Review Article

Exploring Heart Rate Variability as a Biomedical Diagnostic Tool for the Disympathetic Dimension of Eight-Constition Medicine

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Background. Eight-Constition Medicine (ECM), an extension of Traditional Korean Medicine, divides the population into eight groups based on their physiological characteristics. ECM divides these eight groups into two larger groups based on autonomic reactivity: the Sympathicotonic group and the Vagotonic group (herein referred to as the Disympathetic Dimension). Heart Rate Variability (HRV) is a widely used biomedical tool to assess cardiac autonomic function. This raises the question of the utility of using HRV to correctly diagnose ECM constitutions.

Methods. A systematic literature review was conducted to evaluate the correlation between HRV and constitutions in Korean Constitutional Medicine, including Eight-Constition Medicine (ECM) and Sasang Constitution Medicine (SCM). The articles were obtained from both English (Scopus, PubMed, EMBASE, ProQuest, and Medline) and Korean databases (NDSL and RISS), in addition to Google Scholar, without date restriction. 20 studies met the inclusion criteria, and data were extracted against three aspects: (1) correlation between HRV and constitution, (2) HRV reporting and interpretation, and (3) extraneous factors that were controlled in the studies.

Results. 386 articles were initially identified, which was reduced to n = 20 studies which met the inclusion criteria. Of these, 19 were SCM studies and 1 was an ECM study. Sample sizes varied from 10 to 8498 men and women, with an age range of 10–80 years. SCM studies explored HRV differences by constitution, measuring HRV at resting, with controlled breathing, before and after acupuncture stimulation, and by other interventions. SCM studies reported either no significant differences (HRV at resting or with controlled breathing studies) or conflicting data (HRV with acupuncture stimulation studies). The single ECM study measured HRV at resting and after acupuncture stimulation but reported no significant differences between the two groups of Sympathicotonia and Vagotonia.

Conclusions. Due to inconsistencies in study design, study population, and measures of HRV, there was no consistency in the data to support the use of HRV as a biomedical determinant of ECM constitutions.

1. Introduction

Eight-Constition Medicine (ECM) originates from Korean Constitutional Medicine, a further development of Sasang Constitution Medicine (SCM) [1–3]. A constitution refers to the nature of an individual’s health response based on their psychosocial and physiological traits. While SCM classifies people into one of four constitutions (Tae-Yang, Tae-Eum, So-Yang, and So-Eum) [4], ECM differentiates people as one of the eight constitutions: Pulmotonia (PUL), Colonotonia (COL), Renotonia (REN), Vesicotonia (VES), Pancreotonia (PAN), Gastrotonia (GAS), Hepatonia (HEP), and Cholecystonia (CHO) (Figure 1) [5]. Consequently, ECM employs a personalized approach to treatment, even between...
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Consequently, to explore HRV as a biomedical diagnostic for ECM, HRV studies in the Korean Constitutional Medicine (Eight-Constitution Medicine, Sasang Constitutional Medicine) were critically reviewed against three considerations: (1) the correlation between HRV and constitutions, (2) HRV reporting and interpretation, and (3) controlled extraneous factors.

2. Methods

2.1. Databases. A systematic review was conducted on full-text articles obtained from both English (Scopus, PubMed, EMBASE, ProQuest, and Medline) and Korean (NDSL, RISS) electronic databases, in addition to Google Scholar, without date restriction.

2.2. Search Terms. Search terms for English databases include ("heart rate variability" OR HRV) AND "eight constitution", ("heart rate variability" OR HRV) AND "8 constitution", ("heart rate variability" OR HRV) AND "Sasang", while Korean databases search terms include: "heart rate variability" AND 8체질, HRV AND 8체질, HRV AND 팔체질, 심박* AND 팔체질, 심박* AND 8체질, "Heart rate variability" AND 사상체질, "HRV" AND 사상체질.

3. Results

3.1. Review Process. From the 386 total records obtained from database search (n = 384) and manual searches (n = 2), full-text articles of n = 36 were obtained after excluding duplicated papers (n = 60) and nonrelevant papers or unavailable articles (n = 290). The articles (n = 36) were further reviewed against the inclusion criteria (i.e., short-term recordings of HRV) for Korean Constitutional Medicine (Eight Constitution or Sasang Constitution). A further 16 articles were excluded, leaving n = 20 papers for critical review. Of these, one was an ECM article, and the others were SCM studies (n = 19). The review process is presented in Figure 2.

3.2. Study Characteristics (Table 1)

3.2.1. Demographic Characteristics. Sample sizes varied from 10 to 8498 men and women, with an age range of 10 to 80 years. 13 out of 20 studies were in healthy subjects, and the rest were either patient populations or medical information not being available.

3.2.2. Study Intervention. To explore constitutional differences, the studies measured HRV at resting level [40, 43, 45, 53] with paced breathing [34, 36, 54], after acupuncture stimulation [38, 39, 41, 44, 47, 51, 52], or other interventions such as meditation [37], forest healing program [42], autogenic training [48], emotional stimulus [50], and constitutional herbal formula [46].
3.2.3. HRV Analysis and Devices. HRV analysis studies varied: time and frequency domain \( (n = 15) \), frequency domain only \( (n = 4) \), and time domain only \( (n = 1) \). All studies used commercial HRV medical devices of ECG \( (n = 16) \), PPG \( (n = 2) \), or IBI \( (n = 2) \).

3.3. Correlation between HRV and Constitution

3.3.1. ECM and HRV at Resting and after Acupuncture Stimulation \( (p < 0.05) \) (Table 2). A single ECM study [33] measured HRV baseline at resting and after constitutional acupuncture (i.e., a predefined acupuncture formula for a specific constitution) stimulation but reported no significant differences between the two groups of Sympathicotonia and Vagotonia. The study had a small sample size (42 patients), wide age range (14–73 yr), uncontrolled gender factors, and a short observation period after acupuncture.

3.3.2. SCM and HRV at Resting \( (p < 0.05) \) (Table 3). None of the SCM studies reported significant differences in HF at resting between constitutions. Two relatively well-controlled SCM studies indicated Tae-Eum constitution (with characteristics of increased parasympathetic reactivity) showed a lower LF/HF ratio than the So-Yang constitution (with both parasympathetic and sympathetic reactivity) at resting condition \( (p < 0.05) \) [43, 47, 55].

3.3.3. SCM and HRV with Controlled Breathing \( (p < 0.05) \) (Table 4). Three SCM studies explored the effects of different breathing approaches on constitutions by measuring HRV: breath-counting meditation [36], paced breathing (3, 6, or 12 times per min) [34], and the ratio of inhalation and exhalation (4:6 and 6:4, respectively) with posture changes [35], but HRV measures from both baseline and controlled breathing showed no difference between constitutions.
| Reference No. | Medicine | Population (age range) | Autonomic stimulus | Duration and HRV measures | Other measures |
|---------------|----------|------------------------|-------------------|--------------------------|---------------|
| 33            | ECM      | 42 patients (14–73)    | Eight-constitution acupuncture | 5 min, frequency domain | BMI           |
| 34            | SCM      | 32 healthy students (20–30) | Paced breathing in specific respiration rate | 5 min, time and frequency domain | Respiration rate |
| 35            | SCM      | 60 healthy students (20–30) | Ratio of inhalation and exhalation, posture (sitting, standing) | Time and frequency domain | Self-evaluation for physical condition (scale 10 cm) |
| 36            | SCM      | 78 healthy students (20–30) | Breath-counting meditation | 5 min, time and frequency domain | Skin conductance, temperature, abdominal amplitude, thoracic amplitude |
| 37            | SCM      | 78 students            | Meditation program (α version) | Time and frequency domain | BDI (depression), STAXI (anger), STAI (anxiety) questionnaires |
| 38            | SCM      | 16 healthy TE constitution (20–60) | Taeguek acupuncture | 5 min, frequency domain | None |
| 39            | SCM      | 6 healthy SE constitution men (20–30) | Taeguek acupuncture | 5 min, frequency domain | None |
| 40            | SCM      | 63 fatigue and nonfatigue subjects (40–60) | None | 5 min, time and frequency domain | BMI, biochemistry analysis, pulse wave analysis, nail fold capillary microscopy, questionnaires (FSS, GSRS, SF-MPQ, PSQI, SF-12) |
| 41            | SCM      | 8 healthy SY constitution women (20–30) | Taeguek acupuncture | 5 min, frequency domain | None |
| 42            | SCM      | 47 healthy subjects (29–66) | Forrest healing program (aroma, foods, tea by constitution + trekking) | 5 min, time and frequency domain | BMI, BP, fasting blood sugar, cholesterol, abdominal obesity |
| 43            | SCM      | 665 subjects (39–72)   | None | 5 min, time and frequency domain | Pulse wave analysis, cerebral blood flow |
| 44            | SCM      | 20 healthy subjects (18–30) | Bee venom acupuncture | 5 min, time and frequency domain | Facial electromyography |
| 45            | SCM      | 103 idiopathic facial palsy patients (10–79) | None | 5 min, time and frequency domain | None |
| 46            | SCM      | 10 TE constitution patients | Herbal formula for TE constitution (jowisengcheong-tang) | 5 min, time and frequency domain | None |
| 47            | SCM      | 30 healthy men (20–26) | Acupuncture at LI4 | 5 min, time and frequency domain | None |
| 48            | SCM      | 39 patients (20–59)    | Autogenic training | 5 min, time and frequency domain | MBTI questionnaire (extraversion, introversion) |
| 49            | SCM      | 8498 workers           | None | 5 min, time and frequency domain | None |
| 50            | SCM      | 44 healthy subjects (20–30) | Emotional stimulus (horror film) | 5 min, time and frequency domain | None |
| 51            | SCM      | 86 subjects (22–25)    | Electroacupuncture | 5 min, time and frequency domain | None |
| 52            | SCM      | 19 healthy subjects | Acupuncture at LI4 and LR3 | 5 min, time and frequency domain | BP, BMI |

ECM, Eight-Constition Medicine; SCM, Sasang Constitution Medicine; CM, Constitution Medicine; HRV, Heart Rate Variability; MHR, mean heart rate; BMI, body mass index; TE, Taeumin constitution; SY, Soyangin constitution; FSS, Fatigue Severity Scale; GSRS, Gastrointestinal Symptom Rating Scale; SF-MPQ, Short-Form McGill Pain Questionnaire; PSQI, Pittsburgh Sleep Quality Index; SF-12, Short-Form Health Survey; BP, blood pressure; SpO2, peripheral capillary oxygen saturation; APG, Accelerated Plethysmogram; MBTI, Myers–Briggs Type Indicator.
Table 2: HRV difference by constitution \((p < 0.05)\), before and after acupuncture stimulation.

| Reference | 1 [33] | 6 [38] | 9 [41] | 7 [39] | 12 [44] | 15 [47] | 19 [51] | 20 [52] |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|
| Constitution | ECM | SCM | SCM | SCM | SCM | SCM | SCM | SCM |
| Population (range) | 42 patients (14–73) | 16 healthy TE constitution (20–60) | 8 healthy SY constitution women (20–30) | 6 healthy SE constitution men (20–30) | 20 healthy subjects (18–30) | 30 healthy men (20–26) | 86 subjects (22–25) | 19 healthy subjects |
| Subjects by constitution group | Sympathicotonia = 22 (Pul, Col, Ren, Ves) Vagotonia = 20 (Hep, Cho, Pan, Gas) | TE = 16 | SY = 8 | SE = 6 | SY = 5, TE = 8, SE = 7, TY = 0 | SY = 8, TE = 13, SE = 9, TY = 0 | SY = 34, TE = 27, SE = 25, TY = 0 | SY = 6, TE = 7, SE = 6, TY = 0 |
| Age and gender controlled by constitution group | na | na | Age, gender | Age, gender | Age | Age, gender | Age, gender | Age, gender |
| Acupuncture | Eight-constitution acupuncture | Taeguk acupuncture (TE) | Taeguk acupuncture (SY) | Taeguk acupuncture (SE) | Bee venom acupuncture | Acupuncture at LI4 | Electroacupuncture | Acupuncture at LI4 and LR3 |
| HRV baseline difference by constitution | No difference | NA | NA | NA | No difference | Low in TE (LF/HF) | na | No difference |
| HRV by constitution compared to baseline, after acupuncture | MHR | No difference | na | na | na | na | No difference | na |
| mRR (ms) | na | na | na | na | na | na | na | na |
| SDNN (ms) | na | na | na | na | na | No difference | No difference | TE > SY (active) |
| rMSSD (ms) | na | na | na | na | na | No difference | No difference | SY > TE (passive) |
| LF (ms²) | na | na | na | No difference | No difference | No difference | No difference | na |
| HF (ms²) | na | na | na | No difference | No difference | No difference | No difference | na |
| LFnu | Decreased in TE | na | No difference | No difference | na | SE, SY > TE* |
| HFnLu | Decreased in SY | Increased in SY | Increased in SY | Increased in SY | Increased in SY | na |
| Ln (LF) | No difference | na | na | na | na | na | na | na |
| Ln (HF) | na | na | na | na | na | na | na | na |
| LF/HF | No difference | na | No difference | No difference | Increased in SY | na | na | na |
| SE > SY | na | TE > SE* |

ECM, Eight-Constiution Medicine; SCM, Sasang Constitution Medicine; Pul, Pulmotonia constitution; Col, Colonotonia constitution; Ren, Renotonia constitution; Ves, Vesicotonia constitution; Hep, Hepatonia constitution; Cho, Cholecystonia constitution; Pan, Pancreotonia constitution; Gas, Gastrotonia constitution; TE, Taemin constitution; SY, Soyangin constitution; SE, Soeumin constitution; TY, Taeyangin constitution; MHR, Mean Heart Rate; na, not available; NA, not applicable.∗Compared to right after needle insertion vs. 1 hour after needle removal.
3.3.4. SCM and HRV after Acupuncture Stimulation \((p < 0.05)\) (Table 2). 5 out of 7 SCM acupuncture studies reported some HRV differences between constitutions. Two within-subject studies \([38,41]\) reported that Taegeuk acupuncture stimulation (i.e., a predefined acupuncture formula for a specific constitution) resulted in a significant increase in HFnu in both the Tae-Eum and So-Yang type compared to a resting or stress condition, indicating a relative increase in cardiac vagal modulation. Three between-subject studies based on different acupuncture stimulation methods reported different HRV measures or conflicting data: (1) So-Yang type showed higher SDNN than So-Eum type and Tae-Eum type during passive coping conditions (i.e., enduring pain passively) and the opposite during active coping condition (i.e., pain stimulation will stop when signaling) when pain is induced by electroacupuncture \([51]\); (2) So-Eum type showed higher rMSSD compared to Tae-Eum type and Tae-Eum type showed higher LFnu and LF/HF compared to So-Eum type based on changes between right after needle insertion at LR3 and LI4 and 1 hour after needle removal \([52]\); (3) LFnu and LF/HF were increased in So-Yang type and LF/HF was significantly higher in So-Eum type compared to So-Yang type, while LF/HF of Tae-Eum type was in between, after acupuncture stimulation at LI4 only \([47]\).

3.3.5. SCM and HRV after Other Interventions \((p < 0.05)\) (Table 5). So-Eum type had significantly enhanced HRV (i.e., SDNN) after either a meditation program \([37]\) or an autogenic training program \([48]\). SDNN (time domain variable) results recorded on short-term HRV, however, may need further validation of reproducibility.

3.4. HRV Reporting and Interpretation

3.4.1. Reporting of HRV Measures (Table 6). The number of reported HRV variables varied from more than five \((n = 9)\) to only one (e.g., SDNN or LF/HF) \((n = 2)\). The most frequently reported variable was SDNN \((n = 16)\), and the least was mRR \((n = 4)\). Frequency domain variables were used to describe sympathovagal modulation: LF/HF \((n = 14)\), LF and HF

### Table 3: HRV difference by constitution \((p < 0.05)\), at resting.

| Reference | SCM | SCM | SCM | SCM | SCM |
|-----------|-----|-----|-----|-----|-----|
| Population (age) | 63 fatigue and nonfatigue subjects (40–60) | 665 subjects (39–72) | 103 idiopathic facial palsy patients (10–79) | 8498 workers (20–26) | 30 healthy men (20–26) |
| MHR | na | No difference | No difference | No difference | No difference |
| mRR (ms) | na | na | No difference | No difference | No difference |
| SDNN (ms) | No difference | No difference | No difference | No difference | No difference |
| rMSSD (ms) | No difference | No difference | No difference | No difference | No difference |
| LF (ms²) | No difference | No difference | No difference | No difference | No difference |
| HF (ms²) | No difference | No difference | No difference | No difference | No difference |
| LFnu | No difference | SY > TE (all) SY > TE, SE (female, below 60 years) | SY > TE, SE > SY (female, below 60 years) | SY > TE (all) SY > TE, SE (female, below 60 years) | SY > TE (all) SY > TE, SE (female, below 60 years) |
| HFnu | No difference | TE > SY (all) TE, SE > SY (female, below 60 years) | SY > TE (all) SY > TE, SE (female, below 60 years) | TE > SY (all) TE, SE > SY (female, below 60 years) | TE > SY (all) TE, SE > SY (female, below 60 years) |
| Ln (LF) | na | No | No | No | No |
| Ln (HF) | na | No | No | No | No |
| LF/HF | No difference | SY > TE, SY > SE (female, below 60 years) | SY > TE, SY > SE (female, below 60 years) | SY > TE, SY > SE (female, below 60 years) | SY > TE, SY > SE (female, below 60 years) |

SY, So-yang constitution; TE, Taeumin constitution; SE, So-eumin constitution; M, male; F, female; na, not available. Multivariated adjusted odds ratio HRV analysis. The odds ratio adjusted for age, gender, education period, marital status, drinking status, smoking status, past history (hypertension, diabetes mellitus, and hyperlipidemia), BMI, and metabolic syndrome. HRV reporting generated indices (stress index, fatigue index) and TP showed a significant difference between constitution groups.
Table 4: HRV difference by constitution (p < 0.05), controlled breathing.

| Reference | 4 [36] | 2 [34] | 3 [35] |
|-----------|--------|--------|--------|
| Constitution | SCM | SCM | SCM |
| Population (age) | 78 healthy students (20–30) | 32 healthy students (20–30) | 60 healthy students (20–30) |
| Subjects by constitution group | SY = 13, TE = 30, SE = 35, TY = 0 | SY = 10, TE = 11, SE = 11, TY = 0 | SY = 18, TE = 18, SE = 24, TY = 0 |
| Age and gender controlled by constitution group | Age | Age | Age |
| HRV baseline difference by constitution | MHR: SY, SE > TE | No difference | No difference |
| HRV by constitution compared to baseline, with paced breathing | Breath-counting on inspiration and expiration (not controlling) | Paced breathing: 12, 6, or 3 times per min | Ratio of inhalation and exhalation (4:6, 6:4) |
| MRR (ms) | na | No difference | No difference |
| SDNN (ms) | No difference | No difference | No difference |
| rMSSD (ms) | na | No difference | No difference |
| LF (ms²) | No difference | na | No difference |
| HF (ms²) | No difference | na | No difference |
| LFnu | na | na | No difference |
| HFnu | na | na | No difference |
| Ln (LF) | na | No difference | na |
| Ln (HF) | na | No difference | na |
| LF/HF | No difference | na | No difference |

na, not available; CIB, Counting on Inspiration; CEB, Counting on Expiration.

Table 5: HRV difference by constitution (p < 0.05), associated with other interventions.

| Reference | 5 [37] | 10 [42] | 14 [46] | 16 [48] | 18 [50] |
|-----------|--------|--------|--------|--------|--------|
| Constitution | SCM | SCM | SCM | SCM | SCM |
| Population | 78 students | 47 healthy subjects (29–66) | 10 TE patients (20–59) | 39 patients (20–59) | 44 healthy subjects (20–30) |
| Subjects by constitution group | na | M (SY = 10, TE = 17, SE = 20, TY = 0) | TE = 10 | SY = 9, TE = 12, SE = 18, TY = 0 | SY = 10, TE = 20, SE = 14, TY = 0 |
| Age and gender controlled by constitution group | na | Gender, age | na | Age | Age |
| Intervention | Meditation program (α version) | Forrest healing program (aroma, foods, tea, trekking) | TE herbal formula (Jowisengcheong-tang) | Autogenic training | Emotional stimulus (horror film) |
| HRV baseline difference by constitution | No difference | No difference | na | No difference | No difference |
| HRV by constitution compared to baseline, associated with other interventions | Reduced in SE | Increased in SY | na | Reduced in TE | na |
| MRR (ms) | na | Increased in SY | na | Increased in SE | na |
| SDNN (ms) | Increased in SE | Decreased in SY | No difference | Increased in SY | No difference |
| rMSSD (ms) | Increased in SE | Decreased in SY | No difference | Increased in SE | No difference |
| LF (ms²) | No difference | No difference | No difference | Na | Na |
| LF/HF | No difference | No difference | No difference | No difference | No difference |
| Ln (HF) | na | na | na | no | na |
| Ln (LF) | na | na | na | no | na |
| LF/HF | No difference | No difference | na | No difference | No difference |

na, not available; M, male; F, female; SE, Soeumin constitution; SY, Soyangin constitution; TE, Taeumin constitution.
power \((n = 12)\), LFnu and HFNu \((n = 11)\), and natural logarithm \((n = 3)\). Other HRV influencing parameters reported include mean heart rate \((n = 13)\), respiration rate \((n = 1)\), and blood pressure \((n = 3)\).

3.4.2. Normalized Units and Raw Values (Table 7). 13 of the 20 studies reported multiple nu/ratios \(i.e.\), HFNu, LFnu, and LF:HF ratio), and this could present potential problems of redundancy and interpretation, especially when the HRV reporting measures provide inconsistent outcomes, as noted in Heathers’ HRV methodology study \([32]\): for example, if LFnu was significant and LF:HF not, this might be interpreted as a change in sympathetic activity but there is no sympathovagal balance. Some SCM and HRV studies reported redundant \([43]\) or inconsistent results: for example, LFnu increased in So-Yang type, but there is no change in HFnu \([47]\), or HFnu was higher in So-Yang type than Tae-Eum type but there is no difference in LFnu \([52]\). While the task force recommended that research should always report both raw values and normalized units \([56]\) because the changes in the individual frequency bands may be inconsistent with the reporting of lones normalized HRV values \([32]\), 6 of 20 studies reported normalized units without raw values.

3.4.3. Interpretation of HF, LF, and LF:HF Ratio (Table 8). ECM and SCM studies \((n = 14)\) interpreted HF as reflecting parasympathetic nervous system \(PNS\) mediated by RSA \(Respiratory Sinus Arrhythmia\) \((n = 7); n = 6\) as PNS, and \(n = 1\) as RSA. This mirrors the debate on LF interpretation as a mix of sympathetic and vagal, and baroreceptor activities \([58]\), and the ECM and SCM studies \((n = 14)\) showed a mixed interpretation: baroreceptor activity \((n = 1)\), more SNS + PNS \((n = 5)\), baroreceptor + PNS \((n = 1)\), baroreceptor + SNS + PNS \((n = 1)\), SNS + balance of PNS and SNS \((n = 1)\), and index of SNS \((n = 3)\). Although all the ECM and SCM studies reported LF:HF as an index of sympathovagal balance, a recent consensus suggested lowering its predictive value \([58]\), due to the loose relationship of LF power with sympathetic outflow \([32]\), and the nonlinear and non-reciprocal relationship between SNS and PNS activity \([59]\). The discrepancy in HRV interpretation is problematic in deriving a conclusive insight on the correlation between constitutions and HRV.

3.4.4. Extraneous Factors Controlled for HRV (Table 9). In general, some population variables \(i.e.\), age, health condition, and medication) of ECM and SCM studies \((n = 20)\) were well controlled \((n = 14)\), but gender \((n = 9)\) was relatively less controlled. Several procedure- and environment-related variables were frequently controlled \(i.e.\), posture, resting, circadian rhythm, caffeinated drinks, alcohol, room lighting, or noise), with others less frequently controlled \(i.e.\), smoking, wakefulness or talk, food, physical exercise, and temperature), and some not at all \(i.e.\), bladder filling and stress level).

3.5. Classification of Constitutions. An ECM study \([33]\) used pulse diagnosis with an intrarater reliability test \(Kappa index 0.83\%). SCM studies used QSCCI (Questionnaire for
| HRV measures | Explanations | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8* | 9 | 10 | 11 | 12* | 13 | 14* | 15 | 16 | 17 | 18* | 19* | 20 | Total |
|--------------|--------------|---|---|---|---|---|---|---|----|---|----|----|-----|----|-----|----|----|----|----|----|----|-----|
| Year         |              | 2005 | 2016 | 2016 | 2015 | 2014 | 2013 | 2013 | 2012 | 2011 | 2009 | 2009 | 2009 | 2008 | 2007 | 2007 | 2007 | 2007 | 2006 | 2004 |
| LF           | SNS          | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 3   | 14  |
|              | SNS > PNS    | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 5   |     |
|              | SNS, BAL     | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 1   |     |
|              | BAR, SNS, PNS| ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 3   |     |
|              | BAR, PNS     | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 1   |     |
|              | BAR          | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 1   |     |
| HF           | RSA, PNS     | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 7   | 14  |
|              | PNS          | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 6   |     |
|              | RSA          | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 1   |     |
| LF : HF      | BAL          | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | ✓   | 10  | 10  |

BAR, the activity of Baroreflex; PNS, parasympathetic nervous system; SNS, sympathetic nervous system; RSA, respiratory sinus arrhythmia; BAL, a balance of sympathetic and parasympathetic influences. *Explanation on HRV measures not reported; †not applicable.
4. Discussion

This systematic review explored HRV as a biomedical diagnostic for the Disympathetic Dimension of ECM.

4.1. Limitations of the Study. There are limitations to this review. The focus was on a qualitative and descriptive analysis of ECM and SCM studies on HRV reporting, interpretation, and control of extraneous factors. A review of statistical analysis including study population and effect size calculation was not within the study scope. Most articles were derived from the Korean research literature; despite the care with translation, misinterpretation or misunderstanding of the study contents is possible.

4.2. Correlation between HRV and Constitution. The results of the systematic review showed little consistency in the data to support the use of HRV as an objective determinant of ECM constitutions.

(1) A single ECM study of HRV differences after eight-constitution acupuncture had several limitations: sample size, control of age, and gender factors, and the data was not sufficient to draw meaningful conclusions on the use of HRV for constitutional differentiation along the Disympathetic Dimension.

(2) While consensus exists for HF as a proxy to evaluate cardiac vagal modulation when the respiratory frequency is mediated, LF and the LF/HF ratio lack a clear relationship to cardiac sympathetic modulation. None of the ECM and SCM studies reported significant differences between constitutions when measuring HF at resting. Two SCM studies showed some constitutional differences in the LF/HF ratio; however, the ratio lacks consensus as a reliable measure for sympathetic-vagal balance [29, 30, 56]. The results alone, therefore, are not enough to explain the constitutional differences in terms of cardiac autonomic modulation.

(3) While constitutional differences in HRV measures (i.e., SDNN, HFnu, LFnu, and LF/HF) in the SCM acupuncture stimulation studies are notable, there
were limitations: HRV time domain values such as SDNN [21] are preferably computed through long-term recording (24 hours); therefore, the study result based on 30 seconds of SDNN requires further validation of reproducibility; LF/HF and LFnu are not sufficient to reflect cardiac autonomic modulation and changes in those measures alone have limited predictive value of constitutional differences.

(4) While 5 out of 7 SCM acupuncture studies reported some HRV differences (HFnu, LFnu, LF/HF, and SDNN), the variety of study methods and procedure design made it difficult to compare, consolidate, and draw a robust conclusion. This variety includes reporting of HRV measures (e.g., HFnu, LFnu, LF/HF, SDNN, and rMSSD), acupuncture methods and points (e.g., Taeguk acupuncture, bee venom acupuncture, electroacupuncture at ST36 and ST38, acupuncture at LI4 or LI4 and LR3), frequency and duration (e.g., one session vs. three sessions over two weeks, 5 min vs. 15 min acupuncture), stimulation methods (e.g., only acupuncture vs. mental stress and acupuncture), study population (e.g., age, gender), HRV measurement timing (e.g., right after needle removal, 1 hour after needle removal), and control of extraneous factors (e.g., wakefulness or talk, food).

4.3. HRV Reporting and Interpretation. HRV reporting in the studies showed some opportunities to improve: inconsistency in the selection of HRV reporting measures, redundancy or inconsistent outcomes of normalized unit reporting (i.e., HFnu, LFnu, and LF/HF ratio) without raw values, and discrepancy in HRV interpretation (HF, LF, and LF/HF ratio). ECM and SCM studies reported only some of the HRV measures (i.e., mRR, SDNN, rMSSD, LF power, HF power, LFnu, HFnu, and LF/HF ratio) that were recommended by a task force [58, 59] and the selection of measures were also inconsistent among the studies.

4.4. Extraneous Factors. Among the HRV extraneous factors, some of the population variables (i.e., age, health condition, and medication) were well controlled, but gender and other procedural variables (e.g., wakefulness or talk, food) were less controlled in the studies.

In the studies examined, there was no clear relationship between HRV and Korean Constitutional Medicine, including the Disympathetic Dimension of ECM. Reasons included demographic discrepancies (i.e., age, gender, and health conditions), HRV reporting, methodological inconsistencies between the SCM studies, and insufficient ECM research. The continuing debates on whether HRV measures reflect autonomic function accurately add further complications on top of HRV’s sensitivity to various extraneous factors.

5. Conclusions

This review examined HRV in the hope that it would be a useful objective diagnostic tool to bridge the information gap for acupuncture and traditional medicine researchers and, specifically, for determining a patient’s position on the Disympathetic Dimension of Eight-Constiution Medicine. HRV does not seem to be suitable for this purpose alone.

**Abbreviations**

ECG: Electrocardiogram  
ECM: Eight-constitution medicine  
HF: High frequency  
HFnu: Normalized high frequency  
HRV: Heart rate variability  
IBI: Interbeat intervals  
KCM: Korean constitution medicine  
LF: Low frequency  
LFnu: Normalized low frequency  
LI4: Large intestine 4  
LR3: Liver 3  
mRR: Mean of R-R intervals  
SCM: Sasang constitution medicine  
SDNN: Standard deviation of NN intervals  
PPG: Photoplethysmogram  
rMSSD: Root mean square of the successive differences.

**Data Availability**

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

**Disclosure**

The role of the funding body in the design of the study includes collection, analysis, and interpretation of data and in writing the manuscript.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.

**Authors’ Contributions**

HK and SW designed the study. HK conducted the systematic review and drafted the manuscript. SW, BO, and TR reviewed and edited the manuscript. BJC provided advice on ECM. All authors approved the final manuscript.

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**References**

[1] T. Kim, “Tradition on the move,” *Asian Medical*, vol. 11, no. 1–2, pp. 133–159, 2016.  
[2] D. Kuon, “Constitution-acupuncture,” *Journal of Acupuncture - Moxibustion*, vol. 10, pp. 149–167, 1965.
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[39] N. S. Kim, J. Y. Kim, S. G. Kwak, I. H. Shin, S. S. Nam, and Y. S. Kim, “Effects of Taegeuk acupuncture on the autonomic nervous system by analyzing heart rate variability in 20’s Soeumin,” *Journal Korean Acupuncture Moxibustion*, vol. 30, no. 3, pp. 39–49, 2013.

[40] K. Kim, Y.-J. Ha, S.-J. Park, N.-R. Choi, Y.-S. Lee, and J.-C. Joo, “Characteristics of fatigue in Sasang constitution by analyzing questionnaire and medical devices data,” *Journal of Sasang Constitutional Medicine*, vol. 25, no. 4, pp. 306–319, 2013.

[41] N.-S. Kim, S.-J. Kim, H.-J. Ryu, S.-S. Nam, and Y.-S. Kim, “Effects of Taegeuk acupuncture on the autonomic nervous system by analyzing heart rate variability in Soyangin,” *Acupuncture*, vol. 29, 2012.

[42] S.-G. Hong, E.-J. Choi, S.-H. Sun et al., “Biological change by forest healing according to Sasang Constitution: preliminary study,” *Journal of Sasang Constitutional Medicine*, vol. 23, no. 4, pp. 487–502, 2011.

[43] S. Kim, S. Sun, J. Yoo, S. Koh, and J. Park, “Correlation between Sasang constitution and heart rate variability in wonju rural population,” *Journal Internal Korean Medicine*, vol. 30, no. 3, pp. 510–524, 2009.

[44] S.-M. Lee, K. Kim, S.-Y. Oh, Y.-M. Kwon, and J.-C. Joo, “Effects of bievenom acupuncture on heart rate variability, pulse wave, and cerebral blood flow for types of Sasang Constitution,” *Journal of Korean Institute of Herbal Acupuncture*, vol. 12, no. 1, pp. 35–42, 2009.

[45] C. Y. Kim, N. H. Kown, Y. J. Shin et al., “Facial electromyography and heart rate variability values of idiopathic facial palsy inpatients in relationship with Sasang constitutional characteristics,” *Journal Korean Acupuncture Moxibustion*, vol. 26, no. 6, pp. 111–119, 2009.

[46] S.-Y. Oh, S.-W. Lee, E.-Y. Kil, and J.-C. Joo, “Effects of jowisengcheong-tang on heart rate variability,” *Journal of Sasang Constitutional Medicine*, vol. 20, no. 2, pp. 53–57, 2008.

[47] I.-H. Im, *Effect of Acupuncture at LI4(Hapkok) on Heart Rate Variability in Healthy Subjects According to Sasang Constitution*, Graduate School Kyung Hee University, Seoul Korea, 2007.

[48] J.-H. Lee and J.-G. Lee, “The effects of autogenic training on heart rate variability,” *Journal Oriental Neuropsychiatry*, vol. 18, no. 1, pp. 123–132, 2007.

[49] J.-H. Lee, E.-H. Seo, J.-H. Ha, A.-R. Choi, C.-H. Woo, and D.-M. Goo, “A study on the Sasang constitutional differences in heart rate variability,” *Journal of Sasang Constitutional Medicine*, vol. 19, no. 3, pp. 176–187, 2007.

[50] G.-R. Lee, D.-Y. Shin, Y.-W. Kim, J.-H. Yi, J.-M. Song, and L.-H. Kim, “Changes of HRV according to emotional stimulus in Sasang constitutional groups,” *Journal Oriental Neuropsychiatry*, vol. 18, no. 2, pp. 25–34, 2007.

[51] K.-S. Jang, J. K. Kim, and S. K. Lee, “Analysis of heart rate variability in constitution types during active and passive coping caused by electroacupuncture,” *Journal of Physiology & Pathology in Korean Medicine*, vol. 20, no. 1, pp. 115–124, 2006.

[52] C. K. Kwak, E. H. Sohn, E. J. Lee, B. H. Koh, I. B. Song, and W. Hwang, “A study about Sasang constitutional difference on autonomous function after acupuncture stimulation,” *Journal of Sasang Constitutional Medicine*, vol. 16, no. 3, pp. 76–84, 2004.

[53] J.-H. Lee, E.-H. Seo, J.-H. Ha, A.-R. Choi, C.-H. Woo, and D.-M. Goo, “A study on the Sasang constitutional differences in heart rate variability,” *Journal of Sasang Constitutional Medicine*, vol. 19, no. 3, pp. 176–187, 2007.

[54] J.-H. Kim and S.-S. Park, “The effects of posture and the ratio of inhalation and exhalation on heart rate variability,” *Journal of Korean Medicine*, vol. 37, no. 1, pp. 114–124, 2016.

[55] Y. R. Han, H. B. Lee, S. Y. Han, B. J. Kim, S. J. Lee, and H. Chae, “Systematic review of type-specific pathophysiological symptoms of Sasang typology,” *Integrative Medicine Research*, vol. 5, no. 2, pp. 83–98, 2016.

[56] M. Malik, “Heart rate variability,” *Annals of Noninvasive Electrocardiology*, vol. 1, no. 2, pp. 151–181, 1996.

[57] D. Nunan, G. R. H. Sandercock, and D. A. Brodie, “A quantitative systematic review of normal values for short-term heart rate variability in healthy adults,” *Pacing Clinical Electrophysiology*, vol. 33, no. 11, pp. 1407–1417, 2010.

[58] S. Laborde, E. Mosley, and J. F. Thayer, “Heart rate variability and cardiac vagal tone in psychophysiological research – recommendations for experiment planning, data analysis, and data reporting,” *Frontiers in Physiology*, vol. 8213 pages, 2017.

[59] G. Billman, “The LF/HF ratio does not accurately measure cardiac sympatho-vagal balance,” *Frontiers in Physiology*, vol. 4, p. 26, 2013.