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Impact of Body Mass Index (BMI) on Echocardiography

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Abstract

Background: **To determine the demographic characteristics of patients in various BMI groups and the impact of individual BMI group on the utility of trans-thoracic echocardiography .**

Methods: **This prospective observational study was conducted at KRL Hospital, Islamabad from Dec 1, 2006 to Apr 30, 2007. 224 patients, 52% males with mean age 51.4 years (SD±17.23) referred for trans-thoracic echocardiography were studied. All patients had their BMI calculated and test indication, details of echocardiography findings and final conclusion recorded.**

Results: **Forty nine percent of the study population was overweight and obese with female predominance (59%). The normal and underweight people were significantly younger in age (p<0.001) and were mainly referred for assessment of heart murmur. The overweight and obese were referred mainly for assessment of LV function and had significantly high number of poor technical quality echo images (p<0.001). In total 54% of the echocardiograms were normal. Relatively more normal results were obtained in overweight & obese (59%) as compared to normal & underweight people (50%). Obesity was more prevalent in female gender. Both the subgroups (normal/underweight & overweight/obese) used the echocardiography service equally.**

Conclusion: **The high number of normal echocardiograms in overweight & obese people who were mainly referred for assessment of LV function appears to be an inappropriate burden on echocardiography service. Assessment of heart murmur in normal and underweight population is probably due to high prevalence of rheumatic fever in our country.**

Introduction

Echocardiography is a widely employed non-invasive diagnostic tool that is capable of providing accurate, quantitative information driving the management of most cardiac diseases. The use of echocardiography has expanded beyond the boundaries of the specialized cardiac unit. The general and primary care physicians are now requesting an increasing proportion of studies because of its easy availability with minimal risk to the patient.[1]

Obesity has acquired the status of a global epidemic.[2] Developing countries are increasingly vulnerable to this epidemic, which affects all segments of the population, including men, women and now children.[3,4] Compared with populations in industrialized countries, those in the developing world appear to be at greater risk of the diseases associated with overweight and obesity. Alarmingly, cardiovascular disease has become the leading cause of disability and death in many developing countries.[5-7] Greater consumption of health resources with respect to clinic visits, hospitalizations, and medication use have been well demonstrated in overweight and obese population.[8]

Limited information, both nationally and internationally, exists in the literature as regards the impact of BMI on the use of trans-thoracic echocardiography. We aimed to determine the demographic characteristics of patients, in various BMI groups, referred to our echocardiography lab.

Patients and Methods

This prospective observational study was conducted at KRL Hospital, Islamabad from Dec 1, 2006 to Apr 30, 2007. All patients referred to the echo lab for trans-thoracic echocardiogram during the above period were included. All echocardiograms were performed on Toshiba Sonolayer SSH-140 by a single operator. The echocardiography included both imaging (two-dimensional and M-mode), and Doppler modalities (continuous wave, pulsed, and color flow mapping). The technical image quality was subjectively assigned by the interpreting physician as good, fair, poor or very poor.

The height and weight of the patients were measured and recorded. Body mass index (BMI) was calculated as weight in kg divided by height in meters

squared. Patients were divided into standard BMI groups: Underweight (<18.5 kg/m^2), Normal (18.5 – 24.9 kg/m^2), Overweight (25 – 29.9 kg/m^2) and Obese (>30 kg/m^2)

Data including age, gender, height, weight, indication for referral, echo quality and detailed echo findings (chambers dimensions, right & left ventricular function, valves structure & function, evidence of other abnormalities like ASD, VSD, pericardial abnormalities etc.) was collected on a standard proforma and analyzed by using statistical software SPSS 13.0 for Windows (SPSS Inc. Chicago, IL USA). Discrete variables were listed as counts or percentages and were compared using chi-square or Fisher's exact test. Continuous variables were listed as means with standard deviations (SD) and were compared using Student's t test. Significance was set at $p<0.05$.

Results

Of the total 257 patients, 33 could not be weighed or height measured, hence data of 224 patients was available for analysis. The mean age of the study population was 51.4 years (SD±17.23) with slight male predominance (male= 52%, female=48%).

The mean BMI of the total study population was 24.6 (SD±4.8). Analysis of various BMI categories revealed 10.7% under-weight, 40.6% normal-weight, 33.9% overweight and 14.7% obese populations. Assessment of BMI according to gender revealed female population having significantly higher mean BMI as compared to male population (female: 25.9 [SD±5.2], male: 23.4 [SD±3.9]). Table 1 shows that females constitute significantly high number of overweight and obese population as compared to males. The normal and underweight people were younger in age than the overweight and obese people and this difference was statistically significant (Table 2).

Commonest indications as mentioned in Table 3 were assessment of LV function (22%), HTN (14%), assessment of heart murmur (12%) and pre-op evaluation (8%). Ninety three percent (93%) of total patients referred for assessment of heart murmur belonged to normal & overweight while 58% of total patients referred for assessment of LV function belonged to overweight & obese populations.

Significant difference ($p<0.001$) in technical echo quality was observed among the various BMI groups. Thirty three percent (33%) of total echocardiograms were of poor technical quality. Out of these 82% belonged to overweight & obese population. In total 54% of the echocardiograms were normal. Relatively more normal results were obtained in overweight & obese (59%) as compared to normal & underweight (50%) population.

Table 1. Gender distribution in BMI groups

	BMI Group		
Gender	**Normal & Underweight**	**Overweight & Obese**	**Total**
Male	71(62%)	45(52%)	116(52%)
Female	44(38%)	64(48%)	108(48%)
Total	115	109	224
	p=0.002		

Discussion:

Forty nine percent of our study population was overweight and obese with female predominance . Also this population was older than the normal and underweight. The National Health Survey of Pakistan published in 1998 by the Pakistan Medical Research Council has clearly shown that obesity/overweight increases with advancing age, peaking at 45-64 years for both men and women in urban and rural areas, and then decreasing at 65 years. The prevalence of obesity/overweight is higher in females than males regardless of age group and residence. When stratified by sex and age group the highest level is seen in females.[9] Obesity is not restricted to adults only and the risk for acquiring obesity in adulthood is higher in overweight children and adolescents.[10]

Table 2. Age distribution of BMI Groups.

BMI Group	Mean age	Std. Deviation
Normal & Underweight	48 yrs	20
Overweight & Obese	55 yrs	14
Total Group	51 yrs	17
	p=0.005	

The Nurses Health Study, involving more than 100,000 women, concluded that increased levels of physical activity and a low body mass index, are independently associated with reduced mortality rates.[11] The spectrum of medical conditions resulting from obesity not only increase morbidity but also

cause a tremendous economic burden on the individual and the state.[12]

Worldwide, Indo-Asian people are among the populations at highest risk for cardiovascular disease.[13] Evidence also suggests that associations between BMI, percentage of body fat and chronic disease differ between Indo-Asian and European populations. Because of the observed differences between populations, the International Association for the Study of Obesity and the International Obesity Task Force have suggested lower BMI cut-off values for the definitions of overweight (23.0–24.9 kg/m^2) and obesity (25.0 kg/m^2 or greater) in Asian populations.[14, 15]

Table 3. Echocardiography Indications in various BMI groups.

	BMI Group					
Echo indication	Under weight	Normal	Over weight	Obese	Total	Percentage
LVF	7	14	22	8	51	22.70%
HTN	0	11	15	6	32	14.20%
Murmurs/valvular lesions	7	22	2	0	31	13.80%
Pre-op assessment	0	9	6	5	20	8.90%
IHD	0	9	7	3	19	8.40%
Arrhythmia	1	6	5	5	17	7.50%
Job medical	1	4	4	1	10	4.40%
NIDDM	0	0	3	1	4	1.70%
Abnormal ECG	1	1	1	0	3	1.30%
Endocarditis	2	1	0	0	3	1.30%
Stroke	0	2	1	0	3	1.30%
Pericarditis	1	0	0	1	2	0.80%
Syncope	0	1	0	0	1	0.40%
Miscellaneous	3	12	10	3	28	12.50%
Total	23	90	76	33	224	100%

We hypothesized that people with BMI ≥25 kg/m^2 would be using the echocardiography service more as compared to others because of concomitant comorbidities[16] but we found equal usage of echocardiography service in both subgroups. However, the main referral diagnosis in normal and underweight individuals was assessment of heart murmur while it was assessment of LV function in overweight & obese individuals.

Echocardiogram remains the main diagnostic tool for screening and subsequent monitoring of patients with rheumatic heart disease. This disease was rife in Western countries until 50 years ago, with improvements in sanitation and housing and the advent of widespread use of antibiotics, it is now extremely rare.[17] But in the developing countries , which constitute approximately two thirds of the world's population, rheumatic fever and rheumatic heart disease remain significant medical and public health problems.[18] With prevalence rate of 5.7 in 1000 (95% confidence interval 4.2 to 7.2), Rizvi and colleagues describe the current situation as "a pandemic of rheumatic heart disease" in rural Pakistan.[19]

In our study patients with BMI <25 kg/m^2 were younger as compared to other subgroup and were mainly referred for assessment of heart murmur. This finding is in keeping with the above mentioned high incidence of rheumatic heart disease in Pakistan which put a huge burden on echocardiography service. Theoretically this disease is preventable with effective primary and secondary prevention and health education and we should put our best efforts in this cause so as to save our meager health resources.

We found significantly high number of poor technical images in overweight and obese population. Image quality is dependent on the degree of ultrasound tissue penetration, as well as on the instrument used, transducer frequency, instruments settings, and sonographer's skill. Conditions that increase the separation between the transducer and the cardiac structures (e.g., adipose tissue) lead to poor image quality. The above makes accurate diagnosis difficult and precludes quantitative measurements. In some cases, trans-oesophageal imaging may be needed to make an accurate diagnosis.[20]

More than half (54%) of the echocardiograms performed were normal in our study. Among the various BMI groups the overweight population has the maximum normal echocardiograms (60%). This is an important observation. Overweight individuals invariably present with the symptom of dyspnoea. With no obvious cause for their complaint on initial physical and laboratory assessment, the treating physician organizes an echocardiogram to rule out LV dysfunction. The resultant high number of normal

echocardiograms does suggest that they are short of breath because of being overweight. It appears to be an inappropriate burden on the echocardiography service. The above clearly highlights the need for effective measures to bring awareness in people as regards the harmful effects of overweight and obesity.

In conclusion about half the study population is overweight and obese. This population is older with female predominance. Assessment of LV function is the main test indication in overweight and obese . Assessment of heart murmur is the main test indication in normal and underweight population probably due to high prevalence of rheumatic fever in our country. Health education to bring awareness as regards ill effects of obesity/overweight and measures to improve health facilities for both primary and secondary prevention of rheumatic fever remains the essential requisites for improving the current situation.

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