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Original Article

Biopsychological and pathophysiological features of Cold-Heat subgroup of Sasang typology with Sasang Digestive Function Inventory, Sasang Personality Questionnaire and Body Mass Index

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ABSTRACT

Background: The Sasang typology is a traditional Korean personalized medicine and its Cold-Heat subgroup identification is essential for effective use of medical herbs and acupuncture. The purpose of this study was to discover differences between Cold-Heat subgroups with objective clinical measures and to examine its clinical usefulness.
Methods: The pathophysiological symptoms of the digestive system, temperament and body shape of 241 patients were measured using the Sasang Digestive Function Inventory (SDFI), Sasang Personality Questionnaire (SPQ) and Body Mass Index (BMI). The differences between Cold and Heat subgroups of each Sasang types were tested by Analysis of Covariance considering age and sex, while the associations of SDFI, SPQ and BMI with Cold-Heat subgroup were examined by logistic regression analysis.
Results: There were significant differences between Cold and Heat subgroups in SDFI, SPQ and BMI for the So-Yang, SDFI and BMI for the Tae-Eum type and SDFI-Digestion subscale for the So-Eum type. Moreover, the SDFI-Digestion was a substantial predictor for Cold-Heat subgroup identification in three Sasang types. The logistic regression model with SDFI, SPQ and BMI correctly predicted 81.9%, 77% and 75.5% of the Cold-Heat subgroups in So-Yang, Tae-Eum and So-Eum types, respectively.

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Conclusion: The results of the present study showed that the objective and validated clinical measures of SDFI, SPQ and BMI would be useful for differentiating Cold-Heat subgroups of Sasang typology. Further clinical studies on pathophysiological mechanisms in Cold-Heat subgroup are required to generalize these results.

1. Introduction

Personalized medicine or optimized treatment and prevention of a person's disease has long been a major interest of medicine since the Hippocrates and Galen of the West and Yellow Emperor and Ayurveda of the East[1,2]. The Human Genome Project of the present is the modern Western approach to providing safe and effective treatment considering individual susceptibility to disease and treatment based on personal genomic profiles [3].

The Sasang typology of Korea is a personalized medicine scrutinized in the book *Longevity and Life Preservation in Eastern Medicine* (1894, 1900) of *Jema Lee* (1837-1900)[1,4] that has been used with proven safety and effectiveness for hundreds of years [5–9]. The Sasang typology divides people into four groups, Tae-Yang, So-Yang, Tae-Eum and So-Eum types based on pathophysiological symptoms, biopsychological traits, previous history and clinical responses to treatment, and provide type- and subgroup-specific acupuncture and medical herbs (Table 1)[1,2,10–15].

Since the accuracy of differential diagnosis or pattern identification of Sasang type is the first step for the clinical practice of Sasang typology, studies with objective clinical measures and related biological mechanisms have been reported to improve the validity of the clinical procedures. Moreover, there have been studies conducted to investigate the pathophysiological symptoms[10,12,16,17], psychological traits[2,18,19], physical characteristics[2,11,17], and genetic characteristics[20,21] of each Sasang type, and Autonomic Reactivity[11,12], Behavior Activation and Inhibition System [22–24], Extraversion [19] and Yin-Yang temperament [22] were suggested as its biological mechanisms.

The Sasang type-specific pathophysiological symptoms [12] of perspiration, sleep, sleep, digestive function, urination, and defecation along with biopsychological traits[2,11] are pivotal factors to understand and practice Sasang typology in clinic. The Sasang Digestive Function Inventory (SDFI), which was developed to analyze type-specific typical digestive function-related symptoms from pathophysiological perspectives, showed that individuals of Tae-Eum type have significant higher SDFI score than those of So-Eum type. [16] The Sasang Personality Questionnaire (SPQ), which measures the psychological traits of Sasang typology, has been reported to increase in the order of So-Eum, Tae-Eum and So-Yang types.[2,18] The Body Mass Index (BMI) and Ponderal Index (PI) have also been reported to be useful for clinical diagnosis, with individuals of Tae-Eum type having significantly higher BMI and PI than those of the So-Eum type.[2,11,17]

However, these previous studies have only focused on the clinical features of four Sasang types, and have not provided insights into the Cold-Heat subgroup of Sasang typology, which is pivotal for the detailed and carefully guided clinical interventions to treat medical problems[4,25,26]. The Cold-Heat subgroup of Sasang typology (Table 1) refers to intrinsic and innate pathophysiological predispositions, even with identical clinical symptoms[4,12,17], when compared to the Cold-Heat pattern of conventional traditional East-Asian medicine focusing on the current and momentary clinical manifestations in prognosis.

Although there have been quite a few studies of Cold-Heat subgroups of Sasang typology, their results have critical limitations to be generalized. One study examined the pathophysiological features of Cold-Heat subgroups with arbitrary measures lacking quantification and validation[27,28]. Another study examined the temperament of subgroups using only the So-Yang type groups [25], and body shape with two Sasang type groups of Tae-Eum and So-Eum [29].

The present study examined the pathophysiological and biopsychological features of Cold-Heat subgroup in Sasang typology using clinically validated SDFI, SPQ and BMI values of 241 patients. We collected clinical data from university hospital patients which has high integrity for their Sasang type and Cold-Heat subgroup diagnosis, and attempted to reveal objective clinical differences for Cold-Heat subgroup differentiation of Sasang typology. We emphasized the difference between Cold and Heat subgroups rather than the analysis of each Sasang type in this study.

The multi-dimensional analysis of biopsychological and pathophysiological features with objective clinical measures would provide clinical understandings regarding the underlying mechanisms of Cold-Heat subgroups and the differentiation required in personalized and optimized herbal and acupuncture prescriptions.

2. Methods

2.1. Subjects and Procedures

We retrospectively collected clinical data describing 265 patients who visited Korean Medicine hospital from April 1 to October 19, 2015. Patients who did not complete all required measures (n = 9) or for whom there were discrepancies in diagnosis between two (J. L. and N-Y. B.) clinical specialists (n = 15) were excluded from this study. Tae-Yang type subjects were also excluded because the sample size was too small. This study was approved by the Institutional Review Board (PNUKH-IRB-E2015004).

Table 1 – Clinical characteristics of Cold and Heat subgroups of each Sasang types.

Sasang type	Subgroup	KCD* code	Pathophysiological characteristic	Frequent clinical symptoms or disease	Type- and subgroup-specific medical herbs
Tae-Yang	Cold	U98.1	Highly activated energy consuming activities	Emesis, nervousness/neurasthenia abdominal pain, borborygmus, diarrhea, dysentery,	Chaenomelis Fructus, Actinidiae fructus, Pini Lignum
	Heat	U98.0	Disturbed in absorbing resources for qi and body fluid	Sudden weakness in lower extremities, pyrexia, chilling, backache, myalgia, adrenal fatigue syndrome	Chaenomelis Fructus, Actinidia arguta Planch, Vitis Radix, Phragmitis Rhizoma
So-Yang	Cold	U96.0, U96.1	Lack of heat after consuming up qi and body fluid.	Pyrexia, chilling, headache, backache, myalgia, dyspepsia/epigastric discomfort, nausea, diarrhea	Rehmanniae Radix, Rehmanniae Radix Preparat, Osterici Radix, Angelicae Pubescentis Radix, Schizonepetae Spica, Saposhnikovia Radix, Poria, Alismatis Rhizoma, Akebiae Caulis
	Heat	U96.2, U96.3	Highly activated stomach fire or digestive function	Pyrexia, xerostomia, perspiration, polydipsia, night sweats, constipation	Rehmanniae Radix, Rehmanniae Radix Preparat, Gypsum Fibrosum, Anemarrhenae Rhizoma, Corni Fructus
Tae-Eum	Cold	U97.0, U97.1	Hypo-activation of lung function requiring energy consuming activity	Chilling, no perspiration, headache, backache, myalgia, arthralgia, palpitation, asthma, cough, sputum, diarrhea, dyspepsia/postprandial fullness, chest discomfort, abdominal pain, abdominal distension, edema	Ephedrae Herba, Coicis Semen, Castaneae Semen, Liriopes Radix, Platycodi Radix, Schizandrae Fructus
	Heat	U97.2, U97.3	Heat from overstocked resources owing to highly activated liver function	Pyrexia, perspiration, dry eye, dry nose, xerostomia, xeroderma, polydipsia, polyuria, constipation	Puerariae Radix, Scutellariae Radix, Cimicifugae Rhizoma, Angelicae Dahuricae Radix, RheiRhizoma, Ligustici Tenuissimae Radix
So-Eum	Cold	U95.2, U95.3	Lack of stomach fire and digestive function	Abdominal pain, abdominal distension, diarrhea, dyspepsia/epigastric discomfort, anorexia, sallow complexion, edema	Ginseng Radix, Aconiti Lateralis Radix Preparata, Cynanchi Wilfordii Radix, Atractylodis Rhizoma Alba, Zingiberis Rhizoma Siccus, Fraxini Cortex, Pinelliae Rhizoma,
	Heat	U95.0, U95.1	Heat symptom from deficiency or lack of energy	Pyrexia, chilling, perspiration or no perspiration, headache, backache, constipation	Ginseng Radix, Aconiti Lateralis Radix Preparata, Astragali Radix, Cinnamomi Ramulus, Angelicae Radix, Paeoniae Radix Alba, Ligustici Rhizoma,

* KCD, Korean Standard Classification of Diseases.

2.2. *Methods*

2.2.1. *Differential diagnosis of Sasang type and its Cold-Heat subgroup*

The Sasang type and Cold-Heat subgroup differentiation was independently performed by two certified clinical specialists (J. L. and N-Y. B.) of Sasang constitutional medicine based on pulse, tongue and abdomen examination, six pathophysiological symptoms, and psychological and physical characteristics before treatment. The clinical characteristics of Cold-Heat subgroups of each Sasang types as listed on the nationally standardized disease classification of Korea were listed on Table 1. The certified clinical specialist of Sasang typology needs to finish four more years of internship and residency than general practitioner in designated hospitals supervised by Korean Medical Hospital Association and Ministry of Health and Welfare [30]. The participants were prescribed type- and subgroup-specific medical decoctions for 28 days or more, and had clear documentation regarding the response to type-specific treatment that did not manifest any significant adverse events and showed improvements of the main complaints [13].

2.2.2. *Sasang Digestive Function Inventory (SDFI)*

The Sasang Digestive Function Inventory (SDFI) is a 21-item self-report assessment tool measuring digestive function-related pathophysiological symptoms of Sasang typology that shows acceptable clinical validity [16].

The SDFI measures three perspectives of digestion system as digestive capability or function (SDFI-Digestion, SDFI-D) with ten items, appetite (SDFI-Appetite, SDFI-A) with six items, and eating pattern or habit (SDFI-Eating pattern, SDFI-E) with five items. A high score on the SDFI indicates good or hyper-activated digestive function and appetite, large meal volume, and high eating speed. The SDFI and its subscales were reported to increase in the order of So-Eum, So-Yang, and Tae-Eum Sasang types[16,31,32].

Each item is scored using a 5-point Likert scale (0 = 'not at all' to 4 = 'very true'), and some items were coded in reverse. The internal consistency of SDFI, SDFI-D, SDFI-A, and SDFI-E measured with Cronbach's alpha were reported as 0.743, 0.784, 0.798, and 0.757, respectively [16].

2.2.3. *Sasang Personality Questionnaire (SPQ)*

Sasang Personality Questionnaire (SPQ) is a 14-item self-report assessment measuring Yin-Yang temperament of Sasang typology that shows acceptable clinical, concurrent and structural validity in adults and adolescents[2,18,22,32].

SPQ is composed of three subscales that measure behavior (SPQ-Behavior, SPQ-B) based on five items, decision-making or cognition (SPQ-Cognition, SPQ-C) with five items and emotional mobility (SPQ-Emotion, SPQ-E) with four items. Moreover, each item has two opposite words for a specific temperament trait, which is evaluated using a 3-point Likert scale (1 = delicate, 2 = average or middle and 3 = tough).

A high SPQ score represents active behavior, easy-going and dynamic emotionality, while the low SPQ score indicates a passive, meticulous and static characteristics. The SPQ and its three subscales were found to increase with the order of So-Eum, Tae-Eum, and So-Yang Sasang types[2,18,32]. The internal consistency of SPQ, SPQ-B, SPQ-C, and SPQ-E measured with Cronbach's alpha were 0.817, 0.789, 0.711, and 0.685, respectively [18].

2.2.4. *Body Mass Index (BMI)*

BMI was determined by dividing the weight (kg) by the height squared (m^2) of each participant. [1] Previous studies have consistently reported that the BMI score of the Tae-Eum Sasang type is the highest, while that of the So-Eum type is the lowest[2,17].

2.3. *Statistical Analysis*

Demographic features of three Sasang type groups were tested using Analysis of Variance (ANOVA) for SDFI, SPQ, BMI and age, and the chi-squared test for sex. For its post-hoc analysis, Dunnett's T3 was used instead of Bonferroni when significant with Levene's test

The correlations among BMI and subscales of SDFI and SPQ were examined to examine associations among characteristics of pathophysiological, biopsychological and body shapes using Pearson's correlation. The SDFI, SPQ and BMI values of Cold and Heat subgroups of each Sasang type were adjusted for age and sex, and differences between Cold and Heat subgroups were examined by Analysis of Covariance (ANCOVA) with age and sex as the covariates. Differences between Cold and Heat subgroups were also examined using the t-test for age and Fisher's exact test for sex.

Logistic regression analysis with SDFI, SPQ, BMI, sex and age was used to predict Cold-Heat subgroups of each Sasang types. The model fit was examined by the chi-squared test and Nagelkerke's R^2, and the percentage of correctly classified types was also calculated.

Statistical results were presented as the frequency (%) or mean ± standard deviation. All analyses were conducted using IBM SPSS Statistics 20.0 for Windows (IBM, Armonk, NY) and p values of 0.05, 0.01 and 0.001 were used for testing significance.

3. Results

3.1. *Demographic features of the subjects in this study*

Data from a total of 241 subjects were used for the analysis, and demographic features of So-Yang (SY), Tae-Eum (TE) and So-Eum (SE) Sasang types were shown in Table 2. There were no significant differences in sex distribution and age among the three Sasang type groups. ANOVA showed significant differences in SDFI-E and BMI, and post-hoc analysis indicated that the TE has significantly higher score than the SY and SE Sasang types.

3.2. *Differences in biopsychological and pathophysiological features between Cold and Heat subgroups of each Sasang types*

The raw and adjusted value of SDFI, SPQ and BMI considering age and sex for comparing differences between Cold and Heat subgroups were presented in Table 3. As for the demographic features, there were significant differences in the sex ratio between Cold and Heat subgroups in the So-Yang and So-Eum type.

Within the So-Yang type group, there were significant differences in the SDFI (43.08 ± 1.3 and 49.22 ± 1.9), SDFI-D (22.03 ± 0.98 and 25.16 ± 1.43), SPQ (26.87 ± 0.6 and 30.6 ± 0.88), SPQ-B (10.28 ± 0.29 and 11.66 ± 0.43), SPQ-C (9.01 ± 0.24 and 10.32 ± 0.35) and BMI (21.96 ± 0.36 and 23.16 ± 0.53) between the Cold and Heat subgroups. On the contrary the So-Eum type showed significant differences between Cold and Heat subgroups only in SDFI-D (20.5 ± 1.74 and 26.33 ± 1.6).

The Tae-Eum type group showed significant differences in SDFI (42.08 ± 1.96 and 48.31 ± 1.68), SDFI-D (21.62 ± 1.32 and 25.17 ± 1.13), SDFI-E (7.38 ± 0.7 and 9.61 ± 0.6), SPQ-C (8.69 ± 0.34 and 9.62 ± 0.29) and BMI (23.49 ± 0.54 and 26.84 ± 0.46) between Cold and Heat subgroups, respectively.

3.3. *Correlation among biopsychological and pathophysiological features*

The correlation among SDFI, SPQ, and BMI were calculated using Pearson's correlation coefficient and presented in Table 4. The SPQ score was significantly correlated with the SDFI score ($r = 0.278$, $p < 0.01$). However, the BMI showed

Table 2 – Demographic features of participants in this study.

	Sasang type So-Yang	Tae-Eum	So-Eum	Total	statistical analysis
n (male/female)	105 (38/67)	87 (32/55)	49 (25/24)	241 (95/146)	$\chi^2 = 3.473$, $p = 0.176$
Age	52.26 ± 15.47	48.82 ± 15.44	46.61 ± 15.03	49.87 ± 15.47	$F = 2.574$, $p = 0.078$
SDFI	44.61 ± 11.03	45.66 ± 12.86	44.1 ± 9.51	44.89 ± 11.42	$F = 0.345$, $p = 0.708$
SDFI-D	23.04 ± 8.57	23.66 ± 8.62	23.97 ± 8.1	23.46 ± 8.47	$F = 0.24$, $p = 0.786$
SDFI-A	14.77 ± 4.43	13.33 ± 4.45	14.55 ± 3.52	14.2 ± 4.3	$F = 2.89$, $p = 0.057$
SDFI-E***	6.8 ± 4.45	8.66 ± 4.82	5.57 ± 2.66	7.22 ± 4.44	$F = 9.006$, $p < 0.001$, TE > SY,SE
SPQ	27.98 ± 5.33	27.09 ± 5.07	26 ± 4.99	27.25 ± 5.2	$F = 2.517$, $p = 0.082$
SPQ-B	10.7 ± 2.51	10.28 ± 2.29	9.79 ± 2.61	10.36 ± 2.47	$F = 2.359$, $p = 0.096$
SPQ-C	9.39 ± 2.12	9.22 ± 2.1	8.81 ± 1.98	9.21 ± 2.09	$F = 1.266$, $p = 0.283$
SPQ-E	7.88 ± 2.14	7.57 ± 2.15	7.38 ± 2.12	7.67 ± 2.14	$F = 1.042$, $p = 0.354$
BMI***	22.44 ± 2.84	25.42 ± 3.68	21.33 ± 3.36	23.29 ± 3.65	$F = 30.754$, $p < 0.001$, TE > SY,SE

SDFI, Sasang Digestive Function Inventory; SDFI-D, SDFI Digestion; SDFI-A, SDFI Appetite; SDFI-E, SDFI Eating habit; SPQ, Sasang Personality Questionnaire; SPQ-B, SPQ-Behavior; SPQ-C, SPQ-Cognition; SPQ-E, SPQ-Emotionality; BMI, Body Mass Index.
*$p < 0.05$;
**$p < 0.01$;
*** $p < 0.001$.

no significant correlation with SDFI (r = 0.122, n.s.) or SPQ (r = 0.055, n.s.).

3.4. *Logistic regression analysis for the association with Cold-Heat subgroup and biopsychological and pathophysiological features considering age and sex*

The results of logistic regression were presented in Table 5. Regression models with SDFI, SPQ and BMI were found to be acceptable, and these correctly predicted 81.9%, 77% and 75.5% of Cold-Heat subgroup in So-Yang, Tae-Eum and So-Eum types, respectively. The SDFI-Digestion score differed significantly between Cold and Heat subgroups, and was a substantial predictor for Cold-Heat subgroup classification. The BMI was also found to be a significant predictor for classifying Cold-Heat subgroup in Tae-Eum Sasang type.

4. Discussion

This study examined clinically validated pathophysiological and biopsychological measures of 241 hospital patients, and suggested objective measures of SDFI, SPQ and BMI as an important clinical characteristics for Cold-Heat subgroup identification along with Sasang type differentiation.

The Heat subgroup of So-Yang type had significantly higher SDFI and SPQ scores that means highly activated digestive system for supporting its vigorous and energetic Yang temperament, while that of the Tae-Eum type had higher SDFI and BMI values explaining their obesity as a result of good digestive function than the Cold subgroup (Table 3). [28] The SDFI-Digestion score which measures the digestive capacity or function differed significantly between Cold and Heat subgroups (Table 3), and was a substantial predictor of Cold-Heat subgroup classification (Table 5) in So-Yang, Tae-Eum and So-Eum Sasang type groups [28].

The regression model with subscales of SDFI and SPQ and BMI correctly predicted 81.9%, 77% and 75.5% of Cold-Heat subgroups in So-Yang, Tae-Eum and So-Eum types, respectively (Table 5). These findings showed that the SDFI-D subscale increased the probability of being a Heat subgroup 1.1 to 1.16 times in three Sasang types. The BMI increased the odds to be a Heat subgroup 1.57 times in the Tae-Eum type and sex (female) decreased the odds to be a Heat subgroup in the So-Yang types (Table 5).

The results of this study with SDFI and SDFI-D measuring digestive function [16] correspond to those of previous study conducted with an arbitrary questionnaire.[27,28] Specifically, it was reported that Heat subgroups showed good appetite in So-Yang type, while frequent belching and hunger was observed in individuals of Tae-Eum type, and good digestive function was found in Heat subgroup of So-Eum type than its Cold subgroup.[27,28] The SDFI-D was reported to have negative correlation with Nepean Dyspepsia Index-Korean (NDIK) (r = -0.585) and Functional Dyspepsia-related Quality of Life (FDQOL) (r = -0.433) that indicate no or minor digestive problems and related quality of life issues.[10,12,16,17]

SPQ is a measure of Yin-Yang temperament of Sasang typology[2,22] that represents active behavior, easy-going and quick decision-making, and dynamic emotionality. SPQ was positively correlated with Extraversion, Behavior Activation System and Novelty-Seeking of Temperament and Character Inventory[13,18,22], while So-Yang type had a high score for Novelty-Seeking [13]. It was previously reported that NS4, which is a subscale of Novelty-Seeking that embodies disorderliness with intolerance to psychological and physical regulation and easy expression of anger, was significantly higher in individuals of the Heat subgroup than the Cold subgroup [25].

As for the body shape, Heat subgroups of Tae-Eum and So-Yang type have higher BMI value than Cold subgroups in this study (Table 3). In a previous study with So-Yang and Tae-Eum types [29], Heat subgroup was higher than Cold subgroup in the chest circumference of So-Yang male and rib-to-pelvic circumference ratio of Tae-Eum type, although the BMI showed no significant differences between Cold and Heat prescription subgroups. However, other study without considering Sasang typology showed that the BMI of Heat pattern group is higher than that of Cold pattern group in male and female [33]. Other study showed significant differences in BMI between Cold and Heat subgroups for all three Sasang types.[28]

Table 3 – SDFI, SPQ, BMI and demographic features of Cold and Heat subgroups for each Sasang types.

	subgroup				Statistics
	Cold		Heat		
	raw	adjusted[$]	raw	Adjusted	
So-Yang					
n (m/f)***	71 (16/55)		34 (22/12)		Fisher's exact test, p < 0.001
age	51.56 ± 14.9		53.74 ± 16.77		t = -0.671, p = 0.504
SDFI***	42.23 ± 10.16	43.08 ± 1.3	49.58 ± 11.27	49.22 ± 1.9	F = 13.476, p < 0.001
SDFI-D**	21.54 ± 8.68	22.03 ± 0.98	26.17 ± 7.54	25.16 ± 1.43	F = 8.026, p = 0.006
SDFI-A	14.36 ± 4.15	14.57 ± 0.5	15.61 ± 4.91	15.69 ± 0.73	F = 1.554, p = 0.216
SDFI-E	6.32 ± 4.17	6.47 ± 0.46	7.79 ± 4.89	8.37 ± 0.67	F = 3.894, p = 0.051
SPQ**	26.84 ± 5.29	26.87 ± 0.6	30.35 ± 4.63	30.6 ± 0.88	F = 8.539, p = 0.004
SPQ-B*	10.3 ± 2.56	10.28 ± 0.29	11.52 ± 2.21	11.66 ± 0.43	F = 5.484, p = 0.021
SPQ-C**	8.95 ± 2.12	9.01 ± 0.24	8.52 ± 2.1	10.32 ± 0.35	F = 6.954, p = 0.010
SPQ-E	7.57 ± 2.1	7.57 ± 0.25	8.52 ± 2.1	8.61 ± 0.37	F = 3.124, p = 0.080
BMI*	21.95 ± 2.74	21.96 ± 0.36	23.46 ± 2.81	23.16 ± 0.53	F = 4.161, p = 0.044
Tae-Eum					
n (m/f)	37 (13/24)		50 (19/31)		Fisher's exact test, p = 0.825
age	47.24 ± 14.66		50 ± 16.05		t = -0.822, p = 0.4136
SDFI*	42.29 ± 12.81	42.08 ± 1.96	48.16 ± 12.44	48.31 ± 1.68	F = 5.745, p = 0.019
SDFI-D*	21.48 ± 8.31	21.62 ± 1.32	25.28 ± 8.57	25.17 ± 1.13	F = 4.123, p = 0.046
SDFI-A	13.18 ± 4.75	13.07 ± 0.71	13.44 ± 4.26	13.52 ± 0.61	F = 0.223, p = 0.638
SDFI-E*	7.62 ± 4.56	7.38 ± 0.7	9.44 ± 4.92	9.61 ± 0.6	F = 5.628, p = 0.020
SPQ	26.18 ± 4.73	26.1 ± 0.83	27.76 ± 5.26	27.82 ± 0.71	F = 2.457, p = 0.121
SPQ-B	10.35 ± 2.31	10.32 ± 0.38	10.24 ± 2.29	10.25 ± 0.32	F = 0.02, p = 0.889
SPQ-C*	8.7 ± 1.85	8.69 ± 0.34	9.62 ± 2.2	9.62 ± 0.29	F = 4.219, p = 0.043
SPQ-E	7.13 ± 2.16	7.07 ± 0.34	7.9 ± 2.11	7.94 ± 0.29	F = 3.561, p = 0.063
BMI***	23.45 ± 2.9	23.49 ± 0.54	26.87 ± 3.53	26.84 ± 0.46	F = 21.907, p < 0.001
So-Eum					
n (m/f)**	22 (6/16)		27 (19/8)		Fisher's exact test, p = 0.004
age	46.23 ± 14.59		46.93 ± 15.65		t = -0.16, p = 0.873
SDFI	40.63 ± 10.27	42.29 ± 1.92	46.92 ± 7.96	45.57 ± 1.71	F = 1.468, p = 0.232
SDFI-D*	19.95 ± 7.71	21.68 ± 1.38	27.25 ± 6.95	25.85 ± 1.23	F = 4.593, p = 0.038
SDFI-A	14.59 ± 3.54	14.86 ± 0.81	14.51 ± 3.58	14.29 ± 0.72	F = 0.25, p = 0.620
SDFI-E	6.09 ± 2.13	5.74 ± 0.55	5.14 ± 3	5.42 ± 0.49	F = 0.164, p = 0.688
SPQ	26.77 ± 4.5	26.37 ± 1.14	25.37 ± 5.36	25.69 ± 1.01	F = 0.182, p = 0.672
SPQ-B	9.81 ± 2.26	9.56 ± 0.59	9.77 ± 2.91	9.98 ± 0.53	F = 0.25, p = 0.620
SPQ-C	9 ± 1.87	8.93 ± 0.45	8.66 ± 2.09	8.71 ± 0.4	F = 0.114, p = 0.738
SPQ-E	7.95 ± 2.19	7.87 ± 0.48	6.92 ± 1.99	6.98 ± 0.42	F = 1.722, p = 0.196
BMI	20.97 ± 3.69	21.42 ± 0.69	21.62 ± 3.1	21.25 ± 0.62	F = 0.034, p = 0.856

[$] adjusted value of SDFI, SPQ and BMI considering age and sex for comparing differences between Cold and Heat subgroups.
* p < 0.05;
** p < 0.01;
*** p < 0.001;
SDFI, Sasang Digestive Function Inventory; SDFI-D, SDFI Digestion; SDFI-A, SDFI Appetite; SDFI-E, SDFI Eating habit; SPQ, Sasang Personality Questionnaire; SPQ-B, SPQ-Behavior; SPQ-C, SPQ-Cognition; SPQ-E, SPQ-Emotionality; BMI, Body Mass Index.

Table 4 – Correlation coefficients among SDFI, SPQ and BMI measures.

	SDFI-D	SDFI-A	SDFI-E	SPQ	SPQ-B	SPQ-C	SPQ-E	BMI
SDFI	**.789****	**.598****	**.486****	.278**	**.318****	.271**	.044	.122
SDFI-D		.145*	-.018	.126	.185**	.152*	-.057	.101
SDFI-A			.291**	.242**	**.324****	.166**	.052	-.116
SDFI-E				.240**	.151*	.245**	.170**	.233**
SPQ					**.830****	**.796****	**.696****	.055
SPQ-B						**.551****	**.326****	-.018
SPQ-C							**.324****	.111
SPQ-E								.047

Bold represents more than 0.3.

Table 5 – Logistic regression analysis for the associations of pathophysiological symptom, temperament and body shape to the Cold and Heat subgroups.

	Predictors	B	SE	Wald	p-value	Exp (B)	95CI of Exp(B)	χ^2	Nagelkerke's R^2	% correct classification
So-Yang								$\chi^2 = 40.34$, $p < 0.001$	0.445	81.9
	SDFI-D**	0.10	0.04	6.79	0.009	1.10	[1.02, 1.18]			
	SDFI-A	0.05	0.07	0.44	0.508	1.05	[0.9, 1.21]			
	SDFI-E	0.13	0.08	2.60	0.107	1.14	[0.97, 1.33]			
	SPQ-B	0.06	0.15	0.15	0.695	1.06	[0.79, 1.41]			
	SPQ-C	0.17	0.16	1.11	0.292	1.18	[0.86, 1.61]			
	SPQ-E	0.16	0.14	1.34	0.248	1.17	[0.89, 1.52]			
	BMI	0.09	0.10	0.78	0.378	1.09	[0.89, 1.32]			
	age*	0.04	0.02	4.26	0.039	1.04	[1,1.08]			
	sex***	-1.82	0.55	11.10	< 0.001	0.16	[0.05, 0.47]			
Tae-Eum								$\chi^2 = 35.982$, $p < 0.001$	0.339	77.0
	SDFI-D*	0.11	0.04	6.12	0.013	1.12	[1.02, 1.21]			
	SDFI-A	0.00	0.08	0.00	0.977	1.00	[0.86, 1.16]			
	SDFI-E	0.03	0.07	0.19	0.661	1.03	[0.89, 1.18]			
	SPQ-B	-0.34	0.19	3.18	0.075	0.71	[0.48, 1.03]			
	SPQ-C	0.16	0.17	0.89	0.346	1.18	[0.83, 1.66]			
	SPQ-E	0.20	0.15	1.76	0.184	1.23	[0.9, 1.66]			
	BMI***	0.45	0.13	12.91	<0.001	1.57	[1.22, 2]			
	age	0.00	0.02	0.00	0.981	1.00	[0.95, 1.04]			
	sex	0.34	0.63	0.29	0.587	1.41	[0.4, 4.86]			
So-Eum								$\chi^2 = 19.783$, $p = 0.020$	0.444	75.5
	SDFI-D*	0.15	0.07	4.70	0.030	1.16	[1.01, 1.33]			
	SDFI-A	-0.20	0.12	2.60	0.107	0.82	[0.64, 1.04]			
	SDFI-E	-0.11	0.17	0.45	0.502	0.89	[0.63, 1.24]			
	SPQ-B	0.36	0.23	2.50	0.114	1.44	[0.91, 2.24]			
	SPQ-C	-0.28	0.25	1.23	0.267	0.76	[0.46, 1.23]			
	SPQ-E	-0.22	0.19	1.27	0.260	0.80	[0.55, 1.17]			
	BMI	-0.06	0.12	0.24	0.621	0.94	[0.73, 1.19]			
	age	-0.04	0.03	1.58	0.209	0.96	[0.89, 1.02]			
	sex	-1.31	0.90	2.13	0.145	0.27	[0.04, 1.57]			

SDFI, Sasang Digestive Function Inventory; SDFI-D, SDFI Digestion; SDFI-A, SDFI Appetite; SDFI-E, SDFI Eating habit; SPQ, Sasang Personality Questionnaire; SPQ-B, SPQ-Behavior; SPQ-C, SPQ-Cognition; SPQ-E, SPQ-Emotionality; BMI, Body Mass Index.

Considering that the BMI was not correlated with SDFI (r = 0.122, n.s.) or SPQ (r = 0.055, n.s.) in Table 4, the physical characteristics of BMI might be an independent clinical factor along with SDFI and SPQ for classifying Heat subgroup from Cold subgroup in clinical settings. The positive correlation between BMI and SDFI-E (r = 0.233, p < 0.01) might represent the fact that increased body weight (BMI) originated from the unhealthy habit of frequent overeating, consuming a high volume of food and irregularity measured as SDFI-E [34].

Interestingly, the differences between Cold and Heat subgroups were obvious when the SDFI and SPQ scores of specific Sasang type were expected to be high.[28] In the SDFI total score, the difference between Cold and Heat subgroups was distinct for So-Yang and Tae-Eum types which have good innate digestive function, but they were not good for So-Eum type which has poor digestive function.[28] Moreover, evaluation of the SPQ total score revealed that differences in Cold-Heat subgroup were distinct with highly extroverted So-Yang Sasang type, but this was not the case for individuals with So-Eum Sasang type showing low extroversion.

This study focused on pattern identification of Cold-Heat subgroup along with Sasang type classification using objective pathophysiological and biopsychological measures. The Cold-Heat subgroup is the most widely used diagnosis of East-Asian traditional medical doctors examining clinical symptoms of patients[26,35–38]. It was first appeared in the *Yellow Emperor's Classic of Internal Medicine*, used as major clinical procedure in the *Discussion on Cold-induced Disease*, and polished as pivotal clinical diagnosis by great East-Asian clinicians for thousands years.[17,39]

The Sasang typology places emphasis on the innate individuality of pathophysiological characteristics[4,12,17], after which diverse clinical procedures are employed based on this property (Table 1). The Cold-Heat subgroup of Sasang typology refers to an intrinsic and continued pathophysiological and biopsychological predispositions, while that of traditional East-Asian medicine indicates transient and momentary clinical manifestations of the patients.[4,12,17]

Generally, as for the febrile disease, pathophysiological symptoms should be carefully examined to identify the Cold-Heat subgroup (with internal or external origin from deficiency or pathogen) of a patient. The patient would show a Heat pattern if he/she has typical Heat pathophysiological symptoms, while they would show a Cold pattern if they had typical Cold pathophysiological symptoms. [*The Longevity*

and Life Preservation in Eastern Medicine, Tae-Eum type Cold subgroup from external origin [4]]

For patients with abdominal fullness and diarrhea with fever, two opposing diagnoses should be considered. The patient might be diagnosed as internally originated when they have typical Heat pathophysiological symptoms, in which case a prescription of Galgeunhaegitang would be described. However, the patient might be on critical stage from externally originated pathogen when they have typical Cold pathophysiological symptoms, in which case a prescription of Taeeumjowitang would be described. [*The Longevity and Life Preservation in Eastern Medicine*, Tae-Eum type Heat subgroup from internal origin [4]]

For example, the Tae-Eum Sasang type has high BMI, PI and parasympathetic system reactivity [11], and tends to show hypertension, diabetes, metabolic syndrome, stroke and obesity [40]. The treatment principle or type-specific medical herb for Tae-Eum type patients varies according to their Cold-Heat subgroup differentiation, even for the Tae-Eum type patients with identical diseases such as stroke or hypertension [40].

Individuals with the Cold subgroup of Tae-Eum type tend to have little perspiration, fewer drinks, soft stool or diarrhea, high vulnerability to Cold, low appetite and indigestion. For such cases, *Ephedra sinica* is used as a type- and subgroup-specific medication to heat up the individuals and induce sweating (Table 1). Members of the Heat subgroup of Tae-Eum type tend to be characterized by high perspiration, high thirst, high drinking, hard stool, high vulnerability to heat, and good appetite and digestion. For these individuals, *Pueraiae radix* and *Rhei rhizoma* is prescribed to drain out the internal heat via stool as a type- and subgroup-specific medication[4,15,41,42].

It should be noted that this study might have several limitations for the generalization of results. First, the subjects (Table 2) in this clinical study had an unbalanced sex ratio and high variance of age (mean, 49.87; range, 20–83), preventing a decisive conclusion, and these demographic features prevented replication of distinct differences among Sasang types in SPQ and SDFI[2,11,16,17].

Second, the participants were consist of patients received various diagnoses of Western medicine, which might cause bias by aggregating specific Cold or Heat patterns in certain subgroups. However, since this study used the Cold-Heat subgroup pattern identification of traditional medicine [26] listed in the Korean Standard Classification of Diseases (KCD) code (Table 1) [43], the reliability of Cold-Heat subgroup classification might be acceptable. A prospective clinical study of individuals with specific cardiovascular or digestive diseases using a larger sample size to replicate the results in this study would be needed to prevent possible sampling bias.

This study analyzed the clinical features of 241 patients with validated objective measures and showed that SDFI-Digestion measuring digestive function is a key for Cold-Heat subgroup identification in So-Yang, Tae-Eum and So-Eum Sasang types. Moreover, a regression model using the SDFI, SPQ and BMI predicted 76% to 82% of the Cold-Heat subgroups within the three Sasang types.

Differential diagnosis of Cold-Heat subgroup and Sasang type with clinically validated SPQ, SDFI, and BMI would be useful for clinicians planning safe and effective person-centered acupuncture and medications[14,15], as well as for Western clinicians who want to incorporate Sasang typology into their treatments as integrative medical technique in the near future[2,11].

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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