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Associations of Subjective Coldness (*Hie*) with Negative Emotional States, Chronic Low Back Pain, and Menstrual Pain in Japanese Women: A Cross-Sectional Study

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Abstract

Background: *Hie*, a traditional medicine concept of subjective coldness, may relate to low back pain. Despite anecdotal links to menstrual pain, research is limited. Studies reveal discrepancies between subjective and objective findings, suggesting psychological/social factors. This study aims to clarify *Hie*, its causes, exacerbating factors, and ways to improve well-being and prevent chronic low back pain. **Methods:** 341 applicants were categorized into *Hie* (−), (+), and (++) groups. Weight, BMI, body temperature at various sites, mental status/emotion, and physical features (breath, pulse, blood pressure, low back pain, menstrual pain) were analyzed using Chi-square and ANOVA tests. **Results:** Weight and BMI differed significantly among groups, but body temperatures did not. Anger-related mental status showed significant differences. The *Hie* (+) group had more individuals in their 40s with chronic low back pain and menstrual pain. **Discussion & Conclusion:** *Hie* severity (++) links to sympathetic nervous system tension (higher pulse/blood pressure), potentially due to anger. Both *Hie* (+) and (++) groups correlated with negative emotions. Notably, *Hie* (+) was associated with low weight/BMI and higher rates of chronic low back/menstrual pain, leading to more doctor visits without specific diagnoses. Middle-aged women in *Hie* (+) may experience social stress. Addressing *Hie* (+) requires comprehensive approaches beyond just cold sensation.

Keywords

Hie, Low Back Pain (LBP), Subjective Well-Being, Body Temperature (BT)

1. Introduction

Hie, a subjective sensation of coldness in traditional medicine, has been suggested as a potential contributing factor to low back pain (LBP) [1]. As there are many women in Japan experiencing *Hie*, some researchers have studied the effect of menstruation on it. While anecdotal evidence suggests a possible association between *Hie* and menstrual pain, which is unique to women, large-scale research in this area remains limited. Although several studies have investigated *Hie* in Japanese women [2]-[6], some have carefully measured body temperature (BT), especially in the feet [3], and some have looked for causes in lifestyle factors, including diet [6]. However, its precise definition and exacerbating factors have yet to be fully elucidated. Nevertheless, existing research has indicated a notable prevalence of *Hie* in this population. For instance, Saga reported that 50% of female university students experienced subjective coldness, with 36.6% reporting painful *Hie* [4]. Furthermore, another study demonstrated that 70% of female and 50% of male outpatients reported experiencing *Hie* [7]. The subjective nature of *Hie* poses challenges for objective measurements, potentially affecting a significant number of women. Recent investigations employing scales to assess subjective coldness in various body regions [8] reveal that a considerable proportion of *Hie* cases present a discrepancy between objective clinical observations and patients' subjective complaints, suggesting the involvement of non-physiological factors, including psychological impact and social stress. Given the potential influence of psychological variables on *Hie*, a multidisciplinary approach to diagnosis and treatment is warranted. *Hie* may represent a complex interplay between physical and mental states that is potentially influenced by emotional conditions [9]-[11]. The current study, building upon prior research [9] [12], aimed to provide a more refined understanding of the traditional concept of *Hie* by incorporating the measurement of BT, a contemporary physiological parameter. Furthermore, it sought to evaluate the significant psychological impact of various factors on the experience of *Hie* and to develop novel strategies for managing this sensation. This study aimed to investigate the etiology and aggravating factors of *Hie*, with the ultimate goal of preventing future illnesses (such as chronic LBP) and improving the well-being of Japanese women.

2. Methods

2.1. Participants

Our study used data from a Japanese survey company's computerized database (Cross Marketing Inc., Tokyo, Japan). The subsample of 5000 individuals was se-

lected by stratified random sampling from the database of 300,000 individuals. Stratification was performed by region.

Invitations to participate in the survey were sent via email to the 5000 selected individuals. After screening for eligibility, 1000 individuals (20%) completed the survey and were included in the final analysis. The stratified sampling balance was maintained throughout the selection process. The survey results were tabulated in a computer database and statistical analyses were performed. We included participants who answered all questions perfectly.

The exclusion criteria were the absence of an infrared (contact-type) thermometer and the use of specific medicines or supplements without a prescription. An internet-based survey was administered to all participants (a web-based questionnaire-answering system provided by the survey company). Prior to study initiation, the participants were informed that the data collected would be used for research purposes only and that strict confidentiality would be maintained. Informed consent was obtained from all participants before the commencement of the investigation. The participants were additionally informed about their right to withdraw from the study at any time. A total of 341 women answered that they were interested in *Hie*. This study was approved by the Medical Ethics Committee of Ibaraki Prefectural University of Health Sciences (Ibaraki, Japan, e300-r120209).

2.2. Survey Questionnaire

We prepared the questionnaire based on the study conducted by Ouchi, *et al.* [12] as shown in the Appendix.

2.3. Body Mass Index (BMI) and Body Temperature (BT) (Axilla, Forehead, Hand, and Foot and Difference)

As in previous studies, we calculated the BMI [13]-[15] by inquiring about the participant's weight and height.

The participants were asked to report their age category (20 - 29, 30 - 39, 40 - 49, or 50 - 59 years). BT was recorded by the participants themselves at the following four locations: axilla, forehead, hand, and foot. The core BT (axilla) was measured using a clinical mercury thermometer, and the cutaneous BT (on the forehead, hand, and foot) was recorded using a contactless digital thermometer. We calculated the maximum difference (Difference) in BT by calculating the difference between the highest and lowest recorded temperatures. We collected information in accordance with Ouchi, *et al.* [12].

2.4. "Mind" Information: Mental Status/Emotion

As recent researchers have reported that mental status affects *Hie* [12] [16] [17], we studied the levels of their "Mind" information (mental statue/emotion): happiness, anger, depression, inferiority, failure, exhaustion, and deterioration of health (yes, N/A, no) as in the attached appendix.

2.5. Physical Features, Breath, Pulse, Blood Pressure (BP), Pain (LBP, Menstrual Pain)

Apart from information regarding whether participants suffered from *Hie* or not, we also collected information on breaths per minute (<15 or ≥15), pulse (<70, 70–80, or ≥80), and blood pressure (BP) (systolic blood pressure (SBP) <140 and diastolic blood pressure (DBP) <90; SBP <180 and/or DBP <110; or SBP ≥180 or DBP ≥110). LBP refers to the presence of pain, stiffness, and decreased movement of the lower back, as well as difficulty in straightening the lower back. Participants were asked to document LBP (<3 months, ≥3 months, or no LBP). At the same time, we also asked them about menstrual pain, allowing them to select from "painful", "no problem", or "no menses". Our categories are presented in the appendix attached.

2.6. Statistical Analysis

All statistical analyses were performed using SPSS Statistics software for Windows, version 25.0 (IBM Corp., Armonk, NY, USA). Means (±standard deviations) were used to characterize the distribution of continuous variables. Pearson's chi-square test was performed to study the three groups. Participants who selected "No" in the physical features section of the questionnaire in the attached appendix constituted the *Hie* (−) group, those who answered "Yes (mild)" constituted the *Hie* (+) group, and the others constituted the *Hie* (++) group. At the same time, we also conducted a statistical analysis between the two *Hie* groups [*Hie* (+) group and *Hie* (++) group]. We also conducted post hoc comparisons, as appropriate. The level of significance was set at $p < 0.05$ and $p < 0.01$, and all data are presented as mean ± SEM.

3. Results

3.1. Characteristics of *Hie* (−) Group, *Hie* (+) Group and *Hie* (++) Group: Weight, Body Mass Index (BMI) and Body Temperature (BT) (Axilla, Forehead, Hand, and Foot and Difference) Body

Figure 1 shows that weight showed a significant difference among the three groups [$p < 0.01$, average weight (kg): *Hie* (−) group, 53.5 ± 8.1; *Hie* (+) group, 49.9 ± 7.7; *Hie* (++) group, 50.7 ± 9.9]. Post hoc analysis also presented a significant difference between the *Hie* (−) group and the *Hie* (+) group ($p < 0.01$). Therefore, BMI also showed a significant difference among the three groups [$p < 0.01$: *Hie* (−) group, 21.4 ± 3.0; *Hie* (+) group, 19.9 ± 2.9; *Hie* (++) group, 20.2 ± 3.5], and post hoc analysis showed significant differences between the *Hie* (−) group and the *Hie* (+) group ($p < 0.01$) and between the *Hie* (−) group and the *Hie* (++) group ($p = 0.02$). All temperatures (forehead, foot, axillary, and difference) showed no significant difference. For example, the axillary temperature (˚C) was as follows: $p = 0.14$, *Hie* (−) group, 36.2 ± 0.4; *Hie* (+) group, 36.1 ± 0.4; *Hie* (++) group, 36.1 ± 0.5 (**Figure 1**).

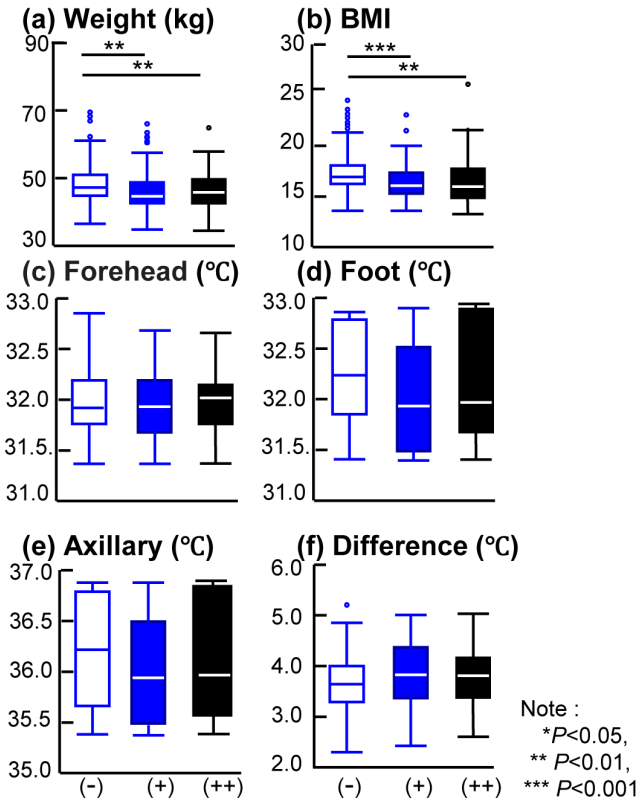
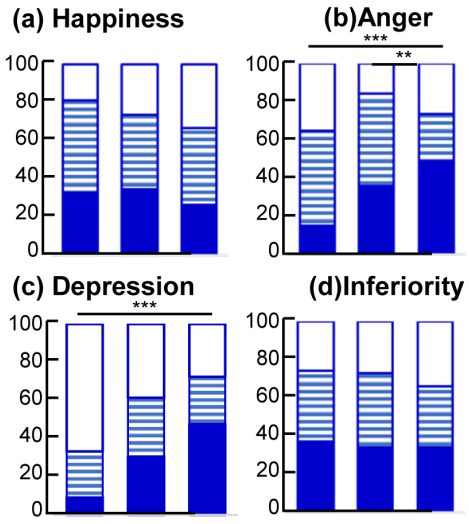


Figure 1. Characteristics of *Hie* (−) group, *Hie* (+) group and *Hie* (++) group: Weight, body mass index (BMI) and body temperature (BT) (axilla, forehead, hand, and foot and difference). The results of ANOVA.

3.2. "Mind" Information: Mental Status/Emotion of *Hie* (−) Group, *Hie* (+) Group and *Hie* (++) Group

Anger, depression, inferiority, failure, exhaustion, and deteriorating health showed significant difference among three groups ($p < 0.01$). Interestingly anger has difference in between two *Hie* groups [$p = 0.007$: *Hie* (+) group and *Hie* (++) group] (**Figure 2**).



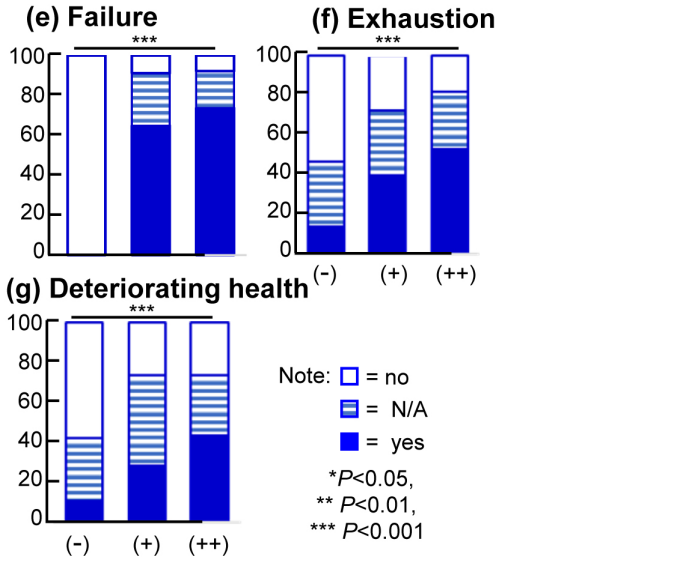
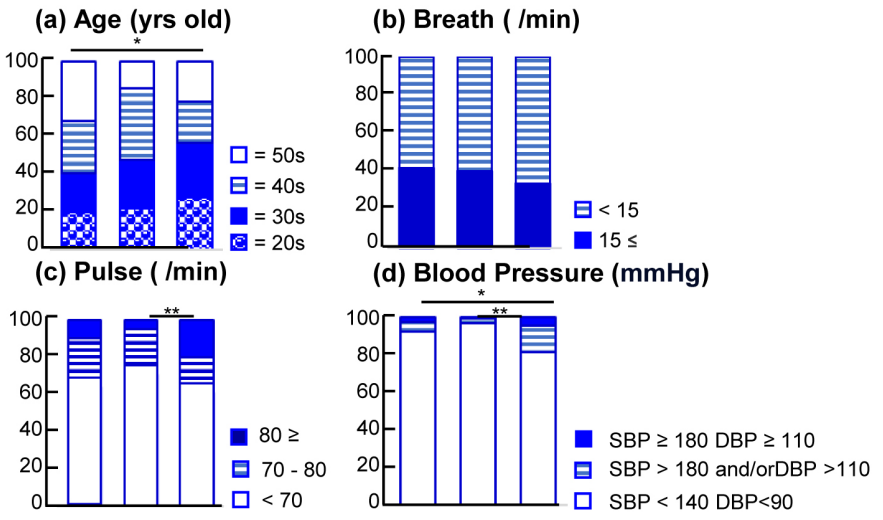


Figure 2. "Mind" information: mental status/emotion. All graphs show ratio of each group (%). of *Hie* (−) group, *Hie* (+) group and *Hie* (++) group. Results of Chi-test.

3.3. Physical Features, Breath, Pulse, Blood Pressure and Pain (LBP, Menstrual Pain) of *Hie* (−) Group, *Hie* (+) Group and *Hie* (++) Group

Age distribution showed a singularity among three groups ($p < 0.05$). The interest is 40s in *Hie* (+) group presented a very high ratio (38.6%). As for pulse, a significant difference was observed between *Hie* (+) group and *Hie* (++) group ($p < 0.01$) because *Hie* (++) group has 20.0% in the category 80≤. In the same way, *Hie* (++) group presented 13.8% in the category of (SBP > 180, DBP > 110), which is higher than other groups. As the result, there are differences: $p < 0.05$, among three groups, $p < 0.01$ between two *Hie* groups.

Both LBP and menstrual pain, there were differences among three groups (both $p < 0.01$). Interestingly, *Hie* (+) group showed the high percentage (3 ≥ months, 31.6%) in LBP as well as (painful, 50.0%) in menstrual pain (Figure 3).



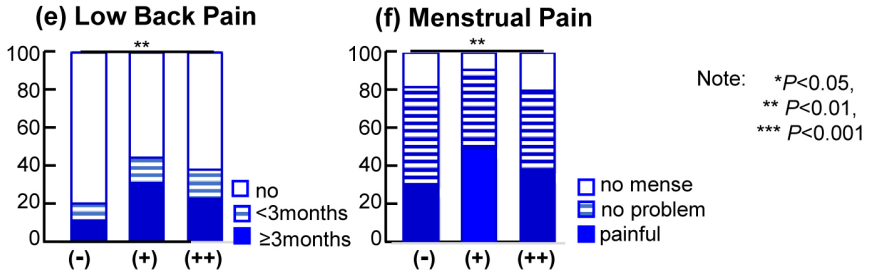


Figure 3. Physical features, Breath, Pulse, Blood Pressure and Pain (LBP, men-strual pain). All graphs show ratio of each group (%) of *Hie* (−) group, *Hie* (+) group and *Hie* (++) group. Results of Chi-test.

4. Discussion

What makes *Hie* more severe? We categorized 341 applicants into 3 groups: *Hie* (−) group (n = 162), *Hie* (+) group (n = 114), and *Hie* (++) group (n = 62).

First, pulse and BP showed differences between the two *Hie* groups [*Hie* (+) group and *Hie* (++) group]. The pulse and BP values of the *Hie* (++) group were higher than those of the *Hie* (+) group, showing that women in the *Hie* (++) group were under sympathetic nervous system (SNS) tension. The SNS can stimulate adrenaline alpha receptors, reducing blood flow and decreasing BT [18] [19]. We may find the reason for this in the result regarding anger. More people in the *Hie* (++) group selected "yes" or "N/A" in the anger choices compared to members of the *Hie* (+) group. On the other hand, regarding emotion, both the *Hie* (+) group and the *Hie* (++) group significantly had more negative emotions such as depression, inferiority, feelings of failure, exhaustion, and deteriorating health. Emotional stress is known to modulate physiological responses, including autonomic nervous system activity; Dr. Nummenmaa's recent research may support our *Hie* study [20]-[22].

Second, the specific features of the *Hie* (+) group, low weight and low BMI, are also interesting. This point is also warned about by the Ministry of Health, Labour and Welfare [23]. Small-scale studies of *Hie* are popular in Japan, Korea, and among Japanese Brazilians; however, they are very few outside these areas. Shirasugi stated that a study of *Hie* was not popular in medical papers before 1956, even in Japan [24]. The feeling of *Hie* is different from the sense of coldness, and it accompanies an uncomfortable feeling. Because it is a personal and a subjective sense, we cannot quantify and measure it objectively. Actually, we analyzed BT at 4 points in 341 members; however, we could not obtain a statistical difference between the *Hie* (−) group and the *Hie* groups [*Hie* (+) group and *Hie* (++) group]. *Hie* does not always mean hypothermia. Recently, researchers have studied the association between *Hie* and Chronic LBP (CLBP) [12] [16] [17]. It has become clear that stress is behind CLBP in fields such as orthopedics. In this study, we asked about LBP as well as menstrual pain because menstrual pain is also affected by stress. And we obtained a statistical difference among the three groups in both LBP and menstrual pain. Interestingly, the *Hie* (+) group showed the highest rates of CLBP and menstrual pain among the three groups. Our further re-

search showed the ratio of those who visited doctors: *Hie* (−) group, *Hie* (+) group, *Hie* (++) group: 24.7%, 33.3%, 21.5% (data not shown). This showed that more people in the *Hie* (+) group visited doctors than the other groups; however, doctors did not point out specific diseases. It shows that the *Hie* (+) group is very conscious about their own bodies.

Third, another interesting point is that 38.6% of people in the *Hie* (+) group were in their 40s. Their anger was not as strong as in the *Hie* (++) group; however, middle-aged women may experience psychological stress related to caregiving or occupational burdens (childcare, elderly care, and gender inequality [25]). Nagashima reported that one cause of *Hie*, the low body weight of young Japanese women, is deeply connected not only to individual eating habits and body image issues but also to social factors [26]. The low body weight underlying *Hie* increases future health risks, increasing the risk of osteoporosis in the future and impacting pregnancy and childbirth. **Figure 3** shows that the *Hie* (+) group complained more about CLBP and menstrual pain than the *Hie* (++) group. Therefore, fortunately, those experiencing *Hie* (+) tend to visit medical institutions more often, so multifaceted measures are required in clinical practice beyond just addressing the complaint of *Hie*.

This study suggested the background of *Hie*, negative emotions, and anger worsen *Hie*, and it showed the relationship between *Hie*, CLBP, and menstrual pain. Above all, CLBP is a big reason for quitting a job [27], and it is a major social loss, so prevention is necessary.

At regular medical checkups, physicians may find and treat women in the *Hie* (++) group because of high BP due to SNS tension. On the other hand, medical professionals need to carefully observe females in the *Hie* (+) group during clinical interviews to prevent future diseases such as CLBP and so on.

This study has several limitations. First, we did not collect detailed information on potential confounding factors such as socioeconomic status, dietary habits, physical activity, medication use beyond the exclusion criteria, or other comorbid health conditions. These factors may influence both the presence of *Hie* and the outcomes assessed (chronic low back pain, menstrual pain, and emotional state). As a result, residual confounding cannot be ruled out. Future research should incorporate a broader set of variables to enable more comprehensive statistical adjustment and to better isolate the specific effects of *Hie*.

Furthermore, we encountered limitations due to our small sample size, underscoring the need for larger-scale studies to validate our findings. The use of an internet-based survey for distribution may have introduced selection bias, potentially overrepresenting frequent internet users. Additionally, the use of non-standardized thermometers could have led to measurement errors. It is also important to consider that local Japanese culture and history might influence the prevalence of *Hie*, suggesting that future research should include comparative studies across different countries. Consequently, our findings might not be fully generalizable to the broader population. Despite these limitations, our results contribute to raising

awareness of this relatively understudied condition and could provide valuable insights for the design of future *Hie* assessments.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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