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Cold sensitivity among female clinical nurses in Japan: A nationwide study

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ABSTRACT

Objectives: This study aimed to clarify the nature of cold sensitivity in female nurses working in hospitals in Japan.
Design: A cross-sectional post survey research design.
Settings: The questionnaire targeted nurses working in 14 hospitals across ten prefectures throughout Japan.
Participants: 1,138 female nurses
Methods: The survey captured participants' characteristics, work environment, health, and life-style. The factors investigated were perceived cold sensitivity, cold sensitivity according to the Hiesho Sensation Scale, and cold sensitivity during nursing care. The Diagnostic Inventory of Health and Life Habits (DIHAL.2) assessed health and lifestyle habits.
Results: Of the respondents, 44.3 % were aware of daily cold sensitivity and 21.4 % had a cold sensitivity disorder. The majority of respondents (63.1 %) felt cold in their hands when providing nursing care, and 28.1 % felt discomfort due to the coldness of their hands. Individuals diagnosed with cold sensitivity disorders exhibited poorer overall health compared to those without such disorders. However, there was no statistically significant difference in the overall health status between individuals who reported perceiving cold sensitivity and those who did not. The group with perceived cold sensitivity had significantly lower scores on exercise behavior, meal regularity, rest, sleep regularity, and sleep sufficiency. The proportion of female nurses working in Japanese hospitals who experienced cold sensitivity was similar to that of Japanese women with the same sensitivity. Most female nurses experienced cold in their hands while providing care. Nearly 30 % of the respondents experienced discomfort owing to cold hands.
Conclusions: The study underscores the widespread issue of cold sensitivity among female nurses in Japanese hospitals, emphasizing the critical need for targeted interventions to improve their comfort and optimize care provision.

1. Introduction

Cold sensitivity presents a significant health concern in Japan, particularly among women (Yoshino et al., 2013). Recent research documented the physiological and health implications associated with this condition. For instance, a study by Kono et al. (2021) found that premenopausal women with cold-sensitivity constitution exhibit sympathetic nervous hyperactivity and vascular endothelial

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dysfunction. Furthermore, research by Mori et al. (2018) indicates that “hiesho” symptoms among young female adults are associated with bodily pain and general health perceptions.

In Asian cultures, cold sensitivity is regarded as a disorder necessitating treatment, whereas in Western societies, it remains a vaguely defined concept (Nakamura et al., 2011; Ushiroyama, 2005). Among the Japanese population, mild cold discomfort is referred to as "hie," while severe cold sensation affecting daily life is diagnosed as "hiesho." In this study, we operationalized these concepts as "perceived cold sensitivity" and "cold sensitivity according to Kusumi’s Hiesho Sensation Scale," respectively. Kusumi’s Hiesho Sensation Scale, developed by Kusumi (2009), assesses cold sensitivity through a standardized scoring system, identifying individuals with hypersensitivity to cold when four or more out of eight items apply.

Previous research has employed various terms such as cold sensitivity (Stjernbrandt, 2018, 2020), cold hypersensitivity (Park and Cha, 2017), hiesho (sensitivity to cold) (Nakamura and Horiuchi, 2013, 2017), and hiesho (cold disorder) (Kimura and Asami, 2016; Mori et al., 2018; Sakaguchi et al., 2016, 2016; Yoshino et al., 2013), leading to confusion in research comparisons. To clarify, perceived cold sensitivity reflects individuals’ subjective awareness of feeling sensitive to cold in daily life, providing insight into their experiences. In contrast, Kusumi’s Hiesho Sensation Scale categorizes cold sensitivity based on a standardized scoring system, distinguishing between those with and without cold sensitivity based on specific criteria.

In Asian societies, treatment for this condition typically involves a combination of traditional remedies, lifestyle adjustments, and medical interventions. This may include dietary changes, herbal therapies, acupuncture, moxibustion, and medication. Moreover, psychoeducational, and behavioral interventions may be utilized to enhance coping strategies and resilience. Healthcare providers must grasp cultural nuances to deliver effective care tailored to individual needs.

Moreover, in this study, cold sensitivity was approached from various perspectives, including physiological and environmental factors. Biological factors such as peripheral vasoconstriction and autonomic nerve function have been implicated in cold sensitivity (Ushiroyama, 2005; Nakamura, 2013). For instance, studies have suggested that alterations in the autonomic nervous system activity, particularly decreased parasympathetic activity and increased sympathetic activity, may contribute to cold sensitivity symptoms (Ogata et al., 2017). Additionally, factors such as blood circulation disorders may play a role in the development of cold sensitivity (Kono et al., 2021).

However, it is essential to acknowledge that traditional concepts like “yin-yang balance” are not typically considered biological factors within the conventional Western scientific framework. While these concepts may have relevance in traditional Eastern medicine, their applicability to biological mechanisms associated with cold sensitivity requires further investigation and validation within the context of contemporary scientific understanding. Symptoms include shoulder stiffness, headrushes, chills, and fatigue, which affect the quality of life (Mori et al., 2018). Growing evidence suggests that cold sensitivity is associated with chronic diseases (Bae et al., 2018) and vascular disorders (Kono et al., 2021; Ogata et al., 2017).

Building on the health concerns associated with cold sensitivity, particularly among women in Japan (Yoshino et al., 2013), this study investigated its prevalence and potential risk factors within a specific female-dominated profession: nursing. Female nurses in hospital settings may experience cold sensitivity due to factors such as the high-stress nature of their work (Reith, 2018), demanding duties, and regular exposure to ill or distressed patients. While there is no direct evidence linking these factors to cold sensitivity, it is plausible that the physiological and psychological stress in such environments could influence sensitivity to temperature changes. For example, a study by Dalri et al. (2014) reported that 46.3 % of hospital nurses experience low physiological stress responses, while 42.1 % experience moderate levels.

Hand washing and sanitization have been reported to reduce hand skin temperature (Suzuki et al., 2021). Frequent hand washing and sanitization are required for infection prevention in nurses’ work environments. Many patient care activities such as bathing and other hygiene practices also require frequent water contact.

Other factors include wearing thinner clothes throughout the year and exposed forearms during nursing care and procedures which compound cold sensitivity issues. Night-shift nurses are prone to shorter sleep times, irregular mealtimes, and meal skipping, which are often associated with a disordered lifestyle, and ultimately, cold sensitivity (Nakamura, 2008, 2013). Based on this risk factor profile, we expected female nurses to have a higher prevalence of cold sensitivity. Physical and mental health affect the quality of the nursing care provided; therefore, it is essential to understand the prevalence and risk factors of cold sensitivity in female nurses.

Therefore, the current study aimed to determine the prevalence of cold sensitivity in female nurses and explore the factors associated with cold sensitivity. The cold sensitivity of female nurses and their nursing practices were also discussed to identify the challenges they faced.

2. Methods

Ethical approval for this research was obtained from the ethical review committee of our university [details blinded for peer review], and the study was conducted in accordance with the principles of the Declaration of Helsinki. The purpose and methods of the study were explained to participants. This included a statement of voluntary participation, a description of how the study material would be maintained, and a commitment to protecting personal information. All the participants provided written informed consent to participate in this study. This study did not include minors (< 16 years old).

2.1. Study design and participants

This cross-sectional study was conducted in February 2018. It targeted 1138 female nurses working at 14 hospitals in 10 out of 11 weather divisions in Japan (Japanese Meteorological Agency, 2022) to consider the influence of climatic differences. Each region

contains between one and nine prefectures (average of 4.3). The prefectures in each region were randomly selected. Nursing directors at municipal hospitals in the selected prefectures were contacted to request their participation. Each hospital was asked to distribute questionnaires to 30 female nurses working in wards, outpatient clinics, units (intensive care units (ICU), critical care units (CCU), etc.), and operating theaters. The questionnaires were returned by mail. If a municipal hospital declined participation, the nearest municipal hospital was approached. Municipal hospitals are likely to have specific work environments including wards, outpatient clinics, units (ICU and CCU), and operating theaters.

The inclusion criteria for the study participants included being nurses (full-time or part-time) and females. Head nurses who were on leave were excluded.

2.2. Questionnaire

The questionnaire asked about participant characteristics such as age, regional location of the hospital, working environment, health and living factors, and cold sensitivity.

2.3. Work environment

Participants were asked about their departments and work settings. They were asked where they worked (outpatient clinic, ward, ICU, or operating theater), employment type (full- or part-time), and whether they worked night shifts (yes/no). They were also asked about their ability to control factors affecting their temperature. This pertained to their control over air conditioning (possible/not possible), hot water temperature (yes/no), type of upper uniform (short sleeve, ½ to long sleeve), wearing additional garments for warmth (yes/no), type of uniform (pants and skirts), socks (yes/no), tights (yes/no), and pantyhoses (yes/no).

2.4. Health and living environment

The Diagnostic Inventory of Health and Life Habit.2 (DIHAL.2) (Tokunaga, 2005) comprises 47 questions designed to assess the health and lifestyle habits of middle school students and adults in Japan. These questions were subjected to item analysis, including correlation coefficient calculations between each question item and the total score for health, exercise habits, diet, and rest categories. The analysis, conducted by the developer, confirmed the significance ($p < 0.01$) and suitability of all questionnaire items. These procedures are outlined in the DIHAL.2 manual authored by Mikio Tokunaga (DIHAL.2, for junior high school students to adults-Guide, TOYO PHYSICAL).

2.5. Assessment of presence or absence of perceived cold sensitivity

In this study, the presence or absence of perceived cold sensitivity was based on Matsumoto's definition of cold sensitivity disorder (Matsumoto, 2001) for whether nurses "feel cold in an environment where others are not feeling cold and feel cold in their hands, feet, or other body parts."

2.6. Assessment of presence or absence of cold sensitivity according to Kusumi's Hiesho sensation scale

Kusumi's Hiesho Sensation Scale (Kusumi and Emori, 2009) was used to assess the degree of cold sensitivity disorders in mature women. It comprised four factors (eight items). These include sensitivity to cold, winter sleep problems due to cold sensitivity disorders, poor peripheral blood circulation, and cold sensitivity disorders in summer. Reliability was confirmed with a reliability coefficient of 0.72, significant correlation with the criteria for cold sensitivity disorder ($r = 0.79$), and concurrent validity.

2.7. Cold sensitivity during nursing care

Presence/absence data were collected in the following areas: cold hands when providing nursing care, cold hand countermeasures, patients expressing discomfort, and apologizing for cold hands.

2.8. Statistical analysis

The sample size for this study was estimated using information from a pilot study. A pilot study found that 20 % of samples had cold sensitivity.

$$n = \frac{4P(1-P)}{d^2}$$

where P is the proportion of cold sensitivity, and d is an error rate of 5 %. An estimated 256 patients were required for this study. Finally, it was assumed that 20 % of the distributed questionnaires would be returned; therefore, 1280 individuals would need to receive the questionnaires. To avoid bias as much as possible, we emphasized in the research request document that people with and without cold sensitivity were enrolled in this study.

Descriptive statistics are calculated for each item. For discrete items, χ^2 tests were used, including whether the occurrence of cold sensitivity differed based on participant characteristics and work environments. The Mann-Whitney U test was used to examine the relationship between health and lifestyle factors and cold sensitivity based on perception and the Hiesho Sensation Scale.

Next, we aimed to identify factors associated with perceived cold sensitivity. According to the Hiesho Sensation Scale, there are two types of cold sensitivity: perceived cold sensitivity and cold sensitivity disorder. The cold sensitivity rating scale includes elements that indicate health problems and a higher degree of coldness. In this study, we aimed to identify the presence of perceived cold sensitivity, or the factors associated with mild cold to identify the factors associated with the presence of perceived cold sensitivity so that we could prevent it from the level of subjective cold. A multiple logistic regression analysis was performed with the presence or absence of perceived cold sensitivity as the dependent variable. This necessitated the input of participant characteristics and work/home environment items that may affect cold sensitivity, as suggested by prior research. These characteristics include age, region-specific climate, air conditioning adjustments, handwashing water temperature, attire, and lifestyle. Lifestyle variables were classified according to their distribution and based on the median value. The analysis was conducted after removing participants with missing data. A sensitivity analysis was conducted to see if similar findings were obtained when age was excluded.

3. Results

Research cooperation requests were sent to 23 hospitals across the 11 regions. These requests were accepted by 14 hospitals across ten prefectures. We requested 120 questionnaires to be distributed per hospital: 30 in wards, 30 in outpatient clinics, 30 in units (ICU, CCU, etc.), and 30 in operating theaters. As the number of participants varied per hospital, the final questionnaire distribution ranged from 4 to 30 to for outpatient clinics, 16–30 to wards, 2–30 to units, and 2–30 to operating theater nurses.

3.1. Participants

Questionnaires were distributed to 1138 female nurses and 626 responses were received, constituting 55.0 % of the total, 594 responses (52.2 %) were deemed valid. These responses met the criteria for validity, demonstrating sufficient completion of the DIHAL.2 questionnaire and confirmed consent for participation in the study. Thirty-two responses were excluded: 21 cases had incomplete responses in the DIHAL.2 questionnaire, and 15 cases lacked confirmed consent. There was an overlap of four cases between incomplete and no consent. The sample consisted of 81.3 % participants under 50 years of age, 53.0 % from West Japan, and 86.7 % who worked full-time. The participants' perceived cold sensitivity characteristics are shown in Table 1.

An investigation of age-based differences in cold sensitivity revealed differences in the percentage of people who perceived cold sensitivity ($p = 0.024$). Specifically, nurses aged 50 and above exhibited a lower prevalence of perceived cold sensitivity compared to younger age groups. However, there was no statistically significant difference in the percentage of nurses with diagnosed cold sensitivity disorder ($p = 0.061$).

Residual analysis further elucidated that the observed trend of decreased prevalence of cold sensitivity with increasing age primarily pertained to nurses over the age of 50. For instance, the percentage of nurses in their 50 s who perceived cold sensitivity was

Table 1
Relationship between participant characteristics and perceived cold sensitivity ($N = 594$).

Participant Characteristics	Perceived cold sensitivity					
		No ($n = 331$)		Yes ($n = 263$)		p-value
	N (%)	n (%)	Adjusted Residual	n (%)	Adjusted Residual	
Age						
20s	142 (23.9)%	76 (53.5)%	−0.5	66 (46.5)%	0.5	0.024*
30s	165 (27.8)%	86 (52.1)%	−1.0	79 (47.9)%	1.0	
40s	176 (29.6)%	92 (52.3)%	−1.0	84 (47.7)%	1.0	
50s	106 (17.8)%	73 (68.9)%	3.1	33 (31.1)%	−3.1	
Region						
North Japan	102 (17.2)%	57 (55.9)%	0.0	45 (44.1)%	0.0	0.097
East Japan	177 (29.8)%	110 (62.1)%	2.1	67 (37.9)%	−2.1	
West Japan	315 (53.0)%	164 (52.1)%	−1.9	151 (47.9)%	1.9	
Department						
Outpatient clinics	182 (30.6)%	106 (58.2)%	0.7	76 (41.8)%	−0.7	0.298
Wards	220 (37.0)%	129 (58.6)%	1.0	91 (41.4)%	−1.0	
Units	102 (17.2)%	49 (48.0)%	−1.8	53 (52.0)%	1.8	
Operating theater	86 (14.5)%	47 (54.7)%	−0.3	39 (45.3)%	0.3	
Employment Type						
Full-time	515 (86.7)%	288 (55.9)%	−0.6	227 (44.1)%	0.6	0.516
Part-time	29 (4.9)%	18 (62.1)%	0.6	11 (37.9)%	−0.6	
Night shift						
No	251 (42.3)%	140 (55.8)%	0.0	111 (44.2)%	0.0	0.097
Yes	338 (56.9)%	188 (55.6)%	0.0	150 (44.4)%	0.0	

* p-value< 0.05; missing and invalid values were excluded from the analysis.

significantly lower (residual −3.1), emphasizing a notable difference in this age group compared to younger counterparts.

In contrast, when investigating region-based differences in cold sensitivity among nurses in North, East, and West Japan, no significant differences were found in the percentage of individuals with perceived cold sensitivity or confirmed cold sensitivity disorders ($p = 0.097$ and $p = 0.755$, respectively).

Of the respondents, 44.3 % were aware of daily cold sensitivity. Respondents identified distal areas such as their fingers and toes as frequently colder (Supplementary Table 1). Central body areas, such as the neck, shoulders, and back, were less frequently cold. Of the respondents, 89.7 % said that cold was sometimes or always bothersome. Cold perception follows seasonal and circadian patterns. Using the Hiesho Sensation Scale, 127 respondents (21.4 %) were identified as having cold sensitivity disorder (Table 2).

3.2. Cold sensitivity when providing nursing care

Most respondents (63.1 %) experienced cold sensitivity in their hands when providing nursing care, and 73.6 % reported this sensitivity for more than one day per week. Most (87.3 %) of those who took countermeasures rubbed their hands. Despite these measures, 66.3 % of the respondents apologized to patients for their cold hands. Additionally, 167 respondents (28.1 %) reported that their patients experienced discomfort because their hands were cold. Of those who made patient comments, 34.7 % said that comments occurred more than once per week.

Some work environment characteristics were not related to perceived cold sensitivity or cold sensitivity disorders. These included the work department, work style, handwashing water temperature, type of lower garment uniform, and use of socks or pantyhose.

Items with significant associations with perceived cold sensitivity were the ability to adjust the air conditioning and garments worn (e.g., upper body uniform garments, nonuniform undergarments/cardigan/protective clothing, or tights). Women with cold sensitivity disorder were significantly more likely to use non-uniform undergarments/cardigan/protective clothing and tights (Table 3).

3.3. Relationship between health, lifestyle, and cold sensitivity

Several lifestyle factors were significantly associated with perceived cold sensitivity in nurses. Although overall exercise and rest habits were significantly associated with cold sensitivity, overall dietary habits were not. The sub scores for exercise behavior and conditions, diet regularity, rest, sleep regularity, and satisfaction were significantly different.

Nurses with cold sensitivity disorder had significantly lower health levels and exercise and rest habit scores than those without cold sensitivity disorder. The overall health and lifestyle scores were also significantly lower. Factor sub scores for physical health, exercise behavior and conditions, rest, sleep satisfaction, and stress avoidance were significantly lower (Table 4).

3.4. Factors influencing perceived cold sensitivity

A multiple logistic regression analysis of the influencing factors—participant characteristics, work environment, and lifestyle—was performed. The dependent variable was the presence or absence of perceived cold sensitivity. The results of the analysis indicated that

Table 2
Relationship between participant characteristics and cold sensitivity using the Heisho Sensation Scale.

Participant characteristics			Cold sensitivity disorder according to the Hiesho Sensation Scale		
	No ($n = 467$)		Yes ($n = 127$)		
	n (%)	Adjusted Residual	*n* (%)	Adjusted Residual	*p*-value
Age					
20s	112 (78.9)%	0.1	30 (21.1)%	−0.1	0.061
30s	125 (75.8)%	−1.0	40 (24.2)%	1.0	
40s	132 (75.0)%	−1.3	44 (25.0)%	1.3	
50s	93 (87.7)%	2.6	13 (12.3)%	−2.6	
Region					
North Japan	81 (79.4)%	0.2	21 (20.6)%	−0.2	0.755
East Japan	142 (80.2)%	0.6	35 (19.8)%	−0.6	
West Japan	244 (77.5)%	−0.7	71 (22.5)%	0.7	
Department					
Outpatient clinics	147 (80.8)%	0.8	35 (19.2)%	−0.8	0.510
Wards	169 (76.8)%	−0.8	51 (23.2)%	0.8	
Units	77 (75.5)%	−0.9	25 (24.5)%	0.9	
Operating theater	71 (82.6)%	1.0	15 (17.4)%	−1.0	
Employment Type					
Full-time	409 (79.4)%	1.8	106 (20.6)%	−1.8	0.075
Part-time	19 (65.5)%	−1.8	10 (34.5)%	1.8	
Night shift					
No	201 (80.1)%	0.7	50 (19.9)%	−0.7	0.505
Yes	263 (77.8)%	−0.7	75 (22.2)%	0.7	

*p-value < 0.05; missing and invalid values were excluded from the analysis. Hiesho Sensation Scale ($N = 594$).

Table 3
Relationship between work environment and cold sensitivity ($N = 594$).

Perceived cold sensitivity	No ($n = 331$)		Yes ($n = 263$)		p-value[‡]
	n (%)	Adjusted residual	n (%)	Adjusted residual	
Air conditioner adjustment					
Not possible	120 (50.2)%	−2.2	119 (49.8)%	2.2	0.026*
Possible	210 (59.5)%	2.2	143 (40.5)%	−2.2	
Type of upper uniform					0.025*
Short sleeves	315 (56.9)%	2.2	239 (43.1)%	−2.2	
Elbow to wrist length sleeves	15 (38.5)%	−2.2	24 (61.5)%	2.2	
Wearing additional garments for warmth					
No	272 (58.7)%	2.8	191 (41.3)%	−2.8	0.005*
Yes	59 (45)%	−2.8	72 (55)%	2.8	
Wearing tights					<0.001*
No	317 (57.6)%	3.3	233 (42.4)%	−3.3	
Yes	14 (31.8)%	−3.3	30 (68.2)%	3.3	
Cold sensitivity disorder, according to the Hiesho Sensation Scale					
	No ($n = 467$)		Yes ($n = 127$)		*p-value*
	n (%)	Adjusted residual	n (%)	Adjusted residual	
Air conditioner adjustment					
Not possible	182 (76.2)%	−1.3	57 (23.8)%	1.3	0.210
Possible	284 (80.5)%	1.3	69 (19.5)%	−1.3	
Type of upper uniform					
Short sleeves	438 (79.1)%	1.1	116 (20.9)%	−1.1	0.285
Elbow to wrist length sleeves	28 (71.8)%	−1.1	11 (28.2)%	1.1	
Wearing additional garments for warmth					
No	377 (81.4)%	3.1	86 (18.6)%	−3.1	0.002*
Yes	90 (68.7)%	−3.1	41 (31.3)%	3.1	
Wearing tights					
No	440 (80)%	2.9	110 (20)%	−2.9	0.004*
Yes	27 (61.4)%	−2.9	17 (38.6)%	2.9	

[‡] Chi-square test performed on valid responses.
* p-value < 0.05, Missing and invalid values were excluded.

being over 50 years old (odds ratio (OR) 0.482, 95 % CI (0.298, 0.778), $p = 0.003$), short-sleeve uniforms [OR 0.391, 95 % CI (0.190, 0.804), ($p = 0.011$)], wearing tights [OR 2.631, 95 % CI (1.339, 5.171), $p = 0.005$], and rest habits [OR 0.639, 95 % CI (0.449, 0.909), $p = 0.013$] were significant. The logistic regression formula was significant ($p < 0.001$), the Hosmer-Lemeshow yielded $p = 0.213$, and the positive likelihood ratio was 61.3 % (Table 5). For the scores of exercise, diet, and rest habits in DIHAL.2, we classified the respondents into two categories based on the median value. Of the 594 survey respondents, five had missing values for age, two for air conditioner adjustment, and one for type of upper uniform, resulting in an analysis of 586 respondents. Sensitivity analyses without adjustment for age resulted in similar findings. The results of the sensitivity analysis indicated that wearing short-sleeve uniforms (OR 0.479($p = 0.036$), wearing tights (OR 2.735, $p = 0.003$), and rest habits (OR 0.621, $p = 0.008$) had a significant association with cold perception. The logistic regression formula was significant ($p < 0.001$), the Hosmer-Lemeshow yielded $p = 0.167$, with a positive likelihood ratio 59.9 %

4. Discussion

Our results indicated that 44.3 % of female nurses in hospitals perceived cold sensitivity daily, which is similar to the ratio of Japanese women in the general population. Perceived cold sensitivity among Japanese women is estimated to be between 38.7 % (Kondo and Okamura, 1987) and 52.0 % (Ushiroyama, 2005). A Swedish study of 12,627 healthy people aged 18–70 reported that only 502 (4.0 %) experienced cold sensitivity (Stjernbrandt et al., 2018). Despite differences in the definitions and inclusion of male and female participants, it is evident that cold sensitivity awareness is higher in the Japanese population.

According to the Hiesho Sensation Disorder Scale, 21.4 % of Japanese individuals have cold sensitivity disorders. This scale includes factors other than perceived cold sensitivity such as disturbed sleep, poor peripheral blood circulation, and cold sensitivity in the summer. Multiple factors indicate cold sensitivity disorder, and this condition may be over-reported.

Based on the temperature distribution and thermoregulation spectra, body temperature can be divided into internal areas, such as the brain and internal organs, and external regions, including the skin and subcutaneous tissue. The primary goal of thermoregulation is to maintain a specific temperature in internal organs, which is a vital factor for biological activities. The external areas are important because they are responsive to internal temperature control (Kanosue, 2010). This means that the temporary occurrence of cool hands due to environmental factors is a human physiological function and a natural phenomenon. The low skin temperature of nurses' hands can cause patient discomfort; therefore, some interventions are necessary.

Additionally, recent research by (Stjernbrandt et al., 2020) aimed to characterize cold sensitivity utilizing a comprehensive

Table 4
Relationship between cold sensitivity, health, and lifestyle ($N = 594$).

Perceived cold sensitivity	No ($n = 331$)			Yes ($n = 263$)			*p*-value
DIHAL.2 scores (full score)	Med	Min	Max	Med	Min	Max	
The total score for health and lifestyle habits (235)	**135**	**81**	**214**	**131**	**76**	**195**	**0.006***
The total score for health (60)	**37**	**16**	**55**	**36**	**17**	**56**	**0.056**
Physical health ***(20)***	14	7	20	13	4	20	0.051
Mental health ***(20)***	13	4	20	13	7	20	0.162
Social health ***(20)***	10	4	20	10	4	20	0.288
The total score for lifestyle habits (175)	**97**	**56**	**161**	**94**	**58**	**141**	**0.003***
Exercise habits ***(40)***	19	8	40	18	8	36	0.044*
Exercise behavior and condition ***(25)***	10	5	25	9	5	23	0.015*
Awareness of the importance of exercise ***(15)***	9	3	15	9	3	15	0.414
Dietary habits ***(65)***	40	21	65	39	21	59	0.135
Nutritional valance ***(35)***	21	7	35	20	8	35	0.320
Regularity of eating ***(20)***	11	4	20	10	4	20	0.025*
Alcohol drinking and tobacco smoking ***(10)***	10	2	10	10	2	10	0.768
Rest habits ***(70)***	39	18	66	37	20	61	<0.001*
Taking sufficient rest ***(15)***	8	3	15	7	3	15	0.013*
Regularity of sleep ***(15)***	7	3	15	7	3	14	0.041*
Sleep sufficiency ***(20)***	11	4	20	10	4	20	<0.001*
Stress avoidance ***(20)***	13	6	20	13	6	20	0.082

Cold sensitivity disorder, according to the Hiesho Sensation Scale DIHAL.2 scores (full score)	No ($n = 467$)			Yes ($n = 127$)			*p*-value
	Med	Min	Max	Med	Min	Max	
The total score for health and lifestyle habits (235)	**133**	**81**	**214**	**131**	**76**	**175**	**0.040***
The total score for health (60)	**37**	**16**	**56**	**36**	**17**	**54**	**0.018***
Physical health ***(20)***	14	7	20	13	4	19	0.018*
Mental health ***(20)***	13	4	20	13	6	19	0.102
Social health ***(20)***	10	4	20	10	4	20	0.423
The total score for lifestyle habits (175)	**97**	**56**	**161**	**94**	**58**	**132**	**0.077**
Exercise habits ***(40)***	19	8	40	18	10	38	0.049*
Exercise behavior and condition ***(25)***	10	5	25	9	5	23	0.048*
Awareness of the importance of exercise ***(15)***	9	3	15	9	4	15	0.253
Dietary habits ***(65)***	39	21	65	40	21	58	0.551
Nutritional valance ***(35)***	20	7	35	21	9	34	0.360
Regularity of eating ***(20)***	11	4	20	11	4	19	0.865
Alcohol drinking and tobacco smoking ***(10)***	10	2	10	10	2	10	0.941
Rest habits ***(70)***	39	18	66	36	20	59	0.009*
Taking sufficient rest ***(15)***	8	3	15	7	3	14	0.028*
Regularity of sleep ***(15)***	7	3	15	7	3	14	0.509
Sleep sufficiency ***(20)***	11	4	20	10	4	17	0.011*
Stress avoidance ***(20)***	13	6	20	13	6	19	0.014*

Mann-Whitney *U test.*;
* *p*-value < 0.05, med, median; min, minimum; max, maximum DIHAL.2, Diagnostic Inventory of Health and Life Habits.

Table 5
Logistic regression analysis for factors associated with cold perception ($N = 586$).

	p	OR	95 %CI	
Age (≧50 years/<50 years)	**0.003**	**0.482**	**(0.298,**	**0.778)**
Region	0.132			
(North Japan/West Japan)	0.664	0.900	(0.560,	1.447)
(East Japan/West Japan)	0.045	0.667	(0.449,	0.991)
Air conditioner adjustment (possible/ not possible)	0.124	0.762	(0.539,	1.077)
Type of upper uniform (short sleeves/elbow to wrist length Sleeves)	**0.011**	**0.391**	**(0.190,**	**0.804)**
Wearing tights (Yes/No)	**0.005**	**2.631**	**(1.339,**	**5.171)**
Exercise habits (≧the median: good /<the median:bad)	0.130	0.764	(0.538,	1.083)
Dietary habits (≧the median: good /<the median:bad)	0.574	0.905	(0.637,	1.283)
Rest habits (≧the median: good /<the median:bad)	**0.013**	**0.639**	**(0.449,**	**0.909)**

approach including semi-structured interviews, physical examination, thermal quantitative sensory testing (QST), and laser speckle contrast analysis (LASCA). Their findings challenge conventional neurosensory pathophysiological hypotheses by demonstrating limited diagnostic aid from physical examination and thermal QST. Instead, LASCA revealed disturbances in microvascular regulation, suggesting its potential utility as a tool for further investigation into cold sensitivity.

Age was the principal characteristic associated with cold sensitivity among female nurses. According to the Hiesho Sensation Scale, female nurses over 50 years of age are rarely diagnosed with cold sensitivity disorder. Earlier studies have shown that younger women

have a higher frequency of perceived cold sensitivity (Imai et al., 2004). In contrast, lower estrogen levels are likely to cause poor circulation, leading to more cases of cold sensitivity post-menopause (Ushiroyama, 2005). The results of the older nurse group may be a bias of the "healthy worker" effect (Chowdhury et al., 2017).

Depending on the hospital, air conditioning is centrally managed, which means that it cannot be adjusted in some workplaces. The ability to fine-tune air conditioning is associated with a lower cold sensitivity. Existing studies have shown positive correlations between room temperature and female nurses' skin temperature and between skin temperature and perceived cold sensitivity (Suzuki et al., 2021). Clothing is also used to regulate the body temperature. Many nurses with cold sensitivity wear winter underwear, cardigans, protective clothing, or tights. Layering creates a microclimate near the skin, allowing the clothing climate to remain within a comfortable temperature range and reducing the dissipation of body heat (Kanosue, 2010). Apart from uniforms, winter underwear, cardigans, protective clothing, and layered clothing such as tights, are appropriate measures for adjusting the temperature of a cold-sensitive person.

Appropriate addressing of cold hands in nursing settings is an ongoing consideration. Measures that can be implemented immediately include hand warming, increasing the water temperature for hand washing, and light movement (Suzuki and Ibe, 2019). In a previous study (Suzuki and Ibe, 2019), hand skin temperature increased after washing the hands with hot water.

Light movements were incorporated following hand washing with warm water in anticipation of an increase in hand skin temperature; however, no significant increase in surface temperature was observed (Suzuki and Ibe, 2019). In future, other simple and hygienic measures that can be incorporated into clinical practice should be considered. The impact of these measures on hygiene practices should be evaluated before implementation.

Participants with perceived cold sensitivity had significantly lower scores for exercise behaviors and conditions, meal regularity, rest, sleep regularity, and sleep adequacy. Nakamura (2013) demonstrated that a disordered living environment is a prerequisite for cold sensitivity. The results of this study suggest that disruptions in the living environment related to nursing work are associated with cold sensitivity. Maintaining exercise behaviors, good rest habits, and regular meals are important for preventing cold sensitivity.

Consistent with previous research, we identified associations between sleep habits and rest, regularity, and adequacy. Blood supply to the peripheral blood vessels increases during sleep, which is related to temperature control (Lack and Gradisar, 2002). The process of heat dissipation involves the flow of blood from arteries to veins through arteriovenous anastomoses. This physiological mechanism triggers activation in the preoptic area and anterior hypothalamus, subsequently stimulating the sleep-promoting region while suppressing wake-promoting areas, ultimately facilitating the onset of sleep (Gilbert et al., 2004).

It is worth noting that while there is emerging evidence suggesting a potential influence of cold sensitivity and poor peripheral blood circulation on sleep patterns, the precise interplay between temperature regulation and sleep remains speculative. Some cold-sensitivity disorders and diagnostic scales do include items related to sleep disturbances, hinting at a possible connection between cold sensitivity and sleep quality. Resting habits were considered changeable. Although maintaining healthier rest habits while working night shifts in hospitals is challenging, it is necessary to have as much rest time as possible, correct for any deviations in sleep cycles, and maintain consistent sleep times.

No significant differences in health status were detected between nurses with and without perceived cold sensitivity. However, a comparison of nurses identified as having cold sensitivity disorder with those who did not reveal that their health levels, particularly physical health factors, were significantly lower. Perceived cold sensitivity is related to an individual's constitution. There is a need to maintain and improve physical health and employ cold sensitivity countermeasures. This can help prevent the transition of individuals with suspected cold sensitivity to the diagnosis of a cold sensitivity disorder. It also prevents the worsening of cold sensitivity disorders.

4.1. Research strengths and limitations

If the response rate to a questionnaire is less than 40 %, the representativeness of the sample is questionable (Gray and Grove, 2020). Valid responses were received from more than half the participants (52.2 %). The 2018 Health Administration Report Summary (Employment Health Care) outlines the respective age ranges of Japanese nurses. They were 21.1 % in their 20 s, 24.5 % in their 30 s, and 28.2 % in their 40 s. In total, 82.2 % were employed full-time (Report of Ministry of Health Labor and Welfare, 2018). The distribution of the participants in this study was similar, with 23.9 % in their 20 s, 27.8 % in their 30 s, 29.6 % in their 40 s, and 86.7 % employed full-time. The results of this study can be generalized to Japanese female nurses working in hospitals.

Our study has limitations. First, Kusumi's Hiesho Sensation Scale, initially designed for women aged 18 to 39, may not fully represent the broader age range in our sample. Additionally, reliance on a written questionnaire may introduce response bias. Respondents may have been more inclined to participate if they were particularly interested in or affected by cold sensitivity, potentially leading to an overestimation of its occurrence. Furthermore, the absence of standardized diagnostic criteria for cold sensitivity may affect the incidence rates reported. Although this study aimed to investigate cold sensitivity nationwide, most respondents were from West Japan. Comprehensive information was acquired from three of the four regional divisions, but we could not locate a cooperative institution in the remaining division. Therefore, future prospective studies should be conducted to explore regional differences in cold sensitivity.

5. Conclusions

Female nurses experience cold sensitivity disorder at a rate similar to that of the general population but face challenges unique to their occupation. Cold sensitivity can affect patient care, the ability to work comfortably, and the health of nurses. This study emphasizes the importance of including cold sensitivity in nursing research. Additional research is necessary to develop viable methods

for addressing cold sensitivity among nursing staff.

Contribution of the paper

What is already known about the topic

- Cold sensitivity is a recognized issue among healthcare professionals, impacting their comfort and effectiveness in providing care.
- Factors such as age, work environment conditions, and lifestyle habits have been previously identified as influencing cold sensitivity among healthcare workers.

What this paper adds

- This paper contributes valuable insights into the prevalence and nature of cold sensitivity specifically among female nurses in Japanese hospitals.
- It identifies specific factors associated with cold sensitivity, including uniform type, ability to adjust air conditioning, and rest patterns, which can inform targeted interventions and policies for improving nurses' well-being and effectiveness in their roles.

Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due to ethical restrictions but are available from the corresponding author upon reasonable request.

Ethics approval and consent to participate

Ethical approval for this research was obtained from the ethical review committee of Hyogo University of Health Sciences (approval number:17,042) and the study was conducted in accordance with the principles of the Declaration of Helsinki. The purpose and methods of the study were explained to participants. This included a statement of voluntary participation, a description of how the study material would be maintained, and a commitment to protecting personal information. All the participants provided written informed consent to participate in this study. This study did not include minors (< 16 years old).

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CRediT authorship contribution statement

Miyuki Suzuki: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Toshie Tsuchida:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Aki Ibe:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

None.

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Supplementary materials

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