



Relationship of daily hot water bathing at home and hot water spa bathing with underlying diseases in middle-aged and elderly ambulatory patients: A Japanese multicenter cross-sectional study

Hiroharu Kamioka^{a,*}, Yasunori Mori^b, Katsutaro Nagata^c, Shigeaki Iwanaga^d, Masahiko Uzura^e, Satoru Yamaguchi^f

^a Faculty of Regional Environment Science, Tokyo University of Agriculture, Japan

^b Mie Prefecture Health and Environment Research Institute, Japan

^c Chiyoda International Clinic, Japan

^d Iwanaga Ladies Clinic, Japan

^e Department of Emergency Medicine, Jikei University School of Medicine Kashiwa Hospital, Japan

^f Department of Oriental Medicine, Saitama Medical University, Japan

ARTICLE INFO

Keywords:

Bathing

Hot spa

Balneotherapy

Underlying disease

Health enhancement

ABSTRACT

The purpose of this study was to clarify the relationship of daily hot water bathing at home (DHW) and hot water spa bathing (HSPA) with the number of underlying diseases in middle-aged and elderly ambulatory patients.

We defined the number of underlying diseases as the main outcome and dependent (criterion) variable. The frequency and time of DHW and the frequency of HSPA were set as explanatory variables. Multiple logistic regression analysis was performed for each frequency and time, adjusted age and sex. Odds ratio (OR) and 95% confidence interval (95% CI) were calculated.

Among the 1261 patients who participated, there was no significant difference in age between males ($n = 508$, 72.8 ± 6.8 years) and females ($n = 753$, 73.5 ± 6.9 years). There was also no significant age difference between males (number of diseases: 2.7 ± 2.0 pts.) and females (number of diseases: 2.7 ± 2.1 pts.) in the occurrence of underlying diseases. Frequency and time of DHW were not associated with the occurrence of underlying diseases. However, compared with participants who utilized hot water spa at least once a week, the occurrence of underlying diseases was significantly associated with bathing frequency: one to three times per month (OR 2.72, 95% CI 1.63–4.52); twice or five times a year (OR 1.92, 95% CI 1.25–2.94).

In conclusion, lower frequency of HSPA was significantly associated with increased risk of the occurrence of underlying diseases in middle-aged and elderly ambulatory patients. However, the relationship between proactive use of hot water spa and patients' mental and physical support should be clarified by well-designed cohort studies.

The present study was registered as UMIN000033018 by the University Hospital Medical Information Network Clinical Trials Registry (UMIN-CTR) in Japan (refer: https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr_view.cgi?recptno=R000037643).

1. Introduction

Balneotherapy,¹ has been frequently used as a complementary therapy.^{2–5} The latest systematic review shows that balneotherapy and spa therapy can significantly improve quality of life of patients with knee osteoarthritis.⁶ A review⁷ that performed a quality assessment of articles ($n = 51$) based on spa therapy studies that were published from 1990 up to 30 September 2013 identified each disease based on the

International Classification of Diseases-10. The review showed that 40 studies (78%) were about “Diseases of the musculoskeletal system and connective” (e.g., osteoarthritis, low back pain, fibromyalgia, ankylosing spondylitis, rheumatoid arthritis), and three studies (6%) were about “Diseases of the skin and subcutaneous tissue” (i.e., atopic dermatitis and psoriasis). Recently, a pilot study showed that spa bathing may reduce the perception of pain and anxiety, and improve well-being among palliative patients.⁸

* Corresponding author at: Faculty of Regional Environment Science, Tokyo University of Agriculture, 1-1-1 Sakuragaoka, Setagaya-ku, Tokyo, 156-8502, Japan.
E-mail address: h1kamiok@nodai.ac.jp (H. Kamioka).

<https://doi.org/10.1016/j.ctim.2019.02.003>

Received 17 December 2018; Received in revised form 5 February 2019; Accepted 5 February 2019

Available online 10 February 2019

0965-2299/© 2019 Elsevier Ltd. All rights reserved.

In addition to the benefits of spa therapy for the treatment of certain disease, its effectiveness on health enhancement has also been reported.^{9–13} A cross-sectional study suggested that spa resort use may have beneficial effects on physical and particularly mental health.⁹ Another cross-sectional study demonstrated that bathing in a bathtub every day or more frequently was associated with a good state of self-rated health and sleep quality.¹⁰ Furthermore, some studies have demonstrated a positive effect on health enhancement as a result of comprehensive health education, which includes lifestyle education and exercise in combination with spa bathing.^{11–13}

There are many studies on bathing, but none has revealed whether the frequency and time of bathing are related to underlying diseases. The purpose of this study was to clarify the relationship of daily hot water bathing at home and hot water spa bathing with the number of underlying diseases in middle-aged and elderly ambulatory patients.

2. Methods

2.1. Procedure, setting, and participants

The Japanese Society of Balneology, Climatology and Physical Medicine has a specialist's certification system for medical doctors. There were 998 doctors based on this system in Japan as of 26 May 2018 (Fig. 1). This study was performed as a special research project by the Academic Committee, Japanese Society of Balneology, Climatology and Physical Medicine. All funds for this research were provided by the Society.

As a first step, we explained the protocol, including the actual interview sheet, to members of the Society at their 83rd annual meeting on 20 May 2018. Next, we sent to all the doctors an email with information regarding our research protocol and requested that they provide the data on ambulatory patients at each of their medical institutions. The doctors were informed that if they participated in this study, he or she would be able to receive credit approval towards

renewal of their certification as a specialist. As a result, 39 doctors (39 medical institutes) expressed a willingness to participate in this research project. We did not calculate the sample size, as this was a multicenter cross-sectional study.

Participants in this study were ambulatory patients aged 60–85 years who were being treated by doctors of the Society during 1–7 October 2018. Patients who lived independently at home were included in the study, but those with certification for long-term care or who were hospitalized were excluded.

Of 1587 potential targeted ambulatory patients, 1423 agreed to be interviewed in the study and 164 declined (Fig. 1). After excluding 162 patients with missing data, data on a total of 1261 patients (79.5%) were valid for analysis. The distribution of medical institutions from which these patients were selected is presented by prefecture in Japan (Fig. 2). However, there were multiple medical institutions that overlapped in one prefecture.

2.2. Study design

This was a multicenter cross-sectional study for ambulatory patients who were being treated by doctors of the Society. The study procedure, analysis, and description were based on the STROBE (the Strengthening the Reporting of Observational Studies in Epidemiology) statement.¹⁴

2.3. Outcome measurements: occurrence of underlying diseases

After the patient was initially treated for their underlying disease in an examination room, the doctor recorded information directly on the interview sheet while reviewing the medical records and listening to the patient. The total time for recording this information ranged from 30 s to 2 min.”

We set occurrence of underlying diseases as the main outcome and dependent (criterion) variable. We scored the number of diseases, one disease per point. Underlying diseases were identified based on two

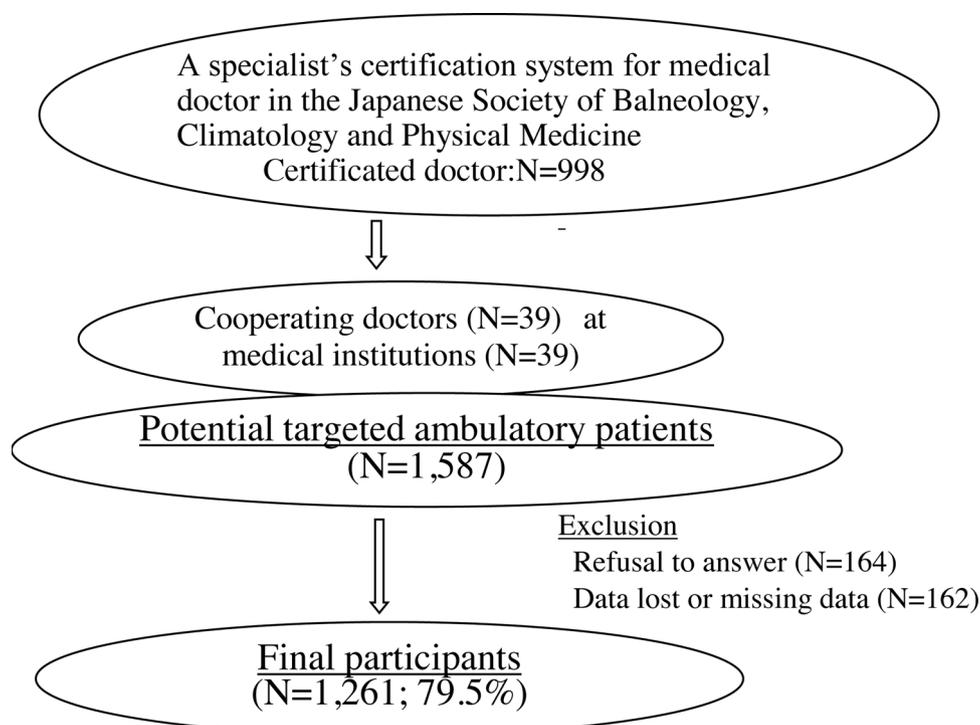


Fig. 1. Participant recruitment.

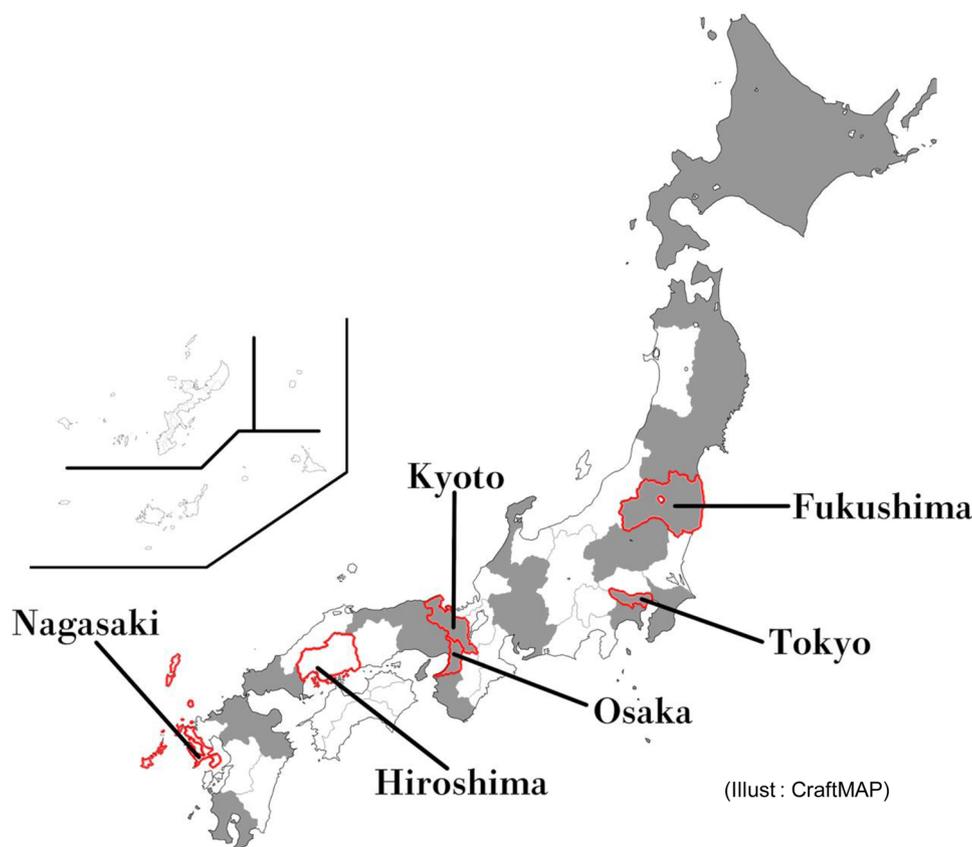


Fig. 2. Distribution of medical institutions as setting of research by prefecture in Japan.

sources. The first source was the International Statistical Classification of Diseases and Related Health Problems (ICD-11). The following chapters in ICD-11 were referenced: Chapter 2, Neoplasms; Chapter 4, Diseases of the blood or blood-forming organs; Chapter 5, Endocrine, nutrition, or metabolic diseases; Chapter 6, Mental, behavioral or neurodevelopmental disorders; Chapter 8, Diseases of the nervous system; Chapter 11, Diseases of the circulatory system; Chapter 12, Diseases of the respiratory system; Chapter 13, Diseases of the digestive system; Chapter 14, Diseases of the skin; and Chapter 15, Diseases of the musculoskeletal system or connective tissue. Specifically, the following diseases were identified: hypertension, hypotension, cardiac failure, peripheral circulatory disturbance, sensitivity to cold, arterial obstructive disease, collagen disease, Raynaud's disease, anemia, ischemic organ derangement, rheumatoid arthritis, noninflammatory rheumatism, chronic inflammatory rheumatism, hypercholesterolemia, hyperlipidemia, hyperuricemia (including gout), glucose intolerance (including diabetes mellitus), hyperthyroidism, obesity, climacteric disturbance, autonomic instability, neurotic disorder, cerebrovascular disease, pulmonary emphysema, chronic obstructive pulmonary disease, asthma, atrophic gastritis, reflux esophagitis, constipation, kidney injury, gastroduodenal ulcer, gastrointestinal symptom, hemorrhoid, xerosis, psoriasis vulgaris, atopic dermatitis, pressure ulcer, insomnia, depression, low back pain, osteoarthritis, bone disease (including all parts), joint disease, fibromyalgia, chronic pain, chronic fatigue syndrome, and malignant tumor (including all body parts).

The second source was a book entitled *Balneology, Climatology and Physical Medicine* (in Japanese) published by the Japanese Society of Balneology, Climatology and Physical Medicine in 2014. From this source, we adopted the section “Medical treatment for specific diseases”.

Finally, the total number of underlying diseases was calculated and scored as point(s).

2.4. Definition of daily hot water bathing at home (DHW) and hot water spa bathing (HSPA)

The terms “balneotherapy”, “hydrotherapy”, and “spa therapy” are frequently confused and tend to be used interchangeably; furthermore the meaning of these words varies depending on the country and culture.¹⁵ We defined each type of bathing as follows, referring to terminology from recent studies.^{1,16–18}

In this study, we defined HSPA as immersion in mineral and/or thermal waters from natural springs, based on the Japanese hot spring law standards. In Japan, a hot spring is hot water (at least 25 °C) that comes out from the ground, and can include mineral water, steam, and other gases (excluding natural gas whose main component is hydrocarbons). Even if the water temperature is 25 °C or less, if it contains one or more of 19 specified dissolved substances, it is a hot spring in Japan. We assumed that natural gases and peloids (mud) do not exist extensively in Japan, and we therefore did not include these exposures. Accordingly, we defined HSPA as just taking a bath (i.e., immersion).

We defined DHW as taking a bath to soak in the bathtub, regardless of whether normal tap water or hot spring water was used. We did not regulate the water temperature.

2.5. Primary explanatory variables

We set frequency and time in DHW and frequency of HSPA as explanatory variables along with the occurrence of underlying diseases. This information was recorded by the doctors conducting interviews.

2.6. Covariates (demographic factors)

The covariates were only sex, age, and other explanatory variables (i.e., other frequency or time on each bathing). In clinical practice, the

time to face a patient is extremely short and it is ethically problematic to put a heavy time burden on them. Furthermore, it was assumed that fewer doctors would participate as the number of items increased and became complicated. Since the priority of this study was feasibility, we did not plan to survey other items (e.g., potential confounding factors and effect modifiers).

2.7. Ethical considerations and clinical trial registration

Checked-style informed consent was obtained from all participants. The style was adapted to reduce the mental and physical burden on patients, who initially came to the hospital to be examined because they had symptoms such as pain or an uncomfortable feeling. The methodology (protocol) of this study was fixed on 16 June 2018 and approved by the Ethics Board of Tokyo University of Agriculture (No.1809).

The study was registered as UMIN 000033018 by the University Hospital Medical Information Network Clinical Trials Registry (UMIN-CTR) in Japan (refer: https://upload.umin.ac.jp/cgi-open-bin/ctr/ctr_view.cgi?recptno=R000037643).

2.8. Statistical analysis

A two-sample *t* test was employed for comparisons between groups with continuous variables in the analysis. The χ^2 test and the Mann-Whitney test were performed with discrete variables.

To examine the association between frequency and time of DHW and HSPA as the explanatory variables and occurrence of underlying diseases as the dependent variable, multiple logistic regression analysis was carried out for each frequency and time, adjusted age, sex, and other explanatory variables. We set “4 pts. and more versus 3 pts. and less” based on the mean value of the dependent variable as the cut-off point for analysis. In clinical practice, there is no criterion for excessive number of underlying diseases. In this study, when the number of underlying diseases was larger than the average value (i.e., 4 pts.), it was considered that the patients had excessive numbers of diseases.

In addition, in order to increase the sensitivity of the multiple logistic model, integration was performed to be in three or four categories in each explanatory variable. Odds ratio (OR) and 95% confidence interval (95% CI) were calculated. Subgroup analysis was not planned.

All statistical analyses were performed with IBM SPSS Statistics 20.0 (IBM Corporation, Armonk, NY, USA) and EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan),¹⁹ which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). More precisely, it is a modified version of R commander designed to add statistical functions frequently used in biostatistics. For all analyses, *P*-values less than 0.05 were considered statistically significant.

3. Results

There was no significant difference in age between males ($n = 508$, 72.8 ± 6.8 years) and females ($n = 753$, 73.5 ± 6.9 years) in this study (Table 1). Regarding sex and the number of underlying diseases, there was no significant difference between males (2.7 ± 2.0 pts.) and females (2.7 ± 2.1 pts.). At the individual disease level, there were significant differences between sexes for the following 16 diseases: sensitivity to cold, other cardiovascular diseases, rheumatoid arthritis, hypercholesterolemia, hyperlipidemia, hyperuricemia, glucose intolerance, cerebrovascular disease, other nervous system diseases, pulmonary emphysema, chronic obstructive pulmonary disease, constipation, insomnia, osteoarthritis, bone disease, and other locomotive diseases. The diseases for which a significant difference in sex was detected well reflected the general population prevalence of those diseases in both sexes.

There were no significant differences between males and females for any of the patient characteristics regarding DHW and HSPA (Table 2).

For daily bathing, few patients used only a shower, while many patients immerse in a bathtub filled with hot tap water every day. This pattern reflects the bathing characteristics at home for middle-aged people in Japan. The frequency of hot water spa use varied, with 42% of patients using it no more than once a year.

Logistic regression analysis demonstrated that frequency and time on DHW were not associated with the occurrence of underlying diseases (Table 3). In Model 2, compared with participants who utilized hot spa at least once a week, the occurrence of underlying diseases was significantly associated with bathing frequency: one to three times per month (OR 2.72, 95% CI 1.63–4.52), and twice or five times a year (OR 1.92, 95% CI 1.25–2.94); exception was once a year (OR 1.25, 95% CI 0.83–1.89). The *p*-value for the overall trend was 0.712.

4. Discussion

In the long history of balneology in Japan, there has been no research that utilized large-scale data about the use of hot springs to reduce diseases. This is the first multicenter cross-sectional study in Japan to utilize a large patient data source to explore the relationship of DHW and HSPA with underlying diseases in middle-aged and elderly ambulatory patients.

One finding from this study was that doctors could use medical records (i.e., charts and other reliable data) to accurately identify the number of underlying diseases for large patient populations.

4.1. Relationship of various diseases with HSPA

This study revealed that a higher frequency of HSPA was associated with a lower number of diseases. Although there are many hot springs in Japan, hot spring facilities that citizens can easily use are extremely limited. A previous case-control study showed that the occurrence rates of death and bone fracture were significantly lower in subjects with twice or more utilization per year of a hot water spa compared with participants who utilized a hot water spa once or less per year; cerebral apoplexy also showed a slightly significant relationship.²⁰ Additionally, a cross-sectional study demonstrated that people who go to hot spring facilities more than once a month have significantly higher subjective happiness.²¹ The current study may be consistent with these previous studies.

However, because this was a cross-sectional study that could not clarify causal relationships, we speculate that there are two possible reasons for the relationship between hot water spa bathing and number of diseases: i) because people often go to hot springs, they have less illness, and ii) people can go to a hot spring because they have few diseases. In support of the first argument, a previous case-control study²⁰ described that the use of hot water spa reduced the occurrence of deaths, bone fractures, and strokes in multiple logistic analysis that adjusted exercise habits and quality of life at baseline.

A review of studies on balneotherapy in combination with standard care for a disease suggested that there were positive effects of the combined balneotherapies on diabetes, rheumatoid arthritis, osteoarthritis, psoriasis vulgaris, atopic dermatitis, ankylosing spondylitis, stiff neck, chronic back pain, peripheral circulatory failure, emphysema, bronchial asthma, and fibromyalgia syndrome.²² This study demonstrated the usefulness of hot water spa as integrative medicine. Additionally, a cross-sectional study on the use of hot spa by ambulatory orthopedic patients concluded that the patients had positive opinions about the effects of hot spa and actually visited hot spas.²³ In particular for chronic pain such as osteoarthritis,^{17,24,25} the study demonstrated hot water spa's positive effect and its high acceptability combined with ordinary treatment.

On the other hand, patients in our study who did not take hot water spa even once a year tended to have fewer underlying diseases. Even among Japanese, there are people who do not like hot water spa bathing or do not like to take a bath in groups. There are also people

Table 1
Participant characteristics and underlying diseases.

	Total (N = 1261)	Male (N = 508)	Female (N = 753)	P-value ^a
	Mean ± SD or N (%)	Mean ± SD or N (%)	Mean ± SD or N (%)	
Age (yrs.)	73.2 ± 6.9	72.8 ± 6.8	73.5 ± 6.9	0.091
60-69	420 (33.3%)	183 (36.0%)	237 (31.5%)	
70-79	546 (43.3%)	214 (42.1%)	332 (44.1%)	
80-85	295 (23.4%)	111 (21.9%)	184 (24.4%)	
Number of underlying diseases	2.7 ± 2.0	2.7 ± 2.0	2.7 ± 2.1	0.841
Hypertension	674 (53.4%)	287 (56.5%)	387 (51.4%)	0.085
Hypotension	4 (0.3%)	2 (0.4%)	2 (0.3%)	1.000
Cardiac failure	29 (2.3%)	14 (2.8%)	15 (2.0%)	0.486
Peripheral circulatory disturbance	30 (2.4%)	10 (2.0%)	20 (2.7%)	0.550
Sensitivity to cold	62 (4.9%)	17 (3.3%)	45 (6.0%)	0.047
Arterial obstructive disease	16 (1.3%)	10 (2.0%)	6 (0.8%)	0.117
Collagen disease	8 (0.6%)	3 (0.6%)	5 (0.7%)	1.000
Raynaud's disease	1 (0.1%)	1 (0.2%)	0 (0.0%)	0.843
Other cardiovascular diseases	111 (8.8%)	61 (12.0%)	50 (6.6%)	0.001
Anemia	31 (2.5%)	12 (2.4%)	19 (2.5%)	1.000
Ischemic organ derangement	3 (0.2%)	2 (0.4%)	1 (0.1%)	0.736
Rheumatoid arthritis	138 (10.9%)	26 (5.1%)	112 (14.9%)	0.000
Noninflammatory rheumatism	5 (0.4%)	3 (0.6%)	2 (0.3%)	0.657
Chronic inflammatory rheumatism	4 (0.3%)	1 (0.2%)	3 (0.4%)	0.909
Hypercholesterolemia	96 (7.6%)	28 (5.5%)	68 (9.0%)	0.028
Hyperlipidemia	334 (26.5%)	108 (21.3%)	226 (30.0%)	0.001
Other blood and immune diseases	25 (2.0%)	10 (2.0%)	15 (2.0%)	1.000
Hyperuricemia (including gout)	67 (5.3%)	55 (10.8%)	12 (1.6%)	0.000
Glucose intolerance (including diabetes mellitus)	238 (18.9%)	122 (24.0%)	116 (15.4%)	0.000
Hyperthyroidism	9 (0.7%)	4 (0.8%)	5 (0.7%)	1.000
Obesity	43 (3.4%)	15 (3.0%)	28 (3.7%)	0.564
Climacteric disturbance	4 (0.3%)	0 (0.0%)	4 (0.5%)	0.257
Other metabolic diseases	14 (1.1%)	3 (0.6%)	11 (1.5%)	0.241
Autonomic instability	23 (1.8%)	5 (1.0%)	18 (2.4%)	0.106
Neurotic disorder	5 (0.4%)	2 (0.4%)	3 (0.4%)	1.000
Cerebrovascular disease	54 (4.3%)	38 (7.5%)	16 (2.1%)	0.000
Other nervous system diseases	34 (2.7%)	20 (3.9%)	14 (1.9%)	0.040
Pulmonary emphysema	9 (0.7%)	9 (1.8%)	0 (0.0%)	0.001
Chronic obstructive pulmonary disease	16 (1.3%)	15 (3.0%)	1 (0.1%)	0.000
Asthma	60 (4.8%)	26 (5.1%)	34 (4.5%)	0.720
Other respiratory diseases	31 (2.5%)	16 (3.1%)	15 (2.0%)	0.264
Atrophic gastritis	57 (4.5%)	21 (4.1%)	36 (4.8%)	0.686
Reflux esophagitis	100 (7.9%)	34 (6.7%)	66 (8.8%)	0.219
Constipation	97 (7.7%)	28 (5.5%)	69 (9.2%)	0.023
Kidney injury	15 (1.2%)	8 (1.6%)	7 (0.9%)	0.440
Hemorrhoid	19 (1.5%)	10 (2.0%)	9 (1.2%)	0.384
Gastroduodenal ulcer	16 (1.3%)	8 (1.6%)	8 (1.1%)	0.589
Gastrointestinal symptom	22 (1.7%)	7 (1.4%)	15 (2.0%)	0.550
Other gastrointestinal diseases	78 (6.2%)	39 (7.7%)	39 (5.2%)	0.092
Xerosis	26 (2.1%)	13 (2.6%)	13 (1.7%)	0.413
Pressure ulcer	2 (0.2%)	2 (0.4%)	0 (0.0%)	0.317
Psoriasis vulgaris	4 (0.3%)	3 (0.6%)	1 (0.1%)	0.364
Atopic dermatitis	6 (0.5%)	4 (0.8%)	2 (0.3%)	0.366
Other skin diseases	23 (1.8%)	8 (1.6%)	15 (2.0%)	0.743
Insomnia	95 (7.5%)	26 (5.1%)	69 (9.2%)	0.010
Depression	20 (1.6%)	7 (1.4%)	13 (1.7%)	0.798
Other mental behavior disorders	10 (0.8%)	1 (0.2%)	9 (1.2%)	0.102
Low back pain	187 (14.8%)	78 (15.4%)	109 (14.5%)	0.726
Osteoarthritis	147 (11.7%)	45 (8.9%)	102 (13.5%)	0.014
Bone disease (including all parts)	51 (4.0%)	9 (1.8%)	42 (5.6%)	0.001
Joint disease	43 (3.4%)	14 (2.8%)	29 (3.9%)	0.372
Fibromyalgia	10 (0.8%)	4 (0.8%)	6 (0.8%)	1.000
Chronic pain	22 (1.7%)	10 (2.0%)	12 (1.6%)	0.780
Chronic fatigue syndrome	0 (0.0%)	0 (0.0%)	0 (0.0%)	1.000
Other locomotive diseases	110 (8.7%)	33 (6.5%)	77 (10.2%)	0.028
Malignant tumor	48 (3.8%)	21 (4.1%)	27 (3.6%)	0.727
Other disease	62 (4.9%)	28 (5.5%)	34 (4.5%)	0.503

^aCompares prevalences by sex using *t*-test for age, Mann-Whitney test for occurrence of underlying diseases, and χ^2 -test for others.

^bCompares prevalences by sex using χ^2 -test for each disease.

who cannot take a hot water spa due to illness or physical reasons, and there are still Japanese-specific rules that prohibit people with a tattoo from using hot spring facilities. Thus, the contradiction between not taking hot spas even once a year and having few underlying diseases may be explained by this background in Japan.

4.2. Relationship between medical expenses and HSPA

Epidemiological research on hot water spa, especially in medical economics, requires evidence to support a reduction in the amount of drugs and hospital visits based on hot spa bathing, which would thereby

Table 2
Participant characteristics for daily hot water bathing at home and hot water spa bathing.

Primarily explanatory variables	Total (N = 1261) n (%)	Male (N = 508) n (%)	Female (N = 753) n (%)	P-value*
Frequency of daily hot water bathing at home				0.272
≥ 2 times/day	43 (3.4%)	14 (2.8%)	29 (3.9%)	
7 times/week	871 (69.1%)	344 (67.7%)	527 (70.0%)	
6 times/week	43 (3.4%)	16 (3.1%)	27 (3.6%)	
4-5 times/week	120 (9.5%)	59 (11.6%)	61 (8.1%)	
2-3 times/week	143 (11.3%)	61 (12.0%)	82 (10.9%)	
≤ once/week	41 (3.3%)	14 (2.8%)	27 (3.6%)	
Time of daily hot water bathing at home				0.290
≥ 20 min.	200 (15.9%)	69 (13.6%)	131 (17.4%)	
15-19 min.	193 (15.3%)	80 (15.7%)	113 (15.0%)	
10-14 min.	244 (19.3%)	110 (21.7%)	134 (17.8%)	
5-9 min.	304 (24.1%)	121 (23.8%)	183 (24.3%)	
≤ 5 min.	223 (17.7%)	89 (17.5%)	134 (17.8%)	
Only showering	94 (7.5%)	39 (7.7%)	55 (7.3%)	
Others	3 (0.2%)	0 (0.0%)	3 (0.4%)	
Frequency of hot water spa bathing				0.732
≥ 6 times/week	93 (7.4%)	31 (6.1%)	62 (8.2%)	
4-5 times/week	15 (1.2%)	6 (1.2%)	9 (1.2%)	
2-3 times/week	44 (3.5%)	20 (3.9%)	24 (3.2%)	
once/week	37 (2.9%)	12 (2.4%)	25 (3.3%)	
2-3 times/month	57 (4.5%)	23 (4.5%)	34 (4.5%)	
once/month	90 (7.1%)	41 (8.1%)	49 (6.5%)	
4-5 times/year	150 (11.9%)	65 (12.8%)	85 (11.3%)	
2-3 times/year	244 (19.3%)	101 (19.9%)	143 (19.0%)	
≤ once/year	531 (42.1%)	209 (41.1%)	322 (42.8%)	

*Compares prevalences by sex for frequency and time of daily hot water bathing at home and frequency of hot water spa bathing.

reduce rising national medical expenses. From the present study, we can make inferences about the potential medical cost reductions, but we have no firm evidence.

Some previous studies have investigated cost-effectiveness.^{26–28} Combined spa-exercise therapy combined with standard treatment with drugs and weekly group physical therapy was more effective and showed favorable cost-effectiveness and cost-utility compared with standard treatment only in patients with ankylosing spondylitis.²⁶ Spa treatment for fibromyalgia temporarily improved symptoms and health-related quality of life and was associated with limited incremental costs per patient.²⁷ A randomized controlled trial reported that mud-bath therapy in addition to standard treatment in patients with knee osteoarthritis provided significant improvement in painful symptoms and functional capacities compared to standard treatment alone.

In addition, it provided a favorable economic profile.²⁸

There are previous studies on nursing care certification in Japan that are relevant to the effects of hot water spa bathing. First, as a result of regional diagnostic research, it may be possible that hot spa is useful for nursing care prevention, but one study described the magnitude of variability in the data for which sufficient adjustment had not been made, and therefore it would be necessary to provide detailed verification in later studies.²⁹ Second, a 5-year cohort study found that HSPA was significantly related to the degree of independence (i.e., care prevention) of elderly people, but confounding factors were not adequately adjusted.³⁰ And third, a well-designed community diagnostic study compared medical expenses for the aged, nursing care expenses, the percentage of advanced nursing care, life expectancy, and spa-related variables among rural governments in the same class based on

Table 3
Odds ratio (95% confidence interval) for occurrence of underlying diseases according to frequency and time of daily hot water bathing at home and frequency of hot water spa bathing (N = 1261).

Primarily explanatory variables	Crude	P for trend	Model 1 (adjusted)	P for trend	Model 2 (adjusted)	P for trend
A: Frequency of daily hot water bathing at home vs ≥ 7 times/week	1.0 (ref.)	0.887	1.0 (ref.)	0.757	1.0 (ref.)	0.984
4-6 times/week	1.24 (0.86-1.78)		1.23 (0.85-1.78)		1.21 (0.83-1.77)	
≤ 3 times/week	0.96 (0.67-1.38)		0.88 (0.60-1.27)		0.94 (0.64-1.37)	
B: Time of daily hot water bathing at home vs > 15 min.	1.0 (ref.)	0.722	1.0 (ref.)	0.817	1.0 (ref.)	0.346
5-15 min.	0.85 (0.63-1.14)		0.83 (0.62-1.12)		0.84 (0.62-1.14)	
< 5 min. or only showering	1.08 (0.78-1.50)		1.06 (0.76-1.47)		1.21 (0.86-1.71)	
C: Frequency of hot water spa bathing vs ≥ once/week	1.0 (ref.)	0.784	1.0 (ref.)	0.611	1.0 (ref.)	0.712
1-3 times/month	2.11 (1.29-3.45) **		2.58 (1.56-4.27) **		2.72 (1.63-4.52) **	
2-5 times/year	1.70 (1.12-2.58) *		1.83 (1.20-2.79) **		1.92 (1.25-2.94) **	
≤ once/year	1.21 (0.81-1.82)		1.22 (0.81-1.84)		1.25 (0.83-1.89)	
Model 1.	Covariate included sex and age.					
Model 2.	Covariate included sex, age, and other explanatory variables#.					

When A was the primary explanatory variable, variables of B and C were covariate. Similarly, the other variables were covariates.

* p < 0.05.

** p < 0.01.

national criteria in order to clarify the factors that affect medical and nursing care expenses.³¹ It determined that correlations with the indices for hot water spa use among medical expenses for the aged and nursing care expenses were low. It is possible that medical and nursing care expenses have a mutually complementary relationship in elderly people. Therefore, the previous and current studies suggest that a well-controlled and large-scale survey on actual medical expenses and hot spa usage frequency of patients is necessary.

4.3. Relationship of various diseases with DHW

DHW was not related directly to the occurrence of underlying diseases in the present study. Japanese people, especially the middle-aged and elderly, may have had no differences in the frequency and time of DHW because they originally had a bathing habit. A previous study reported that bathing in a bathtub every day or more frequently was associated with a good state of self-rated health and sleep quality.¹⁰ A single-arm intervention study described that a 12 day balneotherapy program had a positive effect on pain, mood, sleep, quality of life, and depression in healthy elderly people.³²

It seems contradictory to our finding that bathing habits were not related to the occurrence of underlying diseases, but it might be explained by the following. First, we did not evaluate sleep and subjective health in our study, and second, participants in our study were limited to middle-aged and elderly ambulatory patients.

A cross-sectional study compared bathing habits between Japanese living in Kyoto and Japanese Americans living in Los Angeles.³³ For Japanese Americans, the main purpose of bathing at home was to clean the body by taking showers of short duration (6–10 min) in the morning or evening. On the contrary, for Japanese, the purpose of bathing was to clean and heal the body in the evening and therefore their bathing time was longer (26–30 min.) than that of Japanese Americans.

Regarding other bathing methods for health enhancement, sauna bathing is very popular in Scandinavia, Europe, and especially Finland. A recent systematic review showed that regular infrared and/or Finnish sauna bathing had the potential to provide many beneficial health effects, especially for those with cardiovascular-related and rheumatological diseases, as well as for athletes seeking improved exercise performance.³⁴ It explained that the mechanisms for these effects may include increased bioavailability of nitric oxide (NO) to vascular endothelium, heat shock protein-mediated metabolic activation, immune and hormonal pathway alterations, enhanced excretions of toxicants through increased sweating, and other hormetic stress responses. Exposure to hot water bathing to warm the whole body except for the head has similar effects, so the mechanism of action is considered to be similar.

A new report³⁵ found that sauna bathing is associated with a reduction in the risk of vascular diseases, such as high blood pressure and cardiovascular disease, neurocognitive diseases, nonvascular conditions, such as pulmonary diseases, mental health disorders, and mortality. Furthermore, sauna bathing alleviated conditions such as skin diseases, arthritis, headache, and flu. The evidence also suggests that regular sauna baths are associated with a better health-related quality of life.

4.4. External validity

Even when considering only clinical trials, there has been much research that utilized hot water spa. Spa therapy is a very popular form of treatment for all types of arthritis or related diseases in many European countries, as well as in Israel and Japan.^{36–41} Additionally, the studies have tried to clarify its effectiveness for many diseases such as atopic dermatitis,⁴² hypertension and obesity,⁴³ anxiety disorder,⁴⁴ chronic inflammatory gynecological disorder,⁴⁵ and other diseases.^{7,8} For those people whose bathing culture includes hot water spa, the content of our research will be accepted. They perceive hot water spa as

highly safe for the human body and easily accessible through their country's abundant natural resources. Therefore, it will be increasingly necessary to build evidence for the effectiveness of hot spa as a prevention of disease and a complementary effect of treatment, as well as to improve the means for enhancing treatment compliance.

5. Limitation

Despite the novelty of the present study, there were several methodological limitations. First, the study was cross-sectional, so we were unable to address causality because it was difficult to clearly explain a mechanism by which hot water immersion prevents underlying diseases. Well-designed cohort or case-controlled studies are therefore required for future research. Second, sampling bias is common across a cross-sectional study. Because we did not set eligibility criteria for the medical institutions (types of hospitals and departments) and we restricted the study to a short investigation period, the population of participants might have been ambiguous. Third, the self-responses about bathing habits might have been subject to recall and response bias. Fourth, because we did not investigate other risks and confounding factors that were not included as covariates in this study, it is possible that other important determinants of underlying diseases were overlooked. Fifth, in the setting of this study, since the multiplied value of the frequency and time of DHW was not shown and the duration of exposure was not set as a variable, the overall effectiveness of bathing is unknown. Finally, it is important to know which diseases are closely related to HSPA, but since this was not defined as the original research question, it could not be analyzed post-study. In order to clarify this question, it has to be defined carefully as part of a future study.

6. Conclusion

Lower frequency of HSPA was significantly associated with increased risk of the occurrence of underlying diseases in middle-aged and elderly ambulatory patients. The relationship between proactive use of hot water spa and patients' mental and physical support should be clarified by well-designed cohort studies.

Contributors

Prof. Hiroharu Kamioka, Dr. Yasunori Mori, Dr. Katsutaro Nagata, Dr. Shigeaki Iwanaga, Prof. Masahiko Uzura, Dr. Satoru Yamaguchi. HK (steering author) conceived the study. YM performed the statistical analyses. KN, SI, MU, and SY confirmed medical items on the check sheet. All authors read and approved the manuscript.

Funding

This study was supported by the Japanese Society of Balneology, Climatology and Physical Medicine (President: Dr. Naoki Makino) in 2018. We would like to express our appreciation for their support.

Competing interests

None declared.

Ethical approval

The methodology of this study was approved by the Ethics Board of Tokyo University of Agriculture (No.1809).

Data sharing

No additional data available.

Acknowledgments

We received enormous cooperation from the Organization of Balneotherapists in the Japanese Association of Balneology, Climatology, and Physical Medicine (President: Dr. Toshio Mitomo) for this research. We would like to take this opportunity to express our gratitude. And we would like to express our appreciation to all the doctors who cooperated: Dr. Kozo Ashida, Dr. Miyuki Abe, Dr. Hideki Amma, Dr. Miyoshi Itoh, Dr. Hiroki Inoue, Dr. Yujiro Iwao, Dr. Tatsuo Iwashita, Dr. Toshiki Ohhira, Dr. Izumi Ono, Dr. Mitsuhiro Kamimura, Dr. Shinichiro Kuwano, Dr. Seiichiro Kojima, Dr. Toshimasa Sakakibara, Dr. Shinji Sakano, Dr. Moto Sasaki, Dr. Kazutoshi Sato, Dr. Atsushi Shitara, Dr. Naoki Shiraiishi, Dr. Kaoru Takahashi, Dr. Yasuhiro Takitani, Dr. Masakazu Tada, Dr. Nobuhiko Tsugawa, Dr. Shunichi Nagai, Dr. Hironari Nakano, Dr. Katsuhisa Nishi, Dr. Katsuyuki Nishigori, Dr. Kotaro Nishizawa, Dr. Akihito Hayashi, Dr. Maho Hirakawa, Dr. Kunio Maeguchi, Dr. Ikuko Masuda, Dr. Takashi Murayama, Dr. Masamitsu Yagita, Dr. Koki Yamanaka, Dr. Tomotaka Yoshida, Dr. Koichiro Yoda, Dr. Takao Watanabe, Dr. Naoto Watanabe, Dr. Hiromi Watanabe, Dr. Hisatake Iwanami, Dr. Hideo Takahashi, Dr. Shinichi Ichikawa, Dr. Kenji Oku, Dr. Misako Kaido, and Dr. Yasuo Katsuki. We are thankful for the generous assistance provided by Ms. Michiko Ishida (paper-work), Mr. Shun Nakamura (data input and graphic creation), Dr. Jun Kitayuguchi (support of statistical analysis), and Ms. Mari Makishi (searches of studies).

References

- Fioravanti A, Karagülle M, Bender T, Karagülle MZ. Balneotherapy in osteoarthritis: Facts, fiction and gaps in knowledge. *Eur J Integr Med.* 2017;9:148–150.
- Verhagen AP, Bierma-Zeinstra SMA, Boers M, et al. Balneotherapy (or spa therapy) for rheumatoid arthritis. *Cochrane Database Syst Rev.* 2015;2 CD000518.
- Verhagen AP, Bierma-Zeinstra SMA, Boers M, et al. Balneotherapy for osteoarthritis. *Cochrane Database Syst Rev.* 2008;4 CD006864.
- Kamioka H, Tsutani K, Okuizumi H, et al. Effectiveness of aquatic exercise and balneotherapy: a summary of systematic reviews based on randomized controlled trials of water immersion therapies. *J Epidemiol.* 2010;20:2–12.
- Cimbiz A, Bayazit V, Hallaceli H, Cavlak U. The effect of combined therapy (spa and physical therapy) on pain in various chronic diseases. *Complement Ther Med.* 2005;13:244–250.
- Antonelli M, Donelli D, Fioravanti A. Effects of balneotherapy and spa therapy on quality of life of patients with knee osteoarthritis: A systematic review and meta-analysis. *Rheumatol Int.* 2018;38:1807–1824.
- Kamioka H, Tsutani K, Maeda M, et al. Assessing the quality of study reports on spa therapy based on randomized controlled trials by the spa therapy checklist (SPAC). *Complement Ther Clin Pract.* 2014;20:317–333.
- Skaczkowski G, Moran J, Langridge J, Oatway K, Wilson C. Effect of a spa bath on patient symptoms in an acute palliative care setting: a pilot study. *Complement Ther Clin Pract.* 2018;32:100–102.
- Sekine M, Nasermoaddeli A, Wang H, Kanayama H, Kagamimori S. Spa resort use and health-related quality of life, sleep, sickness absence and hospital admission: the Japanese civil servants study. *Complement Ther Med.* 2006;14:133–143.
- Hayasaka S, Shibata Y, Goto Y, Noda T, Ojima T. Bathing in a bathtub and health status: a cross-sectional study. *Complement Ther Clin Pract.* 2010;16:219–221.
- Sakurai R, Fujiwara Y, Kin H, et al. A randomized controlled trial of the effects of a comprehensive intervention program for community-dwelling older adults. *Nippon Ronen Igakkai Zasshi Jpn J Geriatr.* 2011;48:352–360 (in Japanese with English abstract).
- Kamioka H, Nakamura Y, Okada S, et al. Effectiveness of comprehensive health education combining lifestyle education and hot spa bathing for male white-collar employees: a randomized controlled trial with 1-year follow-up. *J Epidemiol.* 2009;19:219–230.
- Kamioka H, Ohshiro H, Mutoh Y, et al. Effect of long-term comprehensive health education on the elderly in a Japanese village: Unnan cohort study. *Int J Sports Health Sci.* 2008;6:60–65.
- von Elm E, Altman DG, Egger M, et al. The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Ann Intern Med.* 2007;147:573–577.
- Gutenbrunner C, Bender T, Cantista P, Karagülle M. A proposal for a world wide definition of health resort medicine balneology, medical hydrology and climatology. *Int J Biometeorol.* 2010;54:495–507.
- Karagülle M, Kardes S, Karagülle MZ. Real-life effectiveness of spa therapy in rheumatic and musculoskeletal diseases: a retrospective study of 819 patients. *Int J Biometeorol.* 2017;61:1945–1956.
- Kardes S, Karagülle M, Geemen I, Adigüzel T, Yücesoy H, Karagülle MZ. Outpatient balneological treatment of osteoarthritis in older persons: a retrospective study. *Zeitschrift für Gerontologie und Geriatrie.* 2018. <https://doi.org/10.1007/s00391-018-1370-3>.
- Karagülle M, Kardeş S, Karagülle MZ. Long-term efficacy of spa therapy in patients with rheumatoid arthritis. *Rheumatol Int.* 2018;38:353–362.
- Kanda Y. Investigation of the freely available easy-to-use software "EZ" for medical statistics. *Bone Marrow Transplant.* 2013;48:452–458.
- Kagamimori S, Tatsue T, Nakatani Y, Matsubara I, Hirota N, Kajita E. Does the hot spring contribute to the active life expectancy? The 3 years follow-up survey in the J town which commenced health promotion facilities using hot spring. *J Jpn Soc Balneol Climatol Phys Med.* 2006;69:187–194 (in Japanese with English abstract).
- Goto Y, Hayasaka S, Nakamura Y. Health effects of seasonal bathing in hot water, seasonal utilization of hot spring facilities, and high green tea consumption. *J Jpn Soc Balneol Climatol Phys Med.* 2014;77:171–182.
- Wang H, Eboshida A, Kagamimori S. Balneotherapy in combination with other therapies. *J Jpn Soc Balneol Climatol Phys Med.* 2010;73:143–158 (in Japanese with English abstract).
- Yatabe Y. Use of hot springs by ambulatory orthopaedic patients. *J Jpn Soc Balneol Climatol Phys Med.* 2011;74:112–116 (in Japanese with English abstract).
- Karagülle M, Kardes S, Disci R, Gürdal H, Karagülle MZ. Spa therapy for elderly: A retrospective study of 239 older patients with osteoarthritis. *Int J Biometeorol.* 2016;60:1481–1491.
- Özkük K, Uysal B, Ateş Z, Ökmen BM, Sezer R, Dilek G. The effects of inpatient versus outpatient spa therapy on pain, anxiety, and quality of life in elderly patients with generalized osteoarthritis: a pilot study. *Int J Biometeorol.* 2018;62:1823–1832.
- Van Tubergen A, Boonen A, Landewe R, et al. Cost effectiveness of combined spa-exercise therapy in ankylosing spondylitis: A randomized controlled trial. *Arthritis Rheumatol.* 2002;47:459–467.
- Zijlstra TR, Braakman-Jansen LMA, Taal E, Rasker JJ, Van De Laar MAFJ. Cost-effectiveness of Spa treatment for fibromyalgia: General health improvement is not for free. *Rheumatology.* 2007;46:1454–1459.
- Ciani O, Pascarelli A, Giannitti C, et al. Mud-bath therapy in addition to usual care in bilateral knee osteoarthritis: an economic evaluation alongside a randomized controlled trial. *Arthritis Care Res.* 2017;69:966–972.
- Nobunaga M, Itoh K. Relationship between hot springs and the number of aged people needing care. *J Jpn Soc Balneol Climatol Phys Med.* 2004;67:257–263 (in Japanese with English abstract).
- Organization of Balneotherapists in Japanese Association of Balneology, Climatology, and Physical Medicine. Prospective Syrs cohort study on the correlation between bathing habit and need for long term care insurance of aged subjects. *J Jpn Soc Balneol Climatol Phys Med.* 2011;74:200–206 (in Japanese).
- Kamioka H, Okada S, Okuizumi H, Handa S, Kitayuguchi J, Kamada M. A pilot study of medical expenses among rural governments based on the national criteria: a focus to spa-related variables. *J Jpn Soc Balneol Climatol Phys Med.* 2011;74:81–90 (in Japanese with English abstract).
- Latorre-Roman PA, Rentero-Blanco M, Laredo-Agulilera JA, Garcia-Pinillos F. Effect of a 12-day balneotherapy programme on pain, mood, sleep, and depression in healthy elderly people. *Psychogeriatrics.* 2015;15:14–19.
- Yano T, Hiro M, Imanishi J, et al. Comparison of the habit of bathing between Japanese living in Kyoto and Japanese Americans living in Los Angeles. *J Jpn Soc Balneol Climatol Phys Med.* 2017;80:80–92 (in Japanese with English abstract).
- Hussain J, Cohen M. Clinical effects of regular dry sauna bathing: A systematic review. *Evid Based Complement Altern Med.* 2018:1857413.
- Laukkanen Jari A, Laukkanen Tanjaniina, Kunutsor Setor K. Cardiovascular and other health benefits of sauna bathing: a review of the evidence. *Mayo Clin Proc.* 2018;93(8):1111. <https://doi.org/10.1016/j.jmayocp.2018.04.008>.
- Nguyen M, Revel M, Dougados M. Prolonged effects of 3 week therapy in a spa resort on lumbar spine, knee and hip osteoarthritis: follow-up after 6 months. A randomized controlled trial. *Br J Rheumatol.* 1997;36:77–81.
- Frankel A, Reiner L, Pratzel HG. Long-term efficacy of radon spa therapy in rheumatoid arthritis: a randomized, sham-controlled study and follow-up. *Rheumatology.* 2000;39:894–902.
- Gremaux V, Benaïm C, Poiradeau S, Hérisson C, Dupeyron A, Coudeyre E. Evaluation of the benefits of low back pain patients' education workshops during spa therapy. *Jt Bone Spine.* 2013;80:82–87.
- Ciprian L, Lo Nigro A, Rizzo M, et al. The effects of combined spa therapy and rehabilitation on patients with ankylosing spondylitis being treated with TNF inhibitors. *Rheumatol Int.* 2013;33:241–245.
- Fioravanti A, Giannitti C, Bellisai B, Iacoponi F, Galeazzi M. Efficacy of balneotherapy on pain, function and quality of life in patients with osteoarthritis of the knee. *Int J Biometeorol.* 2012;56:583–590.
- Ozkurt S, Dönmez A, Zeki Karagülle M, Uzunoğlu E, Turan M, Erdoğan N. Balneotherapy in fibromyalgia: a single blind randomized controlled clinical study. *Rheumatol Int.* 2012;32:1949–1954.
- Farina S, Gisondi P, Zanoni M, et al. Balneotherapy for atopic dermatitis in children at Comano spa in Trentino, Italy. *J Dermatol Treat.* 2011;22:366–371.
- Oláh M, Koncz Á, Fehér J, et al. The effect of balneotherapy on antioxidant, inflammatory, and metabolic indices in patients with cardiovascular risk factors (hypertension and obesity) - a randomised, controlled, follow-up study. *Contemp Clin Trials.* 2011;32:793–801.
- Dubois O, Salamon R, Germain C, et al. Balneotherapy versus paroxetine in the treatment of generalized anxiety disorder. *Complement Ther Med.* 2010;18:1–7.
- Zámbó L, Dékány M, Bender T. The efficacy of alum-containing ferrous thermal water in the management of chronic inflammatory gynaecological disorders—a randomized controlled study. *Eur J Obstet Gynecol Reprod Biol.* 2008;140:252–257.