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The Effects of *Mompyeogi* Movement Exercise on Body Skin Temperature

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ABSTRACT

Background: Spine stretching and flexibility exercise have been introduced by a group of *Mompyeogi* movement exercise (‘*mom’* as body and ‘*pyeogi’* as stretching) that is growing in the Republic of Korea. Although it does not move as fast as an aerobic exercise, the benefit of body organ stretching movement position on this movement exercise can be perceived by *Mompyeogi* participants.
Purpose: This study aimed to investigate the effects of *Mompyeogi* movement exercise on the alteration of body skin temperature.
Methods: A pre-post experimental study was carried out to 20 participants who were divided into two groups: male and female. Each group was assigned to do either normal breathing (chest respiration) or deep breathing (abdominal respiration) when performing Mompyeogi movement exercise. Body skin temperatures were measured a couple of times before, during, and after the exercise using thermal infrared cameras. The collected data were analyzed descriptively in frequency and percentage.
Results: Results showed that *Mompyeogi* movement exercise combined with deep abdominal breathing methods increased body skin temperature. Participants who were in low group temperature (t<33°C), underweight, and had normal body mass index showed an increased body skin temperature after the exercise. On the other hand, participants who were in the group age of 60-74 years old performing normal chest respiration showed a stable body skin temperature after the exercise.
Conclusion: Stretching organ as a part of basic *Mompyeogi* movement exercise combined with deep abdominal breathing increased the body skin temperature. Future research of *Mompyeogi* movement exercise needs to explore a self-healing effort as a preventing and promoting programs contributed to holistic nursing practice.

Keywords: Body skin temperature; inhalation; *Mompyeogi* exercise; infrared thermoregulation

BACKGROUND

The placement of proper posture is required to support the correct alignment of the spine with instilling an active lifestyle. Posture determines the efficiency of any individuals’ breathing with a relaxed, straight sit with a strong core, active scapula but not tight, and spine erect to expand ones’ chests to take a larger breath, and have more energy on daily activity (Golubic, 2013). A behavioral study showed that the mastery of

body language posture could influence a wider respiratory and have well-preserved spine discs (Huang, Galinsky, Gruenfeld, & Guillory, 2010). The process of spine stretching and flexibility exercise introduced by a group of *Mompyeogi* movement exercise is one of the spinal strengthening exercises that is expanding in South Korea. The word *'mom'* meaning as body and *'pyeogi'* meaning as stretching, have become the basic concept of *Mompyeogi* movement exercise to keep a good body position in any activities. Although the body is not moved as fast as an aerobic exercise, the benefit of body organ stretching movement position in this exercise can be perceived by *Mompyeogi* participants. Body organ stretching position is the main position of *Mompyeogi* movement in which cannot be found in the other exercises (Kyung-Yong, 2017).

During physical exercise, there is a changing on energy for a muscle pump, body temperature regulation, breathing rate, heart rate, carbon dioxide blood, and pH (Gerald et al., 1995). The physiological response to exercise depends on the intensity, duration, and frequency of the exercise as well as the environmental conditions (Deborah, Keith, & George, 2004). A similar opinion stated that during exercise, and immediately after that, active skeletal muscles become significant heat sources. Relating to stretching exercise, there is an impact to the muscle contraction, increasing blood flow affect to thermoregulation of body temperature after exercise (Nigel, Michael, & Glen, 2014; Taylor, Wilsmore, Amos, Takken, & Komen, 1998).

The skin temperature represents the main variable controlling the heat exchanges at the body/environment interface and can significantly vary according to the environmental condition, intensity, and duration of the exercise. As the exercise progresses, the dynamics of physical activity have a noticeable effect on skin blood flow and temperature. The time-evolution of skin temperature during exercise can give useful information about the adaptation of the subject as a function of a specific type, intensity and duration of exercise (Tanda, 2015); the skin temperature response depends on the type of exercise and the level of training (Nigel et al., 2014; Tanda, 2015). It is supported by several previous studies about thermal infrared camera assessment of skin temperature (Bernard, Staffa, Mornstein, & Bourek, 2013; Choi & Lofness, 2012). Advances in body temperature measurement contribute to thermoregulation research and measurement of human body temperature during clinical and exercise settings. The thermoregulatory mechanisms play important roles in maintaining physiological homeostasis during physical exercise and rest (Lim, Byrne, & Lee, 2008; Mitchell, Harris, Cordaro, & Starnes, 2002).

Previous research showed that body temperature investigates the possibility of the use of human body skin temperature to assess thermal sensation by studying skin temperatures from ten body segments and analyzing the correlation between the physiological data: the skin temperature and overall thermal sensation. Results of this study revealed that skin temperature change rates (gradients) were more consistent with the thermal comfort condition than with the actual levels of skin temperatures of participants; and that the measured skin temperatures at their wrists provided more interpretable data than that of any other body segments (Choi & Lofness, 2012). The other study found that infrared thermal imaging can be an appropriate method for

determining the temperature of organisms if this is understood as the surface temperature, and the surrounding environment and temperature are considered (Bernard et al., 2013). However, there has been no evidence of studies which measured local skin abdominal surface area temperature during exercise. Therefore, a thermal infra-red imaging camera was used in this study to measure the body skin temperature on organ stretching posture position of *Mompyeogi* movement exercise to get the benefit of the exercise. The thermal infra-red imaging camera as a non-invasive procedure and a risk-free technique detects local skin temperature on the abdominal surface area. It will represent the interface between the body and the environment that can reflect both the dynamic response and temperature reaction. This study also observed the relationship between gender, ages, body mass index (BMI), and distinguished between normal inhalation and deep inhalation.

PURPOSE

This study aimed to investigate the alteration of body skin temperature through the stretching exercise of *Mompyeogi* movement. This study also examined the body skin temperature according to the characteristics of the participants (gender, ages, body mass index (BMI) and breathing/ respiration types).

METHODS

Research design and samples

This study was tailored in a descriptive research design through an experimental study. The present study was conducted on 20 participants who were divided into two groups: male and female, evenly. The participants were purposively recruited from Wonju *Mompyeogi* Movement Association, Seoul, South Korea.

Intervention

Twenty participants were divided into two groups: male and female. Each group was assigned to do either normal breathing (chest respiration) or deep breathing (abdominal respiration), resulting in four different groups by gender and breathing techniques. For preparation, to eliminate the effects of the temperature due to the body metabolic food process, the participants' temperature measurement was performed at least 30 minutes after eating, smoking, or drinking a hot or cold liquid before taking skin temperature, as well as setting the participants in organ stretching position.

In this study, the procedures of organ stretching were started with: (1) lying on backup over a half-folded cushion placed on a cylinder-shaped pillow with a diameter of 15 cm, (2) raising arms overhead and slightly bend in "hands up" position, ensuring that part of buttocks touch the floor (the pillow was placed just below the seventh thoracic spine, added by a half-folded cushion to push the backbone moving upward), (3) staying in this pose with crossed legs for about 10 minutes and ensuring that shoulders were firmly pulled back while the chest wide opened, the mouth closed, and the neck should be vertical to the floor (doing normal/ deep breathing), and (4) getting up in one time after being 10 minutes in this pose.

Measurement

In this study, body skin temperature measurements were recorded by infrared camera Sonel KT-640 Thermal Imager, a fully radiometric camera which records temperature at each point of the image-high-resolution TTT detector micro bolometric matrix (640 x 480 pixels, 25 μm) type. The absolute accuracy of the measurement was declared at 20°C±2% reading. Thermal sensitivity was <0.05°C at 30°C. This technology combines between visual and IR image, in a range temperature from -20°C to 35°C, the emissivity of body skin of 0.98, in working temperature of -15°C to 50°C. The recording was in the extended jpg format, and real-time monitoring was performed (Gruner, 2003).

All participants performed the procedures by lying on back position, while the pictures were taken on the anterior body of the abdominal skin surface area around the navel point. By using thermal imager infrared instrument KT-640, the temperatures were recorded three times, i.e., before the exercise, and two times during exercise in five and ten minutes. Standard measurement procedures were started with instrument preparation by setting up the equipment on human skin emissivity of 0.98, the temperature range between 30°C to 35°C, a distance of 0.5m to 1m, setting calibration, picture focus, captured and picture saved, and then move to the next participant. The thermal images were taken indoors at around 6 to 9 p.m., during the winter season, in room temperature of 24°C, and relative humidity of 70%.

Data analysis

Descriptive statistics using frequency and percentage were used to analyze the data, according to gender, age, and respiration methods.

Ethical consideration

The study was approved by the ethical committee of *Mompyeogi* Association and the Wonju *Mompyeogi* Movement Association, where the study took place. All respondents have informed the purpose of the study and signed an informed consent to indicate their voluntary participation in the study.

RESULTS

Twenty participants of Wonju *Mompyeogi* movement association were involved in this study. The participants consisted of 10 females and 10 males. The female participants were mostly in middle age (9 participants), had an average height and weight of 1.57 m and 54.7 kg, respectively, and had 5.2 years of the exercise experience. Meanwhile, the male participants were mostly the elderly (7 participants), had an average height of 1.68 m and weight of 68.2 kg, and 6.6 years of exercise experience (see Table 1).

Table 1. Characteristics of the participants

Data	Value	Female	Male	Total
Participant		10	10	20
Ages*				
Middle age	45-59	9	3	12
Elderly	60-74	1	7	8
Height (m)		1.57	1.68	

Data	Value	Female	Male	Total
Weight (kg)		54.70	68.20	
BMI (kg/m^2)				
Underweight	<18.5	2	0	2
Normal	18.5-24.9	6	7	13
Overweight	≥ 25	2	3	5
Exercise experience (years) *(M)*		5.2	6.6	

**World Health Organization standard (WHO, 2011)*

Based on the skin temperature group, Figure 1 shows that the body skin temperature of seven participants (39%) in the low-temperature group (<33°C) increased after 5 minutes and 10 minutes of *Mompyeogi* movement exercise.

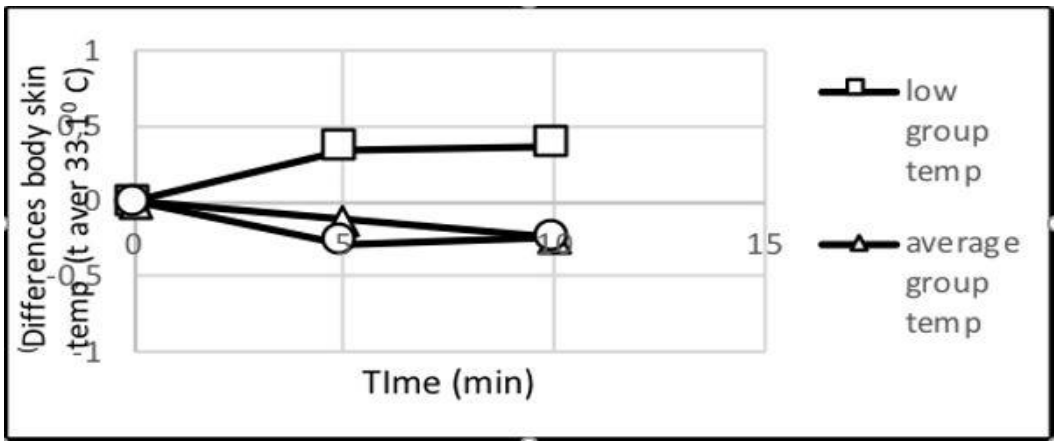

Figure.1. Temperature rate by time measurement on body skin temperature groups

Figure 2 shows that the temperature rates of 8 participants (44%) with chest (normal) respiration decreased after 10 minutes of *Mompyeogi* stretching exercise, while the other 10 participants (56%) with abdominal (deep) respiration showed an increased temperature rate after 10 minutes of exercise.

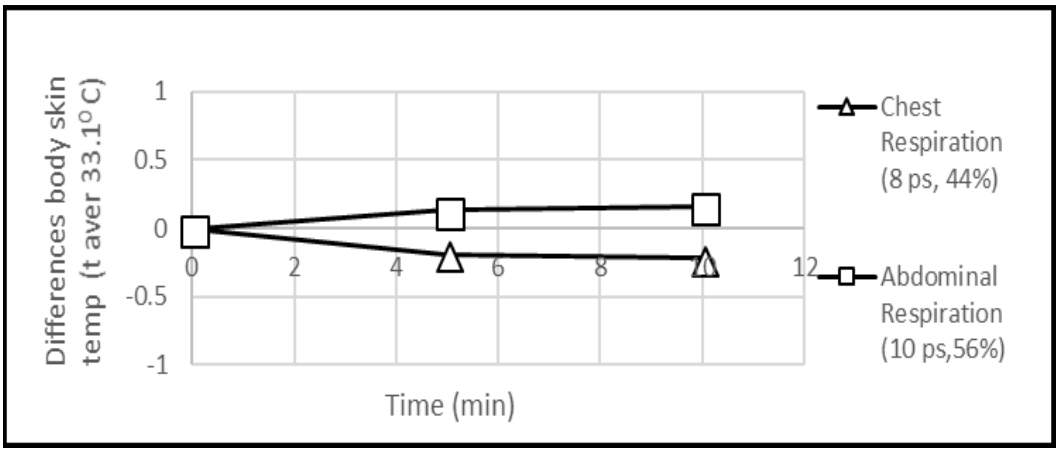

Figure. 2. Temperature rate by time measurement based on respiration methods

Based on the BMI measurement, Figure 3 shows that 11 participants (67%) in normal level of BMI showed increasing temperatures after 10 minutes of exercise. Meanwhile, the underweight participants (11%) and overweight participants (28%) showed decreasing temperatures after the exercise.

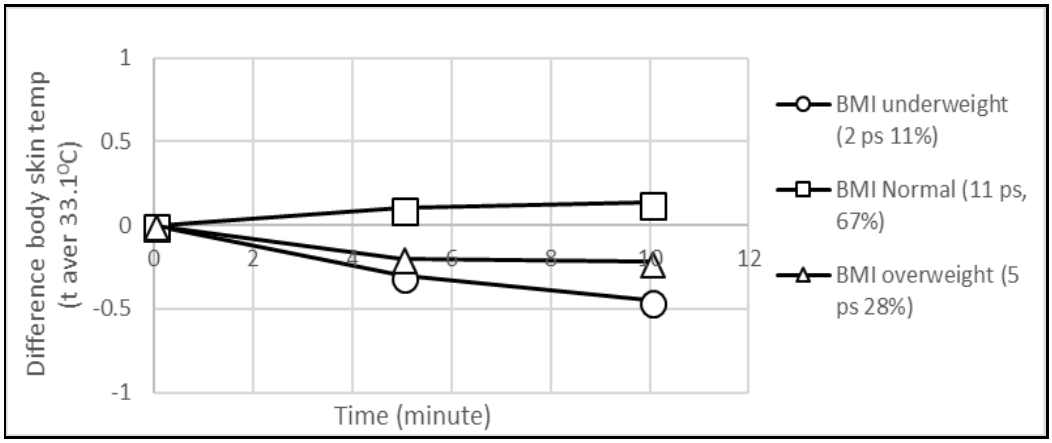

Figure 3. Temperature rate by time measurement based on Body Mass Index (BMI)

The results of combination assessment based on the relation of temperature groups and respiration methods showed that the body skin temperature of the participants in the low group temperature with chest respiration increased in 10 minutes of assessment as seen in Figure 4. A similar result was yielded in 6 participants from low group temperature with abdominal respiration. Meanwhile, the high-temperature group of 4 participants with chest respiration showed a decrease in 10 minutes. In the high temperature group with abdominal respiration, a decrease was found in 5 minutes, and an increase was found in 10 minutes.

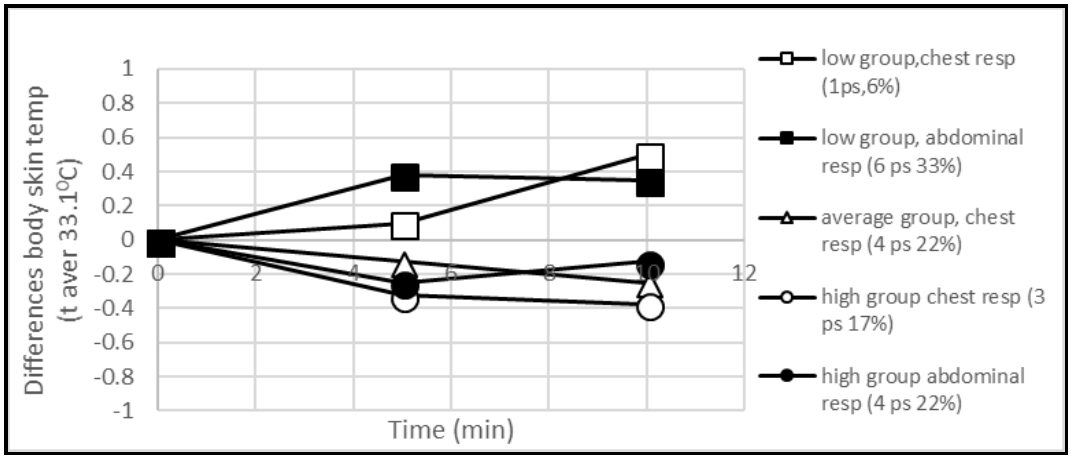

Figure 4. Temperature rate by time measurement based on skin temperature groups and respiration methods

Figure 5 shows the increasing body skin temperature on female and male participants performing abdominal (deep) respiration.

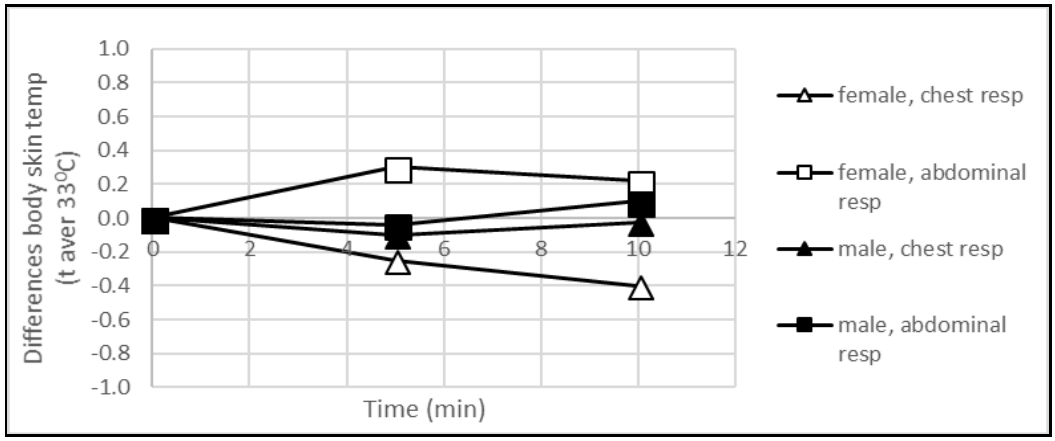

Figure. 5. Temperature rate by time measurement based on gender and respiration method

Figure 6 compares the middle age group with the elderly group based on their body temperature measured in differently ordered respirations. Figure 6 shows a meaningful increasing result for the participants of *Mompyeogi* in middle age group with abdominal respiration in the first 5 minutes, followed with a slight decrease in the remaining 5 minutes. On the other hand, the elderly group with abdominal respiration showed an increase in skin temperature in 5 minutes and a decrease after the 10-minute exercise.

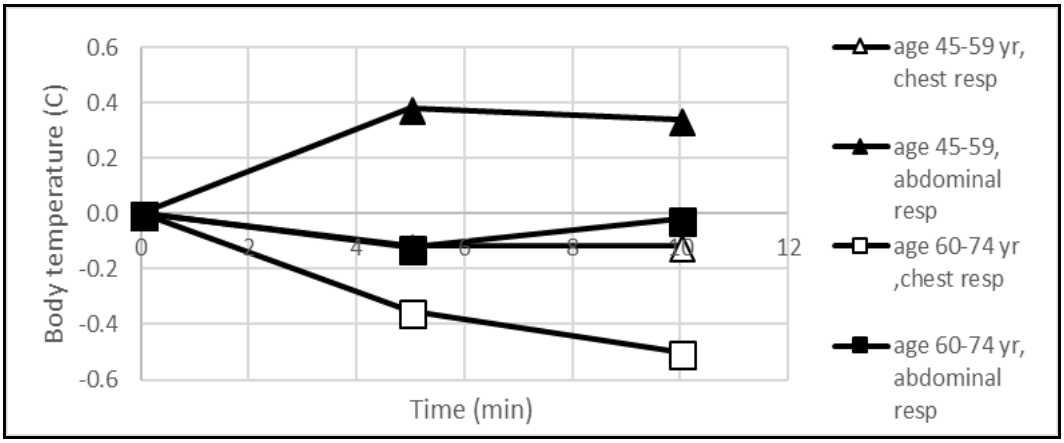

Figure 6. Temperature rate by time measurement based on age's groups and respiration methods

Figure 7 illustrates that temperature rate of underweight and overweight participants with chest respiration decreased at the end of 10 minutes of exercise, while the temperature rate of the underweight and normal level of BMI participants with abdominal respiration increased.

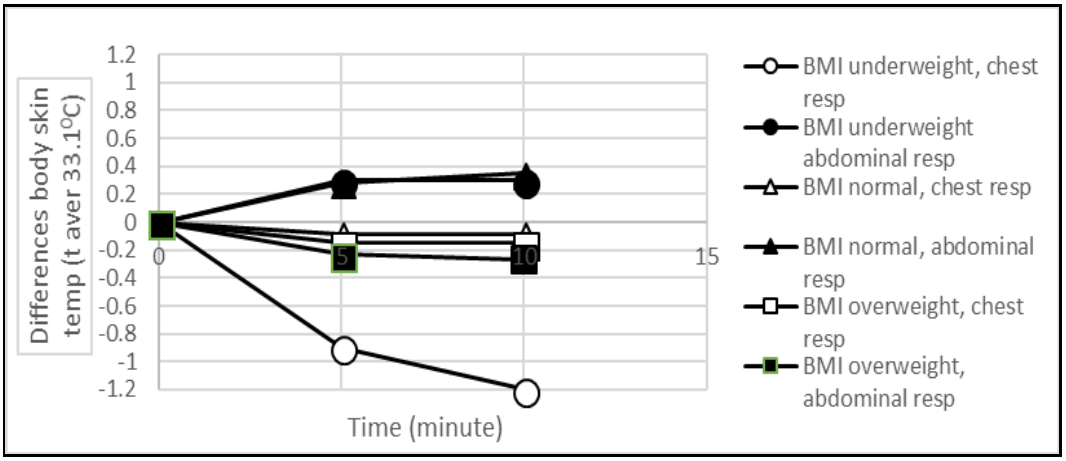

Figure 7. Temperature rate by time measurement based on BMI and respiration methods

DISCUSSION

This study involved twenty participants who fulfilled the requirement in the whole assessment screening mapping distribution. The analysis focused on the differences of skin temperature of *Mompyeogi* movement, on the position of body organ stretching, temperature group distribution, body mass index (BMI), and respiration methods related to gender and age group. The differences in skin temperature observed by the distribution of temperature group variations found that during exercise, the rate of energy increases rapidly known as the heat produced during metabolism. The contraction of large muscle groups was mainly responsible for the change in body temperature during exercise. More heat production means a more significant rise in body temperature during exercise. Conversely, in this study, it was found that the average temperature groups (22%) and high-temperature groups above 33°C (39%) decreased after assessment on 5 and 10 minutes of body organ stretching position. This result is related to a previous study of human body homeostatic systems, in which the brain hypothalamus works as the thermostat for body temperature control. Temperature receptors throughout the human body send feedback to the hypothalamus. If the hypothalamus receives an indication that the body is either too hot or too cold, the brain gives a signal to the body to react accordingly to the temperature receptors; the skin sends the heat signal to the hypothalamus (Giovanni, 2016; Paulev-Zubeita, 2017).

The differences in skin temperature variance were observed by the distribution of respiration methods. This result agrees with another report that core body warming results are achieved with breathing techniques (Maria, James, Jennifer, & Klaus, 2013). Tibet study and western study obtained the same opinion that practicing the phase of deep breathing is a safe technique to regulate core body temperature in a normal range. The participants with this technique were able to elevate their body temperature, within a limit, and reported a feeling of more energized and focused breathing technique which causes thermogenesis, which is a process of heat production. The depth of breathing refers to the amount of air taken in with each breath. In this occasion, the role of hypothalamus as a thermoregulatory circumference affects the respiratory system,

including the lungs and breathing muscles, and the circulatory system including the heart, blood, and blood vessels (Paulev-Zubieta, 2017).

Differences in body skin temperature variance by the distribution of temperature group variations and respiration methods indicated that the body is equipped with mechanisms to prevent large changes in temperature. Exercise is a high-energy condition, requiring the breakdown of nutrients to fuel muscle contraction. The increased metabolism observed in muscles is correlated with elevated tissue temperatures and adaptations in blood flow and sweat production, serving to regulate heat removal during muscular exercise. The body has the capacity to filter excess heat energy if temperatures increase above a certain point. The first step in this process is transporting the heat from muscle tissue to the surface of the skin. This is accomplished through a process known as vasodilation. Capillaries, the smallest blood vessels in the body, can increase their diameter to accommodate large volumes of blood. Blood flow to muscles may increase, thus facilitating the removal of excess heat. Subsequently, capillary networks near the surface of the skin will dilate to increase blood flow and facilitate the removal of heat from the body. During exercise, through vasodilation of capillaries in the skin, our body is attempting to expel the excess heat that generated in our muscles, then follow with the negative feedback of thermoregulation (Michael, & Darren, 2015).

The differences in body skin temperature variance observed by the distribution of gender and respiration methods indicated that in this condition core, body warming is achieved with breathing techniques. Practicing deep breathing is a safe technique to regulate core body temperature in a normal range. Skin temperatures become more heterogeneous. Protective mechanisms buffer heat losses with elevated subcutaneous adiposity and distribution in female, insulating the skin from its heat source, the body core (Nigel, Michael, & Glen, 2014). Meanwhile, the differences in body skin temperature variance by the distribution of age group and respiration methods showed a meaningful increasing result for the participants of *Mompyeogi* in the average age of 45-59 years old with abdominal respiration. Meanwhile, the elderly age with abdominal respiration showed an increase in 5 minutes and a decrease after 10 minutes of exercise.

The relation between body mass index (BMI) and skin temperature in different body areas have been investigated and still result in different opinions between the findings of BMI classification in normal weight, overweight and obese, and they have not related to thermal response at skin level (Fernandez-Cuevas, Marins, Serrano, & Arnaiz-Lastras, 2012; Savastano, 2009). Furthermore, greater sub-cutaneous abdominal adipose tissue provides significant insulation and cooler temperatures, and the mean of body surface temperature is dependent on body fat (Chudecka, Lubkowska, & Kempińska-Podhorodecka, 2014).

Differences in body skin temperature variance by the distribution of BMI and respiration methods showed that *Mompyeogi* organ stretching exercise with deep inhalation using abdominal respiration would increase the body temperature rate. The layer of female fat is different from male, which is influencing the process of insulating in their body, and the work of exercise requires energy. The muscles break down the nutrients, such as glucose and fat, into the more readily processed forms of energy.

Adenosine triphosphate, or ATP, is a ubiquitous form of energy used by muscle cells throughout the body. The cells are continually producing and breaking down ATP, and these chemical reactions produce heat. When exercising is begun, the rate of ATP turnover increases tremendously, thus increasing the temperature of the muscle. During exercise, when multiple muscle groups start contracting and increasing their activity, large amounts of heat are produced. In accordance with the basic laws of thermodynamics, the heat will flow away from its site of production and increase the temperature of the surrounding fluid and blood. Most biochemical reactions occur optimally at specific body temperature; however, muscle activity during exercise often leads to increases in total body temperature.

CONCLUSION

The stretching of body organ using *Mompyeogi* movement exercise combined with proper respiration methods has given benefits in increasing body temperature that creates better thermoregulation in the human body. This study showed that there was a relationship between the organ stretching using *Mompyeogi* movement with abdominal respiration or deep inhalation methods and the increasing body skin temperature among the participants from the low-temperature group (<33°C) and the underweight and normal body mass index (BMI). Organ stretching using *Mompyeogi* movement exercise has a good impact on the well-trained participants. Further research of *Mompyeogi* movement exercise needs to explore a self-healing effort as a contributing prevention and promotion programs for holistic nursing practice.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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