part, qualitative research was used, i.e. examining the features and differences of running technique before and after the research. Qualitative research was also chosen because of the small number of probands. Quantitative research was used when comparing the data from the Salming Runlab running analysis before the DNS method exercise with the observation data when the probands were measured by their own technique, this was Garmin, Polar and STRYD.

**Salming RunLab**

Featuring advanced technology from Swedish company Qualisys, the full-body running analysis captures movements and measures them in 3D space. The same technology is used by film studios to animate 3D characters. This technology is also used by elite athletes, manufacturers of running shoes, physiotherapists and scientists in the field of biomechanics. This technology makes it possible to assess running style from a whole-body perspective.

The camera system is composed of nine high-frequency cameras that can capture 400 frames per second and use 35 passive reflex sensors placed all over the body for optical motion sensing. This system offers greater accuracy than traditional video analysis systems. The system compares the measured motion of the entire body and individual parts with ideal motion.

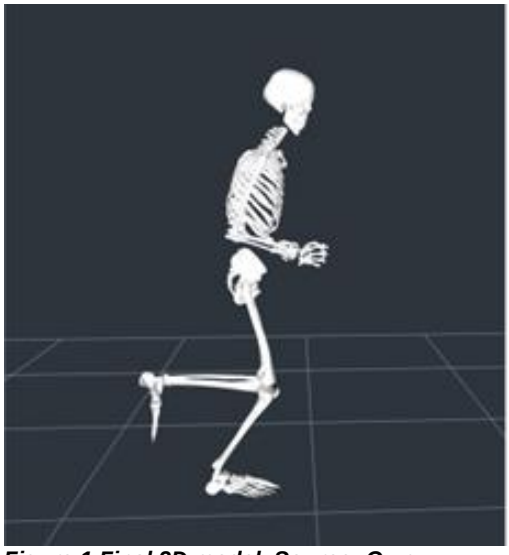


***Figure 1 Final 3D model. Source: Own***

The evaluation consists of three steps:

1. Pelvic and trunk movement abilities
   a. stability - frontal plane
   b. inclination - sagittal plane
   c. rotation - transverse plane
2. Motor skills
   a. lower limbs
   b. upper limbs

3. Evaluation of running parameters.

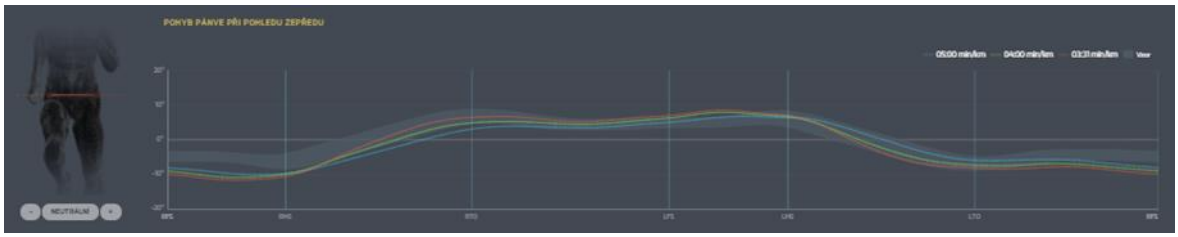



***Figure 2 Evaluation of results. Source: Own***

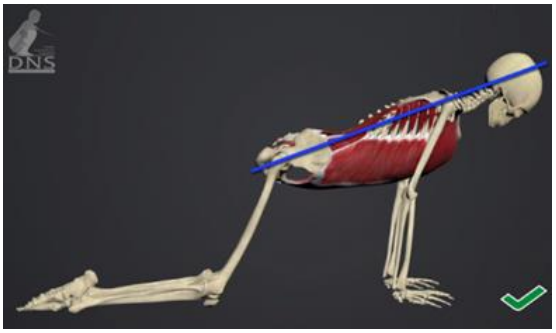
The Figure 2 shows a preview of pelvic movement when viewed from the front, with four curves showing ideal movement (grey curve), movement at 60-65% of maximum (blue curve), movement at 70-80% of maximum (green curve) and movement at 90-100% of maximum (red curve).

Next, the graph shows at what point the motion differs from the ideal, these differences are visible in six parts:

- RFS – Right Foot Strike
- RMS – Right Midstance
- RTO – Right Take-Off
- LFS – Left Foot Strike
- LMS – Left Midstance
- LTO – Left Take-Off

Specifically, the following can be diagnosed from the individual graphs:

- pronation and supination of the leg;
- up and down movement of the pelvis;
- movement of the pelvis when viewed from the front - side-to-side movement;
- angle of the torso when viewed from the front;
- angle of the pelvis in lateral view;
- angle of torso in lateral view;
- pelvic rotation;
- trunk rotation;
- angle of the foot touchdown;
- foot angle;
- foot movement in frontal view;
- foot movement when viewed from the side;
- elbow movement as viewed from the side;
- wrist movement when viewed from the side;
- elbow movement in frontal view;
- wrist movement in frontal view;




*Fifure 3 Correct tilt on all fours*
*Source: Kolář, Kobesová, 2017*

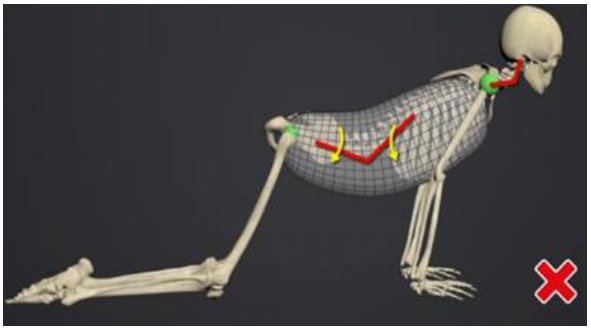


*Figure 4 Incorrect tilt on all fours*
*Source: Kolář, Kobesová, 2017*

DNS tests
For diagnostics using DNS tests are performed:

- diaphragmatic test and its respiratory and postural functions;
- examination of intra-abdominal pressure;
- head and trunk extension test;
- tilt on all fours;
- upper limb elevation;
- squat;

To give you an idea, let's describe how the tilt test on all fours went. The subject rests on all four limbs, with the upper limbs on the palms of the hands and the lower limbs on the knees, which are approximately the width of the pelvis. The thighs and arms are perpendicular to the ground. The therapist notes the position of the segments as he or she is taking up the position, and then the subject slowly transfers the weight of the body back and forth. When viewed from the side, it is visible that the curve of the spine does not change during the movement and the movement is mainly in the hip and shoulder joints. When viewed from above, the shoulder blades are in a neutral position and pressed against the chest, the head is in an extension of the spine, the pelvis is in a neutral position, the spine is tensed and the muscular activity on the trunk is balanced. The upper limbs are loaded evenly and supported by the palm of the hand, the fingers are fanned open.

Errors in execution

- Failure to maintain a neutral, upright spinal posture.
- Increased lordosis in the lumbar spine associated with pelvic anteversion.
- Increased lordosis in the cervical spine associated with reclination of the head.
- Kyphosis of the thoracic spine with associated flexion of the head.
- Kyphotization of the whole spine during backward movement.
- Failure to keep the shoulder blades in a neutral position.
- Decentration of the shoulder joint, elbow joint in hyperextension, palmar support more on the lateral side.
- Pelvic anteversion associated with hip decentration and loading on the outer side of the knees with greater adduction.
- Increased tension in the hamstring area trying to keep the pelvis in a neutral position.
- In pelvic anteversion, lifting the shins above the mat.
- Hyperactivity of the paravertebral muscles, upper trapezius and upper fibres of the pectoralis major.
- Hypoactivity in the area of the trigonum lumbale and above the groin (Kolář, Kobesová, 2017).

**Observations**
The method took the form of video recording of the running technique in the form of SlowMotion. The outdoor terrain was flat and smooth. During the run,

probands wore sport testers of different brands (Garmin, Polar, STRYD) to obtain data that was needed for statistical evaluation.

### 3.4 Statistical method

Changes in the variables studied were calculated from the values before and after the 6-month DNS method exercising. Statistical significance was calculated using a two-sample paired t-test for the mean. The method is used between two samples with paired values. With the sample size given, the paired t-test can only be used when the underlying population is normally distributed. The normality of the distribution was verified using a test based on the studentized range (Hebák, 2013). It is used when comparing the results before and after the experiment. Data from nine probands were compared, specifically pace, cadence, vertical oscillation, stride length, ground contact time.

## 4 RESULTS

Laboratory and field results are compared. When running on a treadmill, the rebound phase of the run disappears, just "lifting the legs" is enough here, but in the field, a rebound is necessary in order to execute the forward movement. The 3D model obtained by diagnostics with Salming RunLab is very detailed - unlike the observation method, where some errors in technique that were detected in the lab are not visible in the field.

When comparing the results of proband 1, there were significant changes, the tilt to the right disappeared, there is no visible protraction of the shoulders, which may be due to clothing. There is no visible unstable pelvis or weakened abdominal musculature.

Proband 2 had a refined running technique at the beginning of testing and the DNS test result was also very promising compared to the others. When comparing techniques, errors such as insufficient body lean, insufficient foot stumbling disappeared.

Proband 3 improved the movement of the arms, which were directed towards the middle of the body before the start of the exercise. The unstable pelvis and weakened abdominal musculature, as in proband 1, is not visible.

Proband 4 has made great progress in improving running technique, posture had improved, thoracic kyphosis had increased and pelvic anteversion is not as expressive as at the beginning of the exercise. Proband praised the better feeling with any movement in his daily routine and during sports.

Proband 5 improved the forward lean of the body during running, in addition to not leaning to one side.

Proband 6 running technique improved by the movement of the arms, which were pointing towards the middle of the body and rotating the trunk before the exercise; after the exercise, the arms performed the correct forward-backwards movement. There is more stumbling in the legs.

Proband 7 had a very specific running technique, his whole body was swaying side to side, he was not in control at all. After the workout, the body is firmed up and the only mistakes are in the arm work and toe-out when stepping.

There was an improvement in the running technique of proband 8 such as leaning the body forward, the correct posture of the arms at the elbow joint. The unstable pelvis and weakened abdominal musculature are not visible from the observation method, as in proband 9, moreover, there was an improvement in posture. The enlarged thoracic kyphosis is not visible in this case.

To more accurately determine whether the improvement in running technique was due to the DNS method practice or due to the inadequacy of the chosen methods, another comparative DNS testing would be helpful as was done at the beginning, where the postural stability and diaphragm use were determined.

## 5 DISCUSSION

Running is spoken of as a natural movement, but it is only in children who are going through or have gone through proper ontogeny. This is not the case in an adult who is sitting most of the time during the day, but the reason may not be just sedentary occupation, it may also be prolonged unilateral activity that sets the body in the wrong position and the correct posture disappears.

Diagnosis using the Salming RunLab revealed not only running technique errors but also postural errors, most of which are described by Tvrzník and Soumar (2012). These deviations are related to improper posture during the day and fixation of the wrong position of each segment. Subsequently, this poor basic position of each segment plays an important role in any movement, in the case of this thesis in running. DNS tests revealed errors in postural stabilization, diaphragm use and respiratory function. Postural stabilization and diaphragm function play an important role in correct posture at rest and in movement.

Similarly, Puleo and Milroy (2019) state that the diaphragm is the most important respiratory and stabilizing muscle. The authors emphasize chest and diaphragm training.

Assessing whether the DNS method has an effect on improving the running technique is not entirely clear-cut; the results are not clearly measurable.

Kolář and Kobesová (2017) report that the diaphragm and pelvic floor in their postural function help to stabilise the trunk, resulting in a more stable pelvis and strengthened abdominal muscles of probands 1, 3, 8 and 9, who improved their running technique as a result. If the diaphragm and pelvic floor were performing their postural function, the pelvis should be in a neutral position in proband 6.

When comparing the techniques of Probands 2 and 5, the errors, e.g. insufficient body leaning, insufficient leg stumbling, disappeared. These errors may be related to improved trunk stabilisation or the performance of the field test. During field running, rebound, forward body lean and leg stumbling are needed, but on the treadmill, these movements are not needed.

The statistical method using a two-sample paired t-test for the mean did not demonstrate the effectiveness of the DNS exercise on improving running technique, it only demonstrated an effect on the lengthening of the running stride, which is not significant for the result of this study. On the contrary, Tvrznik and Soumar (2012) reported that a long stride and a distinctive foot touchdown in front of the body's centre of gravity can cause injury. The values compared in this case may have been inconclusive due to differences in pre-exercise and post-exercise DNS methods. Moreover, the technique that measured each parameter was also different in both cases. In laboratory conditions, measurements were made using Salming RunLab mechanisms, in field conditions some probands used a Garmin chest strap and a Garmin sports tester, others used Polar, and proband 1 used a STRYD wattmeter.

In the case of this research, the reliability of the tests was not ensured, therefore the results are not provable. It is not demonstrable whether the results are better for men or women, but women were certainly more disciplined, resulting from the occasional survey of who was exercising. Men often mentioned various reasons why they could not exercise, women always found the time and enjoyed exercising. Based on interviews with probands, exercise had a positive impact on their feelings when performing daily activities, and they praised the feeling of a firmer and more functional body.

## 6 CONCLUSION

Thanks to the cooperation with Salming RunLab, it was possible to use a unique diagnostic method for the evaluation of running technique and to spread

awareness of this analysis and its use.

The tasks we set ourselves were accomplished. The hypothesized effect of the DNS method on the running technique is not provable because the results are not clearly measurable; the research compared laboratory results with field results. The results, however, also showed us that when working with the human body, one cannot rely on only one redeeming method or a certain trend of the time. The basic pillars of sports training must not be missing in any sport. That is the initial warm-up, in running consisting of training the running alphabet, which prepares the body for the load but also fixes the correct movement patterns for the running style. Then, of course, the main part, which deals with the main focus of the training, improving movement skills, and at the end of the training, stretching must not be missed.

The DNS method is a good complement to any sport, it teaches us to engage the right muscles and think more about our bodies. Proper engagement of the diaphragm and good trunk stabilization will make all movements more enjoyable, healthy and economical. Therefore, the exercises may not only be used to improve posture but can also be used to improve performance. Because of performing more economical movements or, on the contrary, eliminating unnecessary movements compensating for a non-functioning body segment, the movement will be faster and smoother.

All exercise methods and styles are subject to the trends of the time, but it depends on the grasp and promotion of the therapist. Prof. Kolář has been instrumental in bringing the method to the attention of doctors, physiotherapists, trainers and patients/clients. Exercise may not suit everyone, as in the case of this research, women had no problem with exercise, but it was not very attractive to men.

The statistical evaluation did not confirm the effect of DNS exercise on the runner's performance as the pace after the exercise was at the same level as when the research started. Only the hypothesis of stride lengthening after DNS method exercise is valid, after calculating paired t-test it can be stated that at the significance level of 5%. The other running parameters compared such as vertical oscillation, ground contact time and cadence were not affected by the DNS method exercise.

The DNS method has produced results not only in terms of sport but also in terms of improving the probands' feeling of well-being when performing everyday activities, leading to an improvement in their quality of life. Most important was the improvement in posture, which made them feel more comfortable during sedentary work. Running became even more enjoyable for most when probands were feeling more relaxed and lighter.

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*Anatomický atlas: (orgány, systémy, struktury)*. [Anatomical atlas: (organs, systems, structures)] Svojtka & Co.

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