

Stockholm Junior Water Prize – Hungarian competition, 2013

An examination of the therapeutic effect of the medicinal thermal waters at Berekfürdő, and its energy conscious utilization in a health hotel, as a presentation of the many uses of thermal waters



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Long summary

Hungary possesses the fifth greatest wealth of medicinal thermal waters in the world. Our nation only partially utilizes the possibilities that lie in thermal waters. Between 2010 and 2012 we followed the process of a thermal spring as it was drilled, and proclaimed mineral water and later a medicinal hot spring. Since the hot water sprouting up from the ground contains large quantities of dissolved methane gas, we possess a grand opportunity to exploit it for energetics purposes. Our paper would like to discuss the many uses of medicinal thermal springs through personal experience, for example its uses in balneotherapy, and in energetics through the drilling of a well for a thermal spa.

In the first section we discussed the environmentally friendly usage of the heat of the water and the dissolved methane gas. Our well brings forward 46°C water, with which the heating of the hotel can be completed using a heat exchanger. This is possible because only water between 33-38°C can be used for therapeutic purposes. The first task is ridding the water from 650m deep from its dissolved gases. 1m³ of thermal water contains 0.755m³ of dissolved methane gas. We burn most of the gas in a 30kW gas engine, with which we can yield 720 kWh of electrical energy, and 1440kWh of heat energy daily. This is sufficient for the entire energy and gas requirements of the 2500m² hotel. It is possible to use the separated methane as fuel (CNG), which is more environmentally and cost efficient than gasoline.

In the second section of our paper we studied the therapeutic value of our thermal water according to a protocol certified by The University of Szeged. The water of Berekfürdő contains bromine, iodine and sodium bicarbonate. This type of water is most suitable for treating musculoskeletal diseases. The patients participating in our study suffered from large joint arthrosis and lumbal spondylosis, verified by x-ray in each case. Through the study 80 patients participated in bath therapy 15 times in 35°C water. The health of the patients was recorded before, directly and 3 months after the termination of treatment. On the bases of these results the water was qualified as medicinal thermal water in 2012.

At the end of our paper we discussed the further uses of the hot water as it leaves the pools. From the hotel the water flows into two cooling ponds, in which because of the high algae growth and warm temperatures we placed 100 Nile Tilapias. The diet of this fish is mainly green algae. In the future we plan on populating the other cooling pond with African catfish, and using the remaining heat of the water to warm a greenhouse, in order to produce fresh vegetables for the hotel kitchen. We thought it constructive to present the opportunities hidden within thermal waters, for it not only affects Berekfürdő, but the whole country, and others with thermal waters as well.

Declaration

I hereby certify that the project is my/our team's own intellectual property.

I am aware that ideas, innovations, techniques etc. that have been demonstrated in a public context cannot be protected by copyright or patent unless appropriate steps have been taken before public disclosure.

Signature(s) of contestant(s)



Signature(s) of agreement(s) of parent(s) or guardian(s) (where contestant is a minor)



Date (day/month/year)

10 April 2013

Short introduction

The practice of hot water bathing in Hungary goes back hundreds of years. The Hungarian people in the most part took over these traditions from the Turks, who occupied Hungary in the 17th century. Since our childhood, water has been a great part of both our lives. We have known each other since we were children, and we decided to work on this project together because of our great interest in this topic. We are both currently enrolled in high school, and we are both in special classes dedicated to the sciences. Through both personal experience and other channels we have come to realize the severity of musculoskeletal problems, and the great number of people suffering from it. The other contributing factor to writing this paper is our wish to spread awareness that medicinal thermal springs do, in fact, possess immense medicinal value. A significant percent of the Hungarian population is not aware of this truth. In our opinion the spreading of this reality can bring healing to many.

1. Introduction, and short summary

Hungary has the fifth largest stock of hot springs with medicinal properties. Between 2010 and 2012, we followed the process of one specific thermal spring as it was drilled, tested and proclaimed to be mineral water, and later developed into a medicinal hot spring. Our paper would like to discuss the many uses of medicinal thermal springs through personal experience, its uses in balneotherapy, and in energetics through the drilling of a well for a thermal spa. We had two main goals, the first being to present a permanent and side-effect free way to treat musculoskeletal problems, and the second to develop ways to make use of the heat from the water, and its dissolved gasses.

2. Utilization of thermal waters in energetics

Thermal springs possess enormous energy potential. Since the springs in Hungary have an average temperature much higher than that of most springs in Europe, a simple heat exchange can give us large quantities of energy. Above all, the hot springs are accompanied by methane, giving us an even greater opportunity to make use of the green energy these waters bring with them.

2.1 Hungary's energy dependence

The energy industry extracts, processes, and distributes the energy carriers. The energy resources of Hungary are not enough in both quantity and quality to provide for the energy demand of the nation. Today, half of the power supply is of foreign origin, and because of this we are in need of alternative solutions. With a decline in foreign energy dependence, our country's vulnerability could lessen.

2.2 Thermal waters as heat energy sources

Before discussing thermal waters, we must first determine the definition, for in many countries the same name holds different meanings. In Hungary the only underground waters classified as thermal are the ones whose temperature is over 30 °C. Most of our waters meet or exceed these specifications. The suitable temperature for medicinal use is around 33-38°C, which makes it possible to utilize the excess heat to operate a heat exchanger. The waters from the springs of the medicinal spa we studied can be let through a fancoil heating/cooling system. This produces enough heat to provide the heating of the hotel. They cool the 46°C water from the ground to a 42°C temperature.

2.3 The use of the methane gas rising up with the water

In all thermal springs, the methane gas which rises up with the water is separated before use, but in Hungary the later use of this gas in energetics is only done in a small percent of cases. The EU strongly supports the procedure of separating and further processing the methane from the waters, since this gas is thirty times more harmful to the ozone layer than if it is burned to carbon-dioxide. In our case, 1 m³ water from 650 meters deep contains 0.755m³ of dissolved methane. We flow the water through a gas separating mechanism, where it can be rid of the natural gas. A significant part of the gas (85%) is burned in a 30kW engine, which from 1m³ of gas can yield 2.5kWh of electrical energy, and through cooling processes another 5kWh of heat energy. The well pumps 400m³ of water to the surface daily, which means 720 kWh of electrical and 1440 kWh of heat energy per day. In comparison, an average family's energy use is around 15 kWh. The energy won from the hot spring is enough to cover the complete energy requirements of the 2500m² hotel. The remaining

heat energy from the cooling processes are conveyed the radiator systems. The remaining 15% of the methane gas is used in the hotel kitchens.



Gas engine



Main well

2.3.1 The possibilities of utilization in Hungary

“If we burned all of the methane gas from all thermal hot spring in motors, we would produce up to 8% of the electrical energy that is put out by the nuclear reactor at Paks.” (Ferenczi Miklós - Siófoki Gázipari Company). The energy consumption of Hungary is around 39500x106 kWh. 40% of which is supplied by the nuclear reactor at Paks. If we follow Ferenczi Miklós’s thoughts, it could be suggested that the energy acquired by burning all of the methane gas from thermal waters could in fact provide electrical energy for up to two hundred thousand households. Nearly two times as many houses’ heating could be made possible with the gas. A gas engine takes around 9-10 years to pay off, but with the building of a system like this, Hungary’s dependence on foreign resources could lessen.

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2.3.2 The possibilities of utilization of already existent technologies

The methane gas can be used as a fuel. The name of the fuel made from methane is CNG (Compressed Natural Gas). We can group fuel types by their octane number; the octane number of gasoline is 95, while for CNG it is much higher, around 130. In the aspect of carbon-dioxide output (the decreasing of which is a main concern of the EU), CNG produces 25% of the totals that gasoline creates, at the same power. An average vehicle will go the same distance on both fuels. Of the disadvantages of CNG, it must be mentioned that due to the positive pressure of the compressed gas, the canisters have to be relatively small. Because of this the distance between fill-ups is around 450-470 km. There are 3 CNG gas stations currently operating in Hungary, one in Budapest, Győr and Szeged. The amount of methane gas rising up with our thermal waters is significant. It could provide a base for the building of further CNG stations. Not only is CNG more environmentally friendly compared to gasoline, but also with the development of a large net of CNG stations the need for gasoline could be brought down, the price of which, due to diminishing oil wealth, will get higher and higher. For a trip of 100km, the average car will use 7 liters, or 10.5 EUR worth of gasoline. If the gasoline is replaced with CNG, of which 5kg is necessary, the same trip will only cost 5 EUR. Using gasoline is twice as expensive as using CNG.

3. The usage of medicinal thermal waters for medicinal purposes.

The medicinal value of thermal waters has been known for a very long time. In the last few decades, it has still kept its place in contemporary medicine, whose base is evidence, for the positive medical properties of these waters could be conclusively proven. The described thermal spring could only get classification as medicinal water if we could prove its healing properties on patients. In 2012 with the help of the University Of Szeged Szent Gyorgyi Albert Clinical Center’s Regional Humane

Biomedical Research Ethics Committee, we started our research to prove the water's medicinal value.

3.1 Musculoskeletal Illnesses in Hungary and Europe

According to an English survey, 5% of people above the age of 16 suffer from some kind of joint issue. This value increases to 20% above the age of 75 (1). Experts estimate that 15-20% of Hungarians have a diagnosable musculoskeletal problem, and about the same percent suffers from abrasion joint complaints. About one hundred thousand live with inflammatory joint diseases (2). Exact data up till now has only been available from a 1994 survey done by the KSH, according to which 6,3% of the general public suffers from some sort of musculoskeletal problem. The data above is frightening, and their economic influence is not negligible. 120 million people suffer from some musculoskeletal problem in the European Union, about a fourth of the population. This is the contributing factor in 50% of missed work days and 60% of permanent incapacity to work. Every year this costs the member states 240 million Euros. Prevention, early rehabilitation and providing the most percent of patients with a way to return to work are the most important factors to be considered. It would be more profitable for the European governments to support early diagnosis and rehabilitation, but for this a change of viewpoint is necessary (3). Then, balneotherapy would get a leading role, which is cost efficient, long term, and side effect free.

3.2 Important medicinal waters in Hungary

Iodine-Bromine	Berekfürdő, Hajdúszoboszló
Sulfide	Mezőkövesd, Harkány
Radon	Hévíz
Iron	Parád
Alkalines	Balf, Bükkszék, Szeged
Lime-Earth	Gellért-fürdő, Budapest

These thermal waters of various compositions, are all used in different medicinal ways. Our studied well is at Berekfürdő, and is a source of Iodine-Bromine and Sodium-Bicarbonate thermal waters, the medicinal value of which we will further discuss.

3.3 The musculoskeletal healing properties of medicinal thermal waters from Berekfürdő

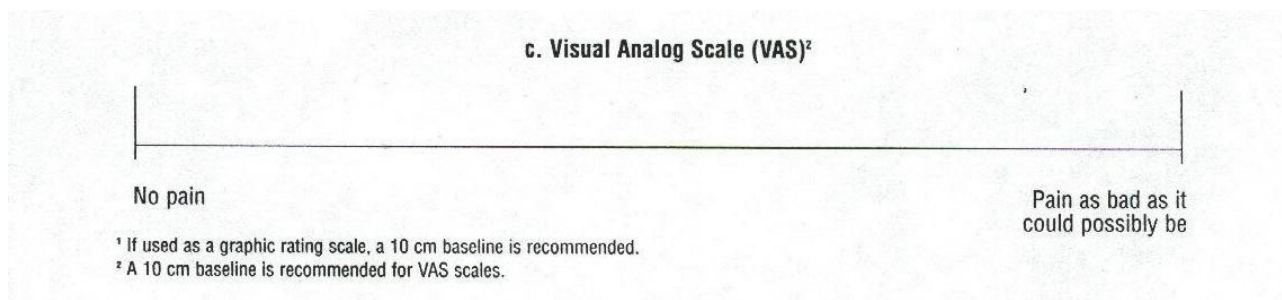
3.3.1 The composition of the studied well

The attached table shows the mineral composition of the water. Our goal is proving the healing properties of the water, which are in strong correlation with its mineral composition. Of the dissolved minerals the most central is the high concentration of Na^+ and HCO_3^- ; these play a large role in the treatment of musculoskeletal diseases. The part that the trace elements in the water play is also significant. The iodine ion stimulates peripheral blood circulation, and reduces inflammation. It also decreases the level of blood sugar and uric acid, while stimulating the functioning of the thyroid and ovary.

	Mineral (mg/l)
Na^+	621
NH_4^+	5,6
Mg^{2+}	6,6
Fe_2	0,603
K^+	4,9
Cl^-	140
Br^-	1,82
I^-	2,22
F^-	0,31
HCO_3^-	1415

3.3.2 The investigation of the medical value of the thermal hot spring using a follow-up method

According to protocol, we selected patients for the study with x-ray proven large-joint (arthrosis) or spinal (lumbal spondylosis) degenerative conditions. During the course of the study the patients participated in a 30 minute pool bath of 35°C water 15 times, for a three week period. The follow-up method means that the patients took part in a control before, directly after, and 3 months after the termination of treatment. We followed the decrease of the pain on a V.A.S. scale. The figures below encompass the general data of the participants, and a V.A.S. scale. During the study we were curious to find out the impact the medicinal water had on the quality of life for the patients. For this we used questionnaires validated in Hungary. Using SF-36 questionnaires on both groups, WOMAC for the arthrosis group, and OSTWESTRY for the lumbal group, we studied the results.



3.3.2.1 Arthrosis

Arthrosis is a slowly progressive degenerative disease of one or more joints, which focuses on the degeneration of cartilage in the joints. During the bath-therapy we studied the pain during rest, starting of movement, bearing a load, and while walking on the stairs. We also studied their ability to move.

3.3.2.2 Lumbal spondylosis

Lumbal Spondylosis is the degenerative transformation of lumbar spine vertebrae, and the intervertebral discs. In this group we studied the tenderness for pressure of the processus spinosus and of paravertebral muscle, and the ability of movement, which was classified in four categories: (1: freely, 2: with difficulty, 3: with after step/with occasional aid, 4: with an aid).

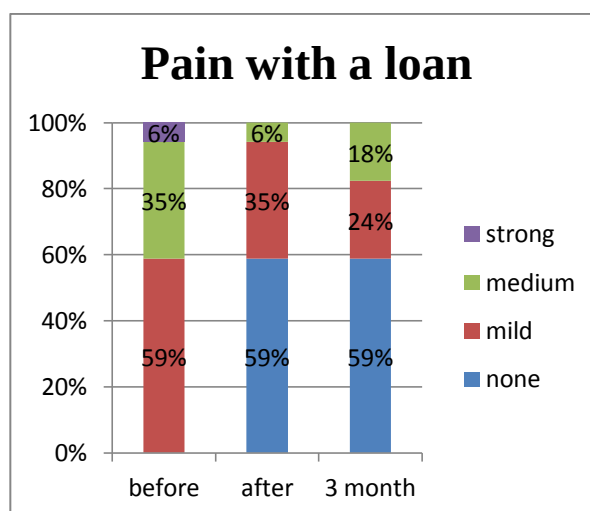
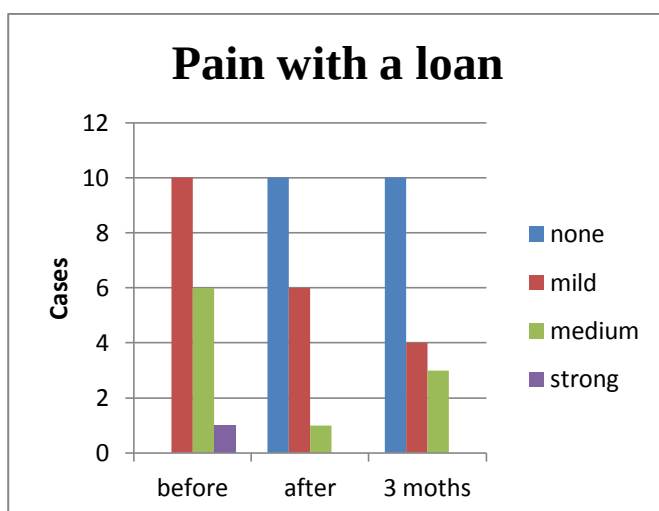
3.3.3 Results

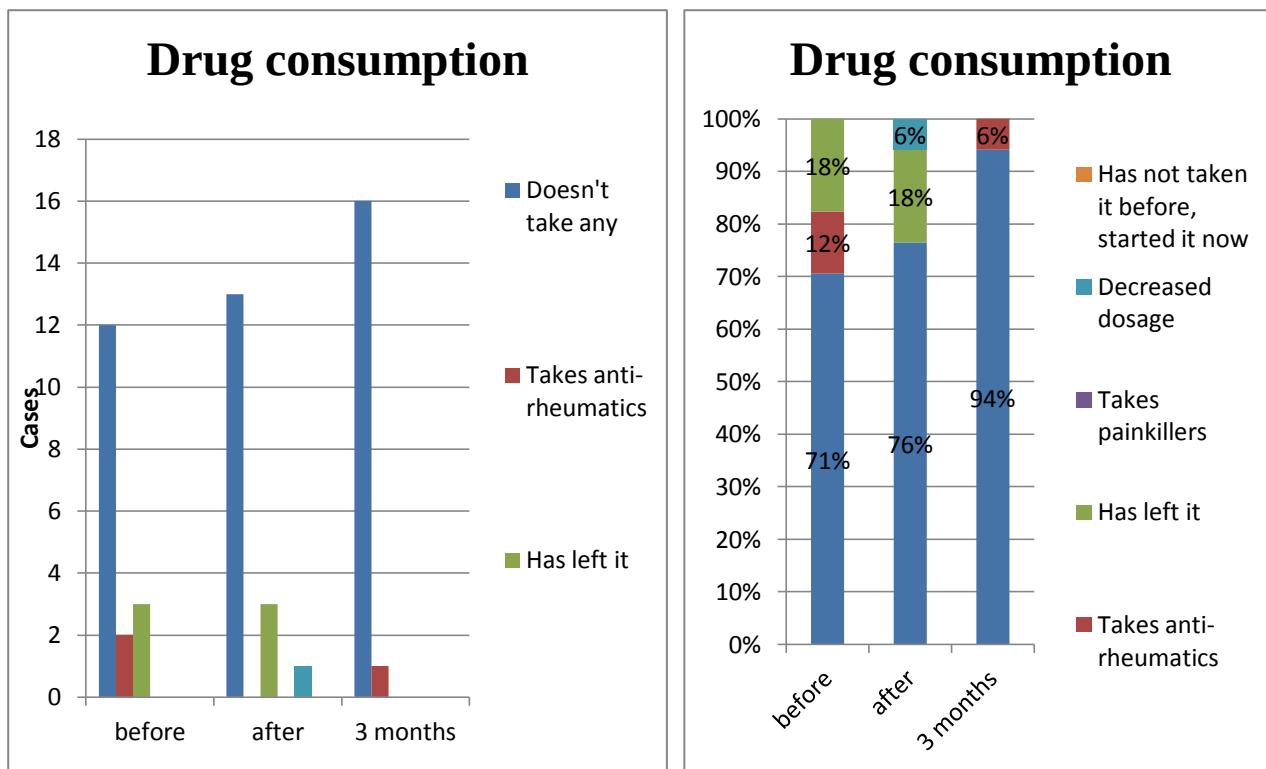
During the study there was a temporary increase in pain according to the V.A.S. scale on days 4-7. This corresponds with the professional literature, with the patients displaying tiredness and the intensification of symptoms, which was not of a degree that any of the patients would have to quit the treatment.

3.3.3.1 Arthrosis

The table below contains the data of the patients with **arthrosis in the knee**, and the results of the bath-therapy.

Started the therapy (#)	20	Men:9	Women:11
Finished the therapy (#)	17	Men:7	Women:10
Average age	64.24	Max:73	Min:56
Average weight (kg)	81.29	Max:107	Min:58

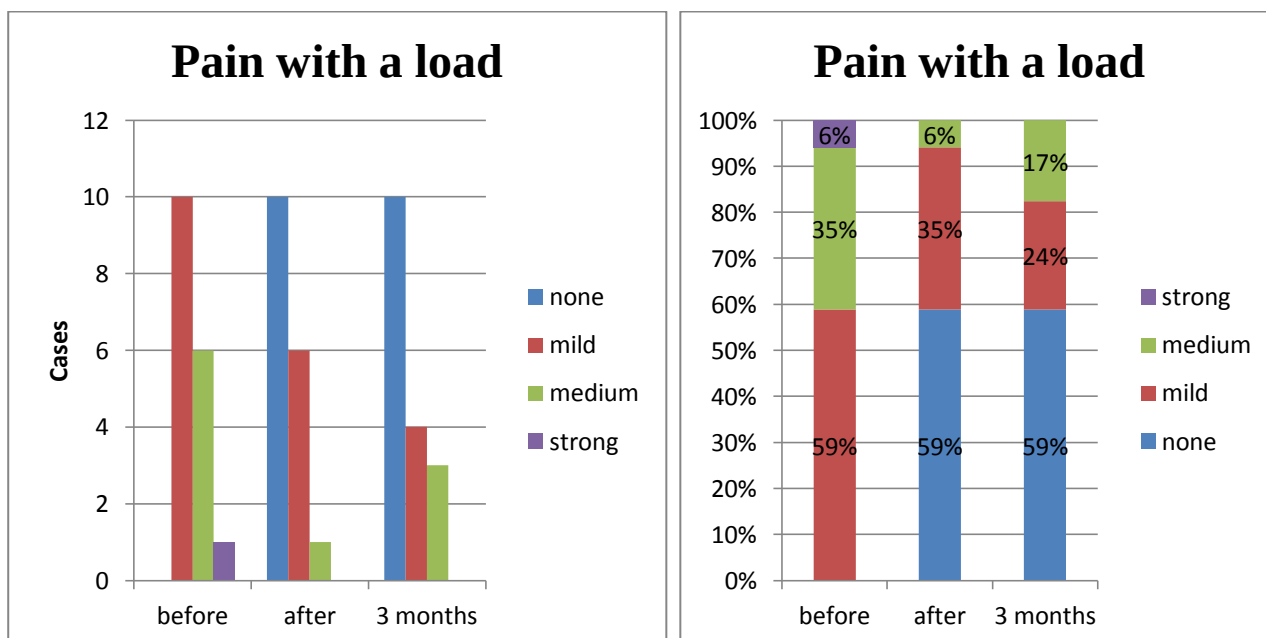


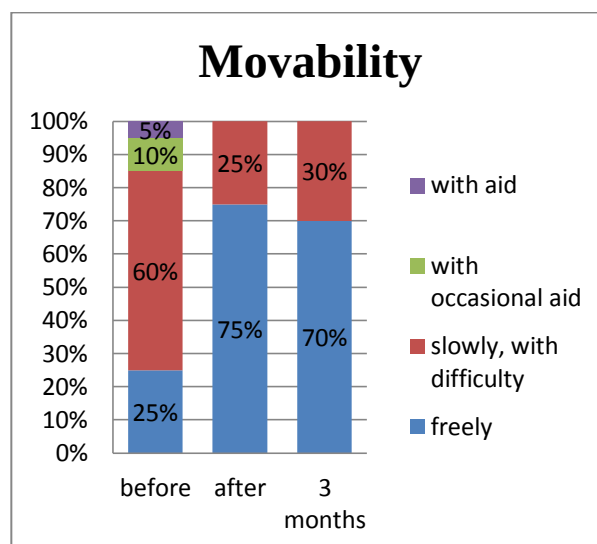
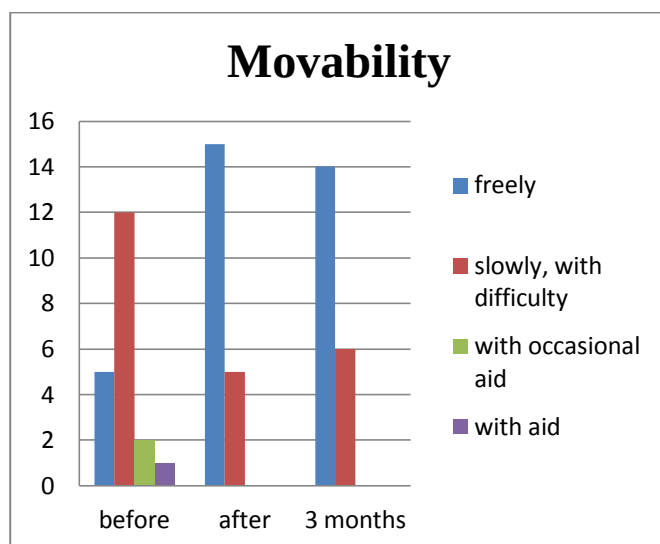


The data of patients with **arthrosis in the hips** is displayed below.

Started Treatment (#)	20	Men:5	Women:15
Finished treatment (#)	20	Men:5	Women:15
Average age	65.6	Min:53	Max:74
Average weight	71.75	Min:40	Max:98

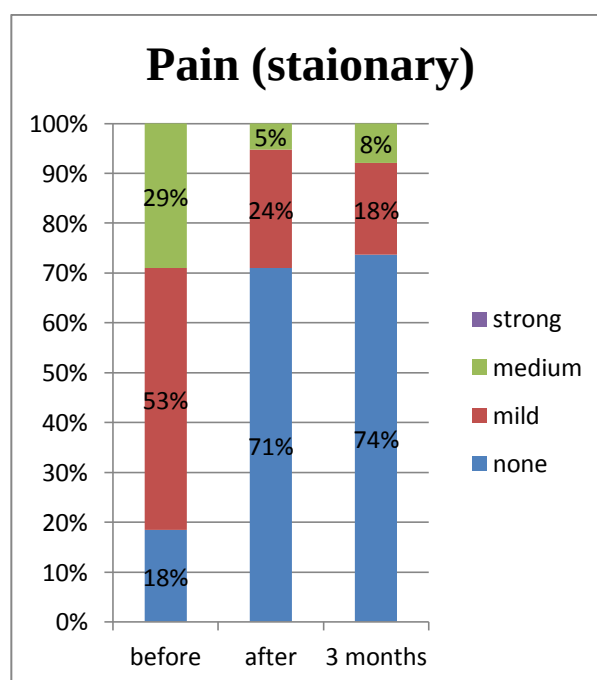
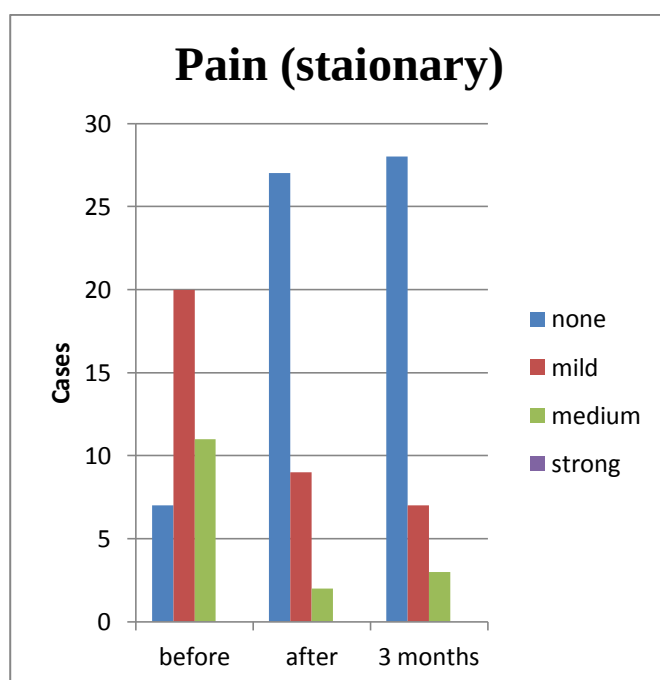
Below are the results of this group.

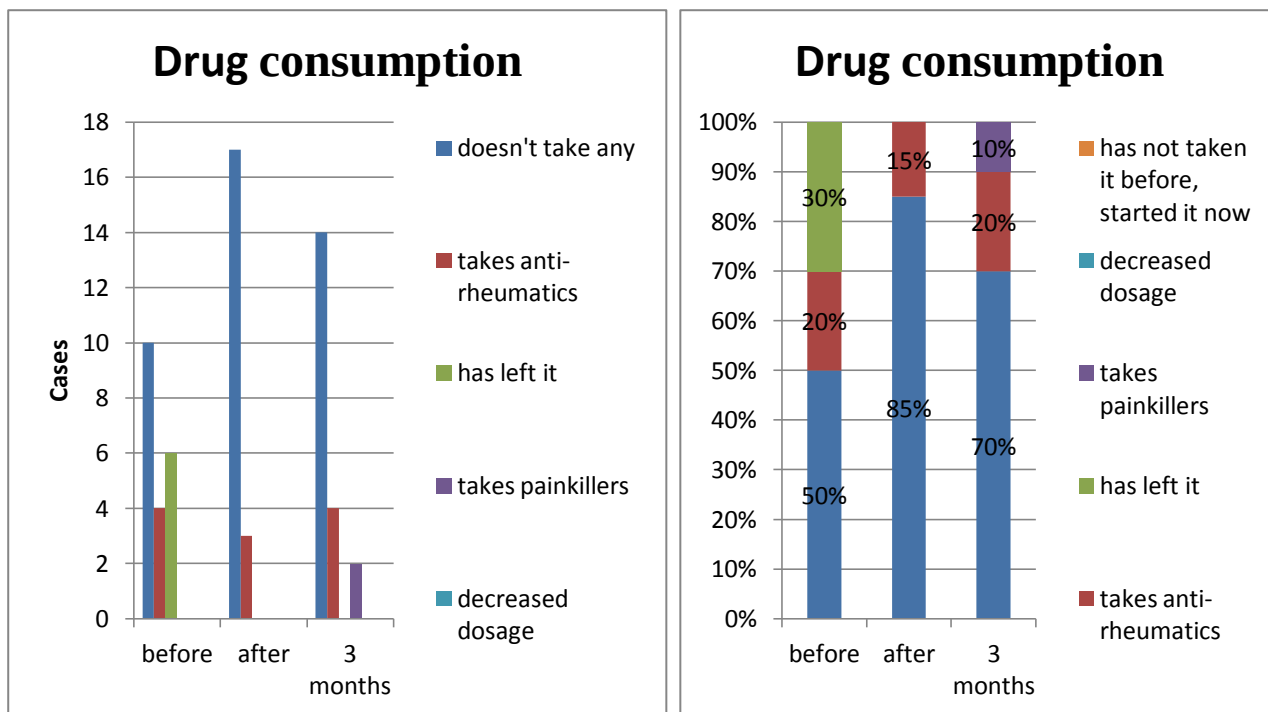




3.3.3.2 Lumbal spondylosis

Started the therapy (#)	40	men: 18	women: 22
Finished the therapy (#)	38	men:17	women:21
Average age	63	Max: 76	Min: 45
Average weight (kg)	80.79	Max: 110	Min: 56

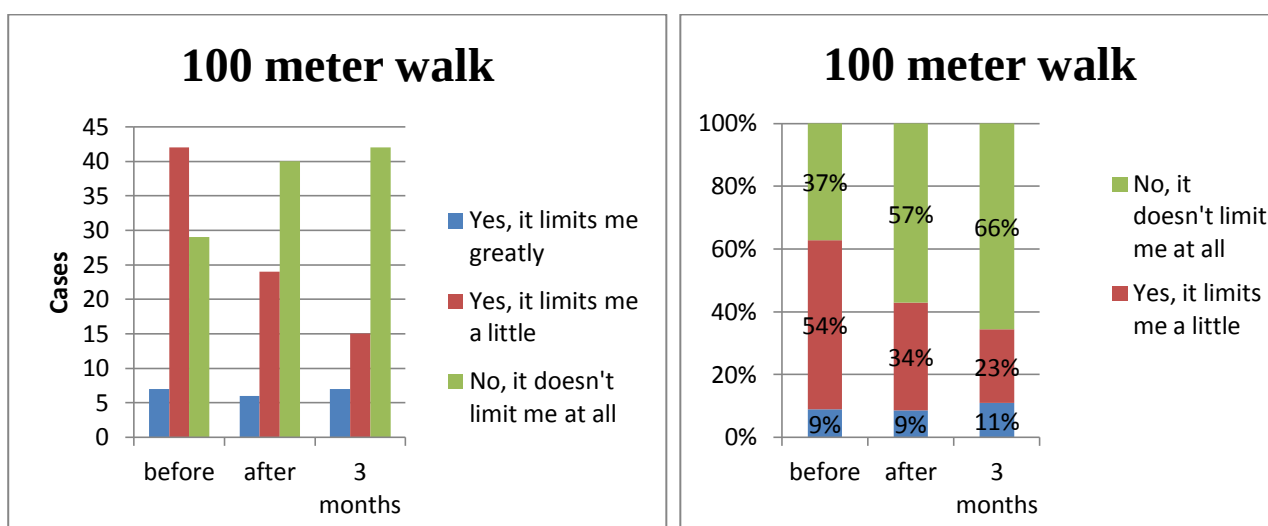


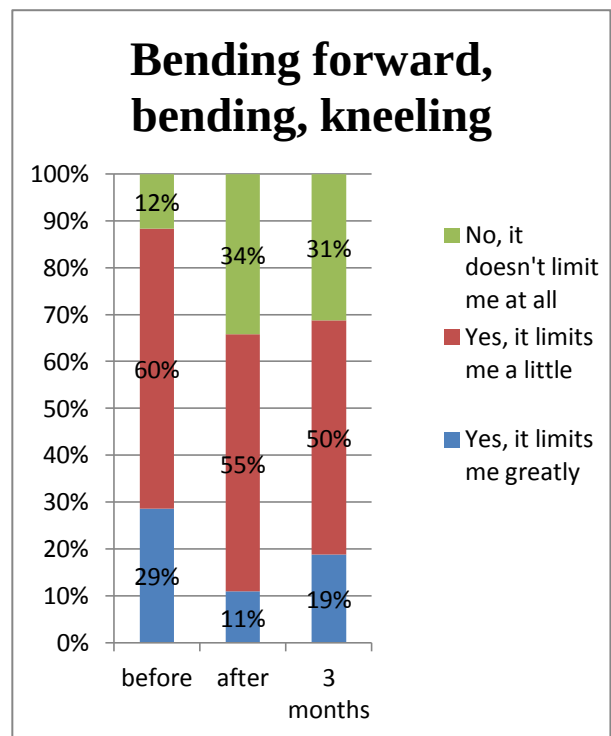
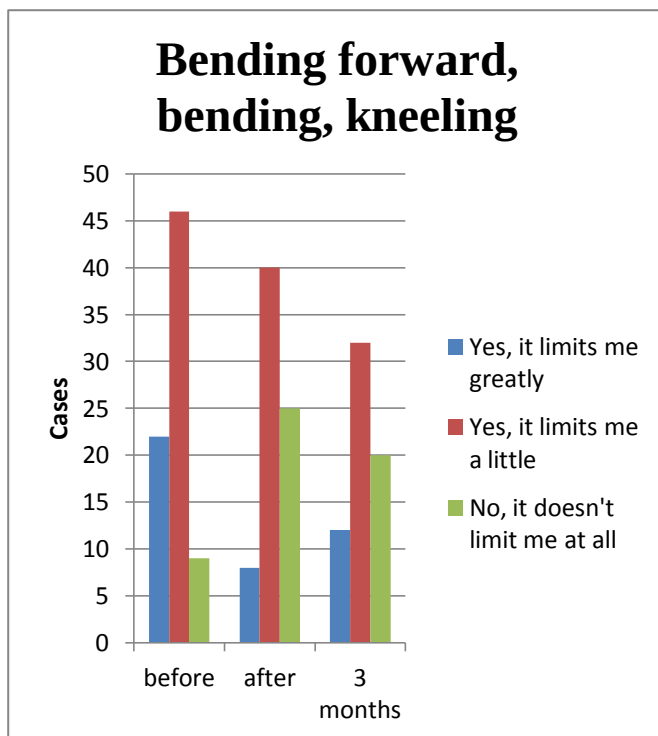


3.3.3.3 SF-36

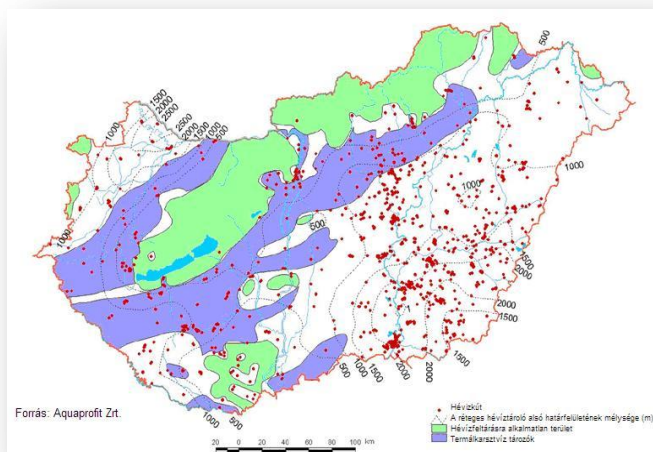
The SF-36 is a questionnaire that measures the therapeutic effect based on the evaluation of everyday situations and actions.

Started the test (#)	77	men: 32	women: 45
Finished the test (#)	64	men:29	women:35
Average age	65	Max: 76	Min: 45
Average weight (kg)	78.91	Max: 110	Min: 40





3.4 The advantages of Balneotherapy in Hungary



- Thermal wells
- Thermal water reservoirs
- Areas in which it is not possible to drill for thermal waters

As we mentioned in the introduction, and as this figure illustrates, Hungary, on a world and European scale would be considered relatively wealthy in medicinal thermal waters. In the future we should make use of this resource, both in medicinal areas, and tourism. A health hotel can take advantage of the thermal springs in both the balneotherapy and touristic aspects.

4. Other uses of medicinal waters



First cooling pond

It is important to note that since there are no additives or disinfectants added to the thermal water, fresh water is continuously pumped into the pools. At the end of our paper we would like to present what happens to the warm (33-38°C) water as it leaves the pools, after having been used for both medical and energy-production needs. The water is

sent into two cooling ponds before reaching 30°C, from where

it can be led into the city's fish-pond. The cooling ponds hold some opportunities as well; in the next few sections we will discuss these further.



Second cooling pond

4.1 The cooling pools of the thermal water- warm water fish farming, and the utilization of the remaining heat.

The temperature of the first cooling pond is around 32°C, suitable for warm water fish species. We observed a strong algae growth in this pond, therefore a fish species, whose diet is mainly green algae, would be best to populate the pond. We fitted the pond with 100 Nile tilapias, and in this way we drastically reduced the algae growth. The tilapias are undemanding and well adapting; they flourish in the warm thermal water. If their breeding succeeds, they could serve as a valuable and healthy raw material for the hotel kitchens. In the future we plan on populating the other pond with African catfish, because of their culinary value, and because they also flourish in warm water. We plan on using the remaining heat for the heating of a greenhouse, where we could produce the produce for the hotel kitchens.



Nile Tilapia

4.2 The growth of algae in thermal waters, and possibilities of utilization

The thermal water's high mineral and organic matter content is ideal for algae growth. Green alga is a valuable dietary supplement and also serves as a component in many cosmetics. It is important to note about algae, that they constitute one third of the living matter in the world. The distinctive color of green algae is due to its high chlorophyll content, which is very beneficial to digestion and metabolism. Its alkaline nature prevents hyperacidity.

They contain the following important nutrients: valuable proteins, various amino acids, vitamins, potassium, magnesium, zinc, iron, beta-carotene and essential fatty acids. Due to these beneficial components, the algae have a good effect on infections and inflammations; it also has cancer-preventing properties. The future possibility arises for extracting the green algae from the (sterile) medicinal thermal water, and its further use as a dietary supplement or in cosmetics.



Green algae

5. Summary

Before the drilling of the well we did not think thermal waters would hold so many opportunities. In our paper we tried to support, with numerical data, what a treasure Hungary's thermal waters are. We came to the conclusion that not everything can be expressed in simple numbers, for our health is not tangible, not something we can easily put a number on. Musculoskeletal patients suffer from lifelong recurring symptoms, and rely on regular drug therapy. A well-chosen balneotherapy can be a way out of the bondage of drugs. The studied medicinal thermal water can play a key role in treating these widespread diseases. We must also keep in mind its significant energy production capabilities. With the diminishing of the supply of non-renewable energy resources we must search for alternative solutions; it helps if we are aware of our country's energy potential. We thought it constructive to present the opportunities hidden within thermal waters, for it not only affects Berekfürdő, but the whole country, and others with thermal waters as well. This is what gives our project national and global importance as well.

6. References

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Bender Tibor: A fürdőkezelések hatásmechanizmusa

7. Abbreviations

CNG	Compressed Natural Gas
EU	European Union
KSH	(Központi Statisztikai Hivatal) Hungarian Central Statistical Office
SF-36	Short Form
V.A.S	Visual Analog pain Scale
WOMAC	Western Ontario and Macmaster University