SCIENTIFIC JOURNAL
VOLUME 12 | NUMBER 1 | 2024
ISSN 1805-8787

ACTA SALUS VITAE

THE COLLEGE OF PHYSICAL EDUCATION
AND SPORT PALESTRA, LTD.

PALESTRA

Scientific Journal
ISSN 1805-8787
VOLUME 12 | NUMBER 1 | 2024

ACTA SALUS VITAE

PALESTRA®
Vysoká škola tělesné výchovy a sportu

ACTA SALUS VITAE
Scientific Journal

ISSN 1805-8787

CONTENT

Acta Salus Vitae, Vol 12, No 1 (2024)
ISSN 1805-8787 actasalus@palestra.cz

SUPPORT OF THE FLORA OF THE SPA THERAPEUTIC LANDSCAPE

Miroslav MAREK

Abstract

The developed method of supporting the growth and vitality of cultivated forest trees, ornamental shrubs, grassy areas and flora in spa parks, forest parks and spa forest stands consists in the application of ectomycorrhizal, or endomycorrhizal fungi, which can utilize a much larger volume of soil with the help of extramatrical hyphae than the root hairs of non-mycorrhizal plants alone. Resistance to phytopathogenic fungi is significantly reduced by a lack of moisture (during summer droughts). Therefore, the addition of biochar, natural polysaccharides based on carrageenan, alginate or xanthan, humic substances, peat and crushed bork (preferably disintegrated using hydrodynamic cavitation) and a porous inorganic carrier significantly contributes to the protection of the flora. In ongoing symbiosis between plants and added mycorrhizal fungi, there is mutual influence of nutrient exchange between the mycorrhizal fungus and the host plant, and these physiological processes are mainly manifested in nutrient cycling in ecosystems. The increased vitality of plants contributes to the creation of a pleasant, healthy environment in spa forests, forest parks and gardens.

Keywords

Mycorrhizal fungi, biochar, hydrocolloids, vitality of plants, spa therapeutic landscape

1 INTRODUCTION

A complete spa treatment includes not only its own healing and regeneration procedures, its important part is also a stay in a certain natural environment, in which there is a synergy of hygienic, environmental and aesthetic prerequisites. When evaluating the therapeutic effect, it is not possible to separate the positive effects of mineral water or other healing sources (gases or peloids) from the synergistic effects of the natural environment of the spa place as a whole, therefore the term spa therapeutic landscape is mainly associated with parks and forests falling within the heritage-protected area of the spa place. Healthy flora, together with a suitable urban planning solution, helps the healing process during a therapeutic stay in the spa environment not only by its effect on the creation of a healthy atmosphere with the content of health-promoting substances, but also by a positive effect on the psyche and aesthetic perceptions of patients and visitors to the spa premises.

The maintenance of healthy spa flora has recently become increasingly difficult for many reasons, but mainly due to the lack of moisture and the increased occurrence of phytopathogenic fungi. Due to the influence of snowdrifts, especially in the summer season, not only the spa forests, especially the Norway spruce, are damaged, but also the grassy areas with the corresponding growth of ornamental trees and shrubs in the spa parks, the irrigation of which must be paid increasing attention.

2 MYCORRHIZAL SYMBIOSES

Mycorrhizal symbiosis is defined as a mutualistic relationship between the roots of higher plants and soil fungi. Mycorrhizal fungi can use extramatrical hyphae to utilize a much larger volume of soil than the root hairs of transplanted plants alone,

resulting in significantly higher uptake of water and mineral nutrients by mycorrhizal than non-mycorrhizal roots (Real, 1991). Mycorrhizal fungi mainly obtain carbon from plants in the form of sugars, which serve as a source of energy. During mycorrhizae, plants are willing to provide up to 20 percent of all the carbon produced by photosynthesis. Their reward is nutrients and water, which the fungi obtain from places inaccessible to the roots of the plants themselves.

The whole range of extant mycorrhizal fungi is divided into many categories not only according to the way in which they associate with the host plant, but also according to the types of plants with which they form mycorrhizal symbioses.

The main types of mycorrhizal symbioses are

1. Ectomycorrhiza
2. Endomycorrhiza
   a) arbuscular mycorrhiza
   b) ericoid mycorrhiza
   c) orchidoid mycorrhiza

2.1 Ectomycorrhiza

Ectomycorrhizal fungi create a so-called hyphal sheath around the root, the fibers also enter between the cells of the primary cortex, but not inside the cells. The morphology of the roots changes – short roots are formed. The network of mycelia increases the volume of the substrate many times over. Most ectomycorrhizal fungi develop above-ground reproductive fruiting bodies (fungi) at the base of mycorrhizal trees. Ectomycorrhiza occurs in all coniferous trees, from deciduous trees to oak, beech, linden, hornbeam, birch, willow, etc.

2.2 Endomycorrhiza

Endomycorrhizae are formed by different groups of fungi depending on whether they are orchid, ericoid or vesiculo-arbuscular (according to the new terminology, only arbuscular) type of mycorrhizae. The subfungi of endomycorrhizal fungi are located inside the cells of the root, grow into the surrounding soil and do not form a fungal mantle around the root, nor do they change the shape of the root and its morphology. Microscopic spores with a diameter of about 0.2 mm mediate the reproduction of fungi in the soil. Endomycorrhizal fungi do not form above-ground fruiting bodies, so their presence in the soil can only be detected with the help of a microscope.

2.2.a Arbuscular mycorrhiza

Arbuscular mycorrhiza (Ferrol & Lanfranco, 2020) is the most widespread type of mycorrhiza in nature, which occurs in 80 to 95% of plant species important from the point of view of agriculture, forestry and horticulture (Buil et al., 2022). This type of mycorrhiza is characterized by the growth of hyphae in inter- and intracellular spaces and the formation of rich extramatrical mycelium. Within the cells, peculiar bush-like formations called arbuscules and vesicle-like formations called vesicles are formed. Arbuscules are usually formed in intracellular spaces, while vesicles are formed in both intra- and intercellular spaces. Short-lived arbuscules are the site of intense nutrient exchange between the host plant and the endomycorrhizal fungus. Vesicles perform a storage function. The fungi form an extensive network of mycelium that extends beyond the rhizosphere of the roots, allowing the host plant to obtain nutrients from a significantly larger volume of soil (Abdalla et al.,2023).

2.2.b Ericoid mycorrhiza

Ericoid mycorrhiza is formed in plants with fine roots without root hairs, found in bogs, bogs and moors, i.e. in places with a low content of mineral nutrients. Ericoid fungi can be beneficial for making mineral nutrients available, they can persist in a certain location for a very long time, 10 to 20 years, without their plant hosts. This fact is apparently the reason for the rapid

uptake of ericoid plants when they are introduced to the given location.

2.2.c Orchidoid mycorrhiza

Orchidoid mycorrhiza is found in members of the Orchidaceae family, where the root system of orchids is made up of strong, sparsely branched or completely unbranched roots. The orchidoid symbiosis is of fundamental importance for the life cycle of the plant, where the extra-root mycelium of the fungi receives nutrients from the soil solution and passes them on to the host plant.

3 PRACTICAL USE OF PLANT MYCORRHIZATION

The specificity of mycorrhizal symbionts is very important for practical application. Mycorrhiza is specific for some plants, non-specific for others. Non-specific mycorrhiza is more widespread, for example some trees, such as poplars, alders, willows or yews, use both ecto- and endomycorrhiza for their growth, while the fact that endomycorrhizal fungi form a symbiosis with the roots of 80 to 95% of plant species is important for practical use including grasses, flowers, ornamental shrubs, agricultural crops, fruit trees, etc., while ectomycorrhiza is specific for conifers and certain types of deciduous trees such as oak, beech, poplar, alder, linden, hornbeam, birch, willow, etc.

Based on the above findings, it can be concluded that arbuscular endomycorrhiza is the most suitable for practice. However, for its practical use, the fact that cultivation of these fungi in artificial media has not yet been successful is a certain problem. For this reason, the appropriate mycelium of endomycorrhizal fungi, e.g. the genus *Glomus* (more recently *Funneliformis*), *Gigaspora, Acaulospora, Claroideoglomus, Rhizophagus, Sclerocystis* and *Diversisporales*, is grown on a host plant, e.g. maize or clover, cultivated hydroponically in a mixture of perlite and sand after the addition of spores or inocula of cultivated endomycorrhizal fungi. The formed mycelium in the form of a substrate with fragments of the roots of the host plant with hyphae and spores of endomycorrhizal fungi is used as an addition to the planting material. The germinating spore grows into one or more germination sacs and forms a mycelium that is able to penetrate the host plant's root cells.

Despite its narrow specificity, the application of ectomycorrhiza is very important especially when planting conifers. Unlike endomycorrhizal fungi, ectomycorrhizal fungi can be cultivated in artificial soils in culture flasks or in fermenters. Biomass of these mushrooms (e.g. *Boletus, Paxillus, Suillus, Laccaria, Russula, Cortinarius, Lactarius, Entoloma, Hebeloma, Lepista, Gymnopilus, Crucibulum, Agaricus, Hypholoma, Macrolepiota, Morchella, Pisolithus, Rhizopogon, Scleroderma* and *Sparassis*) is prepared by cultivation under aerobic conditions in wort liquid medium or in potato-soy broth at 15 to 25 ^{0}C for 14 days in the dark. Cultivated biomass is used directly in the form of cultivation medium with grown biomass, or it is previously converted into a dry form in a spray dryer or by lyophilization. In Fig. 1 is a culture of ectomycorrhizal fungi grown in an Erlenmeyer flask.

Figure 1. Cultivation of an ectomycorrhizal fungus in an Erlenmayer flask

During the actual planting of trees intended for cultivation on a given location, these plants are inoculated with ecto- or endomycorrhizal fungi either already in the forest nursery, or during the actual planting of the given trees.

4 THE PREPARATION TO SUPPORT THE FLORA OF THE SPA LANDSCAPE

At the workplace of the Institute of Spa and Balneology, public research institution, was in cooperation with Tesoro Spin off, Ltd. (spin off company at the University of Chemistry and Technology Prague) developed a preparation to support the flora of the spa therapeutic landscape, registered at the Industrial Property Office as Utility Model No. 37120 (2023) (Marek et al., 2023). Using this product, mycorrhizal fungi are more effectively fixed near the roots of cultivated plants under the influence of the addition of hydrocolloids in the form of a fixing gel and also biochar, humic substances, perlite or other porous material, peat and crushed bork, preferably disintegrated using hydrodynamic cavitation (Krchov et al., 2018).

Using the product according to the technical solution, containing hydrogel with biochar and other components, is very simple. Before planting, a bundle of planting material or individual trees or shrubs is immersed in a preparation that very easily adheres to the roots of these trees intended for planting (Fig. 2). Wrapping the roots with a fixing gel prevents the plants from drying out, which helps maintain high-quality planting material after extraction in nurseries and during transport, or even storage before actual planting.

Figure 2. Inoculation of planting material by soaking in the preparation

Mycorrhization of planting material together with the addition of biochar after application of the product in question increases the vitality and resistance of planted and cultivated plants to negative environmental influences, especially to the very current attack by phytopathogenic fungi (Gianinazz-Pearson & Gianinazzi, 1988). Given that resistance to phyto-pathogenic fungi is significantly reduced in the case of a lack of moisture (during summer droughts), the application of biochar and hydrocolloids (based on alginate, carrageenan, xanthan or preferably pectates as waste secondary raw materials from pectin production) significantly contributes to protection before attacking them.

5 THE CULTIVATION OF GRASSY AREAS

The cultivation of grassy areas, flowers and ornamental shrubs in the respective spa parks is very important for the spa therapeutic landscape. To support this flora, it is advantageous to apply the preparation in question containing the mycelium of endomycorrhizal fungi in the form of a substrate with fragments of the roots of the host plant, preferably clover or maize, with hyphae and spores of cultivated endomycorrhizal fungi, with the addition of biochar, a porous inorganic material on which the endomycorrhizal fungi were grown, and the addition of peat and crushed bark, preferably disintegrated using hydrodynamic cavitation.

The added biochar, preferably obtained by charring waste wood in a retort or heat treatment of sludge from sewage treatment plants (when meeting the conditions set by the standard for the content of heavy metals and polycyclic aromatic hydro-carbons), has the ability to absorb and retain water in the soil and preserve it even during the dry season. It improves the ability to retain nutrients that are dissolved in water or trapped on the surface of biochar, binds mineral substances and,

in addition, with its "prophylactic" effect, it limits the occurrence of diseases and pests attacking the roots of these plants. It brings to the soil the ability to better pass and retain air, significantly better than sand, which lightens the soil, but its grains do not have an internal porous structure (Marek et al., 2015).

To assess the influence of the individual components of the mentioned mixture, grass growth was monitored:

1. On the standard substrate itself (see Fig. 3),
2. On the same substrate with the addition of biochar (see Fig. 4),
3. On the same substrate with the addition of endomycorrhizal fungi (see Fig. 5), and
4. On the same substrate with the addition of the preparation in question, i.e. both components - biochar and endomycorrhizal fungi (see Fig. 6).

The attached images show the positive effect of the addition of biochar (Fig. 4), endomycorrhizal fungi (Fig. 5), and especially the preparation in question containing both components at the same time (Fig. 6) compared to the growth of grasses on the standard substrate alone (Fig. 3) . This procedure is particularly advantageous in the formation of grass mats, where a mixture of substrate with added endomycorrhizal fungi with fragments of host plant roots, added biochar and seed is cultivated in a layer over sand and/or perlite for easy cutting of the established mat of grasses. This result is very encouraging for the realization of the production of lawn carpets.

Figure 3. Control growth of grass on a standard substrate without the addition of endomycorrhizal fungi and without biochar

Figure 4. Grass grown on the same substrate with added biochar.

Figure 5. Grass grown on the same substrate with added endomycorrhizal fungi.

Figure 6. Grass grown on the same substrate with added endomycorrhizal fungi and biochar.

6 CONCLUSIONS

The application of the preparation to support the flora of the spa therapeutic landscape according to the technical solution supports the uptake, growth and vitality of cultivated plants together with their protection against stress factors such as lack of moisture, especially in the form of summer droughts and invasions by phytopathogenic fungi and viruses with the risk of a subsequent attack by bark beetles, especially the spruce bark beetle. For this reason, the application of the preparation in question contributes to the creation of a pleasant, healthy environment in spa forests, forest parks, spa parks and gardens. A non-negligible advantage is the low economic complexity of the preparation and application of this product, regardless of the savings potential related to the achieved protection of treated trees.

7 REFERENCES

Abdalla, M., Bitterlich, M., Jansa, J., Püschel, D., Ahmed, M. A., (2023) The role of arbuscular mycorrhizal symbiosis in improving plant water status under drought. *Journal of Experimental Botany 74* 4808–4824.

Buil, P. A., Jansa, J., Blažková, A., Holubík, O., Duffková, R., Rozmoš, M., Püschel, D., Kotianová, M., Janoušková, M. (2022). Infectivity and symbiotic efficiency of native arbuscular mycorrhizal fungi from high-input arable soils. *Plant and Soil* 1-19.

Ferrol, N., Lanfranco, L. (2020). *Arbuscular Mycorrhizal Fungi,* Springer, Berlin.

Gianinazz-Pearson, V., Gianinazzi S. (1988). Mycorrhizae: a plant´s health insurance. Chimicaoggi, Ottobre, 56-58.

Krchov, R., Marek, M., Pudil, F., Kyselka,

J., Marek, A., Vrba, P. (2018). Method of extracting and purifying biologically valuable substances and preparing food and dietary supplements by hydrodynamic cavitation, CZ Pat. 307660.

Marek, M., Horsáková, I., Krchov, R., Pudil, F., Marek, A. (2015). A method of producing a biochar-based preparation for plant growth support, CZ Pat. 305666.

Marek, M., Rácová, Z., Vylita, T. (2023) A preparation to support the flora of a spa therapeutic landscape, Utility Model No. 37120.

Read, D.J. (1991) Mycorrhiza in ecosystems. Experientia *47,* 376-391.

CONTACTS

Assoc. Prof. Miroslav Marek

Institute of spa and balneology, public research institution
Nábř. Jana Palacha 20
Karlovy Vary 360 01

E-mail: marek@i-lab.cz

INFLUENCE OF CARLSBAD THERMO-MINERAL WATER ON THE AUTONOMIC NERVOUS SYSTEM

Petr KOLISKO, Milada SÁROVÁ, Michele OLIVIANO, Jakub KREJČÍ, Petr UHLÍŘ

Abstract

The drinking cure is an essential part of Karlovy Vary spa treatment. The effect of Karlovy Vary mineral water on the autonomic nervous system has not yet been investigated. Based on case analyses, we hypothesized that the effects of the drinking cure have an effect on the functional activity of the autonomic nervous system. The prospective research study had the character of an experiment in clinical conditions.

Research file: Health women n = 15, age 40-50 years.

Methodology: Before and 30 min after the experimental sequence, the functional state of the autonomic nervous system was examined by the method of spectral analysis of heart rate variability in the ortho-clino-orthostatic position.

The experimental sequence:
- *rest sitting position (pre)*
- *drinking cure in a sitting position (application of 350 ml thermo-mineral water 50 °C)*
- *rest sitting position (post).*

The length of all monitored intervals was 300 heartbeats.

Results:
Pre-post status (30–50 minutes after the application of the drinking cure):
- *an increase in the overall activity of the autonomic nervous system*
- *an increase in activity in the sympathetic and parasympathetic frequency bands*
- *reducing the heart rate*
- *blood pressure values did not change.*

Effects during the application of the drinking cure (comparison with a rest sitting position):
- *a decrease in the overall activity of the autonomic nervous system*
- *an increase in sympathetic activity and decrease in parasympathetic activity*
- *an increase in heart rate*
- *an increase in systolic and diastolic blood pressure.*

Conclusions:
- *A prospective research study highlighted the reflexive relationships between the digestive system and the cardiovascular system. These relationships are modulated by the autonomic nervous system.*
- *Factors that influence the effect of the drinking cure in the area of the upper part of the digestive system are: the rhythm of swallowing and the temperature of the water.*
- *Factors that influence the post-effect of the drinking cure in the area of the duodenum and jejunum they probably are: high content of free carbon dioxide and bicarbonate ions in the Carls Bad thermomineral water. These factors apparently activate the motility of the intestinal tract and have an effect on systemic changes of the functional status of the autonomic nervous system.*

Keywords

Thermomineral Carls Bad water, drinking cure, spectral analyzes of heart rate variability, autonomic nervous system, gastrointestinal system.

1. INTRODUCTION

The drinking cure is an essential part of Karlovy Vary spa treatment. The effects of the Karlovy Vary thermo-mineral water are described by a number of authors (Benda, 1997; Třískala et Jandová 2019; etc.).

The effect of Karlovy Vary mineral water on the autonomic nervous system has not yet been investigated. Based on case analyses, we hypothesized that the effects of the drinking cure have an effect on the functional activity of the autonomic nervous system.

2. RESEARCH QUESTIONS

- Will there be a significant increase in the total functional activity of the autonomic nervous system (Total Power) in the interval of 30-50 minutes after the application of the drinking cure with Karlovy Vary thermo-mineral water?
- How will these changes affect the sympathetic (Spectral Power LF) and parasympathetic (Spectral Power HF) activity?
- Will there be changes in systolic and diastolic blood pressure and heart rate in the interval of 30-50 minutes after the application of drinking cure?
- Will there be changes in the total spectral power (Total Power), during the application of the drinking cure in M2T2 interval?
- Will there be changes in sympathetic (Power LF) and parasympathetic activity (Power HF) and changes in the sympathetic-vagal balance (Ratio LF/HF), during the application of the drinking treatment in M2T2 interval?
- Will there be changes in systolic and diastolic blood pressure and heart rate during the drinking course in the M2T2 interval?

3. METHODOLOGY

The prospective research study had the character of an experiment in clinical conditions.

Research file:
Healthly women , age 40-50 years, n = 15. The test subjects met the pre-determined criteria for the examination (good health, no medication or nutritional supplements, non-smokers, examination in the morning on an empty stomach, 24 hours before examination only light physical load only, etc.).

The length of individual T intervals in individual measurements M1, M2, M3 was 300 heartbeats
During the measurement, the following physiological parameters were monitored:

- the functional status of autonomic regulation of heart activity by the method of spectral analysis of heart rate variability
- blood pressure values (were monitored repeatedly 4x during each interval)
- respiratory frequency values (frequency/min.) were monitored during the entire experiment
- peripheral oxygen saturation was measured with a digital oximeter on the 2nd finger of the hand

3.1. Examination methodology

- Measurement M1- status pre. Intervals: (T1 clinostasis – T2 orthostasis – T3 2.nd clinostasis).
- Measurement M2 - status during the drinking cure. Intervals: (T1 the sitting position pre – T2 drinking cure – T3 the sitting position after. During the drinking cure (interval T2) 350 ml of termomineral water was applied, temperature 50° C).
- Measurement M3 - status after (M3 was started 30 min after the end of M2).

M3 measurement. was identical to the M1 measurement.

3.2. Instrumentation: diagnostic system Sima Media TF7; digital, calibrated Omron tonometer.

The Sima media TF7 diagnostic system enables the recording of R-R intervals and ECG in lead V5 during the measurement. Length of each measured interval (T) = 300 beats. The software of the system enables the conversion of data into numerical form in the frequency range of 0.02 – 0.5 Hz using a fast Fourier transformation and analyzes the activity of frequency bands of Very Low Frequency - VLF (0.02 – 0.05 Hz), Low frequency - LF (0.051 Hz – 0.15 Hz) and High Frequency - HF (0.151 – 0.5 Hz), which provide information on sympathetic activity (LF frequency band) and parasympathetic activity (HF frequency band). A prerequisite for the correct interpretation of results the SAHRV parameters in the LF and HF frequency bands is a spontaneous respiratory frequency > 9 respiratory cycles/min. (Kolisko, Jandová, Salinger et al, 2004; Salinger, Štěpaník, Kolisko et al, 2005).

The result of the spectral analysis of heart rate variability is a graphic and numerical log.

3.3. Variables

Manipulated independent variables throughout the experiment

- Body positions (clinostasis, ortostasis, sitting position)
- Drinking cure, interval M2T2: (350 ml. of thermo mineral water, temperature 50°C)

Observed dependent variables during the experiment (parameters of SAHRV, heart rate, blood pressure).

- Total spectral power/ms^2 (Total Power) in the frequency band 0.02 – 0.5 Hz.
- Spectral power of the low frequency (Power LF/ms^2) in the frequency band 0.051 – 0.15 Hz. (Sympathetic activity)
- Spectral power of the High frequency (Power HF/ms^2) the frequency band 0.151 – 0.5 Hz. (Parasympathetic activity).
- Ratio LF/HF (Ratio LF/HF) – indicator of sympathovagal balance (SV Balance)
- Relative values of LF and HF. Spectral power in %, from Total Power, which express functional changes of sympathetic and vagal activity.
- Average values of the heart rate (SF/min.) in each of the measured intervals (T).
- Average values of systolic and diastolic blood pressure from 4x repeated measurements in each measured intervals(T) of the measurement M1, M2, M3.

3.4. Statistical methods used

- Fast Fourier transformation of SAHRV data into numerical form and transfer of results to Excel for statistical processing.
- The absolute values of the spectral powers (Total spectral power, spectral power VLF, LF, HF) were logarithmized.
- After analyzing the normality of data distribution, the following statistical methods were used: ANOVA, Fischer's LSD test, Kolmogor-Smirnov test, Cohen's d, to estimation of the statistical significancy. .
- As statistically significant changes, we considered changes at the statistical signifikance level $p < 0.050$ with the current size Cohen's $d \geq 0.50$. The measurement results were processed in the form of graphs and tables.

For the interpretation of the data – status pre (M1 measurement) and after (M3

measurement) we present in this article only the changes of monitored variables during the 2nd clinostasis (T3 interval) after orthostasis (T2 interval) during the spontaneous breathing.

Note: interval T3 (2nd clinostatic position after orthostasis) has a higher validity than interval T1 (1st clinostatic position before orthostasis).

During the drinking cure (M2 measurement): intervals M2 T1 (sitting position before); M2T2 (application of mineral water); M2T3 (sitting position post), we describe the changes of variables in all intervals.

4. RESULTS AND DISCUSION

To simplify data interpretation, we present in tables the results with statistically significant changes * ($p < 0.050$, Cohen's $d \geq 0.50$ *) and trends (+) in selected intervals (T) in individual measurements during the experiment.

1. Comparation status before: (M1 measurement) and status after: (M3 measurement).
2. The results during the drinking cure (M2 measurement).

The monitored parameters during the measurements:

- Power LF ms^2; Relative Power LF % (sympathetic activity).
- Power HF ms^2, Relative Power HF % (parasympathetic - vagus activity).
- Ratio LF/HF (sympathetic-vagal balance);
- Total Power ms^2 (total activity of the autonomic nervous system).
- Heart rate/min. (HR/min).
- Systolic, Diastolic blood pressure (BP/mm Hg).
- Frequency of the respiration (Breath/min.)

4.1. Status pre – status after (measurement M1 : M3)

Table 1: Changes of monitored SAHRV parameters characterizing functional changes of the autonomic nervous system. Supine position: status pre (M1T3 interval), status after (M3T3 interval).

Interval M1T3 pre : M3T3 after Women, age 40 - 50		
Parameter	**Stat. sign.**	**Trend**
Total Spect. Power (ms^2)	*	↑
Spect. Power VLF (ms^2)	*	↑
Spect. Power LF (ms^2)	*	↑
Spect. Power HF (ms^2)	+	↗
Ratio LF/HF (SV balance)	-	-
Relative Power VLF %	-	-
Relative Power LF %	-	-
Relative Power HF %	+	↗
HR/min	*	↓
TK Systol. (mm Hg)	-	-
TK Diastol. (mm Hg)	-	-
Breath/min	*	↓

Note: status pre – after drinking cure: M1 : M3 measurement. Beginning of the M3 measurement 30 min. after application of the drinking cure.

Comment on the results (table 1)

Comparison of M1T3 : M3T3 (Interval T3 – supine position).
In the M3T3 interval we found the following functional changes of autonomic regulation cardiac activity:

- A significant increase the total spectral power (Total Power/ ms^2). (Table 1) – See research question 2.1
- A significant increase of the spectral power (ms^2) in the VLF, LF frequency bands and a significant trend of Power HF (ms^2) increase. (Table 1). – Research question 2.2

These functional changes are related to an increase in overall ANS activity (sympathetic and parasympathetic activity). Terminal receptors of the right vagosympathetic in the area of the sinoatrial node and the right atrium have a influence to the conduction system of the heart and thus affect changes in heart rate variability. (Ganong, 1997; Silbernagel, Lang 2012, Šlejfa et al, 2007; Vojáček, Kettner 2017)

- The sympathovagal balance (Ratio LF/HF) does not change significantly.
- The ratio of relative spectral powers (Relative spectral power VLF, LF, HF in %) do not change (Table 1). See research question 2.2

This result is related to a proportional increase in the overall tone of the neurovegetative system and a reflexive relationship of reactivity between sympathetic and vagal activity. (Increasing parasympathetic activity slightly increases sympathetic activity and vice versa). (Ganong, 1997; Silbernagel and Despopoulos, 1993)

- Heart rate is significantly reduced (Table 1). – See research question 2.3.

The decrease in heart rate is apparently not directly related only to higher activity of the right vagus. (Relative Power HF and Ratio LF/HF - symphato/vagal balance do not change). The slowing of conduction through the conduction system of the heart is apparently modulated by other regulatory mechanisms as well. (Modulation of the atrioventricular node by the vagus, periodic changes in cardiac blood volume modulated by breathing, other intracardiac regulatory mechanisms (Ganong, 1997, Šlejfa et al, 2007; Vojáček, Kettner 2017). *It is very likely that the sympatho-medullary system is not activated after a drinking cure.*

- The values of systolic and diastolic blood pressure before - after do not change significantly. – See research question 2.3

Apparently, after the drinking cure, there is no higher activation of baroreflexes or activation of the renin-angiotensin system in the supine position.

The chemical composition of the thermal mineral water in Karlovy Vary significantly increases the motility of the intestinal tract in the area of the duodenum and jejunum. In addition to the intestinal nervous system, long autonomic reflex arcs are activated (viscerosensitive receptors of the jejunum - CNS - visceromotor pathways of sympathetic and parasympathetic nerves). (Sleisenger & Foldtrans Eds., 2006; Trojan 2003). *The result is an increase in the activity of the autonomic nervous system.*

A reflex increase in the activity of the autonomic nervous system after a drinking cure has a systemic character. These functional changes of the autonomic nervous system are very likely to affect other internal organs and glands innervated by the sympathetic and parasympathetic nervous system.

High content of free carbon dioxide and bicarbonate ions in the thermo-mineral Karlovy Vary water is likely to be the triggering factor for the increased motility of the duodenum and jejunum.

4.2. Status during the drinking cure (measurement M2)

Table 2 Changes of monitored parameters during the drinking cure M2 measurement (in a seated position). T1 interval- status pre, T2 interval - drinking cure.

M2T1 pre : M2T2 drinking cure		
Parameter	**Stat.sign.**	**Trend**
Total Spect. Power	*	↓
Spect. Power VLF	*	↓
Spect. Power LF	*	↑
Spect. Power HF	+	↓
Ratio LF/HF	*	↑ LF
Relative Power VLF	-	↓
Relative Power LF	*	↑
Relative Power HF	-	↓
HR/min	*	↑
TK Systol.	*	↑
TK Diastol.	*	↑
Breath/min	*	↓

Table 3 Changes of monitored parameters during the drinking cure M2 measurement (in a seated position): T1 interval- status pre, T3 interval after drinking cure.

M2T1 pre : M2T3 after drinking cure		
Parametr	**Stat. sign.**	**Trend**
Total Spect. Power	*	↑
Spect. Power VLF	*	↑
Spect. Power LF	-	-
Spect. Power HF	-	-
Ratio LF/HF	-	-
Relative Power VLF	-	↑
Relative Power LF	-	-
Relative Power HF	-	-
HR/min	*	↓
TK Systol.	-	-
TK Diastol.	-	-
Breath/min	-	-

Comment on the results (table 2, 3). Effect of the drinking cure.

Comparison of changes in M2 measurement: M2T1 (seated position pre); M2T2 (drinking cure in a sitting position); M2T3 (sitting position after drinking cure).

- During the drinking cure (interval M2T2), there is a significant increase in the activity of the sympathoadrenal system. There is a increase of the Spectral Power LF (ms^2), Relative Spectral Power LF, Ratio LF/HF). (Table 2, 3). – Research question 2.5

- Increased activity of the sympatho-adrenal system is manifested in M2T2 interval by an increase in heart rate, systolic and diastolic blood pressure. (Table 2, 3) – Research question 2.6

The swallowing reflex and the temperature of the water apparently activate mechano- and thermoreceptors in the pharynx and upper part of the esophagus. This activates efferent sympathoadrenal activity.

The overall activity of the sympathetic nervous system during the drinking course prevails over the activity of the vagus, during the passage of mineral water through the cardia into the stomach. (Sleisenger &Foldtrans Eds., 2006).

- After the end of the drinking cure, the monitored parameters return to the initial level before the application of the drinking cure.

Rapid functional changes in the sympathovagal balance are apparently related to the overall sensitivity of the autonomic system of healthy persons. Changes in sympatheticvagal balance, heart rate and blood pressure during the M2 measurement confirm the existence of reflex relationships between the swallowing reflex,- the reactivity of the autonomic nervous system - and the regulation of the cardiovascular system. (Sleisenger & Foldtrans Eds., 2006).

The origin and relationship of increased activity in the VLF frequency band (0.02 - 0.05 Hz) to sympathetic activity during the measurement M2 (interval T1 before - T2 during and T3 after the drinking cure) is unclear. It can probably be a manifestation of increased thermoregulatory activity of blood vessels after drinking thermo-mineral water.

CONCLUSIONS

- A prospective research study drew attention to the existence of reflexive relationships between the digestive and cardiovascular systems. These relationships are modulated by reflex changes in sympathetic and parasympathetic activity.

- Factors influencing the effect of the drinking cure in the area of the upper part of the digestive system are: the rhythm of swallowing and the temperature of the water.

- Factors that influence the post-effect of the drinking cure in the area of the duodenum and jejunum they probably are: high content of free carbon dioxide and bicarbonate ions in the Karlovy Vary thermomineral water. These factors apparently activate the motility of the intestinal tract and have an effect on systemic changes of the functional status of the autonomic nervous system.

6. REFERENCES

Benda, J. (1997). *Karlovarský Mlýnský pramen, domácí pitná léčba*. Karlovy Vary: Karlovarské minerální vody, a. s.

Ganong, W. (1997). *Přehled lékařské fyziologie.* Jinočany: H&H.

Kolisko, P., Jandová, D., Salinger, J., Opavský, J., Ježek, M., & Slováček, K. (2004). Application of method of spectral analysis of heart rate variability during effects assesment of select breathing techniques on functional changes in autonomous nervous system. Acta Universitatis Palackianae Olomucensis. 34; (2); pp. 43-60.

Salinger, J., Štěpaník, P., Kolisko, P., Stejskal, P., Theuerová, Š., Elfmark, M., Gwozdziewicová, Š., Krejčí, J. (2005). The Design and the Verification of the Method for the Measmurent of Breathing Frequency with a focus on 43 the aspect of the Examination of Autonomic Nervous System Activity. Acta Universitatis Palackianae Olomucensis Gymnica. 35; (2)

Sleisenger & Foldtrans (EDS). (2006). *Gastrointestinal and liver disease – pathophysiology, diagnosis, management,* volume 1. 8th Ed. Sounders Elsevier.

Silbernagel, S., Despopoulos, A. (1993). *Atlas fyziologie člověka*. Praha: Grada.

Silbernagel, S., Lang, F. (2012). *Atlas patofyziologie*. Praha: Grada.

Šlejfa, M. a kol. 2007. *Kardiologie*. 3. přepracované a doplněné vydání. Grada publishing a.s.

Trojan, S. a kol. (2003). *Lékařská fyziologie.* Praha: Grada Publishing.

Třískala, Z., Jandová, D. (2019). Medicína přírodních léčivých zdrojů: minerální vody. 1. vyd. Praha: Grada.

Vojáček, J., Kettner J. (2017). *Klinická kardiologie.* Maxdorf Jessenius,

Attachment

Case analysis:
Healthy women 42 years.

Graphical protocols of Spectral Analysis of Heart Rate Variability (SAHRV). Measurement M1, M2, M3.

Figure 1 State before drinking cure: (measurement M1) T1 – clinostasis, T2 – ortostasis; T3 – 2.nd clinostasis; T4 – 3.th clinostasis (rhytmic breathing 12 cycles/min)

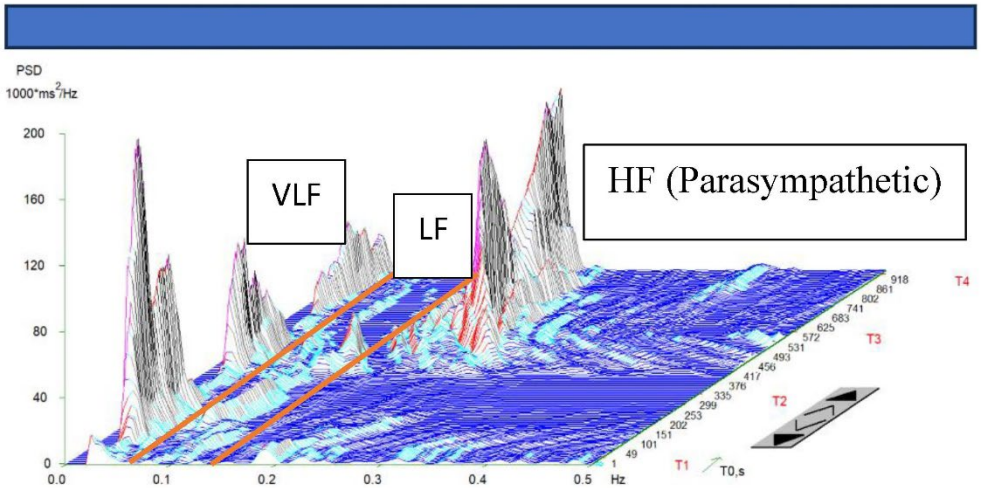


Figure 2 State during the drinking cure: measurement M2 (sitting position):
T1 – before drinking cure; T2 – drinking cure; T3 – after drinking cure

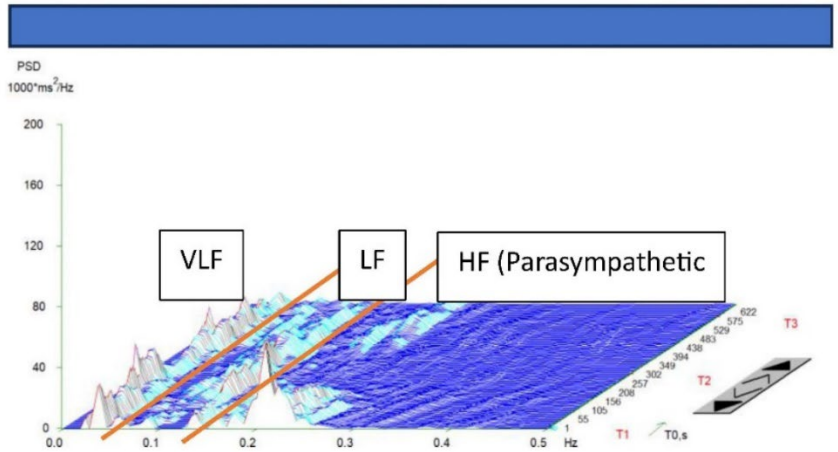
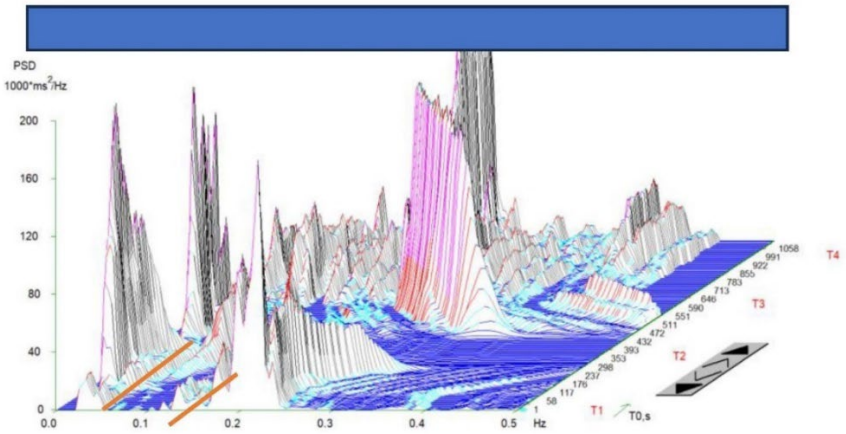


Figure 3 State 30 - 50 minutes after drinking cure (measurement M3):
T1 – clinostasis; T2 – ortostasis; T3 – 2.nd clinostasis; T4 3.th clinostasis (rhytmic breathing 12 cycles/min)



CONTACT

doc. PaedDr. Petr Kolisko, Ph.O

Palestra College of Physical Education and Sports, Prague;
Balneological clinic, Hotel Prezident, Karlovy Vary.
Karlovy Vary - Bohatice Sluneční 21

e-mail: petr.kolisko@seznam.cz

Milada Sárová
Balneology clinic, Hotel Prezident, Carls Bad

Michele Oliviano
Aquaenviro Brno

Jakub Krejčí
Faculty of Physical Culture, Palacky University Olomouc

INFLUENCING PSYCHOLOGICAL WELL-BEING THROUGH PILATES EXERCISES DURING THE COVID-19 PANDEMIC IN PEOPLE WITH MULTIPLE SCLEROSIS

Renata VETROVSKA, Radka PROCHAZKOVA R, Eva VOHANKOVA, Marek ONDRUCH, Klára NOVOTNA

Abstract

Background: The period of the Covid-19 pandemic was also very challenging for people with chronic neurological disease (multiple sclerosis) who already suffer from increased levels of depression and anxiety due to the nature of their illness. They may also have reduced levels of self-efficacy due to disability.

Objective: The aim of the pilot study was to test whether a telerehabilitation programme of Pilates exercises could improve psychological wellbeing in people with multiple sclerosis.

Methods:The online Pilates exercise programme was scheduled for 12 weeks (2 times a week for 45 minutes of Pilates exercise combined with 30 minutes of aerobic activity based on participants preferences).

The participants' psychological well-being were measured before and after exercise programe with the patient reported outcomes Hospital Anxiety and Depression Scale and General Self-efficacy Scale.

Results: There were no significant changes in the evaluated parameters after the three-month telerehabilitation program.

Conclusion: Therefore it is possible that a similar online exercise program could help maintain psychological wellbeing in people with a chronic neurological disease such as MS. However, this needs to be tested in a larger sample of individuals

***Keywords**:*

Pilates, Multiple Sclerosis, Telerehabilitation, Covid-19, Exercise

BACKGROUND

The COVID-19 disease pandemic presented an unprecedented increase in stress stimuli. The public health measures such as quarantine, lockdowns and further limitations, necessary to limit the spread of infectious diseases, caused a disruption in the usual lifestyle. Moreover, combined with an atmosphere of fear of contagion. As a result, increased levels of anxiety and depression were noted in general population (Salari et al. 2020). Some people also reacted on this stresfull situation with pathological eating habits or sleeping disorders (Martínez-de-Quel et al. 2021).

During the pandemic period, various government restrictions resulted in reduced opportunities for physical activities and exercise, and led to an increase in sedentary lifestyles (due to the closure of sports venues, restriction of social contacts and cancellation of all types of exercise classes) (Tarakci et al. 2021). These restrictions on the inability to engage in physical activity have also had a significant impact on people suffering from various chronic diseases, such as

musculoskeletal or neurological conditions. A review study from 2022 of more than 7,000 adult patients with a variety of neurological diagnoses described a reduction in physical activity during pandemic time that was associated with worsening symptoms, depression and reduced quality of life (Abasıyanık et al. 2022). For these people with chronic diseases is the regular physical activity very important to maintain good functional status and also for promoting mental wellbeing. One of these chronic neurological diseases for which physical activity is part of the complex treatment is multiple sclerosis.

Multiple sclerosis (MS) is a chronic neurodegenerative disease affecting young adults that can manifest with different neurological symptoms depending on the specific localization and severity of inflammatory damage to the central nervous system. The most common physical symptoms of the disease include reduced muscle strength, spasticity, balance difficulties, sensory impairment, fatigue, impaired sphincter function etc. (Dobson et al. 2019). The most common neuropsychiatric symptoms of MS include cognitive deficits (work memory, visuospastial memory) and mood disorders (increased level of depression and anxiety) (Chiaravalloti et al.2008). Depression in MS may be a subjective response to the onset of and development of the disease, a direct consequence of the disease process, a side effect of drug therapy, or an independent coexisting disease. The prevalence of depressive disorders is higher in MS patients than in the general population, even than patients with various chronic internal or other neurological disorders (Sadovnik et al.1996, Sullivan et al. 1995). The lifetime risk of depression in MS has been found to be 50,3 % and over 75 % of patients experience at least one depressive episode during the course of their illness (Sullivan et al. 1995). Aproximately 25 % of people with MS suffer from anxiety symptoms, and women are more likely to suffer from them. Anxiety is also a frequent comorbidity with depression, or anxiety disorders can occur independently (Feinstein et al. 1999)

Regular physical activity and exercise helps, not only positively affect many of the physical symptoms of MS (e.g. fatigue, muscle weakness, impaired mobility) (Motl et al.2017), but has also positive impact on depression (Ensari et al. 2014), anxiety (Fahy et al. 2022) and cognitive function (Sandroff et al. 2016). However, during pandemic period the opportunities to engage in physical activity and exercise were limited (Pedulla et al. 2022). It seems that practiced activity in the form of online distance can help to influence the physical condition of patients (Di Tella et al. 2019). However, the question remains whether exercise can also help to influence the psychological state of MS patients during difficult pandemic time.

OBJECTIVE

Therefore, the aim of our study was to evaluate whether regular physical activity, in the form of Pilates exercises practiced online, can help influence the psychological wellbeing of people with MS during a pandemic.

METHODS

Exercise programme

The exercise programme entitled “Pilates Medical Exercise for People with MS” was created simply so that it could be implemented without any special equipment. Participants could watch the exercise on their computer, tablet or smartphone. The programme took place in the form of online broadcasts (via the YouTube platform) once a week (each

lesson lasting 45 minutes) and was also available for later playback. Each week a new lesson was prepared by a physio-therapist with certified Pilates training education. In exercise lessons, exercises that considered the condition of participants as well as their comments from previous lessons (participants could communicate with the physiotherapist during the live broadcast or later in a Facebook chat room). The instruction for participants was to perform Pilates exercise twice a week according to the online lesson and combine it with some endurance activity for at least 30 minutes (based on personal preferences, they could choose from different types of aerobic activities such as walking, cycling, stationary bicycle etc.).

The programme was originally scheduled for 12 weeks, but was extended to 24 weeks, based on participants' increased interest (and due to persisting pandemic restrictions).

During the course of the study, participants (in addition to regular communication with the Pilates instructor) were contacted at least three times (by phone or email) by a study assistant who tried to motivate them to adhere to the exercise regimen. The assistant was available to them in case of any problems and to maximize adherence to the exercise programme.

All participants gave informed consent to participate in the study. The study was approved by the Ethical Committee of the College of Physical Education and Sport Palestra (VŠP/0383/2021).

Sample and settings

The exercise programme was offered to people with MS with the help of patient organization websites and their social networks. Participants were people with clinically stable MS (no relapse or medication change in the last 60 days) who were able to walk independently (without or with a walking aid). The primary goal of the study was to offer people with MS an online physical activity alternative to cancelled exercise lessons, so entry criteria for the programme were not further restricted. Only patients with some other acute or chronic disease that could interfere with physical activity were excluded.

At baseline and after completing the exercise programme participants were asked to complete the patient reported outcomes. Patient reported outcomes included the following questionnaires to monitor patients' psychological well-being and exercise effect: Hospital Anxiety and Depression Scale and General Self-efficacy Scale.

The Hospital Anxiety Depression Scale (HADS*)* is widely used to assess psychological distress in non-psychiatric patients. It consists of two subscales, measured via 14 items, seven items for the anxiety subscale (HADS-Anxiety) and seven for the Depression (HADS-Depression) subscale. Overall, it has demonstrated satisfactory psychometric properties in several different populations, including MS Bjelland et al. 2002, Honarmand et al. 2009). Each item is scored on a response scale with four alternatives ranging between 0 and 3 and a higher score indicates greater anxiety or depression. The HADS-depression cut-off for clinical depression was defined as scores ≥ 8.0.

The General Self-Efficacy Scale (GSES) is scale to measure optimistic self-beliefs regarding coping with variety of difficult demands in life. The scale consists of 10-items scored on 4-point scale, from 1 (not at all true) to 4 (exactly true). High consistency and reliability of scale was confirmed in many studies in patients with various condition (Schwarzer and Jerusalem 1995).

Statistical analyses

The program TIBCO Statistica was used for statistical analyses. In addition to descriptive statistics, selected methods of statistical induction were used for analysis of primary data. If the condition for the use of parametric tests were met, a paired t-test for dependent selection was used. Since the data did not meet the condition of normality of distribution in most cases with respect to the frequency of samples, the Wilcoxon paired test was used to test and generalize the significance of difference in the level of measured parameters. The threshold for significance was set at $p < 0.05$.

RESULTS

The total number of 22 women who completed all 12 weeks of online Pilates training were available for statistical analysis. Mean age of participants was 49.4 years and mean disease duration was 10.9 years. Most participants had relapse remitting MS (only 5 have secondary progressive MS and 2 primary progressive MS). From the total sample, 16 participants reported subjective perceived gait impairment and eight of them were using walking aid. Demographic characteristics are shown in Table 1. The results of the monitored parameters after 12 weeks of training are shown in Table 2. None of participant had a cut-off value for clinical depression at baseline (or at the end of the programe). None of the observed changes achieved a statistically significant improvement. However, a trend approaching statistical significance was observed for GSES (p=0.09).

Table 1 – Demographic characteristics

Parameter (n=22)	Mean (SD)	Median (min-max)
Age (years)	49,4 (12,19)	47 (28-70)
Disease duration (years)	10,9 (8,6)	8 (1,5-29)
Height (cm)	166 (6,9)	165 (156 -185)
Weight (kg)	69,7 (17,5)	65 (48-126)
EDSS	3,1 (1,6)	3 (1,5-6,5)

Table 2 – Changes in monitored parameters

Parameter (n=22)	**Baseline Mean (SD)**	**95 % Confidence Interval**	**After 12 weeks Mean (SD)**	**95 % Confidence Interval**	**p-value**
HADS (points)	12,90 (6,5)	10,01-15,8	12,77 (6,7)	9,8-15,74	0.86
GSES (points)	28,86 (5,7)	26,33-31,39	30,0 (5,85)	27,4-32,59	0.09
Parameter (n=9)	**Baseline Mean (SD)**	**95 % Confidence Interval**	**After 24 weeks Mean (SD)**	**95 % Confidence Interval**	**p-value**
HADS (points)	8,33 (5,65)	3,98-12,68	9,11 (7,02)	3,71-14,51	0.43
GSES (points)	29,11 (5,46)	24,91-33,31	28,88 (6,77)	23,68-34,09	0.89

HADS-Hospital Anxiety and Depression Scale, GSES-General Self-Efficacy Scale

DISCUSSION

The Pilates exercise was chosen for this exercise program due to documented positive effect on different symptoms in people with MS (Sanchez-Lastra et al. 2019) and due to our previous positive experience with this type of exercise from

our clinical practice. Previous study showed that the Pilates performing can improve mental health (Fleming and Herring 2018). We have also considered the fact that people with higher neurological deficits can perform this exercise easily with some modifications, too. This exercise activity does not need any special equipment and can be easily performed at home.

In our cohort, only a slight (not statistically significant) improvement in anxiotic-depressive symptoms (p=0.86) and general self-efficacy was observed (p=0.09) after 3 months of online Pilates. The self-efficacy level has shown to be important determinant of health status and disease management strategies (Wilski and Tasiemski 2016). So, we consider our result, a slight increase in self-efficacy and no increase in anxiety-depressive symptoms, to be a good outcome. Therefore it's possible that even a small increase in self-efficacy will help improve your overall psychological status. Some studies mention an increase in anxiety and depression in people with MS during the pandemic (Garjani et al.2022), but others do not confirm this (Sbragia at al. 2021). This may be influenced by persistently elevated levels of anxiety and depression from the outset (due to the disease), but also by the evolution of the pandemic. Patients' fears for their loved ones and sleep disruption due to pandemic stress have also been documented (Yeni et al. 2022). As a result of the pandemic, a significant percentage of people with MS (especially those with higher levels of neurological impairment) have had to limit or discontinue their regular exercise and physical activities (Pedulla et al. 2022). An international European study also shows that not a very large percentage of people with MS used online exercise options during the pandemic (Moumdjian et al. 2022). This may be due to a lack of awareness of these options or a lack of tailoring them to patients' needs. Therefore, we tried to offer our program to as many patients as possible in the rehabilitation database of the MS centre and also to modify the difficulty of the exercises during the exercise program according to the needs of the participants. We also found it very useful to contact participants during the program by phone or email to maintain their adherence and motivation.

The programme ran from January to March 2021 and was further extended to June 2021 based on participant interest. However, less than half of the participants completed the entire 6-month programme. This is not attributed to lack of interest, but to the fact that as temperatures rose, pandemic restrictions were cancelled, and sports venues were opened as well as outdoor physical activity opportunities were expanded.

Limitation of the study are obstacles connected to telerehabilitations. In the first place, the availability of communi-cation technologies and the ability to work with them, which can be particularly limited in patients with neurodegenerative disorders, should be mentioned. Another disadvantage of telerehabilitation exercises is the lack of manual correction during exercise and limited possibility to assess patient in detail.

CONCLUSION

During an online Pilates exercise programme organised during the Covid-19 pandemic, there was no worsening of anxiety and depression levels in people with MS. There was a small (statistically insignificant) increase in self-efficacy measures. It is therefore possible that a similar online exercise program could help maintain psychological wellbeing in people with a chronic neurological disease such as MS. However, this needs to be tested in a larger sample of individuals.

Conflict of interest statement: None declared.

REFERENCES

Abasıyanık, Z., Kurt, M., & Kahraman, T. (2022). COVID-19 and physical activity behaviour in people with neurological diseases: a systematic review. *Journal of Developmental and Physical Disabilities*, *34*(6), 987-1012. https://doi.org/10.1007/s10882-022-09836-x

Bjelland I, Dahl AA, Haug TT, Neckelmann D (2002) The validity of the Hospital Anxiety and Depression Scale: an updated literature review. J Psychosom Res. https://doi.org/10.1016/S0022-3999(01)00296-3

Di Tella, S., Pagliari, C., Blasi, V., Mendozzi, L., Rovaris, M., & Baglio, F. (2020). Integrated telerehabilitation approach in multiple sclerosis: a systematic review and meta-analysis. *Journal of telemedicine and telecare*, *26*(7-8), 385-399. https://doi.org/10.1177/1357633X19850381

Dobson, R., & Giovannoni, G. (2019). Multiple sclerosis–a review. *European journal of neurology*, *26*(1), 27-40. https://doi.org/10.1111/ene.13819

Ensari, I., Motl, R. W., & Pilutti, L. A. (2014). Exercise training improves depressive symptoms in people with multiple sclerosis: results of a meta-analysis. *Journal of psychosomatic research*, *76*(6), 465-471. https://doi.org/10.1016/j.jpsychores.2014.03.014 https://doi.org/10.1016/j.jpsychores.2014.03.014

Fahy, A., & Maguire, R. (2022). Potentially modifiable associates of anxiety in people with multiple sclerosis: a systematic review. *Disability and Rehabilitation*, 1-12. https://doi.org/10.1080/09638288.2021.2022776

Feinstein, A., O'connor, P., Gray, T., & Feinstein, K. (1999). The effects of anxiety on psychiatric morbidity in patients with multiple sclerosis. *Multiple Sclerosis Journal*, *5*(5), 323-326. https://doi.org/10.1177/135245859900500504

Fleming, K. M., & Herring, M. P. (2018). The effects of pilates on mental health outcomes: A meta-analysis of controlled trials. *Complementary therapies in medicine*, *37*, 80-95. https://doi.org/10.1016/j.ctim.2018.02.003

Garjani, A., Hunter, R., Law, G. R., Middleton, R. M., Tuite-Dalton, K. A., Dobson, R., ... & das Nair, R. (2022). Mental health of people with multiple sclerosis during the COVID-19 outbreak: A prospective cohort and cross-sectional case–control study of the UK MS Register. *Multiple Sclerosis Journal*, *28*(7), 1060-1071. https://doi.org/10.1177/13524585211020435

Honarmand K, Feinstein A (2009) Validation of the hospital anxiety and depression scale for use with multiple sclerosis patients. Mult Scler. https://doi.org/10.1177/1352458509347150

Chiaravalloti, N. D., & DeLuca, J. (2008). Cognitive impairment in multiple sclerosis. *The Lancet Neurology*, *7*(12), 1139-1151. https://doi.org/10.1016/S1474-4422(08)70259-X

Martínez-de-Quel, Ó., Suárez-Iglesias, D., López-Flores, M., & Pérez, C. A. (2021). Physical activity, dietary habits and sleep quality before and during COVID-19 lockdown: A longitudinal

study. *Appetite*, *158*, 105019. https://doi.org/10.1016/j.appet.2020.105019

Motl, R. W., Sandroff, B. M., Kwakkel, G., Dalgas, U., Feinstein, A., Heesen, C., ... & Thompson, A. J. (2017). Exercise in patients with multiple sclerosis. *The lancet neurology*, *16*(10), 848-856. https://doi.org/10.1016/S1474-4422(17)30281-8

Moumdjian, L., Smedal, T., Arntzen, E. C., van der Linden, M. L., Learmonth, Y., Pedullà, L., ... & Coote, S. (2022). Impact of the COVID-19 pandemic on physical activity and associated technology use in persons with multiple sclerosis: an international RIMS-SIG Mobility survey study. *Archives of Physical Medicine and Rehabilitation*, *103*(10), 2009-2015. https://doi.org/10.1016/j.apmr.2022.06.001

Pedullà, L., Santoyo-Medina, C., Novotna, K., Moumdjian, L., Smedal, T., Arntzen, E. C., ... & Tacchino, A. (2022). Physical activity in multiple sclerosis: meeting the guidelines at the time of COVID-19 pandemic. *Journal of Neurologic Physical Therapy*. https://doi.org/10.1097/NPT.0000000000000430.

Sadovnik, A. D., & Remick, R. A. (1996). Allen. J et al. *Depression and multiple sclerosis. Neurology*, *46*, 628-632.

Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., ... & Khaledi-Paveh, B. (2020). Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. *Globalization and health*, *16*(1), 1-11. https://doi.org/10.1186/s12992-020-00589-w

Sandroff, B. M., Motl, R. W., Scudder, M. R., & DeLuca, J. (2016). Systematic, evidence-based review of exercise, physical activity, and physical fitness effects on cognition in persons with multiple sclerosis. *Neuropsychology review*, *26*, 271-294. https://doi.org/10.1007/s11065-016-9324-2

Sánchez-Lastra, M. A., Martínez-Aldao, D., Molina, A. J., & Ayán, C. (2019). Pilates for people with multiple sclerosis: A systematic review and meta-analysis. *Multiple sclerosis and related disorders*, *28*, 199-212. https://doi.org/10.1016/j.msard.2019.01.006

Sbragia, E., Colombo, E., Pollio, C., Cellerino, M., Lapucci, C., Inglese, M., ... & Boffa, G. (2022). Embracing resilience in multiple sclerosis: a new perspective from COVID-19 pandemic. *Psychology, Health & Medicine*, *27*(2), 352-360. https://doi.org/10.1080/13548506.2021.1916964

Schwarzer, R., & Jerusalem, M. (1995). Generalized self-efficacy scale. *J. Weinman, S. Wright, & M. Johnston, Measures in health psychology: A user's portfolio. Causal and control beliefs*, *35*, 37.

Sullivan, M. J., Weinshenker, B., Mikail, S., & Edgley, K. (1995). Depression before and after diagnosis of multiple sclerosis. *Multiple Sclerosis Journal*, *1*(2), 104-108.

Tarakci, E., Tarakci, D., Hajebrahimi, F., & Budak, M. (2021). Supervised exercises versus telerehabilitation. Benefits for persons with multiple sclerosis. *Acta Neurologica Scandinavica*, *144*(3), 303-311. https://doi.org/10.1111/ane.13448

Yeni, K., Tulek, Z., & Terzi, M. (2022). A year with the fear of COVID-19 in multiple sclerosis patients: examination of depression, sleep quality and quality of life before and after the

pandemic. *Multiple Sclerosis and Related Disorders*, *57*, 103370. https://doi.org/10.1016/j.msard.2021.103370

Wilski, M., & Tasiemski, T. (2016). Illness perception, treatment beliefs, self-esteem, and self-efficacy as correlates of self-management in multiple sclerosis. *Acta Neurologica Scandinavica*, *133*(5), 338-345. https://doi.org/10.1111/ane.12465

CONTACTS

Renata Větrovská, PhDr., PhD.
VŠTVS Palestra,
Slovačíkova 400/1, Prague 19,197 00

E-mail: vetrovska@palestra.cz

Acta Salus Vitae, Vol 12, No 1 (2024)
ISSN 1805-8787 actasalus@palestra.cz

THE IMPORTANCE OF INITIAL DIAGNOSIS AND INTERVENTIONAL EXCERCISES ON POSTURE

Eva NECHLEBOVÁ a Monika VAN ROOIJ

Abstract

The article describes the importance of diagnosing differences in lower limb length and the impact on overall musculoskeletal stability and the effectiveness of regular interventional exercise. A case report of one person is used in the article. An analysis of the length of the lower limbs was performed using radiographs, anthropometric measurements and photodocumentation. Based on the results, an intervention program was designed, which included the Dorn method and Spiral Spinal Stabilization exercise for 3 months at a frequency of 2-3 times a day for 15 minutes. The exercises were continuously modified to always meet the current need for correction of the area. Exit examination shows that the foot position has improved as well as muscle corset and posture. The client continues to exercise and is without difficulties.

Keywords:

Initial diagnosis, intervention exercises, posture, unstable lower limb length, unilateral loading

1 INTRODUCTION

Postural functions are the main prerequisite for any movement, especially in locomotor activities. Posture does not improve during sport, but can be impaired by unilateral loading. Postural impairment leads to so-called faulty posture, which occurs especially in individuals with infrequent postural and movement changes or in individuals who are passive in movement. Therefore, comprehensive initial diagnosis and subsequent interventional training is very important and effective.

When checking the foot position, we take into account whether it is primary or secondary - very often this position is the result of incorrect loading of other joints.

Primary position requires intensive therapy to avoid further affecting the overall posture and the development of incorrect movement patterns and dysfunctions in the ankle, knee, hip, pelvis, spine and craniovertebral junction.

In secondary position, it is advisable to look for possible causes in dysfunction of the pelvis, hip joints, lumbar spine, etc. The priority is to find and heal the source of the difficulties rather than fix it with supportive devices (e.g. orthopaedic insoles).

The Dorn Therapy - a gentle form of manual therapy for reversible dysfunctions of the spine and all peripheral joints - deals with joint connections and their proper function. This method can be used as early as infancy and is based on the importance of equal length of the lower limbs. Otherwise, the uneven loading of the lower limbs creates undesirable effects on trunk statics, head position and overall spinal alignment (Burgath, 2006).

The unequal length of the lower limbs can be congenital, post-traumatic or caused by, among other things, incorrect hip joint seating. The difference in the length of the lower limbs has a significant impact on the development of flatfoot as one of the

compensatory mechanisms. Dysfunctions in the pelvis, the entire spine and the shoulders develop from unequal limb length.

2 AIM

The aim of the work was to identify the causes of the client's difficulties and to find a long-term solution to improve her mobility and relieve her pain.

3 METHODOLOGY

The case report of one client was used for this work, which included analysis of the length of the lower limbs using radiographs in collaboration with the physician, comparison of the photographs and subsequent measurement of the umbilical measurements. Based on the results of the measurements, an exercise and therapy plan was developed using the Dorn Method and Spiral Spinal Stabilization exercises. The exercises were continuously modified to always meet the current need for correction of the area. The intervention lasted a total of three months and is ongoing.

Defective posture

Faulty posture is defined as a posture which differs from the correct posture by various deviations which are not due to a structural change. It is a functional disorder of postural function (Čermák, Chválová, 2008).

In clinical practice, we most often encounter excessive curvature of the thoracic spine (thoracic hyperkyphosis), weakening of the interscapular region, excessive sagging in the lumbar region (lumbar hyperlordosis) with an overextended pelvis and other defective postures. As a rule, these disabilities are correctable and require corrective rehabilitation exercises (Repko, 2017).

SPS method (Spiral Spinal Stabilisation)

The Spiral Stabilisation Method (SPS) is a comprehensive exercise that compensates for musculoskeletal problems, stretches shortened muscles, strengthens weakened muscles and corrects posture. At the same time, this exercise affects the control and coordination of movement, which are necessary conditions for the functioning of correct movement stereotypes. Smíšek (2005) described four spiral chains, the activation of which leads to the alignment and traction of the spine. The alternation of spiral and vertical chains in the intervertebral spaces leads to traction and subsequent compression of the intervertebral discs. The term muscular chain is used to describe the connection between muscle units, joints and bones that is formed to allow movement and its stabilisation. Different parts of the muscle chain may be involved in different muscle chains, and almost always more than one muscle chain is involved in the execution of the movement and its stabilisation. The proportional involvement of the chains also changes during the movement (Smíšek, 2005).

The author of the SPS method (Smíšek, 2019) divides muscle chains into vertical and spiral chains, with both types having their own importance and role in different activities.

Smíšek (2019) describes 4 muscle spiral chains:

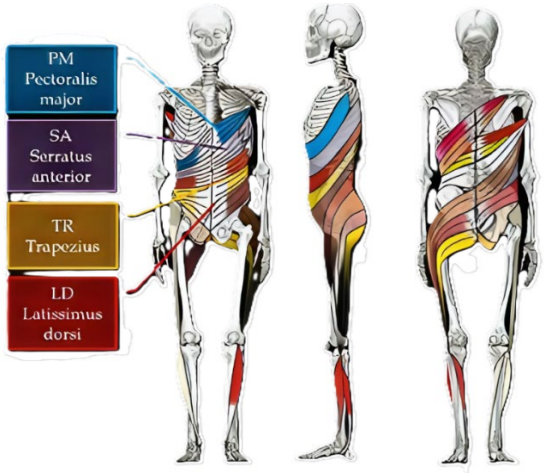
LD - latissimus dorzi;

TR - trapezius;

SA - stratus anterior;

PM - pectoralis major.

Figure 1 Spiral muscle chains



(Source: Smíšek, 2019)

and 4 vertical muscle chains:

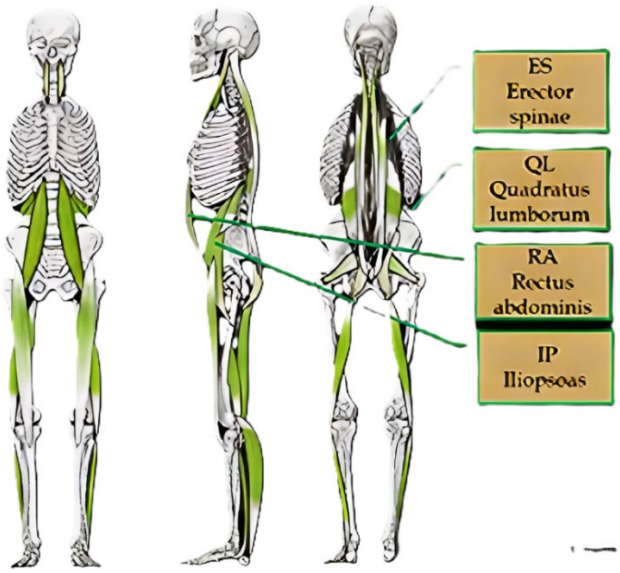
ES – erector spinae;

QL – quadratus lumborum;

IP – iliopsoas;

RA – rectus abdominis

Figure 2 Vertical muscle chains



(Source: Smíšek, 2019)

4 CASE REPORT

Medical history:

Personal history
Gender: female
Age: 46 years old

History of falls - frequent falls from horses. Last big one was 10 years ago when she fell on her left side and couldn't walk for several weeks.

After discovering the different lengths of her lower legs, she recalled going to the doctor as a child with scoliosis and having her left leg put under during scans.

Work history
She works 6-8 hours a day at a computer.

Social history
She and her husband live in the family home and care for 7 horses.
Sports history
Earlier horse riding. Now yoga.

History of current disease
Bilateral flatfoot, pain in lumbar spine, SI joint and left hip joint. Occasional pain in left knee.

Examination of Aspects
The weight of the body is significantly to the left with a slight tilt of the lumbar spine to the right. Scoliotic curvature of the spine. Left hip joint lower. Gluteal grooves and popliteal fossae unequally high. The thoracic spine has a physiological curvature. Measurements show a 1.5 cm shorter left lower limb. Furthermore, a shift of the left iliac blade towards the centre of the sacrum - most probably after the last fall from the horse to the left side. Feet concave, right arch more reduced. Valgosity of knees, left knee more significantly.

The definitive confirmation of scoliosis is a digital image of the entire spine, including the dens axis, shoulders and the entire pelvis, in both anteroposterior and lateral projection, taken in the standing position. The radiograph should include the following structures:

- Both hip joints;
- The entire pelvis;
- The entire spine, including the lumbar, thoracic and cervical regions;
- The lower half of the skull;
- The brachial plexus (Smíšek, 2019).

Description of the intervention
The first therapy focused on checking and possibly correcting the relative position of all the joints using the Dorn method.

During the second therapy, which took place one week later, a diagnostic check was carried out and a Spiral Spinal Stabilisation therapy was added, focusing on the scoliotic spinal position.

Subsequent therapies continued on a weekly basis and were aimed at training the correct performance of exercises from the Spiral Spinal Stabilisation stack according to the method of Richard Smíšek, MD. During each session, the musculoskeletal system was assessed and the exercises were adapted to the current situation.

Interventions according to the SPS
Principles of exercise:

- Standing exercises;
- Barefoot exercise;
- Alternating active and passive postures;
- Coordination of movement (from bottom to top);
- Use of low force and wide range of motion;
- Performing exercises slowly and smoothly;
- Check the correctness and execution of the exercises;
- Didactic progression from simple to complex;
- Intensity adapted to the current condition of the user.

Division of exercises
The SPS exercises are divided into four groups

- Symmetrical exercises SY;
- Asymmetric exercises ASp;
- Asymmetric single leg exercises ASn;
- Stretching exercises P.

Figure 3
View from the back

(source: authors)

Figure 4
View from the back

(source: authors)

Figure 5
Detail of lower legs

(source: authors)

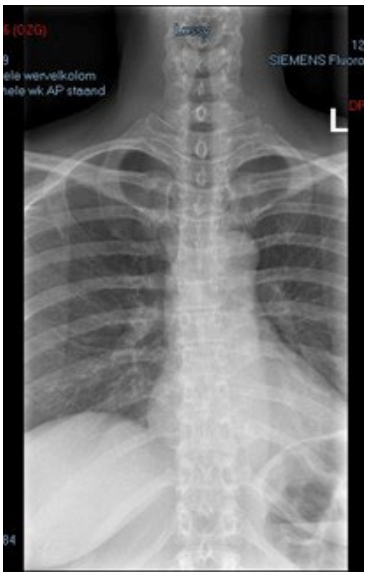
Figure 6
X-ray examination

(source: authors)

Figure 7
Continuous X-ray examination

(source: authors)

Figure 8
final X-ray examination



(source: authors)

All exercises were performed asymmetrically, with one leg resting on the mat, in order to account for the different lengths of the lower limbs. The asymmetric exercise performed with either one upper limb or lower limb is considered to be the essence of the functionality and effectiveness of the SPS method. When performing this exercise, the muscle spirals are activated, and the action of these muscles leads to the activation of the oblique abdominal muscles and the transverse abdominis muscle. This results in a reduction in waist circumference and subsequent upward force. The asymmetrical movement of the

shoulders assists in the mobilisation of the spine and brachial plexus. In the asymmetrical lower limb exercise, the focus is on stabilising the pelvis, mobilising the hip joints, and strengthening the muscles involved in stabilising the pelvis during gait.

This exercise strengthens the abdominal muscles, gluteal muscles, broad back muscles, mid trapezius, and lower scapular fixators. It also stretches and relaxes the neck muscles, upper scapular fixators, spinal extensors, and hip flexors. Following this, a stretching section is performed, which is part of each exercise unit. These exercises target muscles prone to shortening according to muscle imbalance syndromes.

During the execution of the exercises, the participants were instructed to maintain a regular and continuous respiratory pattern. The number of repetitions was selected based on the individual's current physical condition, with a total of eight repetitions for each exercise.

The following excerpt is taken from the SPS upper limb exercises, which include asymmetrical exercises.

Figure 9
Starting Position

(source: authors)

Figure 10
Target Position

(source: authors)

Figure 11
Starting Position

(source: authors)

Figure 12
Target Position

(source: authors)

Output diagnostics

A comparison of the photographs at the beginning of the intervention (Fig. 1) and at the end of the intervention (Figs. 2 and 3) of the three-month therapy demonstrates an overall improvement in statics, pelvic position and more symmetrical loading of the lower limbs. A change in posture was already evident after the second therapy session, as illustrated in Figure 5 in comparison to Figure 4 (baseline).

Figure 13
Before intervention

(source: authors)

Figure 14
After the intervention

(source: authors)

Figure 15
Before intervention

(source: authors)

Figure 16
After 2 the intervention

(source: authors)

Figure 17
Before intervention

source: authors)

Figure 18
After the intervention

source: authors)

5 DISCUSSION AND CONCLUSION

The objective of this thesis was to identify the underlying causes of the client's difficulties and to propose a long-term solution to improve her mobility and relieve her pain. A robust muscular corset was devised to reinforce correct posture through the implementation of appropriate exercises and a meticulous diagnosis. In the case of a diagnosed congenital limb length discrepancy, it was also necessary to collaborate with a podiatrist and produce an orthotic insert for the left leg measuring 0.5 cm.

The client engaged in two to three daily sessions of 10 to 15 minutes each, comprising a series of exercises from the Spiral Stabilization program. They also attended regular follow-up appointments and received continuous therapy in accordance with the Dorn method. Following three months of exercise, there was a discernible improvement in foot position and greater stability of the left leg

knee. The client is currently experiencing no significant difficulties and will continue to engage in exercise. The subsequent exercise phase will encompass supplementary balance training, with the objective of enhancing foot functionality.

6 REFERENCES

Burgath, I. (2016). Dornova terapie u kojenců a dětí. Poznání.

Čermák, J., & Chválová, O. (2008). Záda už mě nebolí (4. vyd). Jan Vašut.

(nd). www.dornova-metoda.com. (2023, 30. listopadu). https://www.dornova-metoda.com/

(nd). Spirální stabilizace páteře. www.spiralstabilization.com. (2023, 10. listopadu) https://www.spiralstabilization.com/metoda/

Repko, M. (2017). Nejčastější potíže s páteří školních dětí. Pediatrie pro Praxi, 18 (4), 212–218. https://doi.org/10.36290/ped.2017.040

Smíšek, R., & Smíšková, K. (2011). Spirální stabilizace. 12 cviků pro regeneraci páteře. Prevence a léčba bolestí zad. Richard Smíšek.

CONTACTS:

Mgr. Eva Nechlebová, Ph.D.

VŠTVS Palestra – Katedra biomedicíny
E-mail: nechlebova@palestra.cz

Monika van Rooij, MsC.

Holistic Body Therapist, Kromme-elleboog 2e laan 1A, Finsterwolde, Nederland
E-mail: monika@monikavanrooij.nl
www.monikavanrooij.nl