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Effects of acupuncture and Nordic walking practice and their interaction on bodily fluids distribution in breast cancer survivors

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ABSTRACT

Purpose. Integrative treatments are growing among breast cancer survivors (BCS), and both acupuncture and Nordic walking (NW) are found particularly useful for them. Their positive effect on BCS health is partially due to their impact on bodily fluid balance. The study of bodily resistance and reactance is a practical method to monitor bodily fluid balance. The aims of our study were to investigate (a) the acute effects of acupuncture treatment on resistance and reactance in BCS who never had received acupuncture treatment before; (b) if BCS practising NW had better resistance and reactance than non-exercising BCS; and (c) if BCS practising NW presented a better response after acupuncture treatment than other conditions.

Methods. A total of 80 BCS (53.24 ± 5.50 years), including 38 women not practising physical exercise and 42 Nordic walkers, were recruited and investigated for bodily resistance and reactance immediately before and after (a) acupuncture treatment; (b) supine rest without acupuncture.

Results. Acupuncture seems to positively influence bodily resistance and reactance variation compared with supine rest. NW practice seems able to assure the best resistance and reactance basal values, and their best positive variation after supine rest and acupuncture alone. The observed results are amplified when NW and acupuncture are coupled.

Conclusions. Both acupuncture and NW could be used to positively influence bodily fluids distribution, also considering that, when coupled, their positive effects are amplified. Therefore, NW should be prescribed to maintain the positive effect of acupuncture or to prepare the body for it.

Key words: interstitium, electrical bioimpedance analysis, fluids, exercise, integrative medicine

Introduction

Complementary and integrative treatments, such as acupuncture, nutrition, massage, physical exercise, mind-body therapies, are used by increasing numbers of cancer patients to prevent and manage the symptoms of both disease and treatments and to improve quality of life [1]. In particular, acupuncture and physical exercise have been increasingly important treatments for breast cancer survivors (BCS) [1–5]. Acupuncture, which involves the stimulation of specific points (i.e., acupoints) by penetrating the skin with thin, solid, metallic needles, eliciting bodily answers, has been shown important against chemotherapy-induced nausea/vomiting and neuropathies, pain management, musculoskeletal complaints, lymphoedema, hot flushes,

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fatigue, stress, anxiety, and sleep disorders [1, 5]. Histological investigations have revealed that acupoints have a number of elements (i.e., a high density of nerve endings; A- and C-afferent fibres; and a higher concentration of neural and vascular elements, especially mast cells) which could recognize stimulation [6, 7]. When acupoints are stimulated, they may release biomolecules to undertake the role of analgesia and/or neuromodulation, stimulating the somatic afferent nerves of the skin, fascia, and muscles under the acupoints [8, 9]. The ancient Chinese believed that qi (i.e., the circulating life force whose existence and properties are the basis for much of the Chinese philosophy and medicine) flowed through a network of channels called meridians and collaterals, which brought qi from the internal organs to the skin surface. Along these meridians, there are acupoints that can be stimulated to correct the qi imbalance, restore the body to normal health, and promote the flow of fluids [8, 9]. Therefore, acupoints are also defined as parts of the body surface for infusing or diffusing 'qi' and the blood of viscera and meridians [8–10]. Translating this principle of traditional Chinese medicine into a Western medicine approach, acupuncture partially exerts its effects through its actions on bodily fluid distribution, as water is the major component of our body. Indeed, whether we use the classical molecular theory of body composition or Pollack's theory [11, 12], water ranges from 60% of body mass to 99% of bodily molecules, while Roumelioti et al. [13] stated that the regulation of body fluid balance was a key concern in health and disease. Acupuncture is increasingly found useful in the regulation of body fluid balance through its effect on interstitial fluid flowing via the interstitial space of low hydraulic resistance. Actually, literature supports the statement that traditional Chinese medicine meridians and acupoints are anatomically and physiologically related to the connective tissues and, consequently, to the connective tissue interstitial fluid system [14–16]. In addition, acupuncture has been shown able to stimulate the expression and translocation of aquaporins, water channels proteins, also regulated by hormones, neurotransmitters, and amino acids, as well as by hypoosmolarity and hyperosmolarity [17–19]. A total of 13 different aquaporins have been described expressed in different organs and tissues in the body, and their balance is increasingly shown linked with health and disease [20]. Even if data concerning aquaporins, acupuncture, and breast cancer are still lacking, acupuncture has been shown able to up- and downregulate the expression of aquaporin typologies, depending on the stimulated acupoints and the condition of the receiver [17, 18].

According to the literature, physical exercise also has an important influence on bodily fluid balance, not only through sweating and metabolic processes, but also through the effects of body movements [21–24]. Indeed, Schleip et al. [21] reported, immediately after static stretching of dense fibrous connective tissues, a total water content reduction, followed by a supercompensation, determining higher than initial water content levels, if sufficient resting time was allowed. In addition, also the active stimulation of the muscle has a key role in body fluids regulation as the muscle contractile cycle is associated with water entry and exit from muscle cells through aquaporins [21–24]. Even if data are still scarce, in animal models, physical exercise has been shown able to up- and downregulate the expression of aquaporin typologies, in accordance with exercise characteristics and conditions [23]. Therefore, especially in BCS, who need the improvements of all regulating aspects of bodily fluid balance, due to the treatments and their side effects [1], it is important to focus the attention on physical exercise practice.

Nordic walking (NW) is being given attention as a useful treatment for BCS since it is a whole-body physical activity, characterized by the active use of trunk and upper limb muscles while walking, through the use of a specifically made pair of poles [25–28]. Indeed, it has been shown to be efficient against lymphoedema and to improve muscle balance, body posture, shoulder range of motion, the strength of both trunk and upper limb muscles of BCS, and other variables linked with their quality of life (e.g., depression, self-efficacy, limitations in activities of daily living and social activities, arthralgia) [2, 3, 29]. After the merge of NW kinesiological characteristics with physiology, it is possible to argue the following functional hypothesis: NW speeds up the circulation of bodily fluids through: (a) the contractions of upper limb muscles, including the alternated open-close cycle of the hands; (b) the effects of the opposite movement of pelvic and shoulder girdles on core and diaphragm stiffness and contraction; (c) lower limb muscle contractions; (d) the stimulation of plantar arches, creating a 'pump effect' when occurring all together. In addition, during NW practice, bodily fluids circulation is coupled with the continuous stretch-rest cycle of the whole-body fascia [21] and with the effects of muscle contractions on aquaporin expression and translocation to the plasma membrane [22–24], practically finalizing the balance of bodily fluids. After connecting this functional hypothesis with the traditional Chinese medicine meridians, we could also consider NW a whole-body discipline that actively engages the traditional Chinese medicine meridians during

its practice. This means that it is conceivable to hypothesize that NW can mimic or speed up the positive effects of acupuncture in fluid balance.

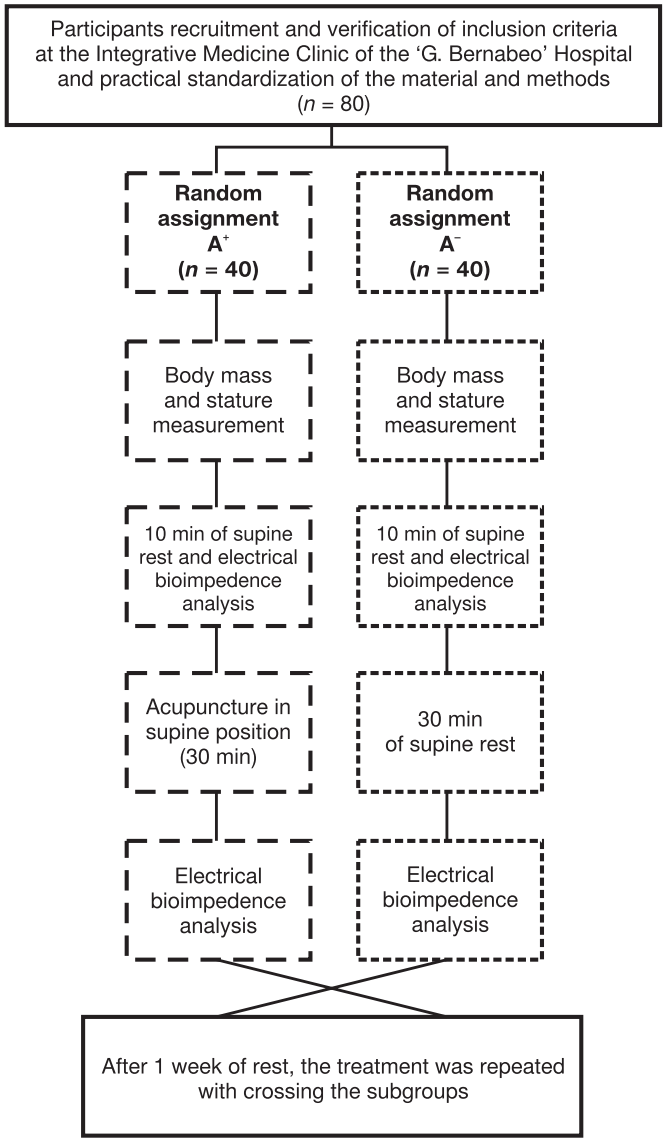
A simple method to acutely and non-invasively estimate body fluid balance is electrical bioimpedance analysis, measuring bodily resistance (Rz) (i.e., the opposition to the flow of the injected alternating current, at 50 kHz of frequency, through extracellular ionic solution, inversely correlated with extracellular fluids) and reactance (Xc) (i.e., the dielectric or capacitative component of cell membranes and organelles and tissue interfaces directly correlated with the cellular density in the fluid environment) and estimating body water, together with other variables concerning body composition (e.g., fat mass and fat-free mass) [30]. In order to eliminate the sum of several errors (i.e., the sum of measurement error with that of the linear regression used to estimate the variable and that of the reference method used to directly measure the variable), it is possible to obtain information about the trend of bodily fluids just by observing the trend of both Xc and Rz, which contain the measurement error.

Therefore, considering the literature, the aims of our study were to investigate (a) the acute effects of acupuncture treatment on Rz and Xc in BCS who had never received acupuncture treatment; (b) if BCS practising NW had better Rz and Xc than non-exercising BCS; and (c) if BCS practising NW presented a better response after acupuncture treatment than other conditions.

Material and methods

Study design

BCS were recruited by the Integrative Medicine Clinic of the 'G. Bernabeo' Hospital (Ortona, Italy) and were among those requesting its services for the first time. A medical doctor specialized in acupuncture verified if the women met the inclusion criteria. The participants were randomly assigned, in an alternate manner, to 1 of 2 starting treatment subgroup (i.e., to the subgroup starting with acupuncture treatment [A^+] or to the subgroup starting without acupuncture treatment [A^-]). Both A+ and A^- underwent the measurements of both Xc and Rz immediately before and after the treatment. After 1 week of wash-out, we performed a crossover of the treatments (Figure 1). Therefore, each woman was studied both with and without acupuncture treatment. The research staff were blinded to the participants' characteristics (i.e., starting treatment group A^+ or A^- and physical exercise practice).



A^+ – subgroup starting with acupuncture treatment
A^- – subgroup starting without acupuncture treatment

Figure 1. Study design

Participants

Overall, 80 BCS (53.24 ± 5.50 years) were recruited for this study. The inclusion criteria were: age > 40 and < 65 years; 8–12 months from surgery; no past or present chemotherapy; past but not present radiotherapy; no endocrine diseases; no lymphoedema; no massages or aesthetic therapies for lymphatic drainage during the previous 2 months; no present use of drugs and/or nutritional supplements affecting body water; no past acupuncture; no smoking; no physical exercise or just NW during the previous 3 months. To be considered a Nordic walker, a person had to follow 10 lessons on the NW technique and then pass an examination with 2 NW instructors from the International Nordic Walking Federation, who independently verified that

the technique was appropriate. As provided by the study design, the participants included both women who were not practising any physical exercise (n = 38, 53.32 ± 8.55 years) (NW^-) and Nordic walkers (n = 42, 52.07 ± 7.06 years) (NW^+), who had been practising it for 8–10 weeks, twice per week, 3 hours per week.

Electrical bioimpedance analysis

Before each treatment, we requested that each woman avoided physical exercise of moderate to vigorous intensity for 1 week. Each subject underwent evaluation at our clinic with 2 hours of fasting (from meals and liquids) and without body cream. The participants were treated in a room standardized for temperature (25°C), humidity (55%), light (soft natural light), and noise (no noise). Even though we decided to focus our analysis just on the measured variables (i.e., Rz and Xc), the measurements began with the recording of body mass and stretched stature. These were measured to the nearest 0.1 kg and 0.1 cm, respectively, with the participants dressed in light clothing and without shoes, by using a stadiometer with a balance-beam scale (Seca 220, Seca, Hamburg, Germany). To record body Rz and Xc, we used the electrical bioimpedance technique with a hand-to-foot 50 kHz frequency bioelectric impedance analyser (BIA 101, Akern, Pontassieve, Italy). Bioelectric impedance analysis of the participants was executed in the supine position, lying on a non-conducting bed, without conducting garments and with limbs away from the body and from themselves. Electrodes (2 on the hand and 2 on the foot, at the side opposite to the surgery) were placed 5 cm from each other, starting from the roots of the fingers. The side that had not been treated with surgery was used for measurements. Each woman was measured 10 minutes after having assumed the described position (T_0).

Acupuncture treatment

Immediately after the bioelectric impedance analysis, women in the A^+ group were treated with acupuncture by using the following needles: new Pyonex 1.2 mm (Seirin, Japan) and Hwato (China) 0.25 × 25 mm. Each patient was treated in accordance with the traditional Chinese medicine technique, specifically through the abdominal semeiotic technique, as described in the classical text Nan Jing [31]. This technique makes it possible to perform an objective diagnostic examination through abdominal palpation and to position the needles depending on the perceived tenderness of the abdominal area. Therefore, the use of this technique allows a personalized treatment that is based on the use of a different number of needles, placed in different abdominal areas in accordance with the patient's needs: e.g., in the presence of pain in the right lumbar region, the HT-4 Lingdao point was treated; in the presence of pain in the left lumbar region, the LU-11 Shaoshang point was treated; in the presence of pain in the hypogastric region, the SP-9 Yinlingquan point was treated; in the presence of pain in the epigastric region, the KI-2 Rangu point was treated [32]. In addition to the abdominal treatment, each woman received treatment of the CV2 Ougu and GV20 Baihui acupuncture points. The CV2 point is the point of the Ren Mai canal, located in the midline of the abdomen at the upper edge of the pubic symphysis, and is the meeting point of Ren Mai with the liver meridian. The GV20 point is the point of the Du Mai canal, located in the midline of the head at the vertex level where the main liver channel ends [31]. The acupuncturist chose to treat the CV2 Ougu point instead of the CV1 Huì Yīn point to avoid a negative reaction due to its intimate position. Therefore, the utilization of CV2 and GV20 points was in accordance with the Ling Shu and with the Zhenjiu Dacheng [33], to activate the small energetic circulation. The acupuncturist, a physician with 15 consecutive years of acupuncture practice, achieved his specialization at the School of Traditional Chinese Acupuncture of Florence (Italy). He used manual stimulation of the identified points. The needle was rotated with the index finger and thumb in an alternating clockwise and counter-clockwise fashion at the rate of 3–5 rotations per second [31, 33]. After 30 minutes of resting from the insertion of the last needle, during which the acupuncturist revisited the needles as appropriate [31, 33, 34], and after having removed the needles, the bioelectric impedance analysis was executed again, respecting the procedures described above (T_1). Women in the A^- group underwent the same measurements, executed in the same order, as those in the A^+ group, but with the absence of the 30 minutes of acupuncture treatment in the A^- group, which was replaced with 30 minutes of supine rest followed by bioelectric impedance analysis (T_1).

Statistical analysis

The data were tested for normality before statistical analysis by using the SPSS 20 software (IBM, Armonk, NY, USA) and are presented as mean ± standard deviation. The chi-square test was used to investigate the difference between NW^+ and NW^- in the frequency

of radiation therapy, quadrantectomy, mastectomy with breast reconstruction, and mastectomy with lymphadenectomy and breast reconstruction. To test the combined effects of NW and acupuncture on bioelectrical impedance parameter changes (i.e., Xc and Rz), a 2 (between-subject: NW^+ vs. NW^-) × 2 (within-subject: A^+ vs. A^-) × 2 (within-subject: T_0 and T_1) mixed multifactorial 3-way analysis of variance (ANOVA) was carried out with Xc and Rz, at T_0 and T_1, with acupuncture (A^+) and lying down without acupuncture (A^-) as dependent variables. Data were preliminarily checked to ensure that the assumptions for mixed multifactorial ANOVA were satisfied [35]. To check for sources of within-/between-subject interaction, new variables were calculated to exclude the effect of the other within-group variables, as follows:

$$A^+\_Xc = A^+\_Xc_0 + A^+\_Xc_1$$
$$A^+\_Rz = A^+\_Rz_0 + A^+\_Rz_1$$
$$A^-\_Xc = A^-\_Xc_0 + A^-\_Xc_1$$
$$A^-\_Rz = A^-\_Rz_0 + A^-\_Rz_1$$
$$Xc_0 = A^+\_Xc_0 + A^-\_Xc_0$$
$$Rz_0 = A^+\_Rz_0 + A^-\_Rz_0$$
$$Xc_1 = A^+\_Xc_1 + A^-\_Xc_1$$
$$Rz_1 = A^+\_Rz_1 + A^-\_Rz_1$$

Thus, the within-/between-subject interactions for acupuncture vs. NW and for time vs. NW were verified by performing the independent *t*-test by using A^+_Xc, A^+_Rz, A^-_Xc, A^-_Rz, Xc_0, Rz_0, Xc_1, and Rz_1 as dependent variables and NW as an independent variable, as well as the paired *t*-test with the following couples:

A^+_Xc *vs.* A^-_Xc
A^+_Rz *vs.* A^-_Rz
Xc_0 *vs.* Xc_1
Rz_0 *vs.* Rz_1

with separating the participants who performed NW from those who did not.

The within-subject interactions for acupuncture vs. time and for time vs. acupuncture were tested by performing the related-sample *t*-tests on the following couples:

$A^+\_Xc_0$ *vs.* $A^+\_Xc_1$
$A^+\_Rz_0$ *vs.* $A^+\_Rz_1$
$A^-\_Xc_0$ *vs.* $A^-\_Xc_1$
$A^-\_Rz_0$ *vs.* $A^-\_Rz_1$
$A^+\_Xc_0$ *vs.* $A^-\_Xc_0$
$A^+\_Rz_0$ *vs.* $A^-\_Rz_0$
$A^+\_Xc_1$ *vs.* $A^-\_Xc_1$
$A^+\_Rz_1$ *vs.* $A^-\_Rz_1$

Finally, the 3-way interaction was analysed as described by Field [36]. The *p* value was set to 0.05 for the multifactorial ANOVA and to 0.025 to account for multiple comparisons [25]. By applying the G*Power 3.1 software, Cohen's *d* was used to assess both between-group and within-group differences and interaction effects, considering a value of 0.2 as small, 0.5 as medium, and 0.8 or above as large.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Ethics Committee of the 'G. d'Annunzio' University of Chieti-Pescara (N° 312/2015).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

No adverse events or drop-outs were recorded. Table 1 shows the descriptive characteristics of the sample and only includes data inherent to the study.

Table 1. Study participants' characteristics

Characteristics	*n* = 80
Age (years)	54.46 ± 5.97
Radiation therapy (y/*n*)	69/11
Quadrantectomy (*n*)	50
Mastectomy with breast reconstruction (*n*)	13
Mastectomy with lymphadenectomy and breast reconstruction (*n*)	17
Body mass (kg)	65.41 ± 11.39
Stretched stature (cm)	160.67 ± 6.55
Reactance (Ω)	53.57 ± 6.18
Resistance (Ω)	590.32 ± 67.26

Tables 2 and 3, respectively, present the distribution of radiation therapy and surgeries between NW^+ and NW^-: no significant differences were found. There were significant effects on Xc ($F_{(1, 78)}$ = 11.05; p = 0.001; d = 0.38) and Rz ($F_{(1, 78)}$ = 3.83; p = 0.05; d = 0.22) for NW; on Xc ($F_{(2, 156)}$ = 3.71; p = 0.05; d = 0.21) and Rz ($F_{(2, 156)}$ = 659.1; p < 0.001; d = 2.9) for acupuncture; and only on Xc ($F_{(2, 156)}$ = 285.8; p < 0.001; d = 1.66) for time. NW participants, as well as acupuncture treatment subjects, showed higher values of both Xc and Rz, while only Xc was influenced by time. Further-

Table 2. Differences in radiation therapy frequency between NW^+ and NW^-. Chi-square test result

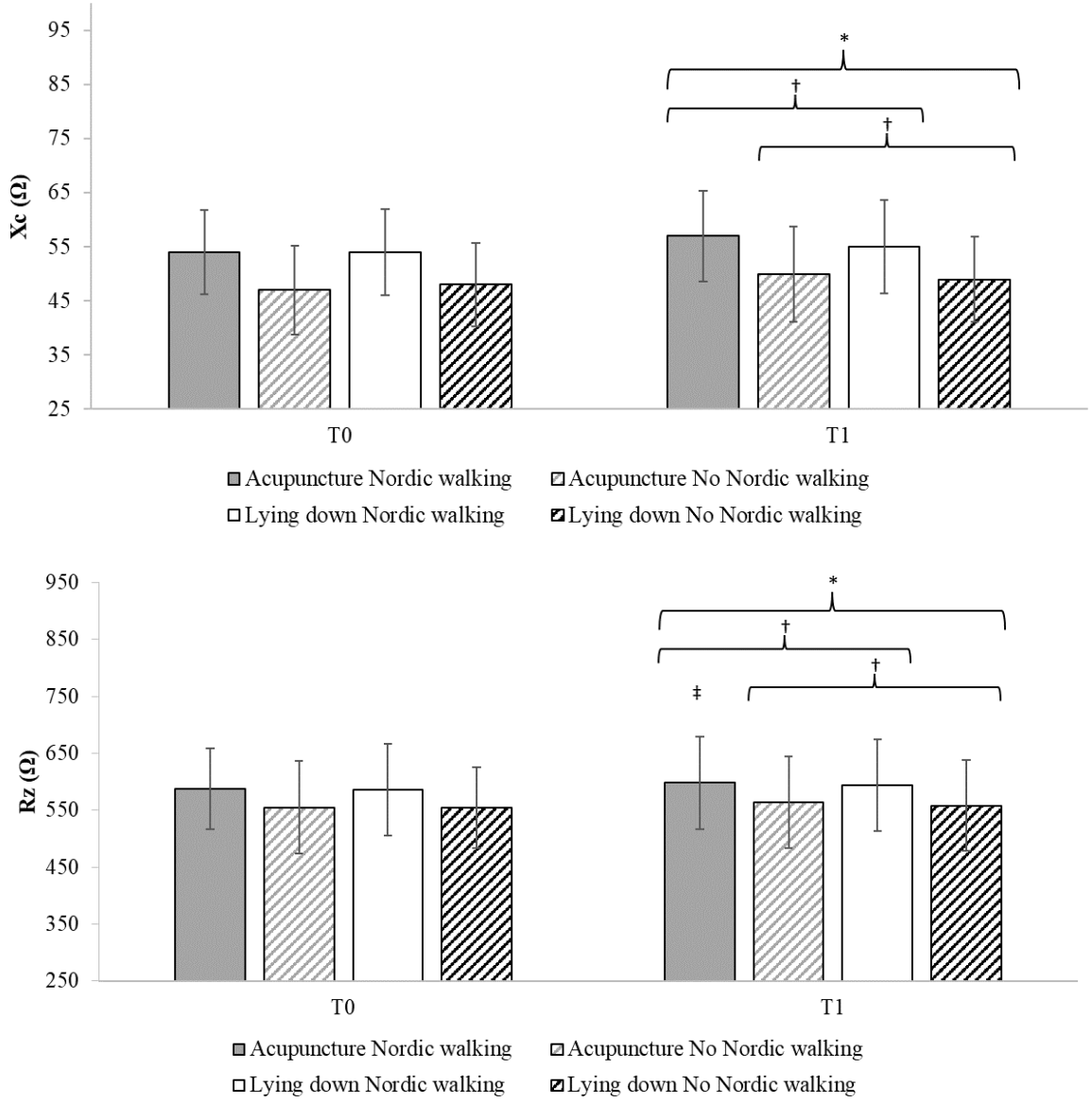
Group	Radiation therapy: no	Radiation therapy: yes	Total
NW^+	4	38	42
NW^-	7	31	38
Total	11	69	80

Pearson's chi-square = 1.332
p = 0.249
NW^+ – Nordic walking
NW^- – no physical exercise practice

Table 3. Differences in frequency of surgeries between NW^+ and NW^-. Chi-square test result

Group	Quadrantectomy	Mastectomy with breast reconstruction	Mastectomy with lymphadenectomy and breast reconstruction	Total
NW^+	23	10	9	42
NW^-	27	3	8	38
Total	50	13	17	80

Pearson's chi-square = 3.958
p = 0.138
NW^+ – Nordic walking
NW^- – no physical exercise practice



* greater than T_0
† acupuncture greater than no acupuncture, both in NW^+ and NW^-
‡ greater than T_0, no acupuncture and NW^-

Figure 2. Effects of treatment on bodily reactance (Xc) and resistance (Rz)

more, a significant interaction was observed for acupuncture and NW on both Xc ($F_{(1, 78)}$ = 4.57; p < 0.036; d = 0.24) and Rz ($F_{(1, 78)}$ = 48.4; p < 0.001; d = 0.79); for time and NW on Xc ($F_{(1, 78)}$ = 18.2; p < 0.001; d = 1.7); for acupuncture and time on both Xc ($F_{(1, 78)}$ = 70.9; p < 0.001; d = 0.95) and Rz ($F_{(1, 78)}$ = 125.4; p < 0.001; d = 1.27); and for acupuncture, time, and NW on Rz ($F_{(1, 78)}$ = 26.3; p < 0.001; d = 0.29). Post-hoc analysis revealed that performing NW determined higher Xc values in both A^+ (t = –3.53; p = 0.001) and A^- (t = –3.05; p = 0.003), independent of time. Furthermore, both T_0 (t = –3.09; p = 0.003) and T_1 (t = –3.53; p = 0.001) Xc values were higher in NW participants, independently of acupuncture. In those participants who performed NW, acupuncture determined a higher Xc (t = 2.78; p = 0.008), independently of time. Furthermore, NW participants presented higher Xc (t = –14.53; p < 0.001) and Rz values (t = –22.7; p < 0.001) at T_1, independently of acupuncture. While both Xc (t = –13.6, p < 0.001; t = –8.84, p < 0.001 – for A^+ and A^-, respectively) and Rz (t = –22.4, p < 0.001; t = –11.7, p < 0.001 – for A^+ and A^-, respectively) were higher at T_1, A^+ determined higher values at T_1 with respect to simply lying down for both Xc (t = –4.60; p < 0.001) and Rz (t = –2.81; p = 0.006). Finally, participants involved in NW demonstrated higher Rz values at T_1, when taking part in the acupuncture session (Figure 2).

Discussion

The most important results of our analysis provide evidence around the concept that both acupuncture and NW can positively and independently modify bodily Rz and Xc, and their positive effects are amplified when they are coupled. Specifically: (a) acupuncture can positively modify bodily Rz and Xc; (b) Nordic walkers have higher Rz and Xc values, both at T_0 and at T_1; (c) the positive results on both Rz and Xc (listed in the previous point) are amplified when acupuncture is applied in Nordic walkers (Figure 2). In the context of the physiological significance of Rz (i.e., the opposition to the flow of the injected alternating current at 50 kHz of frequency through extracellular ionic solution, which is inversely correlated with extracellular fluids) and Xc (i.e., the dielectric or capacitative component of cell membranes and organelles and tissue interfaces that are directly correlated with the cellular density in the fluid environment), our results provide support to the statement that acupuncture and NW can positively influence bodily fluid distribution, acting on interstitial fluids and cell volumes.

If one considers the principle of mechanotransduction [14, 15, 37] applied on the body system and our results, it is conceivable to think that acupuncture is not the only factor able to stimulate traditional Chinese medicine meridians. Indeed, the body system is characterized by the presence of the fascia network that may be considered the physical substrate of traditional Chinese medicine meridians [15]. Theoretically, all of the whole-body physical activities that are able to stress the interstitium along the body's traditional Chinese medicine meridians (e.g., yoga, Pilates, tai chi, and NW), through both the pure stretching-relaxation cycles of the fascia and the contraction-relaxation cycles of muscles (also determining their stretching, both in the longitudinal and transverse directions), could elicit results similar to acupuncture in the field of bodily fluids dynamics, determining fluid migratory tracks in accordance with the interstitial fluid pressures [38, 39]. Therefore, when one also considers the effects of the muscle contractile cycle on aquaporins, being the water cellular 'doors' [21–24], it is conceivable to think that when those physical activities are cyclic (e.g., NW) and regularly performed, it is possible to achieve better results than with acupuncture alone, as reflected in our research, because of the continuity of application of the balancing stimulus. In turn, even if also acupuncture has been shown able to positively influence the expression and translocation of aquaporins [17, 18], it is more difficult to assure its continuity of application with respect to NW. Indeed, regular NW practice, according to our results, seems able to determine better starting (T_0) values of bodily fluid balance (Rz) and cellular density (Xc), and better bodily answer both to simply lying down and to acute acupuncture treatment. Our results support the hypothesis formulated in the introduction: regular walking, with the active use of the trunk (i.e., maintaining a proper posture in a dynamic setting during each forward step, with the body experiencing a rotation of the pelvis and the opposite shoulder) and upper limbs (i.e., the upper limbs moving alternately forwards and backwards during walking, while the hands experience an alternating open and close cycle with the proper use of the NW poles), actively promotes fluids circulation, generally and properly stimulates traditional Chinese medicine meridians, lightening their tension and improving the effects of acupuncture because it acts on 'soft' tissues, and probably finalizes fluids rebalancing through effects on the water cellular channels. We use the word 'generally' because, contrary to acupuncture, where bodily effects start

from the treatment/stimulation of specific bodily regions, NW is a whole-body physical activity that exerts bodily effects starting from whole-body stimulation. Starting with the observation of the major effects of NW rather than acupuncture alone, it is conceivable to think that even if the use of acupuncture alone is beneficial to Xc and Rz, it probably requires more time and more treatments to elicit good results in people who are not engaged in proper physical exercise, as they probably have stiffer and closer fascia and interstitium, owing to daily psychophysical life and memory of fascia (i.e., if the fascia is not properly stimulated in terms of intensity, duration, and frequency, it tends to return to its basal condition [30, 40]), together with unbalanced aquaporin expression and translocation. Therefore, to optimize and improve treatments in these people, it is very important to treat acupoints for the proper amount of time and with the proper frequency, in several ways.

The main study limitations are represented by the fact that we are unable to: (a) verify the effects of both NW and acupuncture on aquaporins; (b) state how much NW practice, at minimum, is needed to positively obtain the observed results; (c) verify whether other whole-body, non-cyclic disciplines of lower dynamics (e.g., yoga, Pilates) than NW determine lower positive results than the latter. Therefore, the next step will be to study this aspect. In turn, the high standardization of the sample, the study design, and the consideration of Xc and Rz instead of the estimated values of total, intracellular, and extracellular body water to reduce the errors represent the strength of this study.

Conclusions

In conclusion, according to our results, and with the consideration of the significance of both Rz (i.e., the opposition to the flow of the injected alternating current, at 50 kHz of frequency, through extracellular ionic solution, inversely correlated with extracellular fluids) and Xc (i.e., the dielectric or capacitative component of cell membranes and organelles and tissue interfaces directly correlated with the cellular density in the fluid environment), NW seems able to speed up the acute effect of acupuncture on bodily fluid distribution and to exert a major effect on it as compared with acupuncture alone. Therefore, NW should be used in combination with acupuncture to optimize its efficacy on bodily fluid balance and should be prescribed to maintain the positive effect of acupuncture or to prepare the body for acupuncture when it is not immediately available. These results are particularly important also because the entity and duration of acupuncture treatments are extremely personal. Thus, in the optic of health promotion, our results fulfil the soul of the integrative approach of breast cancer, underlying that when a multidisciplinary intervention is properly designed, it is also possible to obtain an improvement of the effects of one treatment through interventions made in other fields, creating a further positive stimulation and promoting the psychophysical health of BCS.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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