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RESEARCH

Analysis and modeling of adult male body shape aged 25–45 by CLO3D software

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This study conducted body shape research on 175 males aged 35–45 in Ho Chi Minh City, Vietnam. The aim was to develop accurate and intuitive analytical models to classify different body types. The research team utilized various statistical tools, such as descriptive analysis, principal component analysis, k-means clustering, and discriminant analysis—all supported by SPSS software—to identify the most reasonable body shape classifications. The study results identified the 5 most common body shapes: U-shaped, Y-shaped, V-shaped, O-shaped, and D-shaped. To enhance the visualization of these body groups, the research team created representative shapes based on 30 parameters analyzed through CLO3D software. This approach helped capture the distinct characteristics of each body type identified in the study. The study also integrated anthropometric indicators such as BMI, WHR, and DROP to analyze the characteristics of each body shape group. Focusing on analyzing these body shapes holds significant importance for the fashion industry, as fashion designers can create clothing that meets the preferences of a wider range of customers. It also helps individuals in the age group surveyed increase awareness of their bodies and choose clothes that suit them. In addition, the research results can support various other fields such as medicine and ergonomics.

Keywords: physiques modeling, statistical analysis, body shape, Vietnamese body classification, CLO3D software

Introduction

Body shape plays an important role in many fields. Understanding body shape helps us choose appropriate clothing, design suitable products, evaluate health status, and improve athletic performance. In recent years, Vietnamese people's body shape has undergone significant changes due to the influence of many factors such as nutrition, lifestyle, environment, etc. Nonetheless, information about Vietnamese male body shape is still limited and not fully updated. This study aim provide scientific information to researchers, designers, and manufacturers based on analysis using effective analytical tools and contribute to the development of scientific information. Developing Vietnam's fashion, design, pharmaceutical, and sports industries while raising Vietnamese people's awareness of the importance of health and body shape. In the field of apparel design and manufacturing, understanding variations in body shape plays an important role in ensuring fit, comfort, and aesthetics for consumers (1). Previously, researchers have used many methods to analyze the sophistication of human body morphology. In Vietnam, a number of studies have focused on studying female body shapes from many different aspects. Hien and her colleagues (2) studied the correlation coefficient using 3D V-Stitcher to design basic body blocks for different phenotypes of Vietnamese women. Another study by Hien (3) used a fuzzy logic system to classify female body shapes. In addition, research on male body shape is also of interest in Vietnam, with Kieu and colleagues (4, 5) delving into body classification in Ho Chi Minh City. Meanwhile, Hien and her colleagues (6) developed a system for measuring body size. Furthermore, Nguyen et al. (7) also developed a size system data system for middle-aged men. These studies have contributed valuable insights into the diverse body shapes of Vietnamese people, expanding the scope of body shape analysis to other Asian populations. In China there are also some related studies, such as: Huang and Can used software to analyze and present 4 types of young women's body shapes (8); Ya-Li Ling & An-Hua Zhong used 3D body measurement technology to captures 5 types of middle-aged women's shapes with the purpose of improving the fit of clothes (9); and a research article on the method of choosing the size of ready-made clothes using Using fuzzy techniques through the Sugeno model for the MISO fuzzy system (10, 11), there is also a method to build a 3D parametric model according to the lower part of a young woman's body, which is an important part in the numerical process. chemistry of the garment industry (12). These studies enrich the understanding of Chinese body shape changes. Similarly, research in Korea has shed light on adult body shape (13–15), individuals have large bodies (16), and athletes (17) in Japan. An effective research method for predicting human body type using artificial neural networks and discriminant analysis (18). Additionally, researchers have investigated the possibility of using a virtual clothing system to create 3D avatars reconstructed from 3D human body scan shape data on CLO 3D software (19). They used a variety of methods, including factor analysis, cluster analysis, and body scanning, to identify body types with increasing accuracy.

Therefore, in this study, we will use relevant analyzes using SPSS software to identify the most suitable body shape clustering options and characterize them using CLO3D software. These avatars will provide a more visual presentation and allow for the creation of a database of Vietnamese male body shape avatars.

Methodology

Subjects

The authors randomly measured the first 30 samples to calculate the minimum number of samples that need to be collected. To ensure a 95% confidence level, that is, $\alpha = 0.05$ with a corresponding t-value of 1.96. From the statistical analysis data of the first 30 samples, the highest standard deviation was determined to be $S = 6.74$. We also take into account the measurement error of $m = 1$ cm.

Formula to calculate the number of samples needed for a research article (2):

$$n = \frac{t^2 \times S^2}{m^2} = \frac{1.96^2 \times 6.74^2}{1^2} = 175$$

The results suggest that it is necessary to collect body measurements from at least 175 individuals to ensure the desired level of accuracy and reliability. The authors collected 180 data samples, ensuring the minimum number of samples, and began analyzing. In this study, individuals were randomly selected from many different locations such as companies, parks, and supermarkets. Our data shows that men between the ages of 25 and 35 make up 66.78%, while those between 35 and 45 make up 33.22%. To create the most detailed and accurate avatar in CLO3D software, we meticulously measured each subject to collect data on 30 important body measurements. These dimensions include 10 height measurements, 5 length measurements, 12 circumference measurements, 2 width measurements, and a weight indicator.

Statistical analyses

By utilizing SPSS 27.0 software, the process of classifying body shapes becomes more efficient and accurate. The authoring team employed specific analytical methods, including:

- Principal Component Analysis (PCA), a statistical procedure that transforms highly correlated variables into a smaller number of principal components that capture the majority of the observed variable variance (20).
- K-means clustering to analyze subjects into clusters, where each cluster represents a different body shape type (21).
- Discriminant analysis to provide a more intuitive understanding of the differentiation between body shape clusters identified by K-means clustering.
- Analysis of Variance (ANOVA) to ensure that these clusters represent distinct and statistically significant body types (22).

Following a series of analyses and making selections regarding the number of body shape groups for classification, the team proceeded to use CLO3D to compare representative shapes and ensure their accurate depiction of these body shapes. To set up the avatar's shape on CLO3D software, 30 measurements of 30 dimensions are required.

Findings

The Varimax rotation method was employed to elucidate the characteristics of the factors. These dimensions all adhere to a normal distribution with high reliability. To ascertain whether the selected variables are suitable for factor analysis, KMO and Bartlett's test were conducted through an iterative process 6 times to eliminate undesirable variables. Variables eliminated were those with low factor loadings or high factor loadings of 0.5 or more for two or more factors and high loadings for factors with differing concepts (23). After the first EFA analysis results, the author used the method of eliminating bad variables one at a time. From the 30 observed

TABLE 1 | KMO coefficients and Bartlett's Test in the results of the second EFA.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.936
Bartlett's Test of Sphericity	Approx. Chi-Square	7345.591
	df	378
	Sig.	0.000

variables in the first EFA analysis, remove the vertical trunk and underarm and put the remaining 28 observed variables in the second EFA analysis. After the removal of these variables, the results of the KMO sample adequacy test and Bartlett's test of sphericity were presented in **Table 1**, showing a KMO value of 0.936 and a significance level (sig.) of 0.000, indicating statistically significant values. Thus, factor analysis is appropriate.

In **Table 2**, there are 4 factors extracted based on the criterion Eigenvalue > 1, so these 4 factors best summarize the information of the 28 observed variables included in the EFA. The total variance extracted by these 4 factors is 80.84% > 50%, thus, the 4 extracted factors explain 80.84% of the data variation of the 28 observed variables participating in EFA.

The rotated matrix results indicate that the 28 observed variables were categorized into 4 factors, with all variables showing factor loadings greater than 0.5 and no poor-quality variables remaining. Using the Varimax rotation method, convergence was achieved in 6 iterations (**Table 3**), revealing height, waist circumference, thigh circumference, and wrist circumference as the 4 main components.

Main Component 1: Parameters indicating the body's vertical dimensions. The highest value is displayed at a height of 0.97, with parameters from thigh length to the

TABLE 2 | Total variance explained table.

Component	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	14.693	52.477	52.477	14.693	52.477	52.477	11.011	39.325	39.325
2	6.089	21.747	74.224	6.089	21.747	74.224	8.136	29.058	68.383
3	1.361	4.862	79.086	1.361	4.862	79.086	2.901	10.362	78.745
4	1.050	3.750	82.836	1.050	3.750	82.836	1.145	4.091	82.836
5	0.745	2.659	85.495						
6	0.547	1.954	87.449						
7	0.486	1.737	89.186						
8	0.386	1.377	90.563						
9	0.354	1.266	91.829						
10	0.303	1.083	92.911						
11	0.264	0.942	93.853						
12	0.248	0.887	94.740						
13	0.208	0.743	95.483						
14	0.201	0.718	96.201						
15	0.156	0.557	96.757						
16	0.151	0.541	97.298						
17	0.126	0.449	97.748						
18	0.114	0.409	98.156						
19	0.094	0.337	98.493						
20	0.081	0.288	98.781						
21	0.069	0.246	99.028						
22	0.062	0.222	99.249						
23	0.054	0.194	99.443						
24	0.042	0.148	99.592						
25	0.036	0.130	99.722						
26	0.035	0.124	99.845						
27	0.031	0.112	99.958						
28	0.012	0.042	100.000						

Extraction Method: Principal Component Analysis.

TABLE 3 | Rotation matrix table in the second EFA results.

Rotated component matrix[a]				
	Component			
	1	2	3	4
Height	0.965			
Thigh height	0.960			
Inseam height	0.956			
Arm length	0.942			
Chest height	0.933			
Waist height	0.933			
High hip height	0.931			
Knee height	0.915			
Low hip height	0.913			
Front center length	0.898			
Shoulder Drop	0.837			
Back center length	0.827			
High hip circumference		0.921		
Waist circumference		0.915		
Low hip circumference		0.828		
Arm circumference		0.811		
Weight		0.807		
Chest circumference		0.800		
Across back		0.779		
Total rise		0.764		
Across shoulder		0.691		
Wrist circumference		0.652		
Neck circumference		0.627		
Ankle circumference		0.598		
Thigh circumference			0.799	
Calf circumference			0.795	
Knee circumference			0.789	
Ankle circumference				0.935

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
[a]Rotation converged in 6 iterations.

length from buttocks to heel all having indices above 0.90, and all other dimensions yielding high results greater than 0.80. This factor indicates an eigenvalue of 14.70 and an accumulated variance ratio of 52.48%. This group of factors is characteristic of the body's height, and the ratio of dimensions within this factor allows for the determination of the body's upper and lower proportions.

Main Component 2: Parameters indicating the body's horizontal dimensions. The highest value is displayed at waist circumference at 0.92, followed by hip circumference with 0.92, and parameters from hip circumference to chest circumference all having indices above 0.80, with all other dimensions yielding high results greater than 0.50. This factor shows an eigenvalue of 6.09 and an accumulated variance ratio of 21.75%. This factor may represent the level of obesity in the upper part of the body.

Main Component 3: Parameters indicating the body's horizontal dimensions. The indices for thigh circumference, calf circumference, and knee circumference are 0.80, 0.799, 0.795, and 0.789, respectively. This factor indicates an eigenvalue of 1.36 and an accumulated variance ratio of 4.86%. This group of components may represent the level of obesity in the lower part of the body.

Main Component 4: The wrist circumference dimension with an index of 0.94. This factor indicates an eigenvalue of 1.05 and an accumulated variance ratio of 3.75%.

Analyzing correlations within the factor matrix

Based on **Table 4**, "Height" and "Waist Circumference" have a weak positive correlation (0.278**), meaning as height increases, waist circumference may also tend to increase. "Waist Circumference" and "Thigh Circumference" have a moderate positive correlation (0.487**), suggesting that an increase in waist size often accompanies an increase in thigh size. Other correlations are lower and may not be statistically significant, such as "Height" and "Wrist Circumference" at just 0.031, nearly no correlation.

Body shape classification

To analyze body shapes, the research team utilized K-means clustering and discriminant analysis to identify differences among the study groups. Following this, they conducted ANOVA tests on the mean values of independent sample groups and used these test results for body shape classification. In this study, the team proposed 7 solutions with group numbers ranging from 3 to 7 to determine the most suitable grouping. They then performed scatter plot analysis to examine the overlap between the 7 solutions.

After implementing 7 solutions for the body shape analysis, the authors found Solution 3 (**Figure 1**), which

TABLE 4 | Correlation analysis table to evaluate the relationships between variables.

Correlations				
Pearson Correlation	Height	High hip circumference	Thigh circumference	Ankle circumference
Height	1			
High hip circumference	0.278**	1		
Thigh circumference	0.225**	0.487**	1	
Ankle circumference	0.462**	0.638**	0.564**	1

**Correlation is significant at the 0.01 level (2-tailed).

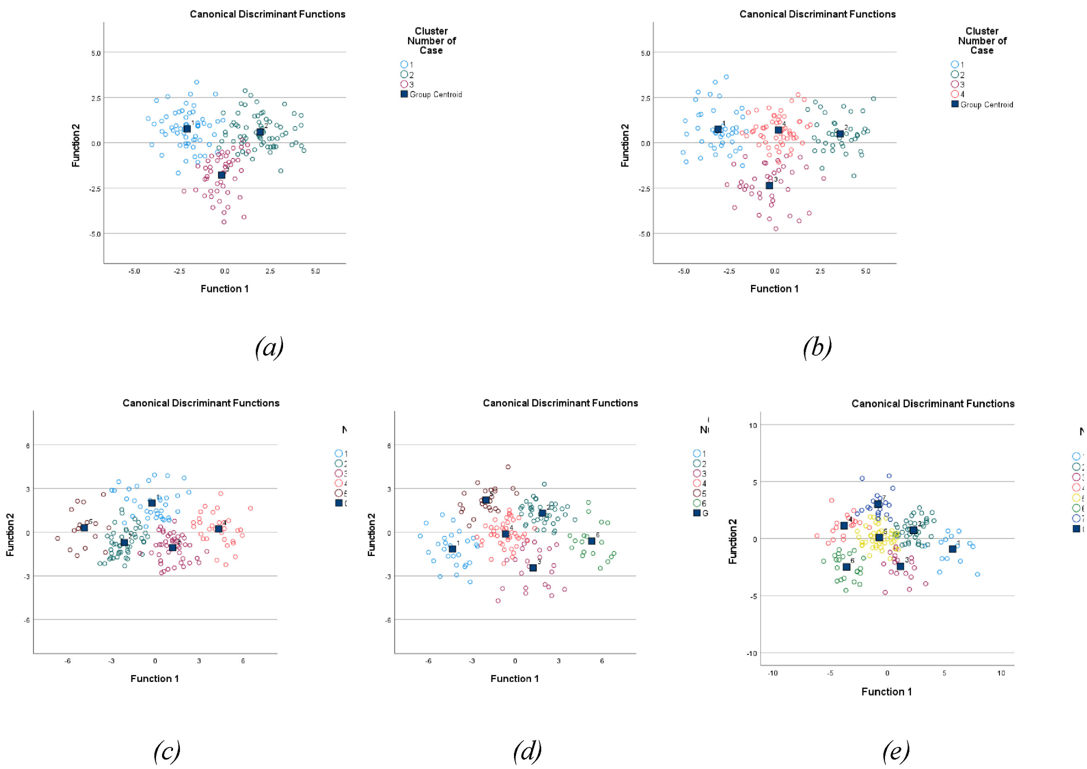


FIGURE 1 | (a) Solution 1 with 3 groups; **(b)** Solution 2 with 4 groups; **(c)** Solution 3 with 5 groups; **(d)** Solution 4 with 6 groups; **(e)** Solution 5 with 7 groups.

divides individuals into 5 distinct body shape groups, to be the most logical. Solution 3 was chosen because there was no overlap or interweaving between the groups. This showed that there was a difference between the body shape groups in this solution. This is one of the reasons for choosing Solution 3 for body shape analysis. In addition, the ANOVA test results (**Table 5**) reveal that 30 out of 30 parameters have a significance value (sig) of less than 0.05, indicating significant differences between groups for the variables mentioned in the table (11). The table detailing the dimensions of each body shape group in **Table 6**. (the table for the 5 groups' dimensions) shows that individuals within the same group share similar dimensions, and there are noticeable differences between groups. According to **Table 7**, there's a significant variation in the number of elements within each group. Although **Figure 1c** displays some overlap among elements of different groups, it is not substantial. The scatter plot indicates that the elements within each group are not spread too widely, suggesting a relatively cohesive grouping.

Setting up parameters for an Avatar in CLO3D

Having successfully established the parameters and distinguished the 5 body shapes, we were presented with visuals providing an intuitive and comprehensive understanding of each type, showcased through front, back, side, and skew views (**Figure 2**). A comparison of avatar display results on CLO3D software between the 5 body groups in this study is shown in **Figure 3**, highlighting the differences in body proportions according to height and circumference among the 5 groups. Armed with these visualizations, our analysis will delve deeper into characterizing each body type through BMI, WHR, and DROP and providing insights tailored to individuals within these body groups.

Discussions

Group 1: U-shaped body shape

Individuals in this group have a BMI of 24.9 (kg/m^2), which falls into the overweight category ($23 \leq \text{BMI} \leq 24.9$) (24). Their waist-to-hip ratio (WHR) of 0.90 indicates a moderate risk of disease according to health evaluations (25). In terms of attractiveness to males, this body type may be less appealing to the opposite sex (26). They are relatively short (shorter than Groups 2, 3, and 4 but taller than Group 5) with horizontally developed bodies. They belong to the medium-short shoulder group with a shoulder drop of 5.31. They also have a slightly hunched back with a backward-leaning posture. The Drop index for Group 1 is 7.25, indicating a smaller waist-to-chest ratio compared to other groups. The height difference between Group 1 and the other groups is relatively large, while the differences in inseam height between Group 1 and the other groups are relatively small, so

TABLE 5 | The ANOVA test table for Solution 3 (27).

ANOVA						
	Cluster		Error		F	Sig.
	Mean square	df	Mean square	df		
Height	921.095	4	12.214	170	75.412	0.000
Weight	2157.144	4	18.456	170	116.878	0.000
Neck circumference	100.136	4	3.453	170	28.996	0.000
Chest circumference	977.844	4	15.670	170	62.404	0.000
Waist circumference	1333.895	4	15.688	170	85.026	0.000
High hip circumference	892.067	4	8.157	170	109.367	0.000
Low hip circumference	586.448	4	7.494	170	78.254	0.000
Total rise	279.518	4	3.595	170	77.761	0.000
Vertical trunk	872.610	4	10.702	170	81.536	0.000
Shoulder Drop	0.395	4	0.016	170	24.930	0.000
Armhole depth	37.798	4	3.673	170	10.290	0.000
Across shoulder	70.336	4	1.370	170	51.351	0.000
Across back	44.459	4	0.901	170	49.366	0.000
Arm circumference	105.966	4	2.582	170	41.046	0.000
Wrist circumference	40.221	4	1.803	170	22.305	0.000
Ankle circumference	8.046	4	2.177	170	3.697	0.000
Arm length	92.395	4	1.624	170	56.898	0.000
Front center length	54.548	4	0.640	170	85.187	0.000
Back center length	49.272	4	0.708	170	69.628	0.000
Chest height	709.783	4	9.998	170	70.992	0.000
Waist height	444.789	4	6.344	170	70.109	0.000
High hip height	382.661	4	5.582	170	68.558	0.000
Low hip height	320.584	4	4.649	170	68.956	0.000
Inseam height	237.435	4	3.943	170	60.216	0.000
Thigh height	168.208	4	3.468	170	48.508	0.000
Knee height	76.347	4	1.636	170	46.677	0.000
Thigh circumference	100.204	4	7.049	170	14.216	0.000
Knee circumference	57.147	4	1.900	170	30.071	0.000
Calf circumference	54.256	4	2.601	170	20.858	0.000
Ankle circumference	12.882	4	0.297	170	43.436	0.000

the legs of Group 1 are longer compared to those of Groups 2, 3, and 4. In short, the authors conclude that this body type resembles a U-shape, which is very common, especially in individuals aged 30 and above. This body type can lead to health imbalances and an increased risk of obesity. It's important to adopt a healthier diet and engage in regular physical activity to achieve a more balanced physique.

Group 2: Y-shaped body shape

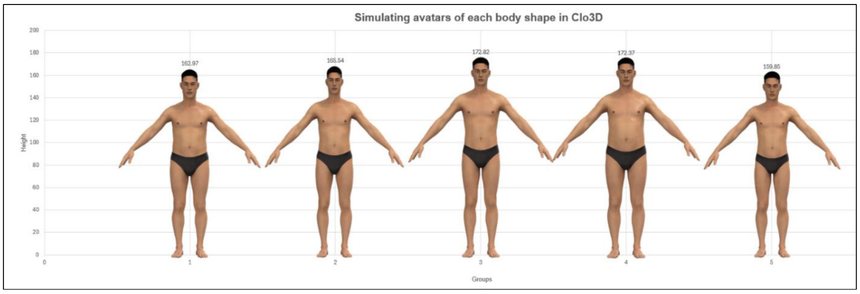
The second group has a body shape with a Y-shaped silhouette. Individuals in this group have a BMI of 21.4 (kg/m^2), falling into the normal category ($18.5 \leq$ BMI ≤ 22.9). Their WHR of 0.87 indicates a low risk of disease according to health evaluations. In terms

TABLE 6 | The dimension parameters table of Solution 3.

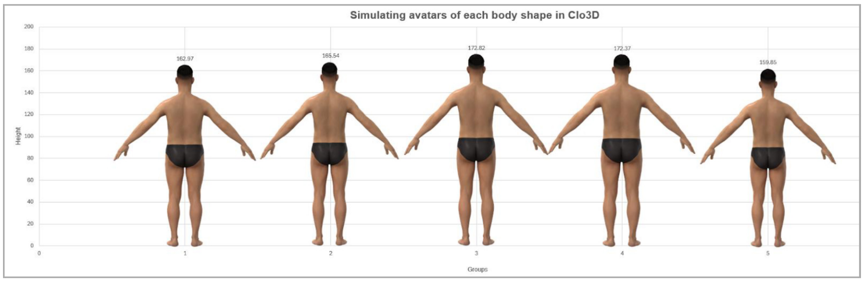
Final cluster centers					
Dimension parameters (kg, cm)	**Cluster**				
	1	**2**	**3**	**4**	**5**
Height	162.97	167.54	172.82	172.37	159.85
Weight	66.36	60.00	69.03	77.73	54.38
Neck circumference	39.38	37.41	39.30	41.28	36.39
Chest circumference	95.83	89.50	98.46	101.95	84.76
Waist circumference	88.59	80.33	80.96	95.20	76.29
High hip circumference	92.59	86.64	88.92	98.47	83.78
Low hip circumference	98.60	92.09	96.73	101.19	89.11
Total rise	69.98	68.18	71.27	73.83	64.93
Vertical trunk	162.22	161.37	167.71	170.16	155.40
Shoulder drop	5.31	5.07	5.44	5.78	4.62
Armhole depth	24.85	24.70	25.77	27.06	24.16
Across shoulder	39.23	40.25	42.71	42.57	38.05
Across back	36.52	35.77	36.98	38.29	34.87
Arm circumference	31.66	29.47	30.84	33.51	28.51
Wrist circumference	27.21	26.28	27.40	28.88	25.81
Ankle circumference	17.45	17.28	17.34	18.47	17.73
Arm length	56.21	57.69	59.40	59.06	55.22
Front center length	35.90	38.68	40.06	41.26	35.96
Back center length	43.85	43.43	45.72	45.83	42.51
Chest height	117.57	120.13	126.35	125.73	115.08
Waist height	98.16	100.02	104.73	105.17	96.03
High hip height	89.94	92.11	95.95	95.85	87.30
Low hip height	82.19	83.96	87.33	87.45	79.20
Inseam height	71.23	73.12	78.04	76.21	72.99
Thigh height	70.03	72.40	74.62	73.87	69.13
Knee height	45.05	46.47	48.01	47.72	44.29
Thigh circumference	53.86	51.75	53.72	55.49	50.61
Knee circumference	35.59	34.54	36.33	37.31	33.69
Calf circumference	35.64	34.63	36.10	37.60	34.07
Ankle circumference	23.53	23.08	23.76	24.28	22.38

TABLE 7 | The proportion of people in the proposed solutions (total 175 people).

Solution 1	Group 1 58 (33.14%)	Group 2 53 (30.29%)	Group 3 64 (36.57%)				
Solution 2	Group 1 44 (25.14%)	Group 2 39 (22.29%)	Group 3 38 (21.71%)	Group 4 54 (30.86%)			
Solution 3	Group 1 35 (20.00%)	Group 2 46 (26.29%)	Group 3 46 (26.29%)	Group 4 31 (17.71%)	Group 5 17 (9.71%)		
Solution 4	Group 1 27 (15.43%)	Group 2 39 (22.29%)	Group 3 23 (13.14%)	Group 4 44 (25.14%)	Group 5 24 (13.17%)	Group 6 18 (10.29%)	
Solution 5	Group 1 14 (8.00%)	Group 2 40 (22.68%)	Group 3 19 (10.86%)	Group 4 18(10.29%)	Group 5 44 (25.14%)	Group 6 21 (12.00%)	Group 7 19(10.86%)



(a)



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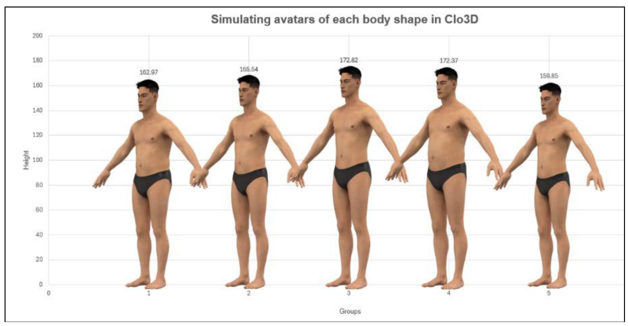

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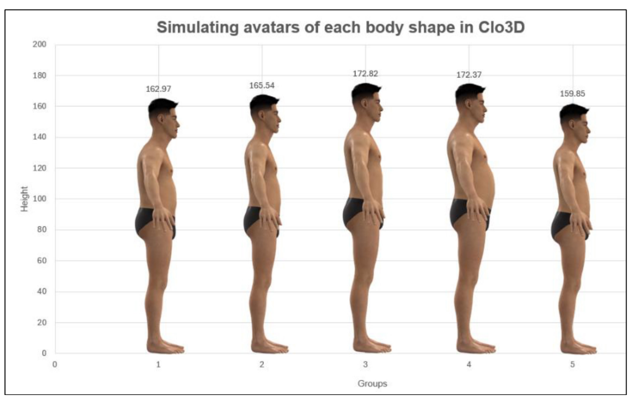
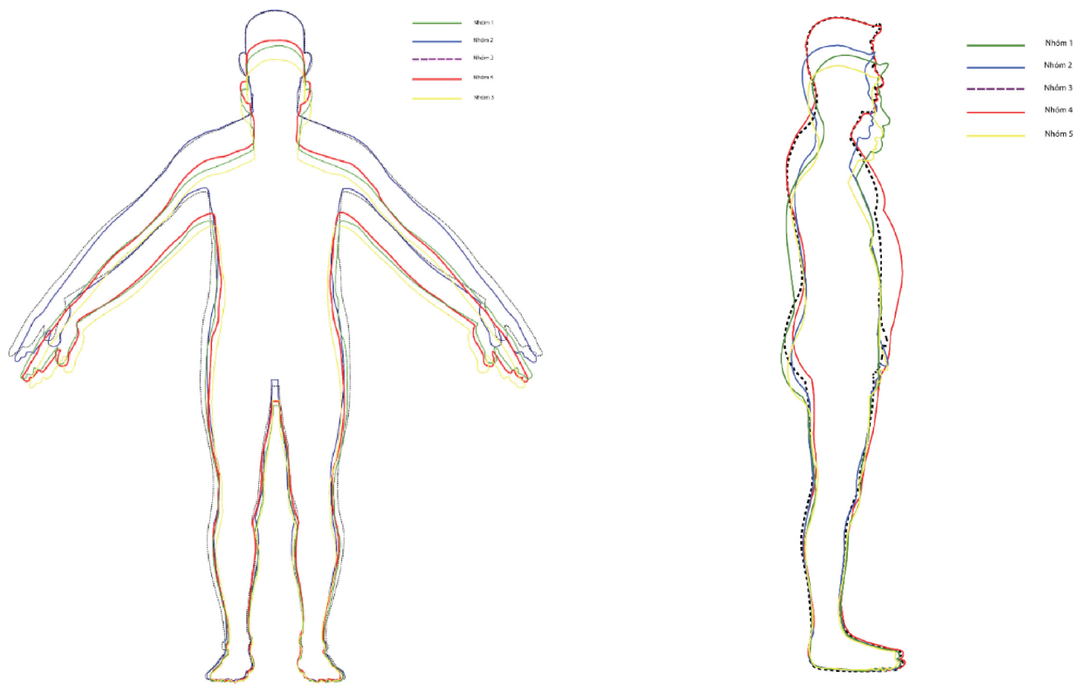


(d)

FIGURE 2 | Classification of 5 body shapes of Vietnamese men aged 25–45 years old **(a)** front view; **(b)** back view; **(c)** side view; **(d)** skew view.

of attractiveness to males, this body type is somewhat more appealing than the first group. Individuals in Group 2 have average height (shorter than Groups 3 and 4, taller than Groups 1 and 5). They belong to the medium shoulder group with a shoulder drop of 5.07. However, the ratio of inseam height to overall body height is equal to Group 1 and lower than Group 5, so their legs are shorter compared to the body, although slightly taller than Group 1 and 5. The Drop index is 9.17, indicating a larger chest circumference compared to the waist, larger than Group 1 and 5. This means they have relatively broad shoulders and developed chest and shoulders, while the waist and hips are slimmer. In



(a) *(b)*

FIGURE 3 | The sketch in body shapes among 5 different physiques **(a)** front view **(b)** side view.

short, the authors conclude that this body type resembles a Y-shape, which is also very common, especially in individuals aged 25 and above.

Group 3: V-shaped body shape

The third group has a body shape with a V-shaped silhouette. Individuals in this group have a BMI of 23.1 (kg/m^2), categorizing them as overweight. However, observations of avatar images from the front, back, and side show that this body shape does not exhibit signs of overweight. Instead, it shows well-developed muscles in the chest, shoulders, arms, and legs. This highlights a limitation of BMI, as it fails to differentiate between fat and muscle mass in the body. Their WHR of 0.84 indicates that this body shape is associated with low health risks and is considered the most attractive body shape for males compared to the other 4 groups. They have a tall stature and well-developed upper bodies. This group has a medium shoulder width with a shoulder drop of 5.44. The Drop Index of 17.5 indicates broad shoulders and chest with well-developed muscles in the chest and shoulders, while the waist and hips are slim. Compared to the Y-shaped body of Group 2, Group 3 has broader shoulders (42.71 > 40.25) and a larger chest (98.46 > 89.5), while the waist circumference of the 2 groups is similar (80.96 > 80.33). Overall, the upper body is broader than the lower body. While the difference in height is relatively small (172.82 compared to 172.37), there is a significant variance in inseam height (78.04 > 76.21). Therefore, the legs of Group 3 are relatively longer compared to those of Group 4. In short, the authors concluded that this body shape resembles a V-shape. This body type is quite common, especially among individuals aged 30 and above, and is considered the ideal physique for men. The V-shaped physique enhances male attractiveness, but achieving this requires consistent exercise and proper nutrition.

Group 4: O-shaped body shape

The fourth body shape group has a BMI of 26.16 (kg/m^2), which falls into the category of obesity (> 25 kg/m^2). Their WHR of 0.93 indicates a high risk of disease, ranking highest among the 5 groups, and this group is considered the least attractive compared to the other 4 groups. This body shape accumulates a significant amount of fat around the abdomen, chest, shoulders, and arms. This group has a low shoulder height measurement of 5.78. The back is slightly hunched compared to group 3. The Drop index of 7.89 indicates that group 4 does not have much difference between chest and waist measurements compared to the other groups. Compared to the U-shaped body of group 1, group 4 has broader shoulders (42.57 > 39.23), a more developed chest (101.95 > 95.83), and relatively different waist-hip measurements. In summary, the authors conclude that this body shape belongs to the O-shaped body type. This body type is quite common, especially in individuals aged 35 and older who are less active, have unhealthy eating habits, and tend to accumulate excess fat around the abdomen.

TABLE 8 | Summarizes the shape of the human body.

Body shape	U-shaped	Y-shaped	V-shaped	O-shaped	H-shaped
BMI (kg/m^2)	24.9	21.4	23.1	26.2	21.3
Whr	0.9	0.87	0.84	0.93	0.86
Drop	7.25	9.17	17.5	7.89	8.47
Characteristics	Relatively short with horizontally developing bodies, narrow shoulders, relatively wide waist, and hips.	Average height, broader shoulders, developed chest and shoulders, slimmer waist, and hips.	Tall stature, well-developed upper body, broad shoulders, slim waist, and hips.	Developed both vertically and horizontally, significant fat accumulation around the abdomen, chest, shoulders, and arms.	Relatively short, broad shoulders, similar sizes of hips and waist.
Health implications	Increased risk of obesity and health imbalances. Recommended to adopt a healthier diet and engage in regular physical activity.	Lower risk of disease compared to U-shaped body. Considered somewhat more attractive than U-shaped body.	Despite BMI indicating overweight, well-developed muscles reduce health risks. Considered the most attractive body shape for males.	Highest risk of disease among the groups. Least attractive body shape for males. Tends to occur in less active individuals with unhealthy eating habits.	Low risk of disease. Considered somewhat more attractive than U-shaped and O-shaped bodies. Creates a strong and stable impression.

Group 5: H-shaped body shape

The fifth body shape group has a BMI of 21.3 (kg/m^2), falling within the range of 18.5 $\leq$ BMI $\leq$ 22.9, categorized as a normal body shape. Their WHR of 0.86 indicates a low risk of disease, and it is somewhat more appealing than Groups 1 and 4. The individuals in Group 5 have a relatively short height (the shortest among the 5 groups) and a slender body compared to the other groups. This group has high shoulders and a shoulder drop of 4.62. The Drop index of 8.47 indicates that Group 5 does not have a significant difference between chest and waist measurements, combined with relatively small chest and waist measurements. Group 5 belongs to the body shape with relatively longer legs compared to Group 1, although this group is shorter than Group 2 (159.85 < 162.97), but with a higher hip level. In summary, the authors conclude that this body shape resembles the H-shaped body. This body type is quite common, especially in individuals aged 25 and older. To maintain and enhance the beauty of the H-shaped body, men need to pay attention to regular exercise and maintain a healthy and balanced diet.

Results

The results of the study categorize individuals into 5 body shape groups: U-shaped, Y-shaped, V-shaped, O-shaped, and H-shaped. Each group is characterized by specific measurements such as BMI, WHR, Drop, shoulder width, shoulder drop, and other body proportions. Table 8 shows a summary of the outstanding characteristics of each physique with accompanying body analysis indicators.

Conclusion

The results of this study highlight the importance of integrating multiple methods to accurately analyze human body shapes accurately. Based on data collected from 175 men aged 25–45, 5 primary body shape types were identified. The implications of this research are significant across various fields, particularly in the realm of fashion. The research provides foundational data for designing clothes that suit the body shapes of Vietnamese men, thereby enhancing the quality and aesthetics of the product. Designers can also segment the market into different customer groups based on individual needs and preferences. Furthermore, customized product lines can be developed for each customer group, optimizing business efficiency and competitiveness.

In addition, the study contributes valuable insights into understanding body shape variations among Vietnamese men concerning age and region. Medically, these data are highly relevant for diagnosing and treating conditions related to overweight and underweight issues, thereby improving men's health. Understanding the changes in the male body can also aid ergonomists in designing products and work environments suitable for different age groups, ensuring optimal support for the body and preventing potential health risks.

Nevertheless, with a relatively small sample size, the authors acknowledge limitations in analyzing male physique in the Ho Chi Minh City area, Vietnam. To improve that, the author proposes research and analysis based on a larger sample size to improve the accuracy of the research topic. At the same time, compare data on men's physique with other countries around the world. Last but not least, using direct manual measurements may cause errors in some measurement dimensions, so it is necessary to apply today's advanced 3D scanning technology to obtain more accurate measurement results in research. after that.

As a result, the CLO3D software application is an essential tool to help achieve results based on research on Vietnamese men's body shape.

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Author Contributions

Based on the distribution of works, author Nguyen is responsible for collecting and processing data. At the same time, create design drawings and study the deviation between results between body shapes. In addition, author Yen is responsible for analyzing the data and contributing to the drafting based on the research results. With the companionship and help of Dr. Hien through instructions and suggestions in editing the manuscript for publication. Finally, all authors discussed and made decisions for the final version of the manuscript.

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