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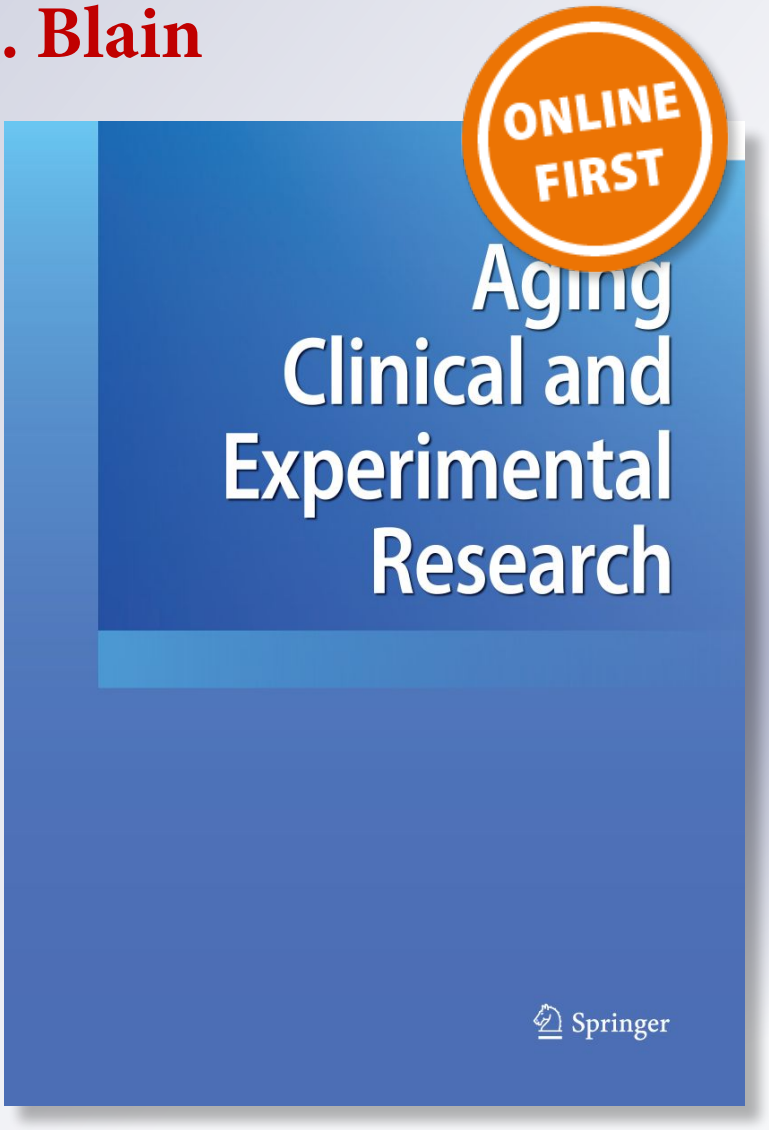

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ORIGINAL ARTICLE

Analysis of the health profiles and prevalence of falls for patients over 65 years of age in a thermal environment

P. L. Bernard[1] · N. Raffort[2] · B. Aliaga[2] · L. Gamon[3] · M. Faucanie[3] · M. C. Picot[3] · O. Maurelli[1] · L. Soriteau[4] · G. Ninot[5] · J. Bousquet[6] · H. Blain[1,7]

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Abstract

Background A falls prevention programme has been initiated in balneotherapy at Balaruc-les-Bains.

Aims To determine the health profiles of subjects who are at risk of falls, over 65 years of age and attending balneotherapy.

Methods Questionnaires were used to evaluate people on their fear of falling. Fatigue was assessed by visual analog scale as well as by functional status over the past 12 months. EQ-5D-3L, the IPAQ questionnaire and Fried's frailty scale were all used. Patients' functional capabilities were tested using the Unipedal stance test, the TUG test, the SPPB, the Tandem walking test and the isometric manual grip strength test.

Results Out of the 1471 patients (72.45 years ± 5.10), the women (67%) were tested. In the last 12 months, 485 of these 1471 patients fell (33%) and 37% of them suffered a severe injury. 45–50% of these subjects are now in good health. Women had a significantly higher impaired perception of their health than men ($0.02 < p < 0.0001$). According to Fried's criteria, 10.2% of the population is considered frail, with a significantly greater number of women ($p < 0.0001$). Static equilibrium was subnormal (less than 12 s during the TUG). The number of steps in tandem position discriminates individuals and gender as does the speed of moving from A to B and muscular strength.

Conclusions More than one-third of the subjects (more women than men) aged 65 or older visiting the Balaruc-les-Bains health resort are pre-frail or frail. They all have a recent history of falls, suffer from impaired muscle strength, and have balance and gait disorders.

Keywords Thermal environment · Elderly · Falls · Health perception · Functional capabilities

✉ P. L. Bernard
pierre-louis.bernard@umontpellier.fr

1 Euromov, University of Montpellier, 700 avenue du Pic Saint Loup, Montpellier, France

2 Société Publique Locale d'Exploitation of Balaruc-les-Bains, Balaruc-Les-Bains, France

3 Department of Medical Information, University Hospital of Montpellier, University de Montpellier 1, Montpellier, France

4 Hospital of Bassin de Thau, Sète, France

5 EA 4556 Epsylon, University of Montpellier, 4 boulevard Henri IV, Montpellier, France

6 MACVIA-LR, European Innovation Partnership on Active and Healthy Aging Reference Site, 34000 Montpellier, France

7 Department of Internal Medicine and Geriatrics, Antonin Balmes Center, University Hospital of Montpellier, Montpellier, France

Introduction

Maintaining autonomy in the elderly is a top priority objective. Developing sensory-motor skills is an important recommendation in active and autonomous life expectancy [1–4].

Balneotherapy is a non-medicinal therapeutic approach demonstrating its interest in rheumatoid arthritis [5, 6], osteoarthritis [7–10], occlusive arterial pathologies [11], sinusitis respiratory diseases [12], anxiety disorders [13, 14] and fibromyalgia [15]. Within this thermal environment, it is important to characterize the patients' functional profile. This approach then enables the balneotherapy treatment programmes to be adapted accordingly and prevents functional dysfunction, therefore avoiding potential factors for future dependence. Every year at Balaruc-les-Bains, 50,000 patients suffering from rheumatological or vascular diseases attend a balneotherapy treatment programme for a period

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of 3 weeks in accordance with the recommendations of the national health insurance fund.

Falls can be caused by rheumatic and phlebologic diseases. A falls prevention initiative has been introduced at Balaruc-les-Bains and the protocol has been published [16]. This project is sponsored by the Reference Site of the European Innovation Partnership on Active and Healthy Ageing—MACVIA (contre les MAladies Chroniques pour un VIeillissement Actif) [17]. One of the major aims of the MACVIA programme is to reduce the amount and severity of falls in the elderly [18, 19].

Falls are complex and multifactorial. Patients at risk of falls are usually old and frail. The functional profile of patients at risk of falls should also consider psychological, neuro-cognitive and social aspects. All these characteristics associated with falls and their severity are analyzed and differentiated by intrinsic and extrinsic factors, as well as by predisposing and precipitating factors [20–23].

The main objective of this preliminary cross-sectional study was to determine the health profile, the prevalence and the characteristics of falls in patients over 65 years of age attending balneotherapy treatment programmes at Balaruc-les-Bains.

Methods

This study was carried out within the Reference Site of the European Innovation Partnership on Active and Healthy Ageing—MACVIA. It was validated by the Internal Review Board (no. 16-04-05) of the University Hospital of Nimes (France). It was not registered, given that it was an observational non-interventional study.

Design of the study

This cross-sectional study is the first stage of a longitudinal study. Its aim is to assess the impact of the falls prevention educational programme on the balneotherapy falls patients. The baseline characteristics of the patients are presented in this paper.

Setting

Balneotherapy center of Balaruc-les-Bains, France.

Participants

From May to September 2016, 1707 patients were pre-included. Further to case stop ($n=2$), exclusions due to age ($n=25$), voluntary discontinuation ($n=1$) and absence of all assessments ($n=198$), 1471 of the patients were included in the study (Fig. 1).

Outcome measures

At the beginning of the balneotherapy programme, each patient was subjected to a series of questionnaires relating to his/her health and to the problem of the fall. A series of tests were also performed to measure functional capacity.

Questionnaires

People were evaluated on

- Their fear of falling—by visual analog scale rated from 0 to 10
- Their state of fatigue over the past month—by visual analog scale rated from 0 to 10
- Their perception of functional status over the last 12 months regarding fatigue, weakness, walking speed, level of activity, fragility and balance. They had to indicate their perceived state as better, worse or the same
- Fried's frailty scale according to the five criteria of weight loss, weakness, fatigue, slowness and decreased physical activity
    - The EQ-5D-3L questionnaire providing information on the state of health perceived that day
    - The IPAQ questionnaire providing information on the level of physical activity over the past 7 days

Functional ability assessment tests

Five complementary tests helped to determine postural, equilibrium, muscular and locomotor capacities:

- Unipedal test [24–26]: The aim was to remain for 10 s in unipedal stance on hard ground with eyes open, first on the dominant side and then on the non-dominant side. Only one measurement was taken and, after 30 s of recovery, the test was repeated on the opposite side.
- Timed up and go test [27, 28]: The objective was to do a 3-m round trip at a comfortable speed, with a half-turn, starting from a 45 cm high sitting position.
- Short physical performance battery [29–31]. This consists of three complementary tests—balance, gait speed and chair stands—providing an overall physical fitness score out of 12 points:
    - *Balance* maintaining a bipedal static position with eyes open on hard ground for 10 s under three increasingly stringent conditions: feet together, semi-

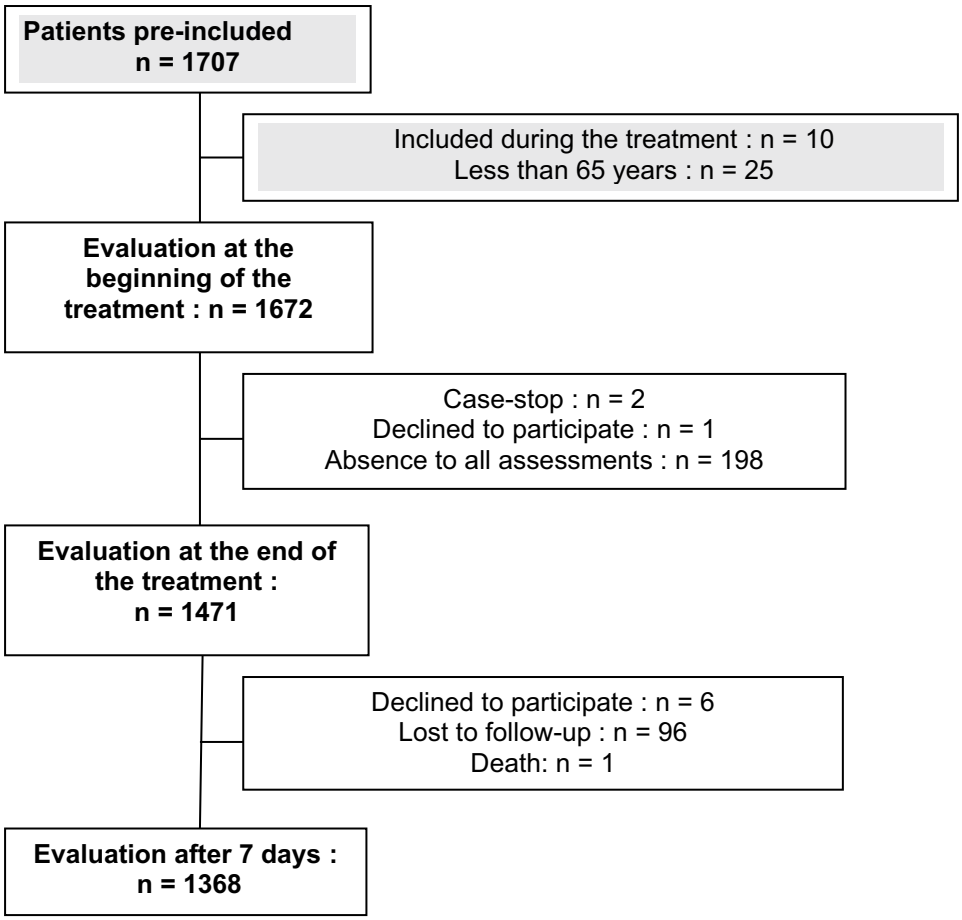

Fig. 1 Flowchart

tandem, then full tandem. Each test was conducted once and 30 s separated each part.
  - *Gait speed* walking for 4 meters, safely and at a comfortable speed. Only one attempt was allowed.
  - *Chair stands* doing five sit-stand exercises as quickly as possible. Only one attempt was allowed.

- Tandem walking test [32]. The goal was to achieve the maximum number of steps in the tandem position in a straight line for 10 s. Only one attempt was allowed.
- Manual grip strength test [33]. The objective was to achieve the maximum manual grip on a Jamar isometric dynamometer for 3 s. The test was performed in a sitting position, the forearm resting on a horizontal support with a 90° arm–forearm angle. The test was performed on the dominant side and the best of two attempts was registered.

Statistical analysis

The participants' characteristics were summarized by frequency and percentage for categorical variables and by mean and standard deviation for continuous variables. The comparisons between gender were made with Chi square analysis or Fisher's exact test if Chi square was not a valid test for categorical variables. For continuous variables, comparisons of means were performed using the Student test. The statistical software SAS (SAS Institute, Cary, NC, USA) was used for statistical analysis.

Results

Demographic characteristics

The average age of the study population was 72.45 years (±5.10) and 67% of the subjects were female. 70% were taking medication, 12% were participating in a treatment programme for the first time and 70% were on their third (or more) treatment programme. Anthropometric data are presented in Table 1.

Out of the total number of 1471 patients, 240 (16.32%) had a fall in the 3 months preceding the treatment. Out of these 240, 64 people were severely injured (26.7%), 18 of whom suffered a fracture. In the last 12 months, 485 patients fell (33%) with 180 of them suffering a severe injury (37%). 56 people had a fracture (3.8%) and 13 had trauma requiring

Table 1 Anthropometric data of the population

Variables	Participants	Mean (± SD)	Median (Q25; Q75)	Min–max
Years (yr)	1471	72.45 (± 5.10)	71.00 (69.00; 76.00)	65.00; 90.00
Weight (kg)	1471	71.77 (± 13.92)	70.00 (62.00; 80.0)	38.00; 128.00
Height (cm)	1471	163.95 (± 8.76)	163.00 (158.00; 170.00)	132.00; 190.00
History of falls	1471	3.41 (± 1.84)	4.00 (2.00; 5.00)	0.00; 11.00
Weight variation (1 yr)	1471	0.26 (± 2.88)	0.00 (− 1.00; 1.00)	− 16.00; 24.00

Table 2 History of falls and injuries in the year before the treatment and by gender

History of falls during last year	Women ($n=986$)	Men ($n=485$)	$p <$
One fall	343 (34.79%)	142 (29.28%)	0.04
At least two falls	183 (18.56%)	69 (14.23%)	0.04
Severe injury	130 (13.18%)	50 (10.31%)	NS
Minor injury	280 (28.40%)	107 (22.06%)	0.01

hospitalization (0.9%). 70% of the patients with severe injuries also suffered minor injuries.

The analysis by gender (Table 2) shows significant differences between the two groups in the number of patients who had at least one fall in the past year ($p < 0.04$) vs at least two falls ($p < 0.04$). The number of minor injuries is significantly different between the two groups ($p < 0.01$) but is not significant for severe injuries. With regard to the number of falls over 1 year, we observe a greater number of women ($p < 0.03$).

Health profile

Perception of health

By comparison to the previous year, among the 1471 patients, 46% reported to be "more tired", 57% to be "weaker", 50% to "walk slower", 46% to be "less active", 44% to be "more fragile" and 45% to have "poorer balance" (Table 3). Around 45% of the patients perceived an identical state of health. Women systematically expressed a significantly more impaired perception of health for the six variables.

Frailty profile

Using the criteria of Fried, 10.27% of the patients were considered frail (Table 4) but no one presented the five criteria of fragility. We observed that 5.64% lost over 4.5 kg in 1 year and that 24.27% had a significant loss in the manual grip strength test and were below the first quintile, adjusted for sex. 37% revealed a loss of energy (VAS score above

Table 3 Perception of health and comparison by gender

Status	Modalities	Participants ($n=1471$)	Women ($n=986$)	Men ($n=485$)	$p <$
Fatigue	Less	154 (10.49%)	154 (10.49%)	52 (10.74%)	0.0001
	More	672 (45.78%)	502 (51.02%)	170 (35.12%)	
	Equal	642 (43.73%)	380 (38.62%)	262 (54.13%)	
Weakness	Less	99 (7.74%)	55 (5.60%)	44 (9.07%)	0.0001
	More	835 (56.88%)	626 (63.68%)	209 (43.09%)	
	Equal	534 (36.38%)	302 (30.72%)	232 (47.84%)	
Walking speed	More	87 (5.91%)	57 (5.78%)	30 (6.19%)	0.006
	Less	730 (49.63%)	518 (52.54%)	212 (43.71%)	
	Equal	654 (44.46%)	411 (41.68%)	243 (50.10%)	
Activity	More	106 (7.24%)	64 (6.52%)	42 (8.70%)	0.02
	Less	681 (46.52%)	482 (49.13%)	199 (41.20%)	
	Equal	677 (46.24%)	435 (44.34%)	242 (50.10%)	
Fragility	Less	96 (6.54%)	60 (6.10%)	36 (7.44%)	0.0001
	More	643 (43.83%)	482 (49.03%)	161 (33.26%)	
	Equal	728 (49.63%)	441 (44.86%)	287 (59.30%)	
Balance	More	61 (4.15%)	40 (4.06%)	21 (4.33%)	0.001
	Less	668 (45.44%)	481 (48.83%)	187 (38.56%)	
	Equal	741 (50.41%)	464 (47.11%)	277 (57.11%)	

Table 4 Criteria of frailty expressed for total population and comparison by gender (Fried 2001)

Variable	Modalities	Participants ($n=1471$)	Women ($n=986$)	Men ($n=485$)	$p<$
Weight loss	No	1388 (94.36%)	935 (94.83%)	453 (93.40%)	0.27
	Yes	83 (5.64%)	51 (5.17%)	32 (6.60%)	
Weakness	No	1114 (75.73%)	741 (75.15%)	373 (76.91%)	0.46
	Yes	357 (24.27%)	245 (24.85%)	112 (23.09%)	
Exhaustion	No	923 (62.75%)	549 (55.68%)	374 (77.11%)	0.0001
	Yes	548 (37.25%)	437 (44.32%)	111 (22.89%)	
Slowness	No	1174 (79.81%)	787 (79.82%)	387 (79.79%)	0.99
	Yes	297 (20.19%)	199 (20.18%)	98 (20.21%)	
Physical inactive	No	1170 (79.54%)	786 (79.72%)	384 (79.18%)	0.81
	Yes	301 (20.46%)	200 (20.28%)	101 (20.82%)	
Frailty	Frail	151 (10.27%)	111 (11.26%)	40 (8.25%)	0.0001
	Pre-frail	794 (53.98%)	559 (56.69%)	235 (48.45%)	
	No frail	526 (35.76%)	316 (32.05%)	210 (43.30%)	

5) and 20% were much slower and had a reduced level of physical activity.

There are significant differences between men and women regarding fatigue ($p<0.0001$) and frailty ($p<0.0001$) profiles (Table 4). As the majority of the criteria are sex adjusted, we did not observe a non-significant difference.

Fitness profile

For the 1471 patients, unipedal stance averaged 7.5 s with median values (Q25-Q75) at 10 s for both sides (Table 5). The mean values of postural balance within the SPPB were between 9 and 10 s with a low-level variance for the first two positions. For the TUG, the average value was 11.7 s (±3.4). The unipedal and TUG tests showed similar results in both sexes. However, there was a significant difference in maintaining the tandem position ($p<0.0005$).

For locomotion of above 4 meters, the average value was 4.77 s (±1.66) with 465 patients (31.6%) walking less than 1 m per second in terms of average walking speed. The muscular profile evaluated by the chair stand test in the SPPB showed an average time of 15 s (±4.6), with 370 patients (25.1%) needing less than 12 s and a significant gender difference ($p<0.003$). The average value for the maximum manual isometric grip strength was 25.2 kilos (±9.82) with a significant gender difference ($p<0.0001$).

Table 5 Mean values, standard deviations, and gender comparison for physical fitness parameters

Variables	Effectif ($n=1471$)	Femmes ($n=986$)	Hommes ($n=485$)	p
Temps d'appui unipodal				
Tps cote dominant (s)	7.46 (±3.23)	7.40 (±3.27)	7.58 (±3.16)	0.33
Tps cote oppose (s)	7.73 (±3.11)	7.59 (±3.16)	8.01 (±3.00)	0.02
Tps le plus faible (s)	6.68 (±3.43)	6.59 (±3.44)	6.84 (±3.41)	0.19
Timed up and go				
Temps (s)	11.69 (±3.42)	11.81 (±3.48)	11.45 (±3.29)	0.07
Equilibre				
SPPB: Tps pieds joints (s)	9.95 (±0.60)	9.92 (±0.72)	9.99 (±0.20)	0.04
SPPB: Tps semi-tandem (s)	9.90 (±0.80)	9.86 (±0.91)	9.96 (±0.51)	0.03
SPPB: Tps tandem (s)	8.89 (±2.44)	8.73 (±2.57)	9.20 (±2.11)	0.0005
Marche				
SPPB: Tps marche 4 m (s)	4.77 (±1.66)	4.87 (±1.76)	4.56 (±1.40)	0.0008
Nb de pas en position tandem	7.72 (±3.23)	7.36 (±3.23)	8.46 (±3.10)	0.0001
Muscle				
SPPB: Tps pour 5 levers (s)	14.99 (±4.58)	15.25 (±4.79)	14.49 (±4.06)	0.003
Force				
Hand grip (kg)	25.24 (±9.82)	20.38 (±6.00)	35.14 (±8.57)	0.0001

Discussion

Out of the 1471 patients with an average age of 72 years (± 5), 33% of them had fallen in the 12 months prior to beginning treatment, of which 34.8% were women and 29.2% men. These results indicated the importance to initiate a falls prevention programme in balneotherapy for rheumatic and phlebologic patients.

These values are similar to some but not all studies in various industrialized countries, globally estimating that 30% of a cohort of patients over 65 fell within 12 months of follow-up. Tinetti et al. [34] quantify 32% in a population of 336 people aged 75 at a follow-up of 12 months. This value is confirmed by Campbell et al. [35] for a sample of 761 subjects of 70 years. Falling incidences of 24% are reported by Vellas et al. [26] in a study conducted in the USA and in France among 316 people aged 73 years. In 2010, in a French population, Leon and Beck reported 21.6% of fallers in the 55–85 age groups [36]. There are 19.2% among 65–69 year olds with 16.6% and 21.3%, respectively, for men and women, while the 75–79-year-old age group has 27.3% of men with a distribution of 18.6% for men and 33.4% for women. In addition, among the 33% of fallers in this study, 37% suffered severe injuries following their fall. This is a high score and causes disability and, most often, activity restriction directly related to sensory-motor mismatch. This is a high value and well above the 22% observed by El Khoury et al. [32] in 706 people aged 75–85 years. As such, we can consider that the population attending this spa specializing in patients suffering from rheumatic and phlebologic problems is particularly concerned in terms of prevalence of fall. Spa treatment is space for education and for the prevention of falls.

Women fell significantly more than men ($p < 0.04$) when considering one fall/two or more falls over the 12 months preceding the treatment programme. In addition, the number of falls over one year was significantly higher in women ($p < 0.03$) as was the number of minor injuries ($p < 0.01$). 18% of women and 14% of men fell at least twice in the last 12 months, indicating a problem of repeated falls and underlining a gap between what the person is capable of doing and what the person actually does [37, 38]. In this population of patients, women are characterized as having more frequent falls and greater consequences relating to minor injuries. This justifies the necessity for specific attention and indicates possible fragility. This will be analyzed by subjective perception of health and objective physical fitness.

The perception of health was questioned using the six criteria of fatigue, weakness, balance, walking, level of activity and fragility. The patient's perceived state was: better, worse or identical. Global observation reveals that 45% of patients consider themselves to be in the same state as a year ago, while 45–50% feel they are in less good health. Gender-based analysis shows significant differences between men and women for the six perceived health variables (Table 2) and a systematically and significantly more impaired perception in women ($0.02 < p < 0.0001$). Although one-third of the total population of patients is affected by at least one fall, we can consider that every other patient considers himself/herself in a worse state of health compared to the previous year. This perception is more marked in women and particularly in feeling weakness and fragility ($p < 0.0001$). Beyond the issue of falls that significantly characterize women, we can see a specific psychological profile whose links with the fear of falling [39, 40] or with the perception of health are identified in various deficient populations [41–43]. This information is particularly interesting and can help to personalize the thermal treatment programme for the 50% of women perceiving impaired health.

However, this perception of lower health status—seen in every other person—does not correspond to an objective state of fragility according to the Fried's criteria. 10.2% of the total population undergoing treatment programmes are considered fragile with a significantly higher rate in women ($p < 0.0001$) (Table 4) and 54% are considered pre-fragile. Various studies highlight the predictive value of fragility in the person's future and the importance of early detection [44–46]. In addition, fatigue, one of the criteria of frailty in Fried's index characterizes 37% of the population with a significant difference according to gender ($p < 0.0001$). After having previously commented on this feeling of fatigue, we observe this condition more objectively for 44% of women and 22% of men. In a future analysis of the factors associated with fall history, it will be necessary to define the relationship between the number of falls, the severity of the fall and the issue of fatigue.

The level of physical activity is considered low for 20% of the overall population, with no significant difference regarding gender. The problem of sedentarisation and its risks is well known as well as its deleterious consequences on health. The thermal environment is a place of care but must also be considered as a privileged space for education. To enroll a patient in an active lifestyle, it is ideal to make him/her aware of the various non-drug interventions including nutrition and, more specifically, physical activity. Analyzing the profiles of our thermal spa subjects enables reasonings and behavior to be identified which then leads to supporting therapeutic education.

We continue to characterize the population by analyzing functional capacities. The static equilibrium is tested in bipedal and unipedal positions for 10 s. The unipedal time is between 7 and 8 s, i.e., beyond the high-risk-of-falling

indication of 5 s. The length of unipedal stance is lower in women on the non-dominant side ($p < 0.02$). Respectively, 65 and 68% of the total population remain between 6.5 and 10 s on the dominant and non-dominant sides.

In the bipedal position (SPPB), feet together and semi-tandem are both very close to the maximum of 10 s. It is notably the full tandem position that mobilizes functional reserves and highlights a significantly longer time for men ($p < 0.0005$). Out of the 1471 patients, the number of those staying for 10 s with feet together, semi-tandem and tandem is, respectively, 1453 (98%), 1441 (98%) and 1158 (79%). These satisfying results of static equilibrium are confirmed partly by a TUG time of less than 12 s for 62% of the patients. If we retain this value as proof of satisfactory equilibration during the 3-m walk without turning around the chair and, considering the absence of a significant difference between men and women, we have a population with satisfactory dynamic equilibration capabilities. This is also generally the case for the 4-m test at a comfortable speed with a stop start. 68% of the total population carried out the test in less than 4 s. With reference to the standards of Guralnik et al. [29], and at a timing of less than 4.82 s (characterizing the best of 5 levels), the total population is very close (4.77). With an average value of 4.87 s, women are close but significantly higher than men (4.56). The test of the number of steps in tandem position [32] seems very relevant, complementary and discriminates behavior. The difference according to gender is significant and the standard deviation is half of the average value. All these data suggest that balance differentiates men and women less than speed of movement and muscular strength.

With regard to muscular function, a mean time of 15 s for the SPPB leg strength test indicates a more or less satisfactory profile when referring back to the norm. The total population, like the two significantly different gender subgroups, is in the same range of 13.7–16.7 s, i.e., one-third of the five performance levels. These data are partly confirmed by manual grip strength values which show satisfactory muscular function for men but which are more limited for women, even if adjusted to gender. For all, but even more so for women, it would therefore be a major focus of work and education to promote long-term muscle reconditioning during the treatment programme for the prevention of cancer, fragility and an active and independent lifestyle [47–49].

Conclusion

Over the past 12 months, 485 people fell (33%) of whom 180 suffered severe injury (37%). In addition, in terms of functional criteria, 10.2% were considered fragile and 54% pre-fragile. The history of falls, the presence of impaired balance/strength/walking, and the fear of falling are present in every other person. Finally, this population is not as healthy as the year before. Given that frailty is potentially reversible and that the management of balance/muscular/musculoskeletal disorders can prevent falls, our data suggest that frailty and risk of falling can be detected among spa patients and that falls can be reduced to promote health and an active and independent lifestyle.

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Compliance with ethical standards

Conflict of interest None.

Statement of human and animal rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standarts. This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all individual participants included in the study.

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