

Physical Effect of Scalp SPA Meridian Massage via Grey Relational Assistant Analysis

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Abstract

Objective: The scalp hair spa has become a popular service in beauty industry. However, the benefit is not proven by scientific analysis. The purpose of this paper is to investigate how the scalp meridian massage based on hair spa affects the physical change of the human body.

Methods: The principle of scalp meridian massage is formulated based on acupuncture treatment along with the experimental study and grey relational assistant analysis. Then, the effect of the scalp meridian massage along with hair spa is scientifically verified by evaluating the autonomic nervous system. Twenty healthy male and female participants join the experiment, where the subjects receive the scalp spa meridian massage. The outcome measurement focuses on subject's status of the autonomic nervous system. Time-frequency analysis of heart rate variation (HRV) is applied to evaluate the effect of scalp spa meridian massage.

Results: According to grey data analysis, the scalp meridian massage manifests stress relief, with post-treatment pressure index (PSI) reduction averaging 69.46%. The significant effect in TP, LF and HF values are improved along with autonomic nervous system balance.

Conclusion: The scalp spa meridian massage has significant effect in PSI, TP, LF and HF values as well as improvement on autonomic nervous system balance.

Keywords: Scalp spa meridian massage • Grey relational analysis • Acupuncture

Introduction

Despite haircut is regarded as a synonym of beauty industry, it is not limited to hairdo or hairdressing. In its routine practice, a hair salon offers a wide variety of services including hair care, scalp massage, etc. Scalp massage coupled with healthy makeup & cosmetics, in particular, has gained increasing popularity. One of the reasons is the beneficial effect of scalp massage on physical and psychological health. Scalp massage is thus offered as an additional service for health and mental care. However, the benefit of scalp massage still needs more scientific confirmation.

Chinese medicine [1] is an important medicine for health and care. There has over the past few years been researched in relation to scalp massage benefits [2-6]. Some researches, which was Chinese medicine-oriented, focused mainly on massaging acupoints. Some papers [2-4] pointed out that head meridian acupoint massage has stress relief effect and regulates the cardiac autonomic nervous system. It was also mentioned that language function [5] or memory ability [6] can be improved through applying scalp acupuncture treatment. Other research suggested that scalp massage can be regarded as hair care, such as relieving androgenic alopecia or prevent hair loss [7,8]. Despite the benefits of scalp massage having been verified by some experiments, there has been, so far, no standardized approach to scalp massage. Neither has there been much investigation of the influence of

traditional scalp massage on psychological change. For example, the study [9] deals with the effect of traditional scalp massage via stress hormone, blood pressure and heart rate. This means that the present study only measures a part of psychological status of the human body. The study on the frequency analysis of the heart rate variability (HRV) [10] is lacked to understand the effect of the scalp massage for general subjects. However, to what extent scalp massage is related to the autonomic nervous system regulation and stress relief needs more in-depth investigation. As past research took only scalp massage on dry hair into consideration, the present study needs to deal further with wet hair scalp massage.

From the first study of grey system theory [11], the applications of grey theory have been proposed in literatures [12-17]. For example, grey theory was applied on data analysis and prediction in the field of engineering science [15]. Indeed, the grey system theory can solve the complex analysis problem in a significant and effective manner for the system with incomplete information and data [16,17]. Besides, the grey system theory can achieve the relational analysis, model construction and prediction of the uncertain and incomplete information. In comparison of traditional regression analysis or mathematical statistics, the grey data analysis does not require a huge amount of data to obtain a correct and good result for analyzing system behavior. Due to the benefits of grey system theory, this study will take it as an assistant analysis tool to find the relationship activity of the scalp spa meridian massage treatment to psychological factors including pressure index, total power and high frequency power, etc.

On the basis of the reasons mentioned above, this research aims to investigate the beneficial effect of the scalp meridian massage with hair spa via the assistant grey relational analysis. This study first introduces the skills of the scalp meridian massage after hair spa. It is a worthwhile note that a standard skill for scalp massage is not formulated in the past researches. In the experiment, the scalp meridian massage is applied on subjects, while the physical factors of HRV are measured. Next, the grey relationship analysis is taken as an assistant tool to investigate the relation to stress and health. Finally, the grey and statistic data analysis indicates that scalp spa meridian massage benefits the autonomic nervous system regulation and stress relief. The result is able to be a guide for course design of scalp care and healthcare of the elderly in the ageing society.

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In this paper, we firstly formulate the skills of the scalp meridian massage in Section 2, while the experiment is designed. Next, Sections 3 and 4 show the results of grey data analysis of factors related to scalp massage along with some discussion. The last section provides conclusions and suggestions for future study.

Methods

To investigate the effect of scalp spa meridian massage, we first formulate the scalp massage gestures for five important meridian areas. Then, the experiments and data analysis are performed.

Massage skill of scalp meridian areas

By following the scalp meridian, five massage areas along with the skills are introduced below:

Area I: Figure 1a shows the first area of the scalp massage, which is labelled in green. Area I corresponds to the meridian for liver, kidney, lung and bladder. The massage procedure is as follows:

1. Use the side of the thumbs to knead the scalp from the temple area toward the top of the head in a clockwise and anticlockwise circular gesture as shown in Figure 1b.
2. Place the left and right thumbs at the top of the head and use both index and middle fingers closed together, then alternately knead the scalp in a small circle from the top to two sides of the head then back to the top of the head. See Figure 1c.
3. Then, take effleurage on the scalp from the top of the head to the temples via the knuckles of ring and middle fingers as shown in Figure 1d.

The overall gesture for Area I can be illustrated in Figure 1. This massage action is repeated in 3 times and one iteration is completed in one minute.

Area II: Figure 2a shows the second area of scalp massage, which is labelled in yellow. Area II is corresponded by the Governor vessel and Bladder meridian reflexology for liver, lung, heart and small intestine. The massage procedure is as follows:

1. Use your thumbs tips, massage the scalp by light-downward pressuring and quick-forward releasing (almost like a push back gesture) along the central line of the head to the crown area. Use this gesture for about one minute. See Figure 2b.
2. Use the thumbs, knead the scalp in short crisscross locus and slide down to the crown area as shown in Figure 2c. Use this gesture for about one minute.
3. Apply the same skill in longer massage routes from the top of head down to the base of two temple areas as shown in Figure 2d. Use this petrissage gesture for about one minute.

The overall gesture for area II is illustrated in Figure 2. This massage action is repeated in 3 times and one iteration is completed in one minute.

Area III: Area III, labelled in yellow-green in Figure 3a, is corresponded by the Gallbladder meridian reflexology for liver, kidney and small intestine. Figure 3a indicates Area III located between Area 1 and Area II. The massage procedure is as follows:

1. Use the knuckles of four fingers together, lightly stroke the scalp in a spiral sliding motion from the top of the ear toward the crown area. Use the same gesture from the back of the ear to the crown area as shown in Figure 3b.
2. Use the knuckles of four fingers together, friction massage this area in a big round spiral sliding motion as shown in Figure 3c.
3. Set the thumb at the top of the head and use the inner edge of the index finger, use the same massage gesture as the above motion shown in Figure 3d.

The overall gesture for area III is illustrated in Figure 3. This massage action is repeated in 3 times and one iteration is completed in one minute.

Area IV: Area IV is corresponded by the Triple Energizer meridian reflexology for liver, bile, kidney and gynaecology. This area is labelled in red around the ear as illustrated in Figure 4a. The massage procedure is as follows:

1. Use both middle and ring fingers in spiral movements, then knead the temple area directly in front of the ear as shown in Figure 4b.
2. Respectively use the index and middle fingers, down caress the front

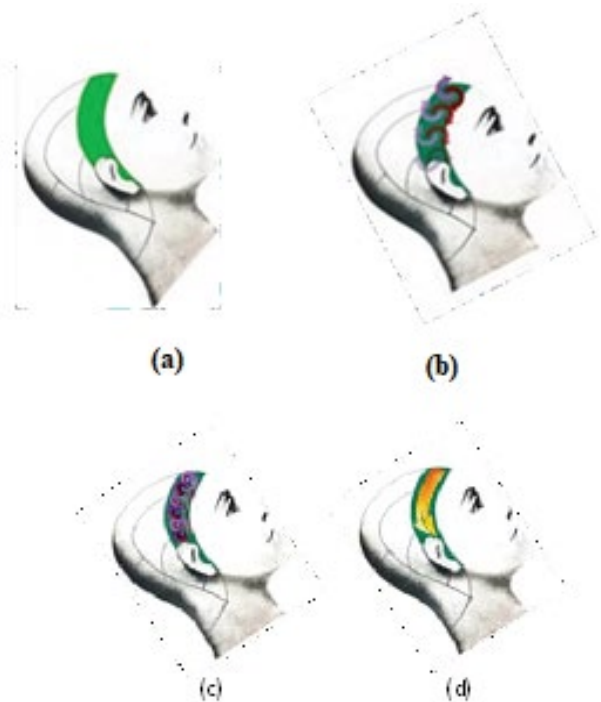


Figure 1. Area-I of scalp massage.

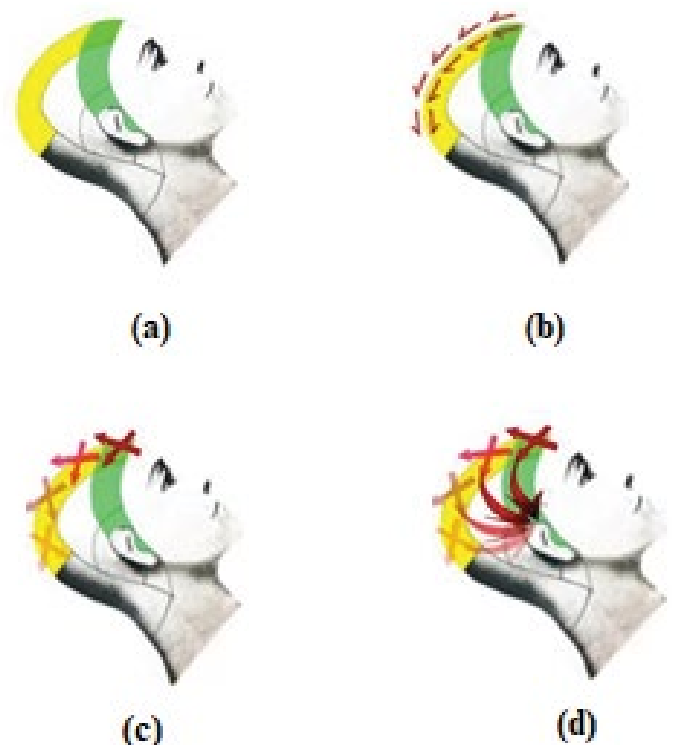


Figure 2. Area-II of scalp massage.

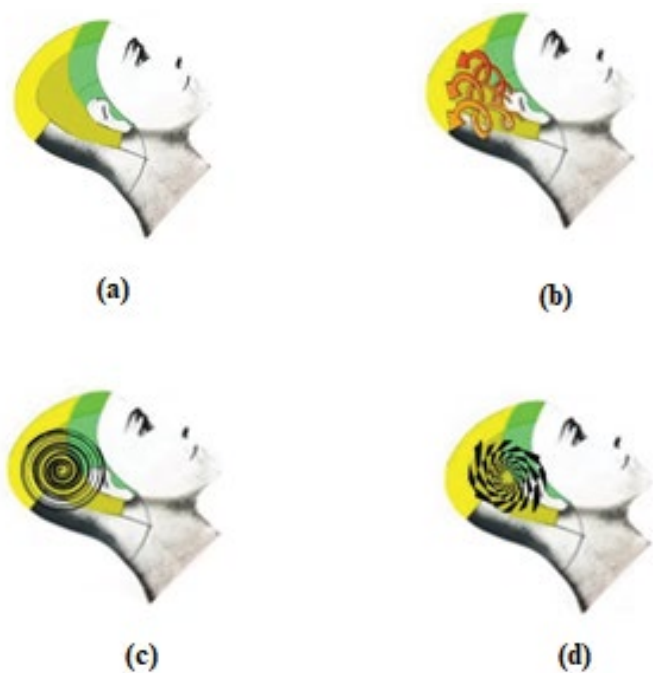


Figure 3. Area-III of scalp massage.

and back sides of the ear. Apply gentle pressure, then caress the back of the ear and base of the head via the index and middle fingers together. Next, slide the two fingers back to the top of the ear. Repeat the same process 2 more times.

3. Repeat the above two steps as shown in Figure 4 up to five times.

The overall gesture for area IV is illustrated in Figure 4. This massage action on the area IV is repeated in 3 times and one iteration is completed in one minute.

Area V: Area V is corresponded by the Triple Energizer meridian reflexology for liver, bile, kidney and gynecology. This area is labelled in dark-red in the posterior side of the head illustrated in Figure 5a. The massage procedure is as follows:

1. Use one hand to lift and support the client's head and massage the base of the neck toward the base of the head in spiral motion via the other hand's fingers.
2. Knead the scalp sliding from the base of the neck to the base of the skull by applying gentle pressure via the index and middle fingertips and then massage Fengchi (GB20) acupoint via the same pressure in about three seconds before repeating the same process. Do this three times.
3. Use your thumbs to support the head while applying pressure with the other hand's fingers and sliding them upward from the base of the neck to the base of the head.

The overall gesture of area V is illustrated in Figure 5. This massage action on the area V is repeated in 3 times and one iteration is completed in one minute.

Overall, the procedure of the scalp meridian massage along with hair SPA is formulated as follows:

1. Clean subject's hair with warm water.
2. Masseur rinses the subject's hair and then performs the scalp meridian massage in order of using the gestures required of respective areas. Then, tap the scalp in one minute.
3. Masseur wraps a towel tightly around the subject's head and rinses it with warm water for 3 minutes SPA. The process of the deep spa scalp massage is thus completed.

By the way, the head blood circulation can be improved through applying the alternating hand kneading skill mentioned above. Meanwhile, the deep massage and smooth press through the running course of the scalp meridians can awaken the Governor vessel, Bladder meridian, Gallbladder meridian and Triple Energizer meridian.

Experimental methods

To avoid any disturbance, the experiment is conducted in a quiet and comfortable room setting. A masseuse who has perfect hand skill is responsible for the scalp massage. This means that the meridian areas and acupuncture points are precisely identified and massage strength is

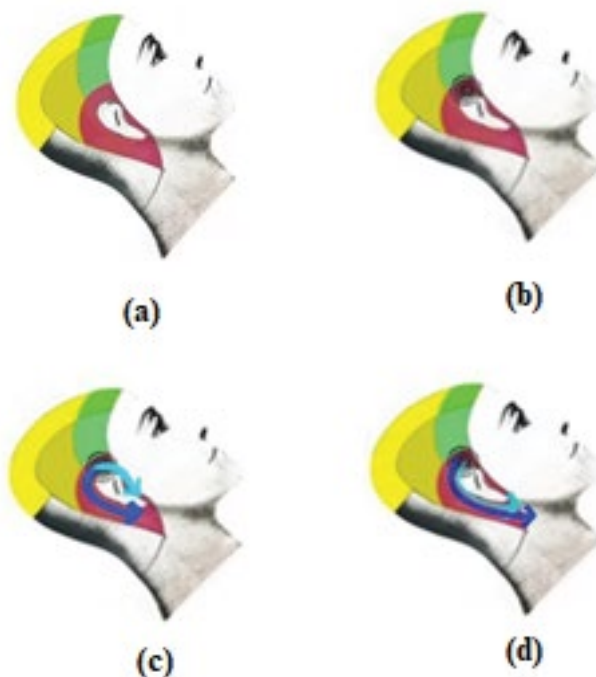


Figure 4. Area-IV of scalp massage.

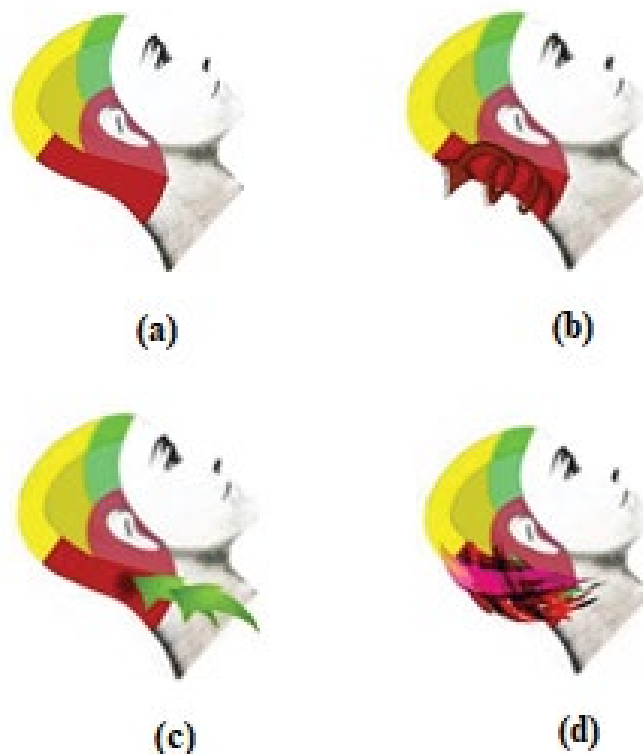


Figure 5. Area-V of scalp massage.

adequately administered. Twenty healthy male and female participants aged between 22 and 57 years old (average age 35) join the experiment as the research subjects. All participants receive scalp massage at the same setting. When doing the scalp massage, all subjects are in a lying down pose and the temperature of warm water is kept at a fixed value. Then, the scalp meridian massage treatment is performed after the tree-minute hair spa.

To investigate the effect of scalp spa meridian massage, the psychological status before and after the treatments is evaluated. The heart rate variability analyzer SA-3000P [18] is used to measure the status factors of the autonomic nervous system, including mean heart rate (HRT, bpm), standard deviation of all normal to normal interval (SDNN, ms), pressure index (PSI), total power (TP), very low frequency power (VLF), low frequency power (LF), high frequency power (HF) and LF/HF ratio (LF/HF). These factors represent the status of the human body based on five-minute record of the HRV. The psychological factors before and after massage are measured, with the massage time being the same (Figure 6).

Grey relationship analysis

This subsection applies the grey model theory to find the relationship of the physiological indices of autonomic nerves and to further quantize the effect of scalp spa meridian massage. The physiological stress index (PSI) is taken as the major sequence factor, while the heart rate (HRT), total power (TP), very low frequency (VLF), low frequency (LF) and high frequency (HF) are taken as the influencing sequence factors. The grey GM (0, N) model will describe the relationship between the influencing sequence factors and the major sequence factor (i.e., it will construct the grey relationship model between the stress potency and the other physiological factors of the HRV). Indeed, the relationship of the physiological factors induced by the scalp spa meridian massage in the grey GM (0, N) model is illustrated as Figure 6. The relationship weighting w_j can represent the characteristic of the resultant physiological situation for the scalp spa meridian massage. The effectiveness of the scalp spa meridian massage can be assistively analysed from the change of relationship weighting of the grey GM (0, N) model before and after the treatment. The balance and the activity of autonomic nerves is clarified through measuring and analyzing the HRV. The grey GM (0, N) model is introduced and applied to identify the model weightings below.

Since the measured data is not dynamic sequence, the grey zero-order GM (0, N) model is used for our static data analysis. Let us denote the data sequence of the main factor (PSI) as $x_0^{(0)}(k)$ i.e.,

$$x_0^{(0)} = (x_0^{(0)}(1), x_0^{(0)}(2), \dots, x_0^{(0)}(P))$$

Where P is the sequence length of the measured data (P=20 is the number of subjects); and the superscript '(0)' means the original data. The

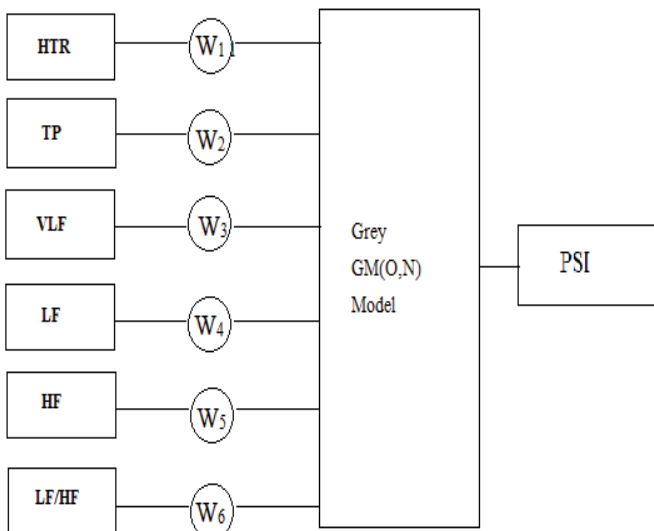


Figure 6. Grey relationship analysis structure.

data sequences of influence factors, which are HRT, TP, VLF, LF and HF, are respectively defined as follows:

$$x_1^{(0)} = (x_1^{(0)}(1), x_1^{(0)}(2), \dots, x_1^{(0)}(P))$$

$$x_2^{(0)} = (x_2^{(0)}(1), x_2^{(0)}(2), \dots, x_2^{(0)}(P))$$

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$$x_{N-1}^{(0)} = (x_{N-1}^{(0)}(1), x_{N-1}^{(0)}(2), \dots, x_{N-1}^{(0)}(P))$$

Where N is the total sequence number and N = 6 in this case. Then, the GM(0, N) model is represented in the following form:

$$\alpha x_0^{(1)}(k) = \sum_{j=1}^{N-1} \beta_j x_j^{(1)}(k) \dots\dots\dots(1)$$

Where α and β_j are some coefficients; k=1, 2, ..., P is the data index; $x_j^{(1)}$, for j = 0, 1, ..., N-1, are the first-order accumulative generation operations (1-AGO) of the original sequences $x_j^{(0)}$ defined below:

$$x_j^{(1)}(k) = \sum_{g=1}^k x_j^{(0)}(g)$$

The accumulative generation operation is applied to convert the sequences to strict monotonic increasing sequences. Then, by multiple regressive method, the grey GM (0, N) model can be further represented in the following noise-free model:

$$\alpha z_0^{(1)} = \sum_{j=1}^{N-1} \lambda_j x_j^{(1)}(k)$$

where α and β_j are some coefficients; k=1, 2, ..., P is the data index; $x_j^{(1)}$ (k), for j = 0, 1, ..., N-1, are the first-order accumulative generation operations (1-AGO) of the original sequences $x_j^{(0)}$ (k) defined below:

$$z_0^{(1)}(k) = \frac{1}{2} (x_0^{(1)}(k) + x_0^{(1)}(k - 1))$$

For k = 2, 3, ..., P. Next, the GM (0, N) model is expressed by one variable through the zero-order grey differential equation:

$$\alpha z_0^{(1)}(k) = \sum_{j=1}^{N-1} \lambda_j x_j^{(1)}(k) = \lambda_1 x_1^{(1)}(k) + \lambda_2 x_2^{(1)}(k) + \dots + \lambda_{N-1} x_{N-1}^{(1)}(k) \dots\dots\dots(2)$$

where the coefficients α and $\lambda_1, \lambda_2, \dots, \lambda_{N-1}$ are called the grey developing and grey input coefficients, respectively. After applying the 1-AGO and the averaged adjacent data sequence, we obtain the overall grey equations:

$$\alpha z_0^{(1)}(2) = \lambda_1 x_1^{(1)}(2) + \dots + \lambda_{N-1} x_{N-1}^{(1)}(2)$$

$$\alpha z_0^{(1)}(3) = \lambda_1 x_1^{(1)}(3) + \dots + \lambda_{N-1} x_{N-1}^{(1)}(3) \dots\dots\dots(3)$$

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$$\alpha z_0^{(1)}(L) = \lambda_1 x_1^{(1)}(P) + \dots + \lambda_{N-1} x_{N-1}^{(1)}(P)$$

Afterward, by dividing α on both sides of the above equations and denoting j=0,1, ..., N-1, the GM(0, N) model can be rearranged in a matrix form:

$$\begin{bmatrix} z_0^{(1)}(2) \\ z_0^{(1)}(3) \\ \vdots \\ z_0^{(1)}(P) \end{bmatrix} = \begin{bmatrix} x_1^{(1)}(2) & x_2^{(1)}(2) & \dots & x_{N-1}^{(1)}(2) \\ x_1^{(1)}(3) & x_2^{(1)}(3) & \dots & x_{N-1}^{(1)}(3) \\ \vdots & \vdots & \dots & \vdots \\ x_1^{(1)}(P) & x_2^{(1)}(P) & \dots & x_{N-1}^{(1)}(P) \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_{N-1} \end{bmatrix} \dots\dots\dots(4)$$

If the developing co-efficient $\alpha \neq 0$, then w_j is the characteristic weighting for the relationship from the influence sequences $x_1^{(0)}, \dots, x_{N-1}^{(0)}$ to the major sequence factor $x_0^{(0)}$. To solve the characteristic weighting, we use the least square estimation method in the linear regression below:

$$W = \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_{N-1} \end{bmatrix} = (X^T X)^{-1} X^T Z \dots\dots\dots(5)$$

Where X and Z are denoted in the following vector and matrix:

$$X = \begin{bmatrix} x_1^{(1)}(2) & \dots & x_{N-1}^{(1)}(2) \\ x_1^{(1)}(3) & \dots & x_{N-1}^{(1)}(3) \\ \vdots & \dots & \vdots \\ x_1^{(1)}(P) & \dots & x_{N-1}^{(1)}(P) \end{bmatrix}, Z = \begin{bmatrix} z_0^{(1)}(2) \\ z_0^{(1)}(3) \\ \vdots \\ z_0^{(1)}(P) \end{bmatrix} = \begin{bmatrix} 0.5(x_0^{(1)}(2) + x_0^{(1)}(1)) \\ 0.5(x_0^{(1)}(3) + x_0^{(1)}(2)) \\ \vdots \\ 0.5(x_0^{(1)}(P) + x_0^{(1)}(P-1)) \end{bmatrix}$$

Since the coefficients w_1, \dots, w_{N-1} carry the intrinsic information contained in the data sequences, the coefficients w_1, \dots, w_{N-1} indicate the relationship between the major sequence (PSI) and the other influence factors (HRT, TP, VLF, LF, HF). This means that the relationship weighting represents the data property, i.e., the relationship weighting w_1, \dots, w_{N-1} is able to show the physiological status. Thus, we can observe the change of the relationship weighting of the grey GM(0, N) model to distinguish the effect of the scalp spa meridian massage. (Table 1-3 and Figure 7).

Results

Experimental results

The physiological status before and after applying the scalp spa meridian massage treatment is obtained in Table 1 and Table 2. Meanwhile, Table 3 provides the average factor values for the measured data of the physiological factors. Figure 7 show the psychological effect of the treatment from Table 3. The results show the benefit of the scalp spa meridian massage.

Assistant analysis via grey relationship calculation

To further understand the change of the autonomic nervous system due to the scalp spa meridian massage, the grey GM(0, N) model is applied on the measured data. The detailed calculation procedure is given in the following. From the above subsection, we first let the data factors of the grey model to be x_0 =PSI, x_1 =HRT, x_2 =TP, x_3 =VLF, x_4 =LF and x_5 =HF. According to Figure 6, the PSI is taken as the major factor (i.e., model output), while the HRT, TP, VLF, LF and HF are taken as the influencing factors (i.e., model input). From Table 1, the physiological data sequences before the scalp spa meridian massage

treatment are defined below:

$$\begin{aligned} x_0^{(0)} &= PSI = (51.137, 135.79, \dots, 18.327, 36.523) \\ x_1^{(0)} &= HRT = (90, 89, \dots, 56, 74) \\ x_2^{(0)} &= TP = (1271.434, 536.002, \dots, 732.304, 431.803) \\ x_3^{(0)} &= VLF = (394.046, 407.985, \dots, 632.304, 331.803) \\ x_4^{(0)} &= LF = (279.028, 55.188, \dots, 73.852, 22.772) \\ x_5^{(0)} &= HF = (598.36, 72.829, \dots, 26.148, 77.228) \end{aligned}$$

Table 1. Data before scalp spa meridian massage.

S. No.	Mean HRT	PSI	TP	VLF	LF	HF	LF/HF
1	90	51.137	1271.434	394.046	279.028	598.36	0.466
2	89	135.79	536.002	407.985	55.188	72.829	0.758
3	89	171.583	80.121	22.382	18.9	38.838	0.487
4	69	74.651	412.924	142.015	72.115	198.793	0.363
5	76	57.957	571.098	353.349	139.269	78.481	1.775
6	102	82.433	546.708	197.142	155.506	194.06	0.801
7	65	59.709	441.539	133.027	57.972	250.539	0.231
8	77	33.389	905.161	153.505	440.463	311.28	1.415
9	70	52.887	420.362	320.362	36.136	63.864	0.566
10	74	31.878	561.165	461.165	30.066	69.934	0.43
11	83	182.123	299.27	197.189	51.842	48.158	1.077
12	79	31.863	2479.625	1546.716	721	211.938	3.402
13	77	72.842	665.214	565.214	62.49	37.51	1.666
14	68	52.473	252.198	152.198	50.486	49.514	1.02
15	84	96.116	122.605	40.569	58.716	23.32	2.518
16	96	55.659	265.273	165.273	76.355	23.645	3.229
17	86	76.996	736.195	636.195	53.498	46.502	1.15
18	85	51.812	262.125	162.125	53.424	46.576	1.147
19	56	18.327	732.304	632.304	73.852	26.148	2.824
20	74	36.523	431.803	331.803	22.772	77.228	0.295

Table 2. Data after scalp spa meridian massage.

S. No.	Mean HRT	PSI	TP	VLF	LF	HF	LF/HF
1	84	39.245	898.142	226.571	345.335	326.236	1.059
2	76	36.455	1268.003	748.797	185.733	333.473	0.557
3	82	39.143	2432.002	897.522	741.507	793.056	0.935
4	62	35.164	1268.385	797.832	167.123	303.43	0.551
5	71	19.767	3595.215	1685.661	1512.679	396.874	3.811
6	77	18.879	1990.679	723.419	678.067	589.193	1.151
7	60	23.133	2546.564	2042.235	122.98	381.348	0.322
8	73	14.472	4478.882	3401.814	335.836	741.359	0.453
9	59	6.454	2224.049	2124.049	71.716	28.284	2.536
10	63	27.927	422.449	322.449	48.814	51.186	0.954
11	55	10.575	1569.294	1469.294	56.133	43.867	1.28
12	74	19.383	2430.103	797.39	1439.58	193.077	7.456
13	68	9.375	4658.026	4558.026	55.939	44.061	1.27
14	66	11.41	5685.265	1515.439	2287.547	1882.755	1.215
15	52	10.245	2269.811	1269.811	604.83	395.17	1.531
16	80	17.07	3089.957	2089.957	675.99	324.01	2.086
17	79	27.898	2439.561	1427.484	74.504	25.496	2.922
18	85	45.154	1058.909	958.909	48.45	51.55	0.94
19	50	9.743	2106.082	1106.082	640.64	359.36	1.783
20	63	14	1365.987	365.987	379.74	620.26	0.612

In the same way, the physiological data sequences after the scalp spa meridian massage treatment from Table 2 are defined below:

$$\begin{aligned}
 x_1^{(0)} &= HRT = (84, 76, \dots, 50, 63) \\
 x_2^{(0)} &= TP = (898.142, 1268.003, \dots, 2106.082, 1365.987) \\
 x_3^{(0)} &= VLF = (226.571, 748.797, \dots, 1106.082, 365.987) \\
 x_4^{(0)} &= LF = (345.335, 185.733, \dots, 640.64, 379.74) \\
 x_5^{(0)} &= HF = (326.236, 333.473, \dots, 359.36, 620.26)
 \end{aligned}$$

Note that the length of each data sequence is $P = 20$. Next, by substituting the above data sequences into Equation (5), the relationship weightings for each factor before and after scalp spa meridian massage treatment are obtained in Table 4, while the relationship weightings have been further normalized in Table 5. According to Table 4, the relationship weightings have large change before and after the scalp massage treatment. Based on the grey data analysis result, the action rules of the scalp spa meridian massage can be formulated and discussed in the next section.

Discussion

According to the above results (cf. Table 4), the grey relationship weightings have obvious change before and after the scalp massage treatment. Since the relationship weightings of the grey GM(0, N) model represent the characteristic of the data system, the physiological status before and after applying the scalp spa meridian massage treatment has been improved. From the normalized factor weightings in Table 5, we can find the importance rank of the influence factors in turn as $LF/HF > LF > HF > VLF > TP > \text{mean HRT}$ and $\text{mean HRT} > TP > LF/HF > VLF > HF = LF$ before and after the treatment, respectively. This means that the mean HRT and TP has been mainly improved after the scalp spa meridian massage. From Table 3, the LF/HF ratio represents more balance between the sympathetic and parasympathetic nerves after the treatment. Since LF increases more than HF, the parasympathetic nerves are reduced so high that the autonomic nervous function becomes more stable. Generally, the normal value of LF/HF is 1.5, i.e., the stress relief of deeply massaging scalp meridian along with hair spa is achieved through regulating the activity balance of sympathetic and parasympathetic nerves. Thus, deeply massaging meridian on the scalp along with hair spa can regulate cardiac autonomic nervous functions, relieve psychological stress and improve cardiovascular activities. (Tables 4 and 5)

In turn, the second importance ranking factor is the mean HRT, i.e., the mean HRT has been obviously improved from the scalp massage. Table 3 points out that the mean HRT has been reduced, which is usually relative to the physiological stress. In other words, the physiological stress has been

improved. Indeed, participants' average value of PSI obviously shrinks after the scalp spa meridian massage from Table 3. The relaxation effect of PSI induced by the scalp spa meridian massage averages 69.46%, i.e., the pre-test PSI value is changed from 71.31 to 21.775 after the test. This means that the scalp spa meridian massage has improvement effect for stress reduction. Based on the assistant grey data analysis, the action rules of the scalp spa meridian massage are formulated.

Furthermore, we illustrate the averaged result of the experiment of Table 3 as shown in Figure 7.

Meanwhile, the change effect of the treatment has calculated in Table 6. From observing Figure 7 and Table 6, the TP value is increased 298.5% after the scalp meridian massage. As we know, subjects would feel tired and weak due to long-term fatigue and chronic diseases when a TP index is lower than the normal range of 1000~2000 [9]. After the scalp spa meridian massage treatment, the averaged TP is increased more than 2000. This means that the scalp spa meridian massage not only relaxes fatigue but also boosts people's spirit (Table 6).

In addition, the benefit of the scalp spa meridian massage can be found through the frequency analysis of the HRV data. From the results in Figure 7 and Table 6, the change of the average VLF, LF and HF values of the heart rate variability are higher after the scalp spa meridian massage. Indeed, the increased change effect of the average VLF, LF and HF for the scalp spa meridian massage is 306.7%, 317.4% and 219.5%, respectively. This phenomenon implies that the activity of parasympathetic nerves is increased. Since the averaged LF is increased more than the averaged HF, the LF/HF ratio becomes higher. The balance between the sympathetic and parasympathetic nerves after the treatment is improved. Therefore, according to the above grey relationship and statistical analysis, the scalp spa meridian massage has better beneficial effect on health.

The scalp spa meridian massage, apart from following the running course of meridian, makes use of the co-frequency resonance principle. Subjects gradually become calm due to stable extremity movement accompanied in a fixed frequency between inhale and exhale. The scalp spa meridian massage awakens the Governor vessel, Bladder meridian, Gallbladder meridian and Triple Energizer meridian. As a result, the participants obtain more physical, mental and spiritual balance. In contrast, pure hair spa does not regulate the

Table 3. Averaged data before and after the scalp spa meridian massage.

	Mean HRT	PSI	TP	VLF	LF	HF	LF/HF
Before	79.45	71.3074	599.656	350.728	125.455	123.376	1.281
After	68.95	21.7746	2389.868	1426.436	523.657	394.202	1.6712

Table 4. Grey relationship weighting before and after the scalp spa meridian massage.

	Mean HRT	TP	VLF	LF	HF	LF/HF
Before	1.634	2.133	7.762	7.757	7.695	7.783
After	0.576	0.234	0.012	0.010	0.010	0.013

Table 5. Normalized grey relationship weighting before and after the scalp spa meridian massage.

	Mean HRT	TP	VLF	LF	HF	LF/HF
Before	0.047	0.061	0.219	0.223	0.221	0.224
After	0.674	0.274	0.014	0.012	0.012	0.015

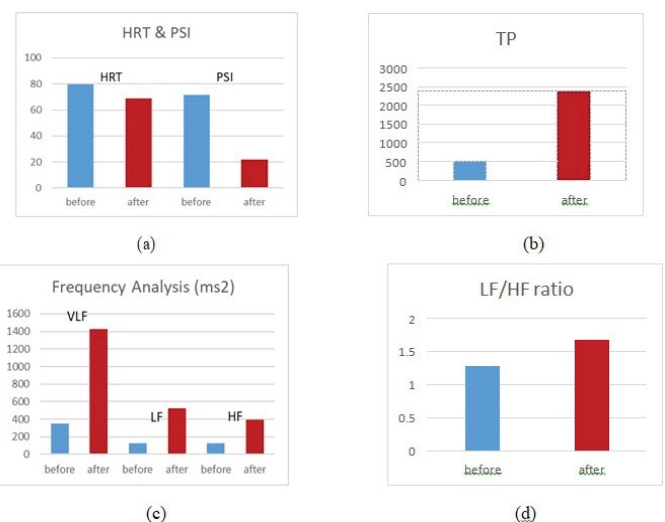


Figure 7. The average of (a) mean HRT & PSI, (b) TP, (c) VLF, LF, HF and (d) LF/HF ratio.

Table 6. Change effect of the scalp spa meridian massage.

	Mean HRT	PSI	TP	VLF	LF	HF	LF/HF
Change effect	-13.2%	-69.46%	+298.5%	+306.7%	+317.4%	+219.5%	+30.5%

running of meridian, such that it only provides the cleaning effect. It tends to apply too much pressure in rapid washing hair, so that psychological feeling of customers is ignored. Therefore, the scalp spa meridian massage has beneficial effect on stress relief and healthcare.

Conclusion

By using the grey relationship assistant analysis, the grey relationship weightings represent the characteristic of the complex physiological system due to the scalp spa meridian massage. As a result, the effect of the scalp spa meridian massage is formulated with the physiological action rules. As the designed scalp meridian massage follows the running course of meridian, the Governor vessel, Bladder meridian, Gallbladder meridian and Triple Energizer meridian can be awaked. It can transmit deeper affection to the head meridian, thus reducing stress. Indeed, the scalp spa meridian massage relieves stress more than 69.46%. Participants treated with the scalp spa meridian massage are manifested with more physical, mental and spiritual balance. The benefit of the scalp spa meridian massage is therefore verified by the experiment and grey data analysis. The result of this study can serve as a scalp massage guide for stress relief and healthcare.

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Conflicts of Interest

The author has no conflicts of interest to declare.

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