Effects on physiological indicators of foot massage using a pressure sensing massage stick

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Abstract

Foot massage is often used as a complementary and alternative medicine. This study uses a special foot pressure-sensing massage stick to massage the soles of the feet, and tests the effects on the physiological indicators of the massaged person. After 3 sessions of massage, the results demonstrated that the assistive stick and the foot massage method used in this study were verified. The sleep quality score and body energy index were improved significantly with increasing massage frequency, whereas the respiration rate, heart rate, and blood oxygen were decreased significantly with increasing massage frequency. The psychological stress and physical ages were not significantly changed.

Keywords: Reflexology, Ergonomic design, complementary and alternative medicine, human factors, mechanical design, healthcare.

1. Introduction

Complementary and alternative therapies are increasingly recognized as a safe and effective way to reduce pain and illness [1]. It is a non-invasive and affordable form of health care that is beneficial to most people, including children, the elderly, cancer patients and pregnant women. Can be used [2]. The World Health Organization (World Health Organization, 1990) pointed out that combining traditional drug-free podiatry medicine with modern surgical medicine can help people understand their own health and increase medical security. In many countries, the reflexology and beauty industry is associated with unorthodox medicine.

Complementary and alternative therapies are actively used in healthcare settings in hospices, nursing homes and obstetrics. Attitudes towards complementary and alternative therapies are shifting around the world towards their use as secondary health care and their integration into mainstream medicine [1]. The British survey found that the average one-year use rate of auxiliary therapy is 41.1% [3]. The use rate of elderly people in the United States is 23%-62.9% [4]. The one-year use rate in Taiwan is 85.65%.

Cai et al., [5] searched the Web of Science for 31 literature published on foot reflexology from 1991 to 2021. Use "foot massage" or "reflexology" to search for all academic publications on foot reflexology, and a total of 801 papers were retrieved. The average annual publication volume in the first six years was 3.5 articles, and the average annual publication volume in the last six years was 72 articles, which was 20 times that of the first six years. It can be seen that this research topic has recently been receiving global attention and investing research resources.

Foot reflexology has been suggested to enhance blood flow, increase relaxation, and improve healing [6]. It is considered to be the most commonly used complementary and alternative therapy by the elderly [7]. It is also the complementary and alternative therapy that young people love to use [8]. Currently, foot reflexology in Taiwan is loved by a wide range of users and is used in daily life, becoming a part of complementary and alternative medicine.

The application areas of foot massage include: toes, inside of foot, instep, outside of foot, and sole of foot. Since the sole of the foot contains the most acupuncture points, has the best massage effect, and is easier to perform, this study first explores the massage of the sole of the foot and explores the impact of foot massage on physiological indicators.

2. Methodology

2.1. Experimental Design

The experiment is a 15-day period, and the detail plan is shown in Figure 1. During this period, the subjects were asked to wear Garmin Forerunner 945watches, record physiological indexes, and be responsible for keeping the Garmin watches.

During the study period, subjects are required to be foot massaged three times, on days 4, 8, and 12 respectively. Each application takes about 40 minutes and is performed by a professionally trained foot reflexology operator. During the experimental study, the subjects continued to work and rest as usual.

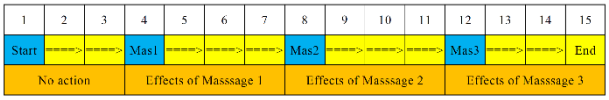

Fig.1 the experimental plan

Fig.2 the recorder of physiological indexes.

2.2. Subjects

This study recruits 6 volunteer adults (3 males and 3 females), over 20 years old with no obvious trauma as subjects.

2.3. Experimental Instruments

There are two main instruments used in this experiment: the GARMIN Forerunner 945 wearable device (Figure 2) and the massage assistive device, a foot massage stick developed by this study (Figure 3). The massage parts on the sole of the feet was showed in Figure 4. The experimental location was the Ergonomic Research Laboratory of National Yunlin University of Science and Technology, Taiwan.


Fig.3 the massage stick.

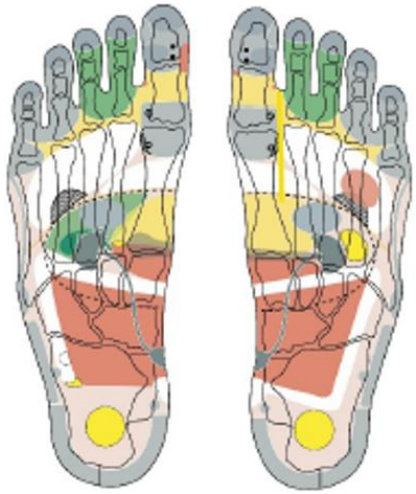
Fig. 4 The massage part on the sole of the feet.

2.4. Variables

Experimental variables: The independent variable of this study is the stages: stage 0 (no application; days 1, 2, 3), stage 1 (first massage on day 4; days 4, 5, 6, 7), stage 2 (second massage on day 8; days 8, 9, 10, 11 days), and stage 3 (third massage on day 12; days 12, 13, 14, 15). The plan of massage schedule was showed in Figure 1.

The dependent variables include: 1) sleep quality score, 2) psychological stress, 3) body energy index, 4) physical age, 5) respiration rate, 6) heart rate, and 7) blood oxygen.

3. Results and Discussion

3.1. Results

The age of the subjects was calculated by genders and showed in Table 1. The age ranged from 44-58 years with a mean age of 51.50 (SD= 5.92) years.

Table 1. the statistics of the age of the subjects

Genders	N	min	max	mean	SD
Male	3	50.0	58.0	53.67	4.04
Female	3	44.0	58.0	49.33	7.57
Total	6	44.0	58.0	51.50	5.92

The statistic results of the seven dependent variables are calculated based on the 4 stages: stage 0 (no action), stage 1 (first massage), stage 2 (second massage), and stage 3 (third massage) of the independent variable and showed in Table 2-8, respectively.

Table 2 showed the results of the sleep quality scores of the 4 stages. The sleep quality scores of stages 0, 1, 2, and 3 were 59.06, 71.21, 76.04, and 81.54, respectively. The sleep quality scores from 59.06 of stage 0 increased up to 81.54 of stage 3.

The table showed that the sleep quality of stage 2 and stage 3 were significantly greater than that of stage 0, and the sleep quality of stage 1 was equal to that of stage 0, 1, and 2. That means the sleep quality were improved when massaged twice and more.

Table 2. the statistics of sleep quality scores

Stages	N	min	max	mean	SD	t-tests
Stage 0	6	40	73.3	59.06	13.43	A
Stage 1	6	44	85.3	71.21	16.30	AB
Stage 2	6	54	87.5	76.04	11.82	B
Stage 3	6	73	91.8	81.54	6.49	B

The results of body energy indexes of the 4 stages were showed in Table 3. The body energy indexes of stages 0, 1, 2, and 3 were 68.28, 79.21, 83.50, and 84.17, respectively. The body energy indexes from 68.28 of stage 0 increased up to 84.17 of stage 3.

The table showed that the body energy indexes of stage 1, stage 2 and stage 3 were significantly greater than that of stage 0. That means the body energy indexes were improved when massaged for the first time, and improved better for massage twice and more.

However, the body energy indexes of stage 2 and stage 3 were equally. This signified that the body energy indexes for more than twice massage, the body energy indexes can maintain a constant and is not increasing continued.

Table 3. the statistics of body energy index

Stages	N	min	max	mean	SD	t-tests
Stage 0	6	52.7	74.7	68.28	8.56	A
Stage 1	6	68.3	91.8	79.21	7.75	B
Stage 2	6	67.3	94.3	83.50	9.01	C
Stage 3	6	76.0	88.8	84.17	5.00	C

The results of respiration rate of the 4 stages were showed in Table 4. The respiration rate of stage 0, 1, 2, and 3 were 14.00, 13.71, 13.54, and 13.33, respectively. The respiration rate decreased from 14.00 down to 13.33.

The table showed that the respiration rate of stage 3 was significantly greater than that of stage 0. That means the respiration rate was improved only when massaged for third time.

The respiration rate of stages 1 was equal to that of stage 2 and not greater than that of stage 0 significantly. This means that the massage effect was not significantly strong on respiration rate.

Table 4. the statistics of respiration rate

Stages	N	min	max	mean	SD	t-tests
Stage 0	6	14	14.0	14.00	0.00	A
Stage 1	6	13	14.0	13.71	0.29	AB
Stage 2	6	13	14.0	13.54	0.51	AB
Stage 3	6	13	14.0	13.33	0.52	B

The results of heart rate of the 4 stages were showed in Table 5. The heart rate of stage 0, 1, 2, and 3 were 76.39, 73.08, 71.42, and 67.92, respectively. The heart rate decreased from 76.39 down to 67.92.

The table showed that the heart rate of stage 1 was significantly greater than that of stage 0. That means the heart rate was not improved when massaged for the first time.

The heart rate of stages 2 was significantly greater than that of stage 0 and the heart rate of stages 3 was significantly greater than that of stage 0, stage 1, and stage 2. This means that the massage effect was significantly strong on heart rate when massage twice and more.

Table 5. the statistics of heart rate

Stages	N	min	max	mean	SD	t-tests
Stage 0	6	66	84.3	76.39	7.85	A
Stage 1	6	65	79.5	73.08	5.73	AB
Stage 2	6	65	76.8	71.42	4.54	B
Stage 3	6	59	71.8	67.92	5.01	C

The results of blood oxygen. of the 4 stages were showed in Table 6. The blood oxygen of stage 0, 1, 2, and 3 were 94.17, 93.42, 93.25, and 93.00, respectively. The blood oxygen decreased from 94.17 down to 93.00.

The table showed that the blood oxygen of stage 1, stage 2, and stage 3 were significantly greater than that of stage 0. That means the blood oxygen was improved when massaged for the first time.

However, the blood oxygen of stages 3, stage 2, and stage 1 were the same. That means that the blood oxygen was not significantly improved when massage twice and more.

Table 6. the statistics of blood oxygen.

Stages	N	min	max	mean	SD	t-tests
Stage 0	6	93	95.0	94.17	0.75	A
Stage 1	6	92	94.8	93.42	1.16	B
Stage 2	6	92	94.0	93.25	0.88	B
Stage 3	6	92	94.0	93.00	0.99	B

The results of psychological stress of the 4 stages were showed in Table 7. The psychological stress of stage 0, 1, 2, and 3 were 37.44, 35.29, 34.46, and 32.50, respectively. The psychological stress decreased from 37.44 down to 32.50.

The table showed that the psychological stress of stage 1, stage 2, and stage 3 were not significantly greater than that of stage 0 although the psychological stresses were slightly decreased. That means the psychological stress was not improved when foot massaged was applied for people regardless the massage frequency.

Table 7. the statistics of psychological stress

Stages	N	min	max	mean	SD	t-tests
Stage 0	6	30	49.3	37.44	6.80	A
Stage 1	6	25	46.3	35.29	8.20	A
Stage 2	6	24	44.3	34.46	7.99	A
Stage 3	6	27	37.5	32.50	3.80	A

The results of physical ages of the 4 stages were showed in Table 7. The physical ages of stage 0, 1, 2, and 3 were

50.75, 49.48, 49.13, and 48.83, respectively. The physical ages decreased from 50.75 down to 48,83.

The table showed that the physical ages of stage 1, stage 2, and stage 3 were not significantly greater than that of stage 0, although the physical ages had declined slightly. That means the physical ages was not improved when foot massaged was applied for people regardless the massage frequency.

Table 8. the statistics of physical ages

Stages	N	min	max	mean	SD	t-tests
Stage 0	6	42.2	57.3	50.75	6.01	A
Stage 1	6	42.0	57.0	49.48	5.84	A
Stage 2	6	42.0	57.0	49.13	5.52	A
Stage 3	6	42.0	57.0	48.83	5.27	A

3.2. Discussions

The results showed that the sleep quality score and body energy index were increased gradually according to the of massage times. On the contrary, the respiration rate, heart rate, and blood oxygen were decreased according to the of massage frequency. On the other hand, the psychological stress and physical age were not significantly changed although the data was slightly different. This illustrated that the effects of the physiological indicators were improved after foot massage using the assistive stick designed by this study.

4. Conclusion

This study conducted a three-stage foot massage using a pressure-sensing massage stick designed by the study. The results and procedure of this study demonstrated that the assistive stick designed by the study and the foot massage method operated in this study were verified. The results illustrated that the sleep quality score and body energy index were improved significantly with increasing massage frequency, whereas the respiration rate, heart rate, and blood oxygen were decreased significantly with increasing massage frequency. The psychological stress and physical ages were not decreased significantly according to the of massage frequency. The results could be a reference for health supplies design.

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