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BODY ADIPOSITY AND BODY TYPES SUSCEPTIBILITY TO KIDNEY STONE DISEASE AMONG THE MEITEIS OF MANIPUR: A CROSS-SECTIONAL STUDY

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ABSTRACT

Diverse human characteristics significantly influence susceptibility to kidney stone disease (KSD), resulting in unequal risks of formation. Human variations can be classified by *prakriti* body types, rooted in holistic mind-body principles, and anthropometric somatotypes, focused solely on physical traits. Therefore, the study aims to investigate the susceptibility to KSD among the Meitei adult population of Manipur across different body types and other body adiposity variables. Among 712 participants (322 males, 390 females) from the Meitei adult population of Manipur, kidney stone prevalence is 11.24%. BMI and body fat show no association with stone formation. Interestingly, *prakriti* body types correlate with kidney stones, while somatotypes do not. The study emphasizes understanding one's body type, especially *prakriti*, for proactive kidney stone prevention. Moreover, it highlights the ancient Ayurvedic system's relevance in averting kidney stone development.

Keywords: *human variations; prakriti body types; somatotypes; kidney stone; body adiposity*

INTRODUCTION

Kidney stone disease (KSD) is one of the most common urologic diseases in the world. It is the most prevalent urinary system disorder, affecting around 12% of the global population [1]. The global prevalence, incidence, and composition

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of calculi vary and have changed over the last several decades. Urinary stones are most commonly found in the kidneys and have plagued humankind for centuries, dating back to 4000 B.C. [9]. Age, gender, dietary habits, fluid intake, climate, occupation and education level, socioeconomic status, and genetic and metabolic diseases are all lithogenic factors that differ between countries [8], which indicates that the interplay between vulnerable biosocial and lifestyle risk factors, alongside physical characteristics, such as phenotype and underlying genetics as genotypes, significantly contribute to the likelihood of developing KSD [5, 7].

As a result, not everyone faces an equal risk of developing kidney stones, even when exposed to similar environments and dietary patterns. This underscores how human variation is an additional determinant for the onset of kidney stone conditions. Similarly, body composition, which is also influenced by genetic factors, might play a role in kidney stone formation. From an anthropological perspective, human body types are categorized as ectomorphic, mesomorphic, and endomorphic. Similarly, in Ayurveda, a traditional medical system, the human body is classified into three *prakriti: vata*, *pitta*, and *kapha. Prakriti* body types are based entirely on the holistic nature of the human mind and body whereas anthropometric body types or somatotypes are based solely on the physical characteristics of the human body. Hence, the primary objective of this study was to investigate the susceptibility to KSD among the Meitei adult population of Manipur across different body types.

MATERIALS AND METHODS

Data were collected from the five valley districts of Manipur, inhabited mainly by the Meitei population. The data were collected only from the Meitei adults aged 18–55 years. A total of 712 (322 males and 390 females) individuals were recruited for the study after obtaining consent. The *prakriti* of the individuals were identified by using a *prakriti* assessment questionnaire and consultation with an Ayurvedic physician. Body adiposity parameters like body mass index and fat percentage were also recorded, and the Heath and Carter somatotype method was employed for the classification of anthropometric body types. Before starting fieldwork, the Human Ethical Clearance Certificate with Ref. No. MU/IHEC/2020/013 was obtained from the Institutional Human Ethics Committee of Manipur University, Manipur. The current study was carried out from October 2018 to October 2022. All anthropometric measurements were conducted by the first author. KSD was determined based on the subjects' medical records. For the other groups, individuals without KSD and with no family history of KSD on either side of the family were included.

Assessment of *prakriti* body types

Assessment of *prakriti* body types was performed by employing a *prakriti* assessment questionnaire comprising 41 questions related to the person's physiological, physical and psychological features as prepared by the Victorian Institute of Yoga Education and Teacher Training (https://www.viyett.com.au/files/Ayurvedic-Constitution-Questionnaire.pdf). The *prakriti* assessment questionnaire is broadly divided into two groups: mental constitution with physiological traits and physical constitution. Each question featured three options based on traits related to *vata*, *pitta*, and *kapha*. Respondents were asked to identify one feature relevant to their physiological, physical, and psychological status. The *prakriti* body type was assigned based on the total maximum characteristics. The questionnaire was prepared and validated by consulting an Ayurvedic physician.

Assessment of fat percentage and body mass index (BMI)

The individuals' fat percentage and body mass index status were recorded using a Tanita Body Composition Analyzer (TBF-300). Fat percentage and BMI status were categorized into groups described below.

(i) Classification of fat percentage

Fat percentage of the participants was classified into underfat, healthy, overfat, and obese according to age based on the NIH/WHO guidelines as reported by Gallagher et al. at the New York Obesity Research Centre [6].

Fat %	Male	Female
Underweight	< 10%	< 20%
Normal	10%–24.9%	21%–34.9%
Overweight	25%–29.9%	35%–39.9%
Obese	≥ 30%	≥ 40%

(ii) Classification of BMI status

The World Health Organisation (WHO) has prescribed different BMI cut-offs for Asian people. As the Meitei people are one of Asian ethnicities, the Asian (Mongoloid) BMI cut-off was used to determine the participants' body mass index in the present study. In the Asian cut-off of BMI, the body mass index is classified into four categories: underweight, normal, overweight, and obese [21].

BMI Asian	Range in kg/m²
Underweight	< 18.5
Normal	18.5–22.9
Overweight	23.0–24.9
Obese	≥ 25

Assessment of anthropometric body types (somatotypes)

Heath and Carter's somatotype classification is used to evaluate anthropometric body types. It is expressed in a three-number rating representing endomorphy, mesomorphy, and ectomorphy components, respectively, always in the same order. Endomorphy is the relative fatness, mesomorphy is the relative musculoskeletal robustness, and ectomorphy is a physique's relative linearity or slenderness. For example, a 3-5-2 rating is recorded and read as three, five, two. These numbers give the magnitude of each of the three components. Ratings of each component from ½ to 2½ are considered low, 3 to 5 are moderate, 5½ to 7 are high, and 7½ and above are very high [2]. Based on the highest value among the three components, the subjects are categorized into three different qualitative groups for the purpose of analysis. The three qualitative groups are endomorph, mesomorph, and ectomorph.

The rating is phenotypical, based on geometrical size dissociation, and is applicable to both genders from childhood to old age. Anthropometric equipment includes a stadiometer or height scale and headboard, a weighing scale, a sliding calliper, a flexible steel tape measure, and a skinfold calliper (Holstein Skinfold Calliper).

Statistical analysis

The information obtained from the household survey was entered into a spreadsheet created in Microsoft Excel. To analyse the relevant descriptive data, IBM SPSS Statistics version 26 was utilized in addition to Microsoft Excel. The percentage frequency of different variables with the prevalence of KSD was calculated using IBM SPSS Statistics version 26. In order to determine the level of significance present in the categorical variables, chi-square analysis was also carried out. The variables that were found to have a significant statistical association in the chi-square analysis were further analysed for the level or degree of association or relationship or correlations.

RESULTS

The present study was carried out among the Meitei adults residing in the valley districts of Manipur. Altogether, 712 Meitei adults were included in the study (322 males and 390 females); out of these 80 (11.24%) individuals were found to have KSD through their medical records (32 males and 48 females). 20% (12 males and 4 females) had cases of recurrence of stones, and 18.75% (9 males and 6 females) had a family history of KSD.

Table 1. Sex-wise prevalence, recurrence rate and family history of KSD.

	KSD			Chi-square	Contingency co-efficient
	Yes	No	Total		
	f (%)	f (%)	f (%)		
Sex					
Male	32 (4.49)	290 (40.73)	322 (45.22)		
Female	48 (6.74)	342 (48.03)	390 (54.78)	0.993	
Total	80 (11.24)	632 (88.76)	712 (100.00)		
Recurrent stones					
Yes	12 (15.00)	4 (5.00)	16 (20.00)		
No	20 (25.00)	44 (55.00)	64 (80.00)	10.21*	0.36 (36%)
Total	32 (40.00)	48 (60.00)	80 (100.00)		
Family history					
Yes	9 (11.25)	6 (7.50)	15 (18.75)		
No	23 (28.75)	42 (52.50)	65 (81.25)	3.077	
Total	32 (40.00)	48 (60.00)	80 (100.00)		

* indicates p value < 0.05

Ayurvedic body types, also known as prakriti body types, and anthropometric body types (somatotypes) were considered for the study. In the prakriti body types, the highest prevalence of KSD was found in pitta prakriti (7.87%). The prevalence of KSD in vata prakriti (1.69%) and kapha prakriti (1.69%) were similar. The chi-square analysis also showed a significant statistical relationship between the prakriti body type and the prevalence of KSD. The strength of the association between prakriti body types and the prevalence of KSD is 0.21 (21%). In anthropometric body types (somatotypes), the body types were categorized as ectomorphy, mesomorphy, and endomorphy. Mesomorphic body type had the highest prevalence rate of KSD (5.34%), followed by endomorphic (4.35%) and ectomorphic (1.54%) body types. However, no significant statistical association was observed between the anthropometric body types (somatotypes) and the prevalence of KSD.

Table 2. Body types and prevalence of KSD.

	(KSD)			Chi-square	Cramer's V
	Yes	No	Total		
	f (%)	f (%)	f (%)		
***Prakriti* body types**					
Vata	12 (1.69)	143 (20.08)	155 (21.77)		
Pitta	56 (7.87)	338 (47.47)	394 (55.34)	32.04**	0.21 (21%)
Kapha	12 (1.69)	151 (21.21)	163 (22.89)		
Total	80 (11.24)	632 (88.76)	712 (100.00)		
Somatotypes					
Ectomorph	11 (1.54)	128 (17.98)	139 (19.52)		
Mesomorph	38 (5.34)	273 (38.34)	311 (43.68)	1.93	
Endomorph	31 (4.35)	231 (32.44)	262 (36.80)		
Total	80 (11.24)	632 (88.76)	712 (100.00)		

** indicates p value < 0.001

The mean distribution of the ectomorphy, mesomorphy, and endomorphy rating components of the Heath and Carter somatotype for two groups of males, those with kidney stones and those without, are described as follows. The mean ectomorphy value is slightly higher in individuals with kidney stones (1.9) compared to those without (1.8), though no significant statistical correlation was found between the ectomorphy distribution in both groups. For mesomorphy, individuals without kidney stones have a marginally higher mean value (4.6) than those with (4.4), but the difference is not statistically significant. In the endomorphy component, individuals with kidney stones show a slightly higher mean value (4.3) than those without KSD (3.7). However, no significant statistical correlation was observed between the two groups within each component. The mean somatotype of individuals without kidney stones is 1.8 – 4.6 – 3.7, which is classified as endomorphic mesomorph, and the mean somatotype of individuals with kidney stones is 1.9 – 4.4 – 4.3, which is classified as mesomorphic endomorph. However, the two groups have no statistically significant difference in the somatotype.

Table 3. Mean distribution of males' ectomorphy, mesomorphy and endomorphy rating components.

Male		Ecto-morphy	Meso-morphy	Endo-morphy	Mean somatotype score
No KSD					
	Frequency	290	290	290	(1.8 – 4.6 – 3.7) Endomorphic mesomorph
	Mean	1.8	4.6	3.7	
	Std. Deviation	1.31	1.29	1.32	
	Std. Error	0.11	0.10	0.11	
KSD					
	Frequency	32	32	32	(1.9 – 4.4 – 4.3) Mesomorph-endomorph
	Mean	1.9	4.4	4.3	
	Std. Deviation	1.35	1.47	1.33	
	Std. Error	0.35	0.38	0.34	
T-test		0.084	0.265	0.612	No statistically significant difference.
p-value		0.772	0.607	0.435	

The mean distribution of ectomorphy, mesomorphy, and endomorphy rating components of the Heath and Carter somatotype for two groups of females, one group with kidney stones and the other without, is described as follows. The mean ectomorphy value is slightly higher in individuals with kidney stones (1.3) compared to those without (1.1), though no statistically significant correlation was observed between the ectomorphy distributions in both groups. In the mesomorphy component, individuals without kidney stones have a marginally higher mean value (4.3) compared to those with kidney stones (4.1), but this difference is not statistically significant. For the endomorphy component, individuals without kidney stones have a slightly higher mean value (5.1) than those with kidney stones (4.8), and no significant statistical correlation was observed between the two groups within each component. The mean somatotype of individuals without kidney stones is 1.1 – 4.3 – 5.1, which is classified as mesomorphic endomorph, and the mean somatotype of individuals with kidney stones is 1.3 – 4.1 – 4.8, which is classified as mesomorphic endomorph. However, the two groups have no statistically significant difference in the somatotype.

Table 4. Mean distribution of females' ectomorphy, mesomorphy and endomorphy rating components.

Female	Ecto-morphy	Meso-morphy	Endo-morphy	Mean somatotype Score
No KSD				
Frequency	342	342	342	(1.1 – 4.3 – 5.1) Mesomorphic endomorph
Mean	1.1	4.3	5.1	
Std. Deviation	0.07	0.09	0.11	
Std. Error	1.24	1.60	1.73	
KSD				
Frequency	48	48	48	(1.3 – 4.1 – 4.8) Mesomorph-endomorph
Mean	1.3	4.1	4.8	
Std. Deviation	1.16	1.40	1.64	
Std. Error	0.18	0.22	0.25	
T-test	0.109	1.522	0.392	No statistically significant difference.
p-value	0.742	0.218	0.532	

Tanita's body composition analyser evaluated the study participants' fat percentage and BMI status. According to fat percentage, the highest prevalence of kidney stones was observed in the normal category (6.60%), followed by the under-fat (2.11%), over-fat (1.97%), and obese (0.56%) categories. However, there was no statistically significant association between the prevalence of KSD and body fat percentage. In the BMI status, the highest prevalence of kidney stones was observed in the overweight category (5.06%), followed by the normal (3.37%), obese (1.83%), and underweight (0.89%) categories. However, no statistically significant association was found between the prevalence of KSD and BMI status.

Table 5. Fat percentage, BMI status and prevalence of KSD.

	(KSD)			Chi-square
	Yes	No	Total	
	f (%)	f (%)	f (%)	
Fat percentage				
Under-fat	15 (2.11)	99 (13.90)	114 (16.01)	
Normal	47 (6.60)	370 (51.97)	417 (58.57)	
Overfat	14 (1.97)	108 (15.17)	122 (17.13)	1.60
Obese	4 (0.56)	55 (7.72)	59 (8.29)	
Total	80 (11.24)	632 (88.76)	712 (100.00)	
BMI Asian (kg/m^2)				
Underweight	7 (0.89)	46 (6.46)	53 (7.44)	
Normal	24 (3.37)	241 (33.85)	265 (37.22)	
Overweight	36 (5.06)	235 (33.01)	271 (38.06)	2.66
Obese	13 (1.83)	110 (15.45)	123 (17.28)	
Total	80 (11.24)	632 (88.76)	712 (100.00)	

DISCUSSION

Several studies have reported a relationship between overweight and obesity and KSD [10, 11, 17]. According to West et al. (2008), metabolic syndrome traits such as being overweight and obesity are associated with kidney stones [20]. Many of these studies did not differentiate between different types of kidney stones; instead, they focused on a potential link between BMI and whether patients had previously reported cases of kidney stones. BMI and calcium oxalate kidney stone promoters have also been linked [3, 4, 15]. However, after checking for several variables, BMI did not affect these risk factors or calcium oxalate supersaturation. Dietary changes are responsible for the positive associations between BMI and urine calcium excretion (animal protein and sodium intake) [18]. The mean somatotypes of individuals with kidney stones in males and females are 1.9 – 4.4 – 4.3 and 1.3 – 4.1 – 4.8, expressed as mesomorph-endomorph in both sexes. The mean somatotypes of individuals with no kidney stones in males and females are 1.8 – 4.6 – 3.7 and 1.1 – 4.3 – 5.1, respectively, expressed as endomorphic mesomorph and mesomorphic endomorph, respectively. However, there is no statistically significant association between somatotypes and the formation or having of KSD.

Taylor and Curhan (2006) did not discover any link between BMI and calcium oxalate supersaturation [18]. They concluded that the likelihood of getting calcium oxalate stones did not increase with body size. They hypothesized that an increase in uric acid nephrolithiasis was to blame for the greater prevalence of kidney stones in obese people. In the meantime, Pigna et al. (2014) also reported that obesity was not a risk factor for forming calcium oxalate kidney stones [12]. Similarly, the current study found no statistically significant link between body adiposity as measured by BMI and body fat percentage and KSD since it only investigated calcium-containing kidney stones. Moreover, urolithiasis is a disease that has several causes. Lithogenic urinary risk factors are influenced by lifestyle and dietary behaviours. Perhaps micronutrients like calcium and vitamin D in food significantly influence stone formation more than body bulk. As a result, a change in food content may be favourable.

According to Ayurveda, each organ in the human body is also controlled primarily by one or two *dosha*. By understanding which *dosha* governs which organ, one can achieve the health of the corresponding organ through elemental balance. In the present study, *pitta prakriti* body types were found to have the highest prevalence of KSD and a higher risk for the formation of kidney stones. Intriguingly, the *pitta dosha* governs the specific organs or body components that are directly or indirectly linked to the formation of KSD. According to the Ayurvedic concept, the small intestine, liver, spleen, gallbladder, kidney, heart, pancreas, and uterus are governed by *pitta dosha* [19]. Therefore, any aggravation or alteration in the *pitta dosha* would ultimately affect the *pitta*-regulating organs of our body, leading to the development of numerous diseases and illnesses associated with the organs governed by *pitta dosha.* Any change or deterioration in the metabolism of the small intestine and kidneys may be one of the underlying reasons for the formation of kidney stone disease, as the two organs are deeply intertwined in the formation of KSD.

The intestinal absorption of calcium is one of the key causes of KSD. The majority of calcium absorption occurs in the small intestine and accounts for 30–40% of dietary calcium absorption. Calcium absorption in the gut is dependent on calcium consumption. When calcium intake is low, calcium is actively transported in the duodenum, and a greater proportion of calcium is absorbed by an active mechanism, resulting in higher fractional absorption of calcium. Calcium absorption is an active, transcellular process that is regulated by calcitriol [1,25-(O.H.)2-vitamin D3]. Vitamin D is the primary regulator of intestinal calcium absorption and can be gained by diet or sun exposure. Similarly, excess *pitta dosha* can induce a burning sensation, a ruddy complexion, heat, intense digestive fire, sweat, and thirst, along with many other symptoms [14, 19]. Therefore, strong digestive fire induced by excess *pitta dosha* might expedite calcium absorption in the small intestine, resulting in a larger calcium concentration in the urine. Moreover, the ingestion of foods that raise *pitta dosha* might increase the risk of the formation of kidney stones among *pitta prakriti* individuals. Increases in *pitta dosha* will eventually enhance the digestive fire, altering the *dosha* balance in a person with a *pitta*-dominant constitution. Increases in *pitta dosha* in *vata* and *kapha* dominant constitutions will not significantly affect the digestive fire because it is already low.

CONCLUSION

The study concludes that body adiposity indicators like body mass index and fat percentage had no association with kidney stone formation among the Meiteis of Manipur. However, the body types categorized by the ancient medical system of Ayurveda as *prakriti* body types have a statistically significant association with the formation of kidney stones, although the anthropometric body types known as somatotypes have no such association. This study highlights the significance of understanding one's individual body type, specifically the *prakriti* body types, as a proactive measure against the development of kidney stones. Furthermore, the study underscores the importance of the ancient Ayurvedic medical system in preventing the occurrence of kidney stone formation.

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