Biometric Cardiac Profile as a Possible Identifier for sex among Sample of Egyptian Population

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Abstract

Biometric cardiac profile measured by Echocardiography is satisfying the properties of being a successful biometric technique which are universality, distinctiveness, collectability, performance, acceptability and circumvention.

Objectives: The aim of the current study is to establish biometric cardiac profile as a possible identifier for sex among Egyptian candidates.

Subjects & Methods: a prospective study involving 250 adult healthy volunteers provided equal sex distribution and age range between 18 & 70 years. The sample was divided into 5 equal groups according to age. Demographic data were collected. Cardiac parameters were measured by echocardiography. Body measurements (weight, height, body mass index 'BMI' and body surface area 'BSA') were taken from each subject to be studied with respect to the corresponding age, sex & cardiac parameters.

Results: Discriminant scoring was calculated to identify sex using echocardiography with accuracy (**65.6%**).

Conclusion and Recommendations: Presumptive categorization of persons according to sex can be achieved through cardiac profile measured by Echocardiography.

Keywords: *Egyptian, sex & biometric cardiac profile*

Introduction

Biometric identification shows great potential in bridging some of the existing security gaps. To reach a higher security level, specific characters from the human must be selected to identify a person. Biometrics use anatomical, physiological or behavioral features that are significantly different from person to other person. This is useful in security applications and authentication devices, offering an alternative to conventional methods.[1]

Echocardiography is the most widely used non-invasive imaging tool for the assessment of heart structure, functions and remains the gold standard especially with the constant evolution of new applications and technologies of various echocardiographic techniques, current guidelines propose normal reference ranges for standard echocardiography measurement for several clinical proposes. [2]

Normal values provide the background for interpretation of quantitative imaging data, to obtain reference values in normal subjects for the left ventricle

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and the left atrium. Data sets for all patients included age, gender, ethnicity, height, and weight. To ensure a normal population, subjects in these studies were excluded if any of the following criteria were met: history of drug-treated hypertension, diagnosis of diabetes and any cardiac disease. [3]

As the number and proportion of aged individuals in the population increases knowledge of normal physiologic changes associated with aging becomes more important to help in identification of sex and estimation of age. More recently we have begun to look more deeply into both the similarities and differences between both sex, with respect to the structure and function of other organ systems, one of them is the cardiovascular system. [4]

Materials and Method

Study population:

250 healthy Egyptian adults were included in the current study. The candidates were recruited -according to specific criteria-from cases coming for cardiac evaluation or conducting their routine preoperative echocardiography in Kasr Al-ainy cardiac investigation units during the period of the study. Egyptian origin and residence, from 18 years to 70 years, both sexes with no history of cardiac diseases (congenital or acquired) were included in the study. While Patients who had any congenital or acquired cardiac diseases, history of any cardiac surgery or history of systemic diseases (endocrinal, metabolic, or infectious) were excluded from the study.

Subjects were divided according to age into 5 equal age groups, each age group included 50 subjects, 25 males and 25 females as following:

o Group 1. From 18-30 years old

o Group 2. from 31-40 years old

o Group 3. from 41-50 years old

o Group 4. from 51-60 years old

o Group 5. From 60-70 years old

Equipment and instruments:

1. **Body scale:** A mechanical Chinese height and weight boy scale, China Medical Dial model

2. **Echocardiography:** Transthoracic echocardiography (TTE), PHILIPS iU22 ultrasound system for 2D image

§ Demographic data were collected from subjects through a structured questionnaire including age, gender, residence and occupation which is divided into either Intellectual workers (students, employees, teachers, secretary and doctors), Manual workers (as carpenters and mechanics) or Non-Workers (as house wives and retired persons).

Study measurements:

· **Body metric measurements**:

The parameters measured were as follows:

I. Weight in kilogram.

II. Height in meter.

III. Body mass index (BMI) (weight in kg / length in m^2). [5]

IV. Body surface area (BSA) [square root of (height in cm x weight in kg)/3600]. [6]

· Echocardiographic measurements:

1- Aortic dimension, (AO) in cm.

2- Left atrial dimension, (LA) in cm.

3- End diastolic dimension, (LVED) in cm.

4- End systolic dimension, (LVES) in cm.

5- Left ventricle fractional shortening, (FS %).

6- Left ventricle ejection fraction, (EF %).

7- Posterior wall thickness, (PWT) in cm.

8- Inter-ventricular septal thickness in cm.

9- Relative wall thickness, (2 x PWT/ LVED).

Ethical considerations:

The study approval was taken by the ethical review committee of medical research, Faculty of Medicine, Cairo University, Egypt and informed consent forms were obtained from all participants. The study information including the purpose and details were explained to participants of both groups.

Results

Table 1 showed that there was a statistical significance between sex and **weight (**p value= 0.030). Also, there is a highly statistical significance regarding relations ***between sex and*** **height** (p value < 0.001). While, there is no statistical significant relations ***between sex and BMI and BSA.*** In addition, the table shows females were heavier and shorter than males. Also, females show higher BMI and BSA than males.

Table1; Relation between body measurements and sex

	Sex				P value
	M		F		
	Mean	SD	Mean	SD	
Weight\ kg.	66.57	8.76	69.37	11.33	0.030*
Height\ m.	1.64	0.07	1.61	0.05	< 0.001**
BMI\ kg\ m2	24.46	3.08	29.26	2.798	0.059
BSA\ m2	1.74	0.14	1.75	0.15	0.522

(Unpaired t test, *P is significant if < 0.05, **P is highly significant if < 0.01). BMI: body mass index, BSA: body surface area, M= male, F= female and SD: stander deviation.

Table 2 showed there was a highly statistical significant relations between sex and **AO, LA, LEVD, PWT & FS** with P value (0.001, 0.007, 0.001, 0.001 & 0.001) respectively. Also, there is statistical significant relations between sex and **LVES, EF & Inter-ventricular septal thickness** with P value (0.020, 0.013 & 0.034) respectively. But there was no statistical significant relations between sex and ***relative wall thickness*** also the table shows that males had higher echocardiographic diameters than females.

Table 2; Relations between echocardiographic parameters and sex

	Sex				P value
	M		F		
	Mean	SD	Mean	SD	
AO\ cm.	2.70	0.33	2.57	0.31	0.001**
LA\ cm.	3.58	0.33	3.47	0.33	0.007**
LVED\ cm.	4.86	0.37	4.72	0.34	0.001**
LVES\ cm.	3.11	0.34	3.02	0.29	0.020*
PWT\ cm.	0.90	0.11	0.85	0.10	< 0.001**
FS %	35.70	4.00	34.38	3.66	0.007**
EF %	65.46	4.52	64.06	4.43	0.013*
Inter-ventricular septal thickness\ cm.	0.88	0.12	0.85	0.11	0.034*
Relative wall thickness	0.37	0.05	0.36	0.05	0.059

(Unpaired t test, **P is highly significant if < 0.01). **AO: aortic dimension, LA: left atrial dimension, LVED: end diastolic dimension, LVES: end systolic dimension, PWT: posterior wall thickness, FS% Left ventricle fractional shortening, EF%: Left ventricle ejection fraction, SD: stander deviation, M= male and F= female.**

Discriminant function analysis for determination of sex using the most sensitive parameters in **echocardiographic** assessments shown in **table 3** which were **AO, LVED, PWT and FS.**

Table 3; Canonical Discriminant Function Coefficients for determination of sex using Echocardiographic parameters

Unstandardized coefficients	Function
AO\ cm.	1.354
LVED\ cm.	1.305
PWT\ cm.	4.957
FS%	0.125
Constant	-18.555

AO: aortic dimension, LVED: End diastolic dimension, PWT: posterior wall thickness, FS% Left ventricle fractional shortening, EF%.

Functions at group centroid

Table 4 showed that positive scores are classified as males and negative scores are classified as females. The function at group centroid of discriminant score results in males (0.400) and females (- 0.400).

Table 4; Functions at group centroid of discriminant scores for each group for determination of sex using Echocardiographic parameters only

Sex	Function
M	0.400
F	-0.400

M= male & F= female.

Calculating discriminant score and accuracy of sex determination model from measured echocardiographic parameters reveals the following results. A negative correlation was present between BMI and both **QRS interval** & **QT interval.** The stronger correlations were present with **QRS interval (r=-0.234) then with QT interval (r=-0.219) as revealed in table 4.** Also, there was a highly statistical significance between BMI and **QRS & QT intervals** with P value < 0.001.

Discriminant score I (Determination of Sex using Echocardiographic parameters only)

Where AO: aortic dimension, LVED: End diastolic dimension, PWT: posterior wall thickness, FS% Left ventricle fractional shortening.

Table 5 showed shows accuracy of sex determination model from measured Echocardiographic parameters using unstandardized canonical discriminant functions evaluated at group means in which 65.6% of original grouped cases are correctly classified.

Table 5; Unstandardized canonical discriminant functions for determination of sex using echocardiographic parameters only evaluated at group means

Classification Results					
		Sex	Predicted Group Membership		Total
			M	F	
Original	Count	M	88	37	125
		F	49	76	125
	%	M	70.4	29.6	100.0
		F	39.2	60.8	100.0
	Count	M	86	39	125
		F	49	76	125
	%	M	68.8	31.2	100.0
		F	39.2	60.8	100.0
65.6% of original grouped cases correctly classified.					

M= male & F= female.

Discussion

Regarding echocardiographic measurements relations with sex, results of the current work reported a highly statistical significant relation (P<0.01) between sex and most of measured echocardiographic parameters. Also, males had significantly larger mean values of LVED, LVES, IVSd, PWd, LA antero-posterior dimensions and aortic root dimensions which had statistical significance with sex (p= 0.001), (p= 0.020), (p= 0.034), (p < 0.001), (p= 0.007) and (p= 0.001) respectively.

Similar results was traced by [7] **who** conducted their study on normal volunteers from 14-68 years old of age of both sexes at **Sohag University Hospital.** They reported there was increase in the mean value of different cardiac dimensions in males over females with significant difference which confirms that the discussed parameters are affected by type of gender. Also, their study showed that males had significantly larger LVEDD, LVESD, IVSd, PWd, LV mass, LA antero-posterior diameter and aortic root diameter with statistical significance with sex (p<0.0001 for each). The similarity between both studies may be explained by matched ages of studied groups and also, both studies were Egyptian studies.

But in **contrast** with the current study which showed that **LV ejection fraction** was higher in males with statistical difference with sex (p=0.013), while in the study of [4] **LV ejection fraction** was higher in females with no statistical difference with sex. This explained by difference of age groups in both studies.

Sex has significant independent influences on LV end-diastolic volume (EDV) and LV end-systolic volume (ESV). After puberty sex hormones have a great effect on cardiac structures and functions that reflect on echocardiographic measurements. [3]

Regarding sex identification using echocardiographic parameters, using discriminant

function analysis for determination of sex by echocardiographic parameters, our study concluded a discriminant score = -18.555+ 1.354* (AO) +1.305* (LEVD) + 4.957* (PWT) + 0.125* (FS) where positive scores are classified as males and negative ones are classified as females.

On the other hand, [7] used simple linear logistic regression analysis to predict sex from each echocardiographic parameters and calculated equations. In which sex = 5.96-0.21* **(AO)** or 3.97-0.38***(P.W.T).** The differences between both studies may argued to differences in group's structure and statistical analysis used to interpret data in both studies.

Using discriminant function analysis for determination of sex via multiple parameters is more powerful than usage a simple logistic analysis. In which the independent variables are quantitative (cardiac parameters) started with testing the equality of means between males and females. Stepwise statistics revealed the significant predictors which were used to determine the discriminate function. [8]

Regarding relations of weight with sex, the current study found that females are heavier than males with mean value ranged from 59 to 69 kg in males versus 62 to76 kg in females which had statistical significance with sex (p =0.030). On the contrary, [4] said that; males were heavier than females 70.7± 11.17 kg versus 65.62± 10.47 kg which had statistical significance with sex. Moreover, [9] **said** that; males were heavier than females (72; 82) in males versus (55; 67) kg which had statistical significance with sex.

Regarding the relation of height with sex, the present study showed that males were taller than females with mean value ranged from 1.60 to 1.67 m in males and from 1.60 to 161m in females which had highly statistical significance with sex (p <0.001). Similar results were conducted by [4] who reported that males were taller than females 1.7± 0.07 versus 1.64± 0.08 m which had high statistical significance with sex (p <0.0001). Also, the current results came in agreement with [9] who said that males were taller than females (173;182) cm in males versus (160; 170) cm in females which had high statistical significance with sex (p <0.0001).

Conclusion and Recommendations

The Current study distinguishes itself from other studies by the selectivity of the healthy population, comprising both sexes, the broad range of ages, and the exhaustive set of measurements (body and cardiac). Presumptive categorization of persons according to sex can be achieved through cardiac profile measured by Echocardiography. Cardiac parameters shown to be affected by body metric measurements. We need to establish national data basis using the studied cardiac parameters for application in medico-legal investigations requiring individualization and positive identification of humans.

Declarations:

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- **Conflict of Interest**: The authors declare that they have no competing interests.
- **Availability of data and materials:** Data will not be shared with public access.
- **Consent for publication:** Consent forms were given and signed by all subjects prior to participation

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