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# Competency in home body fat monitoring by portable devices based on bioelectrical impedance analysis: A pilot study

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## Abstract:

**INTRODUCTION:** With the advancement of bioelectrical impedance analysis method, body fat can be estimated with portable devices at home. These devices are popular in home body fat monitoring (HBFM). However, improper use of the device may provide erroneous result.

**AIM:** This study aimed to find out the level of competency of the operator in HBFM.

**MATERIALS AND METHODS:** A cross-sectional survey was conducted with 34 individuals (males = 11, females = 23) during March–December, 2017. A pretested questionnaire was used to collect information by expert interviewer. Data were collected about premeasurement precautions, steps followed in body fat measurement proper, and postmeasurement action. Survey data were expressed in mean, standard deviation, and percentage and statistically tested by unpaired *t*-test and Chi-square test according to necessity with  $\alpha = 0.05$ . Analyses were done in GraphPad Prism 6.01.

**RESULTS:** Premeasurement precautions for maintaining proper hydration level were not followed by majority of the participants. Avoidance of exercise in preceding 12 h was not followed by 94.12% ( $\chi^2 = 26.47$ ,  $P < 0.0001$ ), voiding bladder before the measurement was not followed by 88.24% ( $\chi^2 = 19.88$ ,  $P < 0.0001$ ), and avoidance of diuretics (e.g., chocolate, caffeine) was not practiced by 82.35% ( $\chi^2 = 14.24$ ,  $P = 0.0002$ ). Prescribed steps for measurement proper were followed by majority of the operators. However, 61.76% ( $\chi^2 = 1.88$ ,  $P = 0.17$ ) forgot to keep log of the readings.

**CONCLUSION:** Clinicians, fitness instructors, and nutritionists should emphasize on premeasurement factors for educating their clients for HBFM. This would help proper tracking of body fat level.

## Keywords:

Adipose tissue, body mass index, electric impedance, home body fat monitoring, obesity

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## Introduction

The burden of obesity is not limited to the developed countries anymore.<sup>[1]</sup> The prevalence of obesity is significantly increasing in developing countries too.<sup>[2]</sup> For classification of overweight and obesity, the World Health Organization still recommends the use of body mass index (BMI).<sup>[3]</sup> One major limitation of BMI is that it cannot differentiate between the

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relative portion of body fat and fat-free mass; rather it considers whole body weight. Hence, determination of body fat may help in more accurate estimation of body fatness. For measurement and estimation of body fat, there are different laboratory methods (e.g., Dual-energy X-ray absorptiometry, magnetic resonance imaging, hydrostatic weighing) with variable accuracy.<sup>[4]</sup> However, these tests are not feasible to use in mass survey or in home body fat monitoring (HBFM). Bioelectrical impedance analysis (BIA)

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method provides a promising way to estimate body fatness, and this method has been used to make portable devices.<sup>[5,6]</sup> These portable devices can be used in the estimation of body fatness in clinical studies,<sup>[7]</sup> as well as at home by the individuals on themselves. However, these devices should be used with several precautions. Otherwise, it may provide erroneous report of body fatness.<sup>[5,7,8]</sup>

To the best of our knowledge, no previous study has been conducted to ascertain the level of competency at operator level for HBFM.

With this background, the aim of this study was to find out the level of competency in HBFM carried out by portable body fat monitors (BFM), which is based on BIA principle.

## Materials and Methods

### Ethical statement

This study was designed as a cross-sectional, noninvasive, survey-based study. The recruited participants used their own BFM to estimate their body fat which they frequently do at their home. Hence, there were negligible risks to its participants. The study was conducted in full accordance with the World Medical Association Declaration of Helsinki after taking permission from the Institutional Ethics Committee (No: 333/Chairman-IEC).<sup>[9]</sup> All the participants were adult and provided written consent. The survey was conducted during March–December 2017 in Kolkata, India.

### Sample of the study

Considering the aim and nature of the study, a convenience sample was found to be feasible according to available logistics. Adults whose age was >18 years, having body fat analyzer of her/his own with an experience of HBFM >3 months, were included after taking written consent. Individuals suffering from any acute illness or any mental stress were excluded from the study.

Participants were recruited from four fitness centers situated in and around Kolkata. Individuals attending fitness centers were asked about the availability of BFM at their home. Those who had the BFM were first described about the aim and procedure of the study, and then their willingness was recorded in the informed consent form.

### Survey questionnaire

A questionnaire was drafted in accordance with the aim of the study. This questionnaire was intended to be used as the survey instrument. It was composed

of two parts. The first part was for recording age, weight, height, and experience in HBFM. The second part of the questionnaire was for recording the competency in HBFM. It was composed of statements with “followed” and “not followed” closed option to record the response. Premeasurement statements were asked as question by the interviewer. Statements for measurement proper was structured in such a way that the interviewer can record the responses by observing the participant, while they were measuring body fat by BFM on themselves. Postmeasurement recording of the reading of body fat was either observed or asked by the interviewer. After drafting the instrument, face and content validity was checked by senior colleagues who had expertise in questionnaire development. The questionnaire was intended to be used by the expert interviewer, and the response would not be recorded by self-administered mode. Considering these factors and assuming the scarcity of participants with BFM, pretesting of the survey instrument was done by interviewers on four fitness trainers as participant. After the experience of pretesting, the questionnaire was found to be feasible to be used by surveyor for the study. Data of these pretesting were not included in the analysis. The survey questionnaire is available at the end of this article.

### Data acquisition

The participants were informed about the date of survey a week before the survey. They brought their BFM to the fitness centers and the survey was conducted by the interviewers with the pretested questionnaire. Age of the participants was recorded in years as declared by the participants. Height was measured by stadiometer to nearest 0.1 cm and weight was measured by digital weighing scale with 0.1 kg sensitivity. Experience of HBFM was recorded as declared by the participants. For the second part of the questionnaire, competency in premeasurement was recorded as the participants answered the questions. Competency in measurement proper was observed by the interviewer during HBFM. Postmeasurement recording of reading, if practiced by the participant, was observed and recorded. In cases where participants did not record the reading, they were asked if they usually record or not.

### Statistical analysis

Responses were first coded in a spreadsheet application OpenOffice Calc (Apache Software Foundation, Maryland, USA). Data were analyzed by expressing it in mean and standard deviation and percentage. Unpaired *t*-test was used to compare the mean of variables in male and female. Chi-square test was used to compare the proportions. For all statistical test, two-tailed  $\alpha$  was set at 0.05. Unpaired *t*-test and Chi-square tests were carried

out in GraphPad Prism 6.01 (GraphPad Software, Inc., CA, USA).

## Results

A total of 437 individuals attending the fitness centers were enquired about the availability of BFM at their home, and among them, 34 (7.78%) person had the monitor. Data were collected from all the participants by the interviewers; hence, survey data from 34 participants were analyzed which indicate survey response rate of 100%. Eleven male (32.35%) and 23 female (67.65%) participants participated in the study. Age, anthropometric parameters, and their experience in HBFM are shown in Table 1.

Competency in HBFM in percentage is shown Table 2. Only avoidance of alcohol before measurement ( $\chi^2 = 19.88, P < 0.0001$ ) and no measurement during illness was showed ( $\chi^2 = 23.06, P < 0.0001$ ) proper practice. Rest of the premeasurement precautions were not followed by majority of the operators [Table 2]. Highest incompetency was found for exercise in preceding 12 h of measurement with 94.12% ( $\chi^2 = 26.47, P < 0.0001$ ) participants doing wrong. Voiding of bladder before the measurement was not followed by 88.24% ( $\chi^2 = 19.88, P < 0.0001$ ), and avoidance of any kinds of foods having a diuretic effect

**Table 1: Age, height, weight, body mass index, and experience in home body fat monitoring**

Parameter	Male (n=11)	Female (n=23)	t, P
Age (years)	22.18±4.14	23.96±4.78	1.05, 0.29
Weight (kg)	75.55±9.64	58.78±12.95	3.81, 0.0006*
Height (cm)	173.09±5.96	156.17±6.96	6.92, <0.0001*
BMI (kg/m <sup>2</sup> )	25.36±4.28	24.14±5.47	0.65, 0.52
Experience in HBFM (months)	15.91±9.28	17.17±9.24	0.37, 0.71

\*Statistically significant P value of unpaired t-test. HBFM=Home body fat monitoring, BMI=Body mass index

**Table 2: Competency in premeasurement, measurement and postmeasurement procedures followed by operators (n=34) in home body fat monitoring**

Variables	Followed, n (%)	Not followed, n (%)	$\chi^2, P$
<b>Premeasurement precaution</b>			
No alcohol consumption in previous 48 h	30 (88.24)	4 (11.76)	19.88, <0.0001*
No diuretics (e.g., chocolate, caffeine) in previous 24 h	6 (17.65)	28 (82.35)	14.24, 0.0002*
No exercise in previous 12 h	2 (5.88)	32 (94.12)	26.47, <0.0001*
No eating or drinking in previous 4 h	8 (23.53)	26 (76.47)	9.53, 0.002*
Voiding bladder within 30 min	4 (11.76)	30 (88.24)	19.88, <0.0001*
Not suffering from any acute disease symptoms (e.g. fever, dehydration)	31 (91.18)	3 (8.82)	23.06, <0.0001*
<b>Measurement proper</b>			
Input of accurate data (viz., sex, age, height, weight) on monitor	26 (76.47)	8 (23.53)	9.53, 0.002*
Proper body position during measurement	31 (91.18)	3 (8.82)	23.06, <0.0001*
Proper body contact with all electrode	32 (94.12)	2 (5.88)	26.47, <0.0001*
No movements during measurement	34 (100)	0	34, <0.0001*
<b>Postmeasurement action</b>			
Keeping log of body fat readings	13 (38.24)	21 (61.76)	1.88, 0.17

\*Statistically significant P value of Chi-square test

(e.g., chocolate, caffeine) was not practiced by 82.35% ( $\chi^2 = 14.24, P = 0.0002$ ) of participants. In contrast, correct steps for measurement proper were followed by majority of the operators. Postmeasurement storage of reading was equivocal ( $\chi^2 = 1.88, P = 0.17$ ).

## Discussion

As the BIA-based BFM is easily available in the market at affordable cost, it is being used by many health-conscious people. This study revealed that though the measurement proper at the operator level is satisfactory, the premeasurement protocols are not followed. There may be multiple causes for this incompetency. Lack of training may be one of the causes which can be taken care of by the fitness trainer or nutritionist or clinicians. Measuring without proper knowledge about the importance of hydration during measurement may be another cause. The reading of the body fat highly depends on the hydration level of the individual. Less hydration would give a high body fat percentage, while excess hydration would give a lower body fat percentage.<sup>[10]</sup> Hence, maintenance of proper hydration level before measuring body fat is of paramount importance in HBFM.

Among the participants, females were keener to check and track their body fat than males, though their age and BMI were not significantly different [Table 1]. The female showed slightly more time of experience in HBFM at the time when this survey was conducted; however, the difference was not statistically significant [Table 1].

Portable BFM uses prediction equation to estimate the body fat from the data obtained by BIA, and this equation is specific for a particular device and ethnic group. For estimation of body fat with less error, devices designed

for particular ethnic group should be used.<sup>[11]</sup> This should be taken into consideration while suggesting a BFM to the clients.

Instant measurement of body fat gives us no conclusive result. Because, even if the proper premeasurement protocols are followed, devices may not provide the same result if measured several times within a short period.<sup>[12]</sup> Hence, it is recommended to take at least three readings for a particular session and take the average of the reading as final.

The result of this study showed that only 38.24% of the participants were maintaining a logbook for the body fat readings. Those who are in any diet control program or having exercise with an aim to reduce the body fat are advised to keep a logbook of their body fat. This would help them to track the changes in body fat percentage over the time course.

We created a list of actions to be followed and precautions to be taken for body fat measurement by BIA devices according to the standard guidelines in Figure 1.<sup>[8,13,14]</sup> Clinicians, fitness trainers, and nutritionists can use this list for educating their clients.

This study has some limitations. Although the participants were briefed about the aim of the study, individuals' consciousness and social desirability bias were beyond our control. For data collection, home visit was not possible due to logistics limitations (time, money, and workforce). A home visit would reflect the actual condition (e.g., temperature of room) in which the measurements are normally done, because ambient temperature has effect in BIA.<sup>[15]</sup>

## Conclusion

Appropriate measures to control the hydration level before body fat measurement are not practiced by majority of the operators in HBFM. Hence, during client training, special emphasis should be on premeasurement

precautions. The Dos and Don'ts chart presented in this article may be used as a quick educational tool. Result of this pilot study may be used as reference literature for future studies.

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## Conflicts of interest

There are no conflicts of interest.

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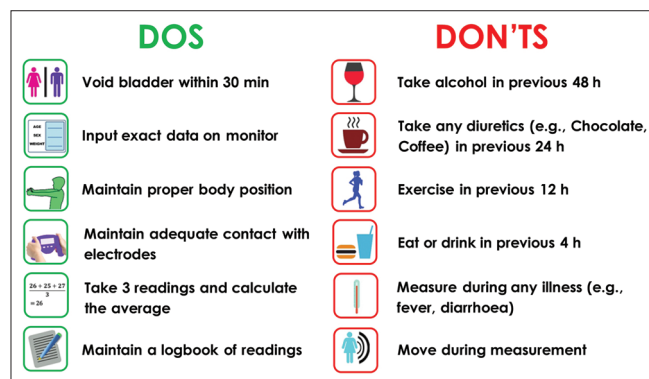


Figure 1: Dos and Don'ts during body fat estimation by portable body fat monitors which uses bioelectrical impedance analysis methods for estimating body fat

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## Survey Questionnaire

### Survey questionnaire for assessing competency in home body fat monitoring (HBFM)

(Intended for data collection by interview, measurement, and observation by expert interviewer)

#### Part 1: Fill up by interview and measurement

Identification number

Age (years)

Height (cm)

Weight (kg)

Experience in HBFM (months)

#### Part 2: Fill up by interview and observation

##### Premeasurement precautions

Component	Followed	Not followed
No alcohol consumption in previous 48 h	<input type="checkbox"/>	<input type="checkbox"/>
No diuretics (e.g., chocolate, caffeine) in previous 24 h	<input type="checkbox"/>	<input type="checkbox"/>
No exercise in previous 12 h	<input type="checkbox"/>	<input type="checkbox"/>
No eating or drinking in previous 4 h	<input type="checkbox"/>	<input type="checkbox"/>
Voiding bladder within 30 min	<input type="checkbox"/>	<input type="checkbox"/>
Not suffering from any acute disease symptoms (e.g. fever, dehydration)	<input type="checkbox"/>	<input type="checkbox"/>

##### Measurement proper

Component	Followed	Not followed
Input of accurate data (viz. sex, age, height, weight) on monitor	<input type="checkbox"/>	<input type="checkbox"/>
Proper body position during measurement	<input type="checkbox"/>	<input type="checkbox"/>
Proper body contact with all electrodes	<input type="checkbox"/>	<input type="checkbox"/>
No movements during measurement	<input type="checkbox"/>	<input type="checkbox"/>

##### Postmeasurement action

Component	Followed	Not followed
Keeping log of body fat readings	<input type="checkbox"/>	<input type="checkbox"/>