Relationship of Human Personal Characteristics in the three Independent Stratification Systems

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Objectives: We aimed to analyze theassociation between the biophysiological characteristics of body constitution and temperament type with Mongolian Traditional Medicine (MTM) constitution type to understand further and integrate the application of these stratification systems in clinical medicine. **Methods:** Body constitution type was classified using the body-mass index, temperament type was determined using personality test, and dominant MTM constitution type was determined in 287 active blood donors. Age, gender, and ABO blood groups were considered as additional biophysiological characteristics. The correlation between the biophysiological characteristics and the nature of their relationship was investigated using likelihood ratio and receiver operating characteristics analysis. **Results:** Obesity and body-mass index were related to aging, and donor's age and Badgan expression rate were shown as a sensitive and specific classifier for obesity state. The relationship between Badgan dominant types of human constitutions practiced in Mongolian Traditional Medicine and melancholic temperament was established. Badgan expression was a sensitive and specific classifier for melancholic and phlegmatic temperament. **Conclusions:** Stratification of human subjects using the primary types of human constitutions practiced in Mongolian Traditional Medicine may be helpful in clinical research and application.

Keywords: Body Constitution, Temperament, Precision Medicine, Mongolian Traditional Medicine

Introduction

Personalized medicine, also referred to as precision medicine, is a medical model that separates people into different groupswith medical decisions, practices, interventions and products being tailored to the individual patient based on their predicted response or risk of disease [1]. Among 14 Grand Challenges for Engineering, an initiative sponsored by the National Academy of Engineering (NAE), personalized medicine has been identified as a key and prospective approach to "achieve optimal individual health decisions," therefore overcoming the challenge to "engineerbetter medicines" [2]. Stratification of individuals based on differences of the genetic information on results of molecular and cellular investigations is considered to be the priority and essential approach in personalized medicine [3]. However, besides genomic variation, many other features, including epigenetic factors, have been used to group individuals [1, 4, 5]. Examples are human personality(or psychometric) [6] and body constitution (or biometric) [7, 8] parameters. Specificphysiological (age and gender) andneuroendocrine characteristics of a personality are strong indicators for pathology development, both inexperimental animals and humans [6]. Overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health and representa major risk factor for many chronic diseases, including diabetes, cardiovascular diseases, and cancer [9]. Blood classificationis based on the presence or absence of inheritedantigenic substances on the surface of red blood cells and antibodies to these antigens. There is no scientific consensus that a relationship exists between the ABO blood group and personality traits [10], but scientific hypotheses concerning ABO blood groups and personality traits have been reported [11].

In contrast to conventional medicine, the main concepts of other medicines such as alternative, integrative, complementary and traditional medicines initially were based on the personal features of human subjects [5, 12]. There are several human typology systems practiced in Oriental medicines; namely, Prakriti constitutional types in Indian Ayurvedic medicine [13, 14], Yin-Yang and Qi typology in Chinese Traditional Medicine [15, 16], The Sasang typology system in Korean Medicine [17-19] and human constitutional types in Tibetan medicine [20, 21] are widely used as stratification approaches in personalized medicine research. Studies among the general population in Beijing,

China, found some association between the Tibetan Medicine constitution types and the obesity state, but this study used the Tibetan Medicine constitution scale based on a self-reporting questionnaire, without any physical examination. The Ying-Yan and Qi constitution types in Traditional Chinese Medicine demonstrated independent and significant associations among the Qi deficient and Yang deficient groups with overweight, obesity, and underweight [22].

The biopsychological personality profiles of traditional Korean Sasang typology were compared to the Temperament and Character Inventoryin Korean adults. Significant differences in the temperament dimensions of Novelty Seeking and Harm Avoidance were found among the Sasang types [23]. But we should note that the theoretical basis and methodology of human stratification between Mongolian Traditional Medicine (MTM) and Chinese or Korean medicine is quite different. Many of the basic theories in MTMare taken directly from Indian and Tibetanmedicines [24, 25]. Concepts in MTM describe human health as a balance of three abstraction notes, Hii, Šar and Badgan, which should be an expression of the individuals' vital or existential qualities[24, 25] and herewith, each person has their own balance of these qualities obtained at birth. However, the proportion may have to change over a lifetime under the influence of both internal and external factors, including aging, harmful and pathogenic factors [26]. According to this concept, humans may be classified into one of three singles (single Hii, Šar and Badgan), three duals (dual Hii-Šar, dual Hii-Badgan, dual Šar-Badganor vice versa) or one collective (Hii-Šar-Badgan) types, also known as uvurchlul [22-23].

Our study aimed to analyze theassociation between human biophysiologicalcharacteristics in participants stratified using stratification systems of body constitution type, temperament type, and Mongolian Traditional Medicine constitution type.

Materials and Methods

Study population
A total of 287 active blood donors from the Center of Transfusion Medicine in Ulaanbaatar, Mongolia, were enrolled in this cross-sectional study. Demographic, biometric data and blood group information were collected from the medical records of study participants. Blood groups (ABO, Rhesus and Kell system) in all donors were established using hemagglutination test.

Stratification by Rhesus and Kell blood groups was not used in the statistical analysis because we found only 2 Rh (-) and 2 K (+) cases.

Measurement of biophysiological characteristics

Three independent stratification systems were used for the stratification biophysiological characteristics of the study participants: a) the body-mass index (BMI) was used as biometric strata; b) human temperament types classified by personality traits were used as psychometric strata and c) human constitution type described in Mongolian Traditional Medicine. Age, gender and ABO blood groups of participants also were studied.

Measurement of body constitutional type. We calculated the body mass index (BMI) as a body constitution measure and determined the BMI classification for each participant using the U.S. Center for Disease and Prevention criteria [19].

Measurement of human temperament. We used an interactive personality test of the "Four Temperaments" Scale (available at O4TS v 1.0) based on the Ancient Greek medical theory of humorism and developed by the Open-Source Psychometric Project [19] to measure temperament. The test has 24 statements of opinion that the responder selects an answer on a five-point scale of how much the responder agrees with the statement. It was developed by finding questions that statistically predicted self-identified temperament in samples of people who already hadan opinion on which temperament they were.Items for the O4TS were selected based on their correlation with self-reported temperament.

Measurementof human constitution described in Mongolian Traditional Medicine. We determined the Mongolian Traditional Medicine constitution types for all participants using theexamination developed by Sachs in 1995 [17] and modified by Batchimeg et al. In 2003 [12]. The test system uses the findings from anamnesis, observation and physical examination and all these componentswere grouped in three sections such as body characteristics (6 tests), pulse properties (1 test) and body's functional properties (15 tests). The test results were expressed using scores in three columns corresponding to Hii, Šar and Badganqualities. Each subject's MTM constitution type was determined by calculating thesum of the scores using a formula [3,15]. The expression scores for Hii, Šar, and Badgan in percentiles were calculated for each donor.

One of 3 single, 3 (6) dual and 1 collective MTM constitution type and one of 3 additional types determined by the dominantly expressed or dominant type in each person. The dominant types were defined as follows: Hiidominant type includes single, Hii- and Hii-Šardualtypes; Šardominant typeincludes singleŠar, Šar-Badganand Šar-Hiidualtypes; and Badgan dominant typeincludes single Badgan, Badgan-Šar and Badgan-Hii dual types. Donors were stratified into 9 different single and dual MTM constitution types varying 2.4 – 24.0% for each type. Knowing that many strata would cause difficulties analyzing our data statistically, we did not compare the distributions of all of the MTM constitution types in this study. Instead, we stratified donors by their one dominant MTM constitution type.

Statistical analysis

Distribution and diagnostic capacity for prediction of different strata defined by three independent human stratification systems were analyzed. The age, gender and ABO blood group were used as supplementary variables or strata for the comparison. The nominal data (gender, temperament, ABO blood group and dominant MTM constitution type) and ordinal data (age and obesity groups) were stratified, and Pearson's Chi-square, odds ratio (OR) and likelihood ratio (LR) were calculated. The capacity of variables (age in years, BMI, and Hii, Šar, Badgan expression in percent) to predict certain states or classify donors into obesity categories and temperament and dominant MTM constitution type were evaluated using receiver operating characteristics (ROC) analysis. The analyses were performed using IBM SPSS version 26.0 software.

Ethical statement

The study design and methods were introduced at the Mongolian National University of Medical Sciences Review Board meeting on March 26, 2018 project as a PhD student research and the ethical issues discussed. The Review Board approved the study's ethical aspects (No. 2018/3-07) for PhD student Tsendsuren Sampil

Results

Donors

All donors considered themselves Mongolian. Some demographic and biophysiological characteristics of participants are shown in Table 1.

Table 1. Biophysiological characteristics of study participants.

Characteristics	Males	Females	Total
	Mean ± SD	Mean ± SD	Mean ± SD
Age (years)			
Mean, mean ± SD	33.5 ± 11.9	32.7 ± 13.1	33.1 ± 12.4
Median (Min. – Max.)	29.0 (17 - 60)	29.0 (18 - 58)	29.0 (17 - 60)
Age strata in years, n (%)	N(%)	N(%)	N(%)
≥25	109 (38.0)	73 (25.4)	182 (63.4)
≥ 30	83 (28.9)	60 (20.9)	143 (49.8)
≥ 35	69 (24.0)	49 (17.1)	118 (41.1)
≥ 40	55 (19.2)	39 (13.6)	94 (32.8)
≥45	35 (12.2)	36 (12.5)	71 (27.7)
≥ 50	21 (7.3)	26 (9.1)	47 (16.4)
Total	158 (55.1)	129 (44.9)	287 (100.0)
Dominant constitution, n (%)			
Hii dominant	41 (14.3)	35 (12.5)	76 (26.8)
Šar dominant	79 (27.2)	70 (24.7)	149 (51.9)
Badgan dominant	38 (12.9)	34 (12.2)	72 (25.1)
Expression percent, mean ± SD			
Hii	32.6±16.8	30.9±16.6	31.8±16.7
Šar	40.8±15.2	39.6±15.8	40.3±15.4
Badgan	26.6±16.3	29.5±17.3	27.9±16.8
Temperament, n (%)			
Choleric	25 (8.5)	17 (5.7)	42 (14.2)
Sanguine	64 (22.4)	51 (17.8)	115 (40.2)
Phlegmatic	63 (22.4	54 (19.2)	117 (41.6)
Melancholic	6 (1.8)	7 (2.1)	13 (3.9)
BMI			
Mean, mean ± SD	25.7 ± 4.3	24.9 ± 4.4	25.3 ± 4.3
Median (Min. – Max.)	24.2 (18.8 – 41.5)	24.7 (17.2 – 38.7)	24.5 (17.2 – 41.5)
BMI strata			
< 25.0 (normal weight)	76 (26.5)	74 (25.8)	150 (52.3)
25.0 - 29.9 (overweight)	54 (18.8)	39 (13.6)	93 (32.4)
≥ 30.0 (Obesity)	28 (9.8)	16 (5.6)	44 (15.3)
Blood groups, n (%)			
O.I.	58 (20.8)	46 (16.2)	98 (37.0)
AII	34 (12.1)	36 (12.5)	65 (24.5)
BIII	46 (16.2)	36 (12.5)	76 (28.7)
ABIV	20 (6.8)	11 (3.0)	26 (9.8)

S.D., standard deviation; MTM constitution type in Mongolian Traditional Medicine

Personal characteristics
Body constitution
Receiver operating characteristics analysis found a significant predictive capacity of BMI for age strata (Figure 1A) and donors' age for obesity states (Figure 1B).
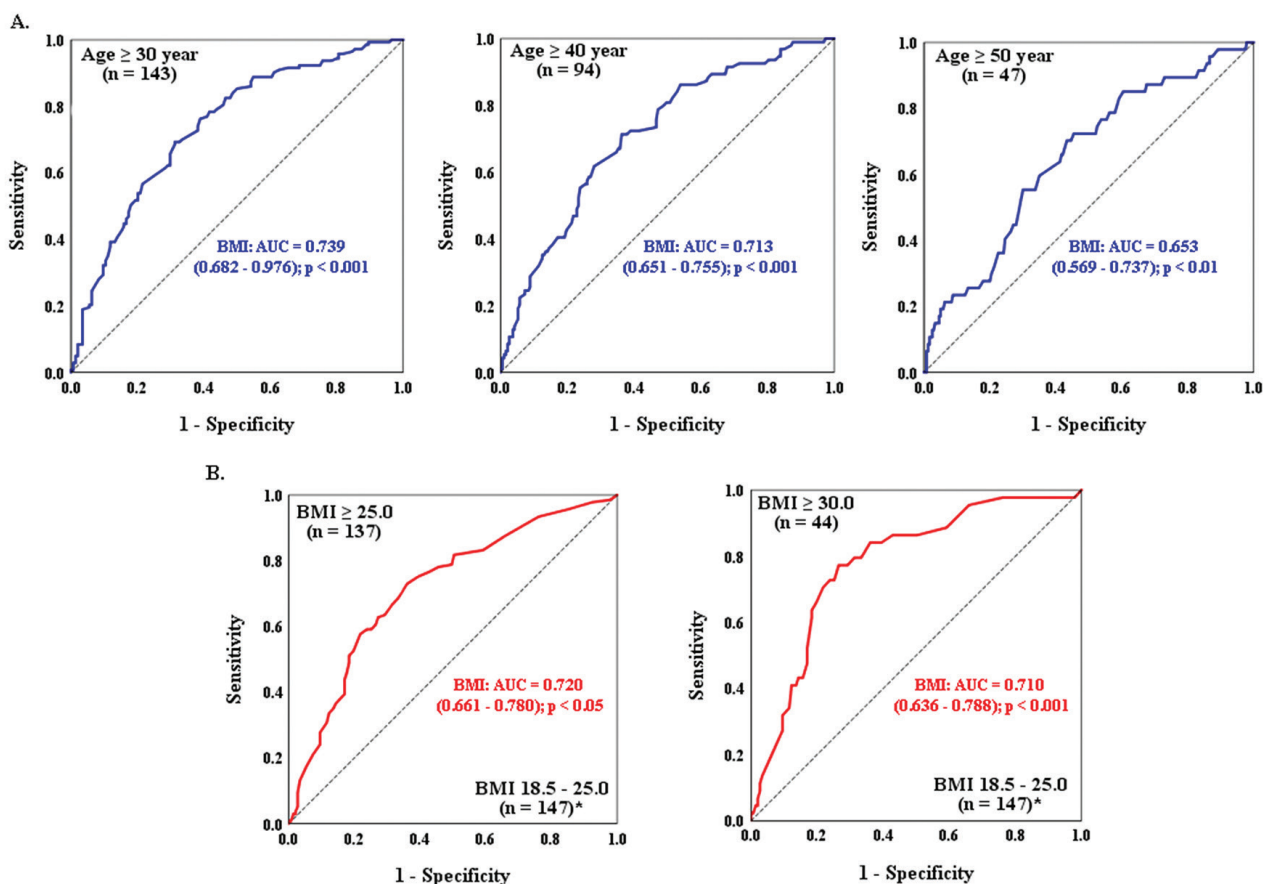
Figure 1. Receiver operating characteristics (ROC) analysis. Age of study participants stratified by BMI. A. Curves for the BMI of participants (blue curves) stratified by age cut-offs ≥ 30, ≥ 40 and ≥50 years; B. Curves for the age of participants (red curves) stratified by BMI (body constitution types). AUC, area under the curve; p, asymptotic significance. *-data of 3 donors with BMI lower than 18.5 were excluded from the analysis.

Figure 1 shows that on the one hand, donors' age wasasensitive and specific classifier for. The obesityrange, and on the other hand, BMI tended to increase with age.

The donor gender demonstrated no significant relation with the body constitution types classified by BMI.

No significant differences were found in the distribution of temperament types by ABO blood groups stratified by body constitution. The distribution of the dominant MTM constitutional type in blood donor groups stratified by body constitution resulted in significant differences (Table 2).

Table 2. The distribution of constitution types in Mongolian Traditional Medicine stratified by BMI of study participants (only types with significantly different distributions are shown).

Constitution Type	BMI ≥ 25.0	BMI < 25.0	Total
Badgan dominant type	45 (32.8%)	26 (17.7%)	71 (25.0%)
Other types	92 (67.2)	121 (82.3%)	213 (75%)
Total	137 (100.0%)	147(100.0%)	284(100.0%)a
		$\chi^2 = 8.692$; OR = 2.276 (1.308 − 3.960); LR = 8.755; $p < 0.01$	
Constitution Type	**BMI ≥ 30.0**	**BMI < 25.0**	**Total**
Šar dominant type	13 (29.5%)	78 (53.1%)	91 (47.6%)
Other types	31 (70.5%)	69 (46.9%)	100 (52.4%)
Total	44(100.0%)	100(100.0%)	191(100.0%)ab
		$\chi^2 = 7.507$; OR = 0.371 (0.180 − 0.765); LR = 7.711; $p < 0.01$	
Constitution Type	**BMI ≥ 30.0**	**BMI < 25.0**	**Total**

Badgan dominant type	21 (47.7%)	26 (17.7%)	47 (24.6%)
Other types	23 (52.3%)	121 (82.3%)	144 (75.4%)
Total	44(100.0%)	147(100.0%)	191(100.0%)ab

$\chi^2 = 16.472$; OR = 4.249 (2.053 − 8.796); LR = 15.057; p < 0.001

OR, odds ratio; LR, likelihood ratio; p, statistical significance calculated by Pearson's chi-square; a-3 donors with BMI lower than 18.5 were excluded from the analysis; b-donors with classified as overweight or higher were excluded from the analysis.

The body habitus stratified by BMI had a relationship with the Mongolian Traditional Medicine constitution, specifically with the Badgan or Šardominant MTM constitution types. Furthermore, to determine the nature of this relationship, we used ROC analysis. We found that Badgan expression is a classifier for the obesity states classified by BMI but not Šar expression (Figure 2).
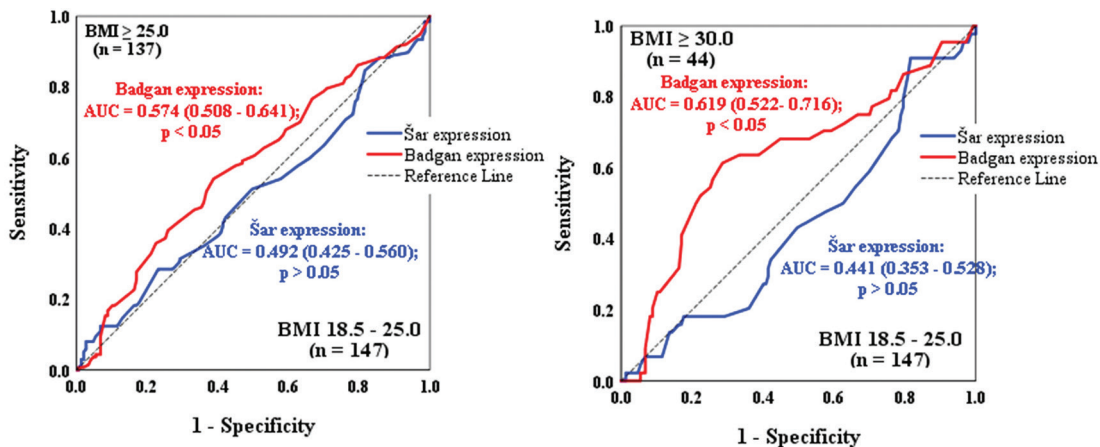

Figure 2. Receiver operating characteristics analysis. Mongolian Traditional Medicine constitution types stratified by BMI. Badgan (red curve) and Šar (blue curve) expression in percentile, meaning stratified by BMI cut-offs ≥ 25.0 (study participants who were overweight or obese) and ≥ 30.0 (participants with obesity). AUC, area under the curve; p, asymptotic significance.

Temperament

Significant differences in the distribution of temperament types were found among study participants with a particular dominant MTM constitution type. The distribution of the participants' temperament types were not significantly different when stratified by age, gender, body constitution, and ABO blood groups (Table 3).

Table 2. Distribution of the dominant constitution type in Mongolian Traditional Medicine among study participants with different temperaments (only types with significantly different distributions are shown).

Constitution Type	Sanguine	Non-sanguine	Total
Badgan dominant type	18 (15.7%)	54 (31.4%)	72 (25.1%)
Other types	97 (84.3%)	118 (68.6%)	215 (74.9%)
Total	115 (100.0%)	172(100.0%)	287(100.0%)
		$\chi^2 = 9.089$; OR = 0.405 (0.223 − 0.737); LR = 9.495; p < 0.01	
Constitution Type	Phlegmatic	Non-phlegmatic	Total
Badgan dominant type	38 (32.5%)	34 (20.1%)	72 (25.2%)
Other types	79 (67.5%)	136 (79.9%)	215 (74.8%)
Total	117(100.0%)	170(100.0%)	287(100.0%)
		$\chi^2 = 5.607$; OR = 1.910 (1.113 − 3.276); LR = 5.541; p < 0.05	
Constitution Type	Melancholic	Non-melancholic	Total
Badgan dominant type	8 (61.5%)	64 (23.4%)	72(25.1%)
Other types	5 (38.5%)	210 (76.6%)	215 (74.9%)
Total	13(100.0%)	274(100.0%)	287(100.0%)
		$\chi^2 = 9.627$; OR = 5.250 (1.659 − 16.611); LR = 8.133; p < 0.01	

OR, odds ratio; L.R., likelihood ratio; p, statistical significance calculated by Pearson's chi-square.

The Badgan dominant type had a significant likelihood ratio, indicating that it helped predict the sanguine, phlegmatic and melancholic types.

The receiver operating characteristics analysis demonstrated a more accurate classifying capacity of Badgan expression for melancholic temperament (Figure 3A) compared to phlegmatic (Figure 3B) and sanguine (Figure 3C) temperaments.
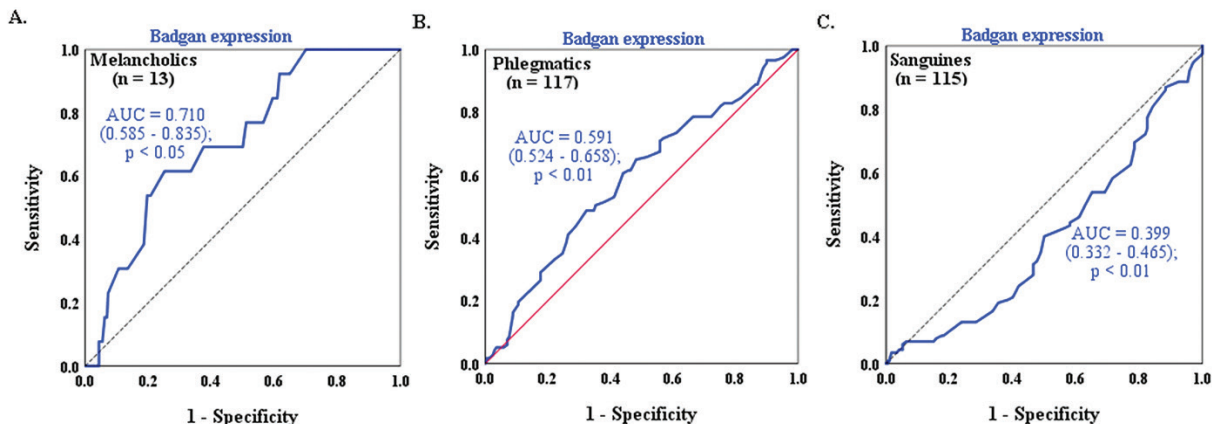

Figure 3. Receiver operating characteristics analysis. Temperament types of study participants stratified expression of Badgan. Badgan expression as a classifier for A, donors with melancholic temperament; B, donors with phlegmatic temperament; and C, donors with sanguine temperament. AUC, area under the curve; p, asymptotic significance.

Figure 3 shows the Badgan expression classifies donors as either melancholic or phlegmatic, but melancholic donors have a larger AUC. Badgan expression likely classifies donors for not having a sanguine temperament.

Dominant Types of Constitution practiced in the Traditional Mongolian Medicine

Were found greater number of donors aged ≥50 years in the group of donors with Šar dominant MTM constitutional type (OR = 0.4; LR = 4.7; $p < 0.05$), and fewer number of donors aged ≥50 year in group of donors with Badgan dominant MTM constitutional type (OR = 2.1; LR = 4.8; $p < 0.05$). ROC analysis found only Badgan expression as a classifier for elder age (≥50 years) (Figure 4).
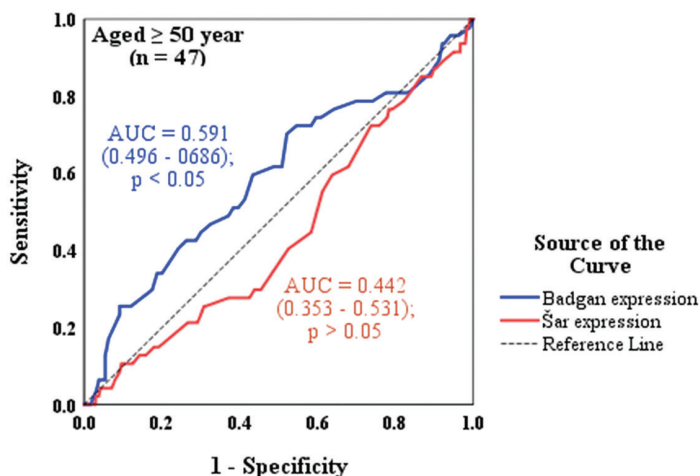

Figure 4. Receiver operating characteristics analysis. Mongolian Traditional Medicine constitution type stratified by the donors' age. Šar (blue curve) and Badgan (red curve) expression in study participants age ≥ 50 years of age. AUC, area under the curve; p, asymptotic significance.

The study participants' dominant MTM constitutional type demonstrated no significant distribution in male and female patients. Age strata showed no significant distribution in Hii

dominant donors. The difference in the distribution of dominant MTM constitutional type among donors with different ABO blood groups was not significant.

Discussion

MWe did not find any studies analyzing human typology system association in MTM with other human stratification systems. How ever, we found several studies focused on analyzing some biophysiological characteristics using typology systems in Oriental medicines. For example, Luo and Li (2020) [21] used the modified Tibetan Medicine constitution scale. They stratified 650 subjects in Beijing, China, into three general strata such as rlung, mkrispa and badkan, which correspond to Hii, Šar and Badgan, respectively. They found some association between Tibetan Medicine constitution types and BMI, but the stratification system in our study was more granular than the Tibetan Medicine constitution scale, based on a self-reporting questionnaire without any physical examination.

Korean studies have focused on the association of Sasang types with obesity and personality, but the theoretical basis and methodology of human stratification in MTM are quite different than Korean medicine [17, 18].

We found the participants' age a sensitive and specific classifier of the obesity state. Also, we found that BMI tendsto increase with age.Some other studies described the age-dependent relationship between BMI and mortality among the elderly [16,17]. The conditions and comorbidities of obesity mirror those of aging and age-related diseases [18]. Data on age-related changes in obesity has led some researchers to postulate that obesity could be considered a condition of premature metabolic dysfunction resembling aging [19-21]. Other studies claim that molecular pathways of regulation involved in obesity and aging are divergent and specific or at least not overlapping [12].

Badgan expression was shown as a classifier for the obesity states stratified by BMI. Badgan is a Tibetan word transferred into the Mongolian language and means bad – earth and gan – water. Its nature in MTM is described as hardness, heaviness, coldness and balancing. Heaviness is related to their heavy habitus and reduced mobility[13]. Despite some supposed differences in constitution typology approaches, typology systems in the traditional Tibetan and Mongolian Medicines are quite reliable, and similar results were observed in the cross-sectional study,which enrolled 622 individual sof the general population inBeijing, China [21]. This study found the body-mass index was negatively correlated with the score of the sub-rlung (Hii) scale,

slightly positively correlated with the sub-mkhris pa (Šar) scale, and positively correlated with the sub-bad-kan (Badgan)scale.

A total of 2506 outpatients between the ages of 20 through 70 who requested traditional medical assessment and treatment in Korea were evaluated the Sasang Personality Questionnaire (SPQ) and BMI. The results showed that the SPQ and BMI are reliable measures for quantifying each types'biopsychological characteristics and helpful in guiding personalized and type-specific treatment with medical herbs and acupuncture [17].

Li et al. [22] in 2017 found an association of Ying-Yan and Qi constitution types in Traditional Chinese Medicine with obesity states among more than 4000 inhabitants of the Shanghai city investigated between 2011 – 2014. The study demonstrated independent and significant associations among the Qi deficient and Yang deficient groups with the overweight, obesity, and underweight outcomes.

Melancholic temperament was correlated with the Badgan dominant MTM constitutional type. Ancient Greek thinkers believed that one's personality, or temperament, depended on the various fluids, or "humors"strength in one's body.But there is no evidence that any of these ideas areaccurate, and the ancient Greeks themselves did not do any empirical research to find out whether the levels of these bodily humors were actually related to personality characteristics. Nevertheless, the idea of the four humors or temperaments remained popular during medieval times and was influential even in the modern era [14].

The Tibetan term nyes pa is a direct translation of the Sanskrit dosha, and it has traditionally been translated into English as "humor" by both Tibetan and non-Tibetan practitioners and scholars. However, this translation is somewhat problematic, and it has been suggested that this comparison with Western humoral theory(such as that found in Greek/Hellenic medicine) is, in fact, somewhat misleading [15].

We compared the characteristics of the OS4T temperament types and MTM constitutional types described in ancient manuscripts and summarized after modern authors. For instance, the phlegmatic temperament is fundamentally relaxed and quiet, ranging from warmly attentive to lazily sluggish. Phlegmatics are referred to as "the watcher" — they are best in positions of unity and mediation and solid in situations that desire steadiness. The Phlegmatic humoris cold and wet and includes not just phlegm but all the other clear fluids of the body: mucus, saliva, plasma, lymph, and serous and interstitial fluids. Together, these fluids

cool, moisten, nourish, lubricate, protect, and purify the organism. The Melancholic temperament is fundamentally introverted and thoughtful. Those with melancholic temperaments are often referred to as "the thinker." Their analytical personalities desire caution and restraint, are best at attending to details and analyzing problems too difficult for others. Melancholic humor or Black Bile is cold and dry. Black Bile has a retentive virtue or force and a cooling, drying, astringing, precipitating, condensing, coagulating, solidifying effect on metabolism necessary for building the bones, teeth, and all dense, solid structural connective tissues of the body [8].

In contrast, badgan is generally located in the head, chest, and above the diaphragm. It functions and rules the body fluids (water) and sustains the energy in the body. In Tibetan and Mongolian medicine, the unification of the mind and matter is recognized, and the mind becomes the cause of the manifestation of the three humors: attachment is the precondition for rLung/Wind (Hii) humor, hatred for mkhrispa/Bile (Šar), and closed-mindedness for Badken/Phlegm (Badgan) humor [8, 13].

Some significant positive relationships between the Badgan type of the MTM with the phlegmatic and melancholic temperament types of Greek medicine were established in our study. However, we did not find a relationship between the other types. This may be caused by the fact that each humoral notion in Tibetan and Mongolian medicine describes several subtypes [8,9,25].

Biopsychological personality profiles of traditional Korean Sasang typology were compared to the Temperament and Character Inventory in a Korean adult clinical sample. The seven dimensions of Temperament and Character Inventory were compared between the different Sasang types, andsignificant differences in the temperament dimensions of Novelty Seeking and Harm Avoidance among the Sasang typeswere found [23].

Study limitations and further consideration

Sub-differentiation in both MTM constitutional type and temperament typing was not performed in our study. But classification at a primary level demonstrated encouraging associations between the systems of the Western and Oriental medicines. Our previous results demonstrated a relationship of the MTM constitutional type with immune function in healthy donors [13] and in patients with chronic hepatitis B [14]. All these findings may guide further study of the personalized approaches

in the diagnostics and management of human pathology, with special concern on mental and metabolic disorders.

Conclusion

Stratification of people using primary types of constitution practiced in Mongolian Traditional Medicine may be a useful tool in clinical research.

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