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Full Length Research Article

Somatotype Components as Valuable Predictors of Type 2 Diabetes Mellitus

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ABSTRACT

This study examined the association between somatotype components and the risk of Type 2 diabetes mellitus (T2DM) and also assessed the diagnostic accuracy of the somatotype components in predicting T2DM for the Nigerian population. This cross-sectional study comprised 170 participants aged 30-65; 28 males and 62 females confirmed T2DM, and 37 males and 43 females' control, selected using systematic random sampling from the Endocrine Outpatient Clinic, Ahmadu Bello University Teaching Hospital Zaria, Kaduna State. Subjects were somatotyped using the Heath and Carter method. Binary logistic regression revealed significant associations between the somatotype components (endomorphy, mesomorphy, and ectomorphy) and the risk of T2DM in males (χ^2 (3) = 22.546, P < 0.0001) and females (χ^2 (3) = 50.750, P < 0.0001) respectively. Receiver operating characteristic curve (ROC) analysis; endomorphy demonstrated a moderate accuracy in predicting T2DM in females (AUC: 0.638, 95% CI: 0.539-0.736). Mesomorphy also showed moderate accuracy in predicting T2DM (AUC: 0.680, 95% CI: 0.577-0.784). In males, all the somatotype components [endomorphy (AUC: 0.844, 95% CI: 0.741-0.946), mesomorphy (AUC: 0.930, 95% CI: 0.874-0.986), and ectomorphy (AUC: 0.876, 95% CI: 0.782-0.969) demonstrated high accuracy in predicting T2DM. Overall, the study provides valuable insights into using somatotype components as predictors of T2DM, which can inform the development of targeted interventions to reduce the burden of T2DM in the population.

KEYWORDS: Endomorphy, Ectomorphy, Mesomorphy, Type 2 diabetes mellitus

INTRODUCTION

In modern society, Type 2 diabetes mellitus (T2DM) is the most acute problem in medicine due to the worldwide soaring prevalence of 6.37% (537 million people), morbidity and mortality rate (Sun *et al*., 2022). T2DM affects around 24 million people in Africa, predicted to more than double in the next two decades, posing a significant danger to Africa's already achieved socioeconomic accomplishments (Ogurtsova *et al*., 2022). A recent meta-analysis reported that approximately 5.8% (about 6 million) of adult Nigerians live with T2DM (Uloko *et al*., 2018). This figure has been likened to the tip of the iceberg, as it is estimated that two-thirds of T2DM cases in Nigeria are yet undiagnosed (Adeloye *et al*., 2017).

Managing T2DM and diagnosis is challenging and requires a multidisciplinary approach (Jones *et al*., 2021). Numerous risk factors, such as environmental, genetic, and lifestyle, have been identified over time, predisposing people to T2DM (Kyrou *et al*., 2020). Other predictors need to be identified to enhance T2DM early detection and prevention. It is unclear how well somatotype components predict T2DM. Somatotype is a biometric classification system that uses relative scores for endomorphy (fatness), mesomorphy (musculoskeletal robustness), and ectomorphy (linearity or slenderness) to assign people to different body types (Carter and Heath, 1990; Mustapha *et al*., 2019). Somatotypes may provide a non-invasive and inexpensive approach to pinpoint people more likely to develop T2DM (Padilla *et al*., 2021). The development of targeted prevention and treatment plans for those more likely to develop the disorder could be made possible by identifying certain somatotype elements that predict the likelihood of T2DM, which would result in better disease management, better health outcomes, and lower healthcare costs (Kukes *et al*., 2018; Guryeva and Alekseyeva, 2021).

Some studies, especially among Caucasians, have revealed inconsistent associations between the somatotype components and the risk of T2DM (Baltadjiev and Vladeva, 2014; Baltadjiev, 2015; Buffa *et al*., 2007; Yadav *et al*., 2007; Urrutia-Garcia *et al*., 2015). Therefore, further research is needed to determine the potential of somatotype components as valuable predictors of T2DM.To the best of our knowledge, this study is the first to examine the association between somatotype components and the risk of T2DM and assess the somatotype components' diagnostic accuracy in predicting T2DM for the Nigerian population.

MATERIAL AND METHODS

Study Design, Setting and Ethical Statement

This cross-sectional study was conducted from January to May 2021 at Ahmadu Bello University Teaching Hospital (ABUTH) Zaria, Kaduna State, Nigeria. Though there are other tertiary hospitals in Northwestern Nigeria, ABUTH remains the primary referral center for the whole region. Hence, the reason for the choice of this hospital. The Health Research Ethics Committee approved the study protocol (ABUTH/HREC/G13/2020), and participants signed

written informed consent was obtained before data collection. Also, explanations of the techniques used to take the anthropometric measurements were provided. The anonymity and confidentiality of study data were guaranteed.

The Sample

This formula was used to compute the sample size (Naing *et al*., 2006):

Sample size, $n = [(Z)^2 (p)(1-p)]/(\Delta)^2] = [(1.96)2 (0.03) (1-0.03)] / (0.05)^2] + 20\% = 45 + 20\% = 55$ subjects

Where n = sample size, Z = value representing the desired confidence level, Δ = precision, and p = anticipated population proportion. With 80% power of the study, a precision value of 0.05 and a confidence level of 95%, the Z-score will be 1.96, whereas the prevalence of T2DM at 3.0% was obtained (Uloko *et al*., 2018). Taking into account a 20% nonresponse rate, the final participant number for this study was approximately 55. Nevertheless, a total of 170 participants comprising 90 confirmed cases of T2DM based on case record review (Cho *et al*., 2017; Goulding, 2002) and 80 age-matched controls were recruited to increase the generalizability of the result.

The sample population comprised 105 females (62 T2DM and 43 control) and 65 males (28 T2DM and 37 control) aged 30-65. The T2DM patients were selected using systematic random sampling i.e., every second patient during their visit for laboratory analyses and routine checkups in the Endocrine Outpatient Clinic of ABUTH, Zaria. While the age-matched control was selected using simple random sampling (without replacement) around the Zaria community, a fasting blood sugar test was carried out to rule out the possibility of the control being diabetic. The participants were of Nigerian origin, traced back to the first generation of parents. All participants enrolled were on treatment with either oral hypoglycemic drugs, diet, or both, with a disease duration of not less than two years and a controlled disease state at the time of the study. Three months before the study, patients admitted to a hospital or with any apparent deformity that could compromise the anthropological profile were excluded. Pregnant and lactating mothers and T2DM with severe comorbidities like stroke, chronic renal failure, and chronic lung disease (defined from patient records) were also excluded from the study.

Anthropometric Measurements and Somatotyping

Ten anthropometric measurements, including height, weight, flexed upper arm and calf circumferences, humerus and femur breadths, triceps, subscapular, supraspinal and medial calf skinfolds, were taken according to the standard protocols reported by the International Society for the Advancement of kinanthropometry (ISAK), (Silva and Vieira, 2020). Each measurement was taken in duplicate by two trained evaluators. The somatotype was computed from the ten anthropometric parameters reported by Carter and Heath, 1990.

Reliability and Validity Assessment

This precision estimates absolute technical error of measurement (aTEM), relative technical error of measurement (rTEM), coefficient of reliability (Rr), and coefficient of variation (Cv) were used to calculate the intra- and inter-observer measurement errors (Gwani *et al*., 2017).

TEM was determined by applying the formula:

$TEM = \sqrt{\Sigma(m_1-m_2)^2} /2n$

where n is the number of participants being measured, and m_1 and m_2 are the first and second measurements.

From the equation, rTEM was determined:

$rTEM = (TEM /VAV) \times 100$

The variable average value (VAV) is the average of the two measurements, while TEM is the absolute technical error of measurement.

Rr was determined using the following formula:

$R = 1 – (TEM^2/SD^2)$

TEM is the absolute technical error of measurement, and SD is the standard deviation of all measurements.

Cv was calculated as:

$Cv = SD*100/ X$

where SD is the standard deviation, and X is the mean of all measurements

Statistical Analyses

The one-sampleKolmogorov-Smirnov test tested the normality of data. The somatotype calculation and analysis software was used to determine the somatotype component ratings, the somatotype attitudinal distance (SAD), and somatocharts (Carter and Heath, 2002). Height, weight, skin fold thickness, bone breaths, arm and calf girths, the three somatotype elements (endomorphy, mesomorphy, ectomorphy), and SAD were all presented as descriptive statistics [mean (SD)]. The significance of T2DM and control differences were assessed using a somatotype analysis of variance (SANOVA), which examines the somatotype of each group by applying the SAD both within and between the groups. To assess the relationship between independent somatotype components and T2DM risk, binary logistic regression (BLR) was applied. Before running the BLR, all possible 2-way interactions, multicollinearity, model assumptions (normality, linearity, and homoscedasticity) and outliers were checked using plots of residuals.

To evaluate the effectiveness of the somatotype components in predicting T2DM status and to establish a cut-off score, receiver operating curve (ROC) analysis was employed. The ROC curve is a graphical representation of a measure's sensitivity plotted against its false positive rate (i.e., 1-specificity). The area under the curve (AUC), based on the average sensitivity value for all possible specificity values, represents a test's overall accuracy or ability to identify cases from non-cases. AUC values are categorised

as being perfect (1.0), highly accurate (0.91 to 0.99), moderately accurate (0.71 to 0.90), or non-informative (0.50) (Kumar and Indrayan, 2011). The Youden index (YI) determined the ideal cut-off score for each somatotype component. All statistical analyses were performed using Graphpad Prism version 9.2.0.332 software. However, somatotype components and ratings in this study were computed using Somatotype calculation and analysis software (Burdukiewicz *et al*., 2016). Statistical significance was set at the level of 0.05 (2-tailed).

RESULT

The intra and inter-observer absolute TEM, relative TEM, coefficient of reliability, and coefficient of variation for all the anthropometric parameters were within the acceptable limits; hence table is not presented. Descriptive statistics [mean (SD)] for the weight, height, femur breath, humerus breath, triceps, subscapular, supraspinal and medial calf skinfolds, flexed upper arm and calf circumferences in males, females, diabetic, and control are shown in Table 1.

The somatotype analysis of variance (SANOVA) table for the study population, which compares the somatotype of females (diabetes and control) and males (diabetes and control) using the somatotype attitudinal distances (SAD), is presented in Table 2. There were statistically significant differences in the overall somatotypes of both female and male subjects (F=5.99, *P*=0.001 and F= 45.39, *P*<0.001), respectively. Also shown in Table 3 is an analysis of the variance of the dominant somatotype component of males (both type 2 diabetes and control groups) and females (both diabetes and control groups). There were statistically significant values of *P*<0.001 in all the somatotype components of the male participants, whereas only the mesomorphic component differed statistically significantly among the female participants.

Table 1: Descriptive statistics of anthropometric parameters

	DIABETIC (n=90)		**CONTROL (n=80)**	
	Female	**Male**	**Female**	**Male**
Parameters	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Weight (kg)	71.50 (13.30)	71.96 (12.60)	69.23 (13.52)	48.65 (8.73)
Height (cm)	158.18 (5.86)	165.49 (5.92)	155.58 (11.93)	171.12 (7.38)
Femur breath (cm)	8.73 (0.63)	9.07 (0.70)	8.56 (0.54)	9.39 (0.64)
Humerus breath (cm)	6.08 (0.47)	6.74 (0.79)	6.18 (0.45)	7.63 (0.68)
Triceps skinfold (mm)	19.48 (6.39)	11.24 (4.95)	17.39 (6.37)	7.09 (3.55)
Subscapular skinfold (mm)	22.13 (8.42)	15.41 (7.49)	21.22 (8.46)	9.82 (3.16)
Supraspinal skinfold (mm)	16.75 (5.70)	9.78 (4.01)	14.81 (5.46)	5.89 (1.89)
Median calf skinfold (mm)	15.80 (6.05)	8.31 (4.22)	13.56 (5.70)	6.73 (2.48)
Calf girth (cm)	33.11 (3.89)	33.53 (3.00)	32.59 (3.87)	24.73 (3.07)
Arm girth (cm)	30.90 (4.16)	30.55 (2.89)	32.01 (3.80)	22.37 (3.18)

In Table 4, a binary logistic regression analysis was performed to examine independent associations between somatotype components and the probability of T2DM. The model provided a good fit for all three components in the female group ($\chi^2(3) = 50.750$, $P < .0001$), particularly the mesomorphic component (OR: 9.382; 95 CI: 2.368-37.169) and also in the male group, ($\chi^2(3) = 22.546$, $P < .0001$), particularly the endomorphic component (OR: 1.464; 95% CI: 1.029-2.082).

Figure 1 is a somatochart showing the somatotype distribution of the female diabetic patients, n=170 (A) and control (B) and male diabetic patients (C) and control (D). For the female diabetic patients, the mean age was 50.16 years, and most of the somatotype means clustered on the southwestern axis of the boundary of the somatochart. On the Somatochart, a profile marker inside an empty circle represents the mean somatotype for all the profiles in the document. Thus, the mean somatotype for the female diabetes profiles was mesomorphic-endomorph (5.9-4.8-0.6), whereas that of the female control was endomorph-mesomorph (5.6-5.9-0.7) with a mean age of 51.19 and most of the somatotype means clustered around the North Western and South Western boundary of the somatochart. On the other hand, the mean age for male diabetes was 50.43 years, with the somatotype means clustering majority in northwestern Axis of the boundary of the somatochart; thus, the mean somatotype for the male diabetes profiles was endomorphic-mesomorph (3.8-4.9-1.2) whereas that of the male control was mesomorphic-ectomorph (2.2-2.3-3.1) with a mean age of 45.16 and the majority of the somatotype means clustered around the North Eastern and South Eastern boundary of the somatochart.

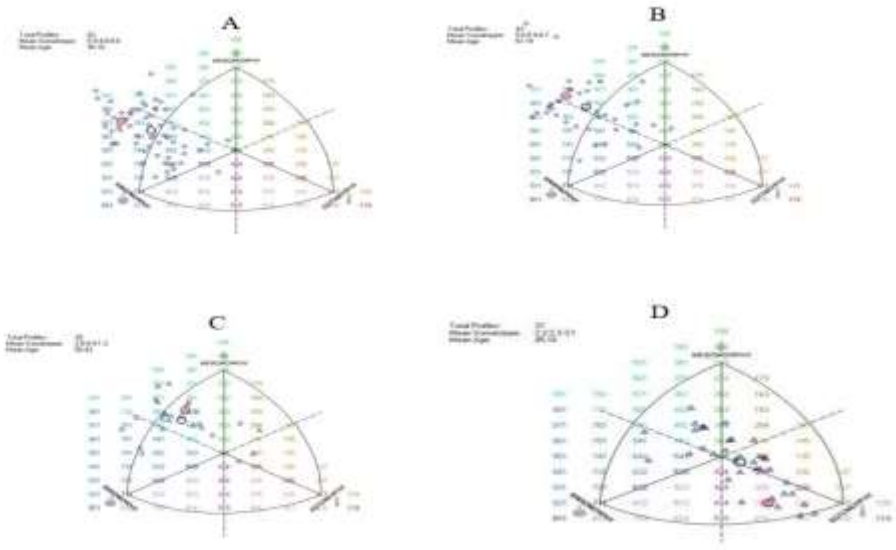

Figure 1: Somatochart showing the somatotype distribution of the female diabetic patients (A) and control (B) and male diabetic patients (C) and control

Table 2: Somatotype analysis of variance table of T2DM control

	GROUP	COUNT	MEAN (SD)
Female	T2DM	62	5.93 (1.38) - 4.76 (1.64) - 0.64 (0.83)
	Control	43	5.58 (1.60) - 5.90 (1.95) - 0.70 (0.90)
	ANOVA	F = 5.99	*P* = 0.001*
Male[a]	T2DM	28	3.76 (1.27) - 4.85 (1.06) - 1.15 (0.15)
	Control	37	2.21 (0.86) - 2.32 (1.44) - 3.11 (1.38)
	ANOVA	F = 45.39	*P* = 0.001*

(F-ratio=10.54, *P* = 0.002).

Notes: a: Somatotype analysis of variance using the somatotype calculation software was employed; Results were significant at *P*< 0.001

The area under the curve (AUC) was 0.8436 in the male T2DM group for endomorphy (Figure. 2a, Tables 5a & b), demonstrating an excellent discriminatory power. The ideal cut-off for endomorphy was >2.750, which implies that people with endomorphy scores over this limit are more likely to have T2DM. According to its sensitivity, approximately 71.43% of people with T2DM were accurately recognized by the endomorphy score at this cut-off. It correctly identified 78.38% of people without T2DM, according to the specificity of 78.38%. The diagnostic performance for endomorphy in detecting T2DM in male participants was good, as indicated by the likelihood ratio (LR) of 3.305 and the Youden's Index (YI) of 0.4981. Similarly, the AUC was 0.9300 for mesomorphy (Fig. 2a, Tables 5a & b), suggesting strong discriminatory power. An individual with a mesomorphy score above this cut-off was likelier to have T2DM, according to the ideal mesomorphy cut-off value of >3.750. At this cut-off, the mesomorphy score had a sensitivity of 85.71% and a specificity of 83.78%.

Table 3: Analysis of variance of the individual somatotype components in both female T2DM and female control and male T2DM and male control

GROUP	VARIABLES	DF-WITHIN	DF-BETWEEN	F-RATIO	*P*-VALUE
Female	Endomorphy	103	1	1.43	0.233
	Mesomorphy	103	1	10.54	0.002*
	Ectomorphy	103	1	0.12	0.273
Male	Endomorphy	63	1	34.3	<0.001*
	Mesomorphy	63	1	61.49	< 0.001*
	Ectomorphy	63	1	36.77	< 0.001*

Note: *Results were significant at *P*< 0.001

Table 4: Associations between somatotype components and risk of T2DM

		GOODNESS OF FIT TEST		HOSMER & LEMESHOW TEST			
Group	**Somatotypes**	**χ^2 (df)**	***P*-value**	**χ^2 (df)**	***P*-value**		**OR (95% CI)**
Female	Endomorphy						2.562 (1.039-6.314)
	Mesomorphy	50.750 (3)	0.0001*	1.640 (7)		0.977	9.382 (2.368-37.169)
	Ectomorphy						2.054 (0.714-5.914)
Male	Endomorphy						1.464 (1.029-2.082)
	Mesomorphy	22.546 (3)	0.0001*	2.922 (8)		0.932	0.540 (0.275-1.060)
	Ectomorphy						0.437 (0.322-0.694)

Notes: OR: Odd ratio; CI: Confidence interval; *Results were significant at *P*< 0.001

Mesomorphy appears to have an excellent diagnostic performance when diagnosing T2DM in males, as indicated by the LR of 5.286 and the YI of 0.6949. The ideal ectomorphy cut-off value was 1.350, meaning that people with ectomorphy scores below this limit were more likely to have T2DM. The ectomorphy score's sensitivity at this cut-off was 78.57%, correctly identifying about 78.57% of people with T2DM. At 89.19%, the specificity was even higher. The results showed that ectomorphy had a strong diagnostic performance for detecting T2DM in male participants, with the LR being 7.268 and the YI being 0.6776.

In the female T2DM group, the area under the curve (AUC) for endomorphy (Fig. 2b, Tables 5a & b) was 0.6377, demonstrating a reasonable level of discriminating power. Individuals with an endomorphy score over this cut-off were likelier to have T2DM since the ideal endomorphy cut-off score was >5.750. The endomorphy score's sensitivity at this cut-off was 53.23%, indicating that it properly diagnosed roughly 53.23% of people with T2DM. With a specificity of 66.13%, it correctly identified 66.13% of those without type 2 diabetes. The likelihood ratio (LR) of 1.571 and the Youden's Index (YI) of 0.1936 provided more details on the endomorphy score's diagnostic efficacy. Similarly, the AUC for mesomorphy (Fig. 2a, Tables 5a & b) was 0.6802, demonstrating a marginally higher level of discriminating power than endomorphy. Individuals with a mesomorphy score below this cut-off were more likely to have T2DM, and the ideal cut-off score for this trait was 4.800. The mesomorphy score's sensitivity was 53.23% at this cut-off point, while its specificity was higher at 74.42%. A moderate diagnostic performance for mesomorphy in diagnosing T2DM was shown by the LR of 2.082 and the YI of 0.2765. In contrast, ectomorphy exhibited no discernible discriminatory power for T2DM (Fig. 2a, Tables 5a & b). The AUC was 0.5088, which signifies a weak degree of discrimination. Although 0.5500 was the ideal cut-off value for ectomorphy, it was insufficient to distinguish between people with and without T2DM. Although the specificity was just 39.33%, the sensitivity of 62.90% indicated that it properly identified 62.90% of those with T2DM. The LR was 1.040, and the YI was 0.0243, showing a limited ability to diagnose T2DM.

DISCUSSION

Somatotype gives a gestalt summary of an individual's overall body shape and composition, which is determined by their genetic makeup, gender, lifestyle factors such as diet and exercise, and other environmental factors (Koleva *et al*., 2002). An individual's somatotype can indicate a tendency to certain diseases and a marker of metabolic processes in the body (Adamu *et al*., 2007). Studies have shown that somatotypes could be used in clinical settings to determine phenotypic predictors of disease development, severity, and prognosis (Koleva *et al*., 2002; Kukes *et al*., 2018).

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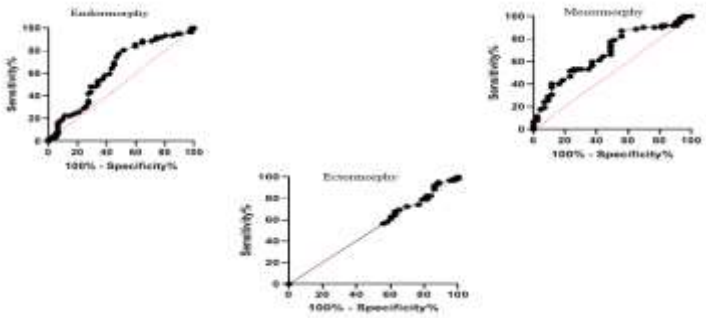

Figure 2a: Receiver Operating Characteristics (ROC) curve analysis showing the area under the curve for the prediction of T2DM using the somatotype components in male

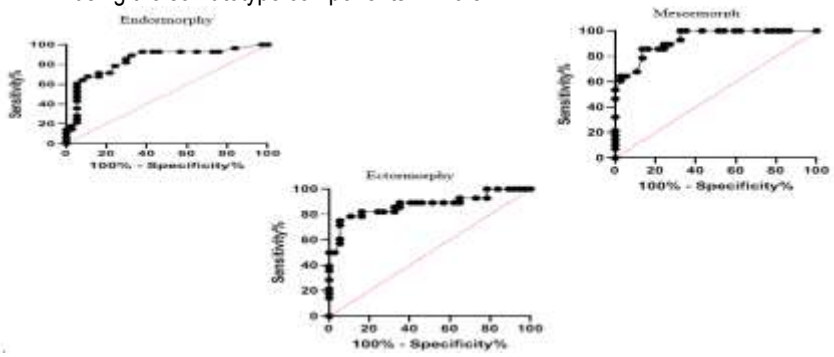

Figure 2b: Receiver Operating Characteristics ROC) curve analysis showing the area under the curve for the prediction of T2DM using the somatotype components in males

The present study examined the association between somatotype components and the risk of T2DM and assessed the diagnostic accuracy of the somatotype components in predicting T2DM. In the present study, significant gender differences were observed between the T2DM patients and the control, reflecting the distinct body composition variations between the two groups. These unique somatotypes seen in the study's participants could impact several health outcomes, including our understanding of the risk factors for T2DM and how to manage the condition. They could also serve as a basis for guiding tailored interventions based on body composition. Previous studies have also reported similar findings (Buffa *et al*., 2007; Baltadjiev and Vladeva, 2014; Baltadjiev, 2015; Urrutia-Garcia *et al*., 2015).

The endomorphic component was discovered to be especially more linked to the risk of T2DM in the male group. Individuals with a larger endomorphic component had a 1.464 times higher risk of having T2DM compared to those with a lower endomorphic component, according to the odds ratio (OR) for the endomorphic component of 1.464. Similarly, the mesomorphic component showed a particularly substantial correlation with the likelihood of T2DM in the female group. The mesomorphic component's OR was 9.382, meaning that people with a higher mesomorphic component had T2DM at a rate of about 9.382 times than those with a lower one. According to these results, different somatotype traits are individually linked to a higher risk of T2DM in both males and females. These findings add to our understanding of the connection between body composition and the risk of T2DM, highlighting the significance of considering somatotype elements as a possible risk factor among different genders.

A few studies have also indicated a relationship between elements of the somatotype and the risk of T2DM. Still, the specific findings have varied across research due to variations in study design, sample size, population characteristics, and statistical techniques (Buffa *et al*., 2007; Baltadjiev and Vladeva, 2014; Baltadjiev, 2015; Urrutia-Garcia *et al*., 2015).

Table 5a. Characteristics of the ROC curves for somatotype components in female T2DM and male T2DM groups

	FEMALE			MALE		
Area under the ROC curve	**Endo**	**Meso**	**Ecto**	**Endo**	**Meso**	**Ecto**
Area	0.6377	0.6802	0.5088	0.8436	0.9300	0.8755
Std. Error	0.05029	0.05271	0.05783	0.05234	0.02881	0.04777
95% confidence interval	0.5392 to 0.7363	0.5769 to 0.7835	0.3955 to 0.6222	0.7410 to 0.9462	0.8735 to 0.9865	0.7819 to 0.9691
***P* value**	0.0081	0.0017	0.8783	<0.0001	<0.0001	<0.0001
Youden's index	0.1936	0.2765	0.0243	0.4981	0.6949	0.6776

Notes: Endo: Endomorphy; Meso: Mesomorphy; Ecto: Ectomorphy; ROC: Receiver operating characteristics

Table 5b: Sensitivity, specificity and likelihood ratios of somatotype components in the female and male type 2 diabetes groups

GROUP	**SOMATOTYPES**	**CUT-OFF SCORE**	**SENSITIVITY (%)**	**95% CI**	**SPECIFICITY (%)**	**95% CI**	**LR**
Female	Endomorphy	> 5.750	53.23	40.98 to 65.09	66.13	53.72 to 76.66	1.571
	Mesomorphy	< 4.800	53.23	40.98 to 65.09	74.42	59.76 to 85.07	2.081
	Ectomorphy	< 0.5500	62.90	50.46 to 73.84	39.53	26.37 to 54.42	1.040
Male	Endomorphy	> 2.750	71.43	52.94 to 84.75	78.38	62.80 to 88.61	3.304
	Mesomorphy	> 3.750	85.71	68.51 to 94.30	83.78	68.86 to 92.35	5.286
	Ectomorphy	< 1.350	78.57	60.46 to 89.79	89.19	75.29 to 95.71	7.268

Notes: CI: Confidence interval; LR: Likelihood ratio

In an attempt to determine the diagnostic accuracy of the somatotype components in predicting the risk of T2DM, all three somatotype components (endomorphy, mesomorphy, and ectomorphy) were valuable predictors for T2DM in male T2DM subjects. In the female T2DM subjects, endomorphy and mesomorphy were also invaluable in identifying individuals at risk for T2DM, while ectomorphy may not be a useful predictor in this context. Therefore, endomorphy and mesomorphy in both sexes demonstrated strong discriminatory abilities, providing useful information for identifying individuals at risk for T2DM. However, it is essential to note that these results are specific to the dataset and population studied, and further validation and replication in diverse populations are necessary to confirm these findings. To be modest, no literature has documented the diagnostic accuracy of the somatotype components in predicting T2DM risk; hence, the need for more studies to revalidate this novel finding.

The outcomes of this study demonstrate the potential clinical value of taking into account aspects of somatotype, such as endomorphy and mesomorphy, when determining the likelihood of developing T2DM. These components may offer information beyond conventional risk factors, enabling healthcare professionals to recognize people who may be more susceptible to developing T2DM. Similarly, healthcare professionals can customize interventions and preventive measures depending on a person's unique body composition by including somatotype components in risk assessment. For instance, people with higher endomorphy may benefit from targeted weight-management strategies. People with higher endomorphy may benefit from programs meant to lower visceral adiposity and encourage physical activity. Further, the ideal cut-off values for the somatotype components (such as >5.750 for female endomorphy and >2.750 for male endomorphy) can be used as screening tools in clinical practice. These cut-offs and sensitivity and specificity scores can aid medical professionals in determining which patients may require additional assessment for T2DM risk.

The results of this study may not be representative of the general population, so extrapolating them to other demographics or ethnic groups should be done with caution. This is one of the study's weaknesses. Similarly, the study used a cross-sectional design, which examines the relationship between variables at a specific time. The determination of causation or the investigation of temporal correlations is not possible with this design. Longitudinal studies would offer more decisive proof of the somatotype components' ability to predict T2DM. Additionally, not all potentially confounding variables that may affect the relationship between somatotype components and T2DM risk were considered in this study. The study did not take into consideration things like genetic predisposition, lifestyle characteristics, dietary patterns, physical activity levels, and other metabolic variables, but they should be taken into account.

CONCLUSION

These findings imply that somatotype components, with particular components having differing degrees of relationship and discriminatory power in different genders, contribute to the likelihood of developing T2DM. While ectomorphy may play a minor role in females but is very relevant in males, endomorphy and mesomorphy appear to be significant predictors in both females and males. These findings underscore the necessity for gender-specific considerations when evaluating the influence of somatotype components on health outcomes, adding to our understanding of the link between body composition and the risk of T2DM. Although the study's findings are insightful, further research and confirmation in various demographics must confirm the clinical implications. The scientific evidence would be strengthened, and the usefulness of somatotype components in everyday clinical practice would be improved by replicating these results in more extensive and diverse cohorts.

AUTHOR CONTRIBUTIONS

HLS wrote the original manuscript draft. WOH, AAS, FSB, AA, and MM conceptualize the research idea and methodology. IA, AIA, and AUD did a literature search and data analysis and prepared the bibliography. WOH, AAS, FB, MM and AA review and modify the final draft of the manuscript. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest

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