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## Normal reference values of echocardiographic measurements in young Egyptian adults

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### KEYWORDS

Echocardiography;  
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**Abstract** *Background:* Normal values for echocardiographic measurements are widely based on cohorts from North American populations. Differences have been shown to exist that could be attributed to racial and ethnic differences.

*Objective:* To define the normal echocardiographic reference values for various cardiac measurements in young, healthy Egyptian adults.

*Methods:* This study was performed on 1,364 healthy adults aged 18–35 years. Standard trans-thoracic echocardiographic studies were performed to obtain end diastole measurements of left ventricular (LV) posterior wall thickness (PWd), interventricular septum thickness (IVSd), LV internal dimensions at end diastole (LVEDD) and end systole (LVESD), left atrial (LA) diameter, aortic root diameter and right ventricular outflow dimension (RVd). LV ejection fraction (LVEF), LV mass and relative wall thickness were assessed. All measurements were then indexed to body surface area (BSA). Based on our results we proposed normal reference values for young Egyptian adults.

*Results:* On comparing subjects according to gender, absolute measurements showed males had significantly larger LVEDD, LVESD, IVSd, PWd, LV mass, LA anteroposterior diameter and aortic root diameter ( $p < 0.0001$  for each). LV ejection fraction was higher in females ( $p = 0.008$ ). There was no difference regarding RVd ( $p = 0.118$ ). Females had larger indexed LVEDD ( $p = 0.0003$ ), indexed LA and aortic root diameters ( $p = 0.0005$  and  $0.007$  respectively) and indexed RVd ( $p < 0.0001$ ). However, indexed LV mass was larger in males  $83.56 \pm 20.37$  versus  $77.76 \pm 18.56$  g/m<sup>2</sup> ( $p < 0.0001$ ). We proposed normal values for absolute and indexed echocardiographic measurements based on our results.

*Conclusions:* Estimation of local reference values is important to define normalcy. The main difference from international values was a higher upper reference limit for LV mass especially in females and relatively smaller LA dimensions in young Egyptians.

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## 1. Introduction

Echocardiography is the most widely used non-invasive imaging tool for the assessment of heart structure and functions and remains the gold standard especially with the constant evolution of new applications and technologies of various echocardiographic techniques. This is still valid despite the appearance of other imaging modalities of the heart.<sup>1,2</sup> The number of echocardiographic studies performed yearly in the United States, for instance, is estimated to be more than 20 billion studies.<sup>3</sup>

Decisions regarding medical, interventional or surgical management of patients are widely based on the results of echocardiography on a daily basis for both cardiac and non-cardiac patients. Therefore, in order to detect abnormalities, accurate definition of normal values of echocardiographic measurements is of the utmost importance in order to be a reliable guide for decision making.<sup>2,4</sup>

Normal values for echocardiographic measurements have been presented in several guidelines and statements. The most recent was a joint recommendation for chamber quantification by the European Association of Cardiovascular Imaging (EACVI) and the American Society of Echocardiography (ASE)<sup>5</sup> which had been previously endorsed by several societies, namely the International Alliance Partners of the ASE, Canadian Society of Echocardiography, Indian Academy of Echocardiography, Indonesian Society of Echocardiography, and the Japanese Society of Echocardiography. This was mostly done after conducting local studies to assess the application of such measurements to their respective populations.<sup>6</sup>

Differences have been shown to exist in some echocardiographic measurements that could be attributed to racial, ethnic or gender differences.<sup>4,6,7</sup>

The aim of this study was to define the normal echocardiographic reference values for various cardiac measurements of dimensions and function in young, healthy Egyptian adults.

## 2. Methods

This study was performed on 1364 healthy adults aged 18–35 years presenting to four echocardiography units in tertiary hospitals in Mansoura city, Dakahlia Governorate, Egypt, in the period from October 2013 to February 2015. Patients were excluded if they had any congenital or acquired cardiac abnormality, history of long-term regular physical training, any systemic disease (endocrine, collagen, metabolic, nutritional or infectious), hypertension, diabetes mellitus, chronic kidney diseases, and/or chest disease.

Approval of institutional ethical committee was obtained in addition to an informed consent from all subjects. Height in meters and weight in kilograms were measured and used to estimate body mass index (BMI) in kg/m<sup>2</sup> and body surface area (BSA) in m<sup>2</sup>. BSA was calculated using the Mosteller formula<sup>8</sup>, where BSA = square root of ([height in cm × weight in kg]/3600).

## 3. Echocardiographic study

Standard trans-thoracic echocardiographic studies with machine-integrated ECG recording were performed using Vivid S5 machines with an M3S matrix array probe with a frequency range from 1.7 to 3.2 MHz (GE Vingmed, Horten, Norway). All studies were done with patients lying in the left lateral decubitus position and breathing quietly.

A comprehensive echocardiographic study following standardized protocols<sup>5,9</sup> was performed for all subjects and all

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