The inter-observer variations in symphysio-fundal height measurements obtained by fourth year medical students: Are they associated with maternal and observer factors?

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Abstract

Introduction

Inter-observer variations are one of the several limitations in the use of Symphysis-Fundal Height (SFH) measurements which are frequently used to screen for foetal growth abnormalities prior to ultrasound foetal biometry.

Objectives

The objectives of this study are to measure the inter-observer variations of SFH measurements obtained by Semester 8 medical students of the International Medical University (IMU), Malaysia and to determine whether there is any association between maternal and observer factors and the inter-observer variations.

Method

A cross sectional study was carried out among 77 pairs of the IMU Semester 8 medical students who underwent training in the Obstetrics and Gynaecology (O&G) posting from 26th February to 31st May 2018. The first student in each pair was aware of the patient's demographics, her gestational age (GA) and her obstetric complications if any, while the second student was blind to all the maternal data. The Limits of Agreement between the two SFH measurements obtained by a pair of students were calculated. The association between the inter-observer variations in the SFH measurements obtained by a pair of students and maternal height, weight, GA, parity, body mass index (BMI) and the students' duration of training in the O&G posting were studied.

Results

The limits of agreement between the two SFH measurements obtained by a pair of students were very wide and ranged from –6.0 cm to + 5.6 cm. Approximately 34% of the 77 pairs of students had inter-observer variations of SFH within the clinically acceptable limit of - 2cm to +2cm. There was no association between inter-observer variations in SFH and maternal height, weight, GA, parity, body mass index (BMI) and the students' duration of training in the O&G posting.

Conclusions

There were wide inter-observer variations between the SFH measurements obtained by IMU Semester 8 medical students but the variations were not associated with maternal or observer factors.

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Introduction

The measurement of the SFH which was introduced in Sweden by Westin in 1977[1], as an acceptable tool in screening for foetal growth, is an inexpensive method that can be easily used in any setting providing antenatal care. Limitations of the SFH measurement have been described even before Westin's Gravidogram was introduced[2]. Although sensitivities of up to 84% have been reported, high false positive rates and very low sensitivities of 27% too have been reported[3]. Similarly, specificities ranging from 87% to 100% with

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sensitivities ranging from 81% to 0% in the detection of a small for gestational age (SGA) foetus have also been reported depending on the SFH reference chart used[4]. It would not be feasible to perform ultrasonography on every pregnant woman, at each antenatal review visit, in all settings. Hence, SFH measurements continue to be practised widely as an inexpensive screening tool for foetal growth abnormalities. Health care personnel carrying out SFH measurements should be trained to carry it out correctly in order to improve its validity. Similar to ultra sound foetal biometry, a single measurement *per se* is of limited value unless it is grossly abnormal. The SFH measurements too should be plotted on an appropriate chart and its trend observed, in order to improve its validity in the detection of foetal growth abnormalities[3,4]. In the absence of customised SFH charts, the International Standards for SFH could be used [5].

Like any other measurement obtained by multiple individuals, SFH will have inter-observer and intra-observer variations. In a study carried out in England in 1989, inter-observer variations of SFH measurements obtained by two experienced obstetricians were reported to range from -5.0cm to + 1.6 cm [6]. In a study conducted in 2016/2017, in a Teaching Hospital in Sri Lanka, inter-observer variations in SFH measurements obtained by post graduate trainees in obstetrics and gynaecology (O&G), in women between 30 to 36 weeks' gestation, were reported to vary from -1.7cm, (95% CI -1.6 to -1.8) to + 1.8 (95%CI -1.7 to 1.9)[7]. As can be expected, these variations are known to be large amongst relatively inexperienced observers, and to become less with increased experience, although they cannot be completely eliminated. Clinical features obtained by a detailed current antenatal and past obstetric history and a careful physical examination must be taken into consideration when interpreting the SFH measurements especially as the SFH measurement can also be affected by factors affecting the size and shape of the uterus as well as maternal factors e.g. gestational age (GA), maternal height, weight, body mass index (BMI), and the shape of the mother's body[8-12]. It is important to be aware of these variations when interpreting SFH measurements of a pregnant mother who is being followed up by several caregivers during her pregnancy.

During the first week of the reproductive module in Semester 4, medical students of the International Medical University (IMU) at the Bukit Jalil Campus are taught to carry out a complete antenatal physical examination on obstetric manikins and this includes the technique of measuring the SFH. Thereafter, they are required to demonstrate the measurement of the SFH on a manikin, at least once under supervision, in the Clinical Skills Unit (CSU). During the last week of the reproductive module they again have a revision session where they have the opportunity to perform a complete antenatal physical examination including SFH measurements on a manikin. The students are allowed to practise the measurement of SFH as many times as they want to in the CSU to prepare themselves for the semester 5 Objective Structure Clinical Examinations. In Clinical School Seremban, early exposure to measurement of SFH starts during their family medicine posting where it is compulsory for semester 6 students to visit the maternal child healthcare clinic and observe the conduct of antenatal booking visits throughout the seven weeks of their Family Medicine posting. During this posting students are also given the opportunity to carry out abdominal examination including SFH measurements on a pregnant woman under the supervision of a lecturer or a nursing sister.

As an integral component of their clinical training, the Semester 8 medical students of IMU are sent to the O&G Department of the Tuanku Jaafar Hospital Seremban (HTJS), where they interview and obtain data and examine as many pregnant women as possible, and observe, assist or perform procedures under supervision. All students are expected to measure SFH of the women they examine, document their findings in their "clerking sheets", and interpret the SFH they obtain. Therefore, this study was designed to measure inter-observer variations of SFH measurements obtained by IMU Semester 8 medical students and determine whether maternal GA, parity, height, weight, BMI and the duration of students' training in the O&G posting are associated with the inter-observer variations of SFH measurements obtained by IMU Semester 8 medical students.

Materials and Methods

One of the learning methods routinely adopted in Ward 3A of HTJS was for two medical students to independently examine a pregnant woman, without knowing each other's findings, and then compare their findings. Only one student would have interviewed and obtained data from the patient. This procedure has been routinely adopted in Ward 3A of HTJS from July 2017, in order to educate students regarding the occurrence of inter-observer variations and also to improve their skills in obtaining SFH measurements. For this purpose, students routinely obtained verbal consent from the women they examined. A convenient sample (n=77) of pregnant women, in the third trimester, who were admitted to ward 3A of HTJS during the period 26th February 2018 to 31st May 2018 were recruited for the study. Women with unstable lies and placenta previas were excluded from the study. There were no drop outs after consent was obtained. A cross sectional study of inter-observer variations in the measurement of SFH was carried out on 77 pairs of students who underwent training in O&G during this period. Each patient who participated in the study had her SFH measured by a pair of students. The two students of each pair carried out the measurements independently, within 24 hours of each other. Blinding of the first student regarding the woman's GA was not possible as the student would have obtained the history from the woman prior to examining her. The second student examining the woman was not informed about the patient's demographics, her GA and her obstetric complications if any. This was to avoid any bias due to prior knowledge of the patient's data by the second student. Each pair of students had identical number of days training and experience in obtaining SFH measurements after commencing the O&G posting and also identical opportunities to have practised it earlier. The objective of the study was not to investigate the accuracy or the validity of the SFH measurements but to assess the inter-observer variations of the measurements obtained. Therefore, women with factors which could affect the accuracy or validity of the SFH measurements were not excluded from the study.

The SFH measurements were carried out with the pregnant woman lying comfortably and relaxed in the recumbent position on her bed with bladder emptied. By using a non-elastic tape measure with the centimetre measure facing downward so that the measurement was not visible during the actual SFH measurement, the measurement was taken from the variable point (the fundus) to the fixed point (the upper border of pubis symphysis), along the longitudinal axis of the uterus. For purposes of this research project, the SFH measurements were documented by each student in the data collection forms which were provided in addition to recording

it in their respective "clerking sheets". The woman's parity, height, current weight, BMI and GA were also documented in the data collection sheet only by the first student who had obtained the history from the woman prior to examining her. The woman's weight and height were measured using a digital scale (Seca 769, Hamburg, Germany). The gestational age determined by either the calculation from menstrual data or by the ultrasound dating scans was used. The number of days of training in the O&G posting of each pair of students was also documented.

The data collection was done in a cross-sectional manner and a pregnant woman had her SFH measured only once a week, unless she remained in the ward for more than a week. Only one set of SFH measurements obtained by a pair of students, per pregnant woman, was included for the study. The data was stored confidentially in a password protected ongoing computer database and analysed using the computer software Statistical Package for the Social Sciences (SPSS) and Microsoft Excel. The correlation between the SFH measurements obtained by a pair of students was assessed using Pearson's Correlation Coefficient. The agreement between the inter-observer measurements in SFH was assessed by calculating the Limits of Agreement by plotting a graph between the difference in the SFH measurements obtained by a pair of students against the mean of the SFH measurements obtained by a pair of students[11,12] (Bland-Altman method). The clinically acceptable inter-observer variation was considered to be a maximum of –2cm to +2cm. Pearson's Correlation was used to study any association between the inter-observer variations and the GA, maternal height, weight and BMI and the duration of training of IMU Semester 8 medical students in the O&G posting. Spearman's rank correlation was used to study the association between maternal parity and the inter-observer variations. Throughout the current study, informed written consent was obtained from all the women in whom the SFH was measured for purposes of the study as well as from all the students who participated in the study. The study was approved by the IMU – Joint Committee on Research and Ethics (Registration No: IS 308).

Results

The characteristics of the study population are shown in Table 1. The maternal height, gestational age and parity were found to be skewed (skewness less than – 0.5 or more than +0.5) and maternal height was found to have a significant kurtosis (3.2). However, after removal of outliers (defined as values lying outside + 2 standard deviations), all the factors were found to have normal (Gausian) distributions.

Table 1: Characteristics of the study population (n=77)

Characteristics	Range	Mean	SD	Median	IQR	Skewness	Kurtosis	10thC	90thC
Weight (kg)	45-120	70.7	15.9	68.3	59.5 – 81.0	0.421	0.066	49.0	90.8
Height (m)	1.4 – 1.8	1.6	0.1	1.6	1.5 – 1.6	0.910	3.213	1.5	1.6
Body Mass Index (kg/m^2)	18.1 – 49.3	28.6	6.4	27.7	24.2 – 33.4	0.436	0.195	20.0	36.6
Gestational Age (weeks)	28 – 40	35.0	2.7	36.0	33.5 – 37.0	-0.554	0.181	31.0	38.0
Parity	0-5	-	-	1	1-2	1.014	0.471	0	4
Duration of training of a pair of students in the obstetrics & gynaecology posting (days)	2 – 46	24.8	13.3	24.0	12.0 – 24.5	-0.072	-1.014	3.0	44.0

SD= Standard Deviation, IQR= Interquartile Range, C= Centile, kg= kilogram, m= metre

Table 2: Symphysio Fundal Height (SFH) measurements and inter-observer variations (n=77)

Characteristics	Range	Mean	SD	Median	IQR	Skewness	Kurtosis	10thC	90thC
SFH – A (cm)	26 – 42	33.6	3.6	35.0	31.0 – 36.0	-0.213	-0.573	28.0	37.2
SFH – B (cm)	27 – 42	33.4	3.2	34.0	31.0 – 36.0	0.097	-0.129	29.0	37.1
Inter-Observer Variations	-7.0 to +6.0	-2.0	3.0	0.0	-2.0 to +2.0	0.090	-0.319	-4.0	+3.6

SFH= Symphysio Fundal Height, SD= Standard Deviation, IQR= Interquartile Range, C= Centile, cm= centimetre

The SFH measurements obtained by the students had normal (Gausian) distributions. The inter-observer variations in the SFH measurements obtained by the students also had a normal (Gausian) distribution but had a wide range from –7.0 cm to +6.0 cm.

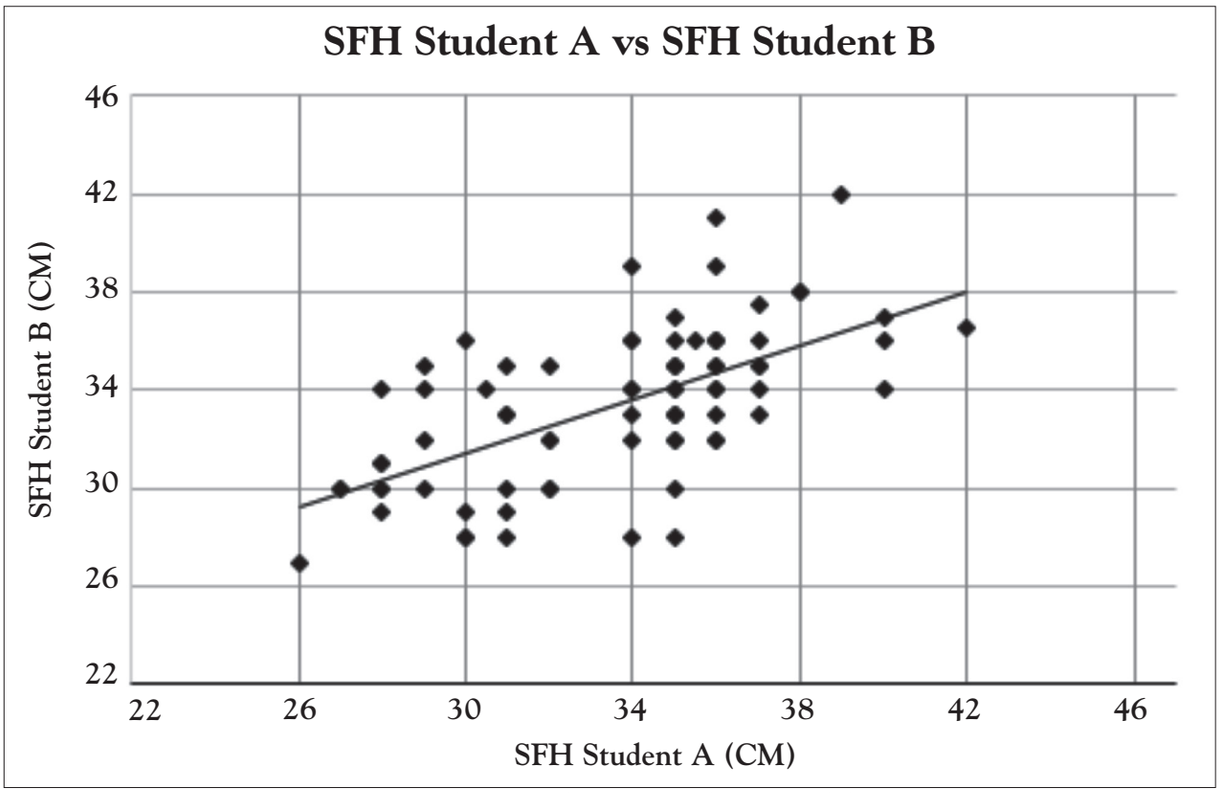

Figure 1: Correlation between the two Symphysio Fundal Height (SFH) measurements obtained by a pair of students. (n= 77)

Using Pearson's Correlation, there was a significant, strong positive correlation between the two SFH measurements obtained by a pair of students ($r = 0.618$, $r^2 = 0.381$, $p < 0.0001$) (Figure 1). However, the Limits of Agreement between the two SFH measurements obtained by a pair of students were very wide, and ranged from –6.0cm to +5.6cm (Figure 2). Furthermore, approximately 34% of the 77 sets of data sets obtained from the participants in this study had inter-observer SFH variations within the clinically acceptable limits of –2cm to +2cm. Approximately 30% had variations > +2cm and 36% had variations > –2cm. (Figure 3).

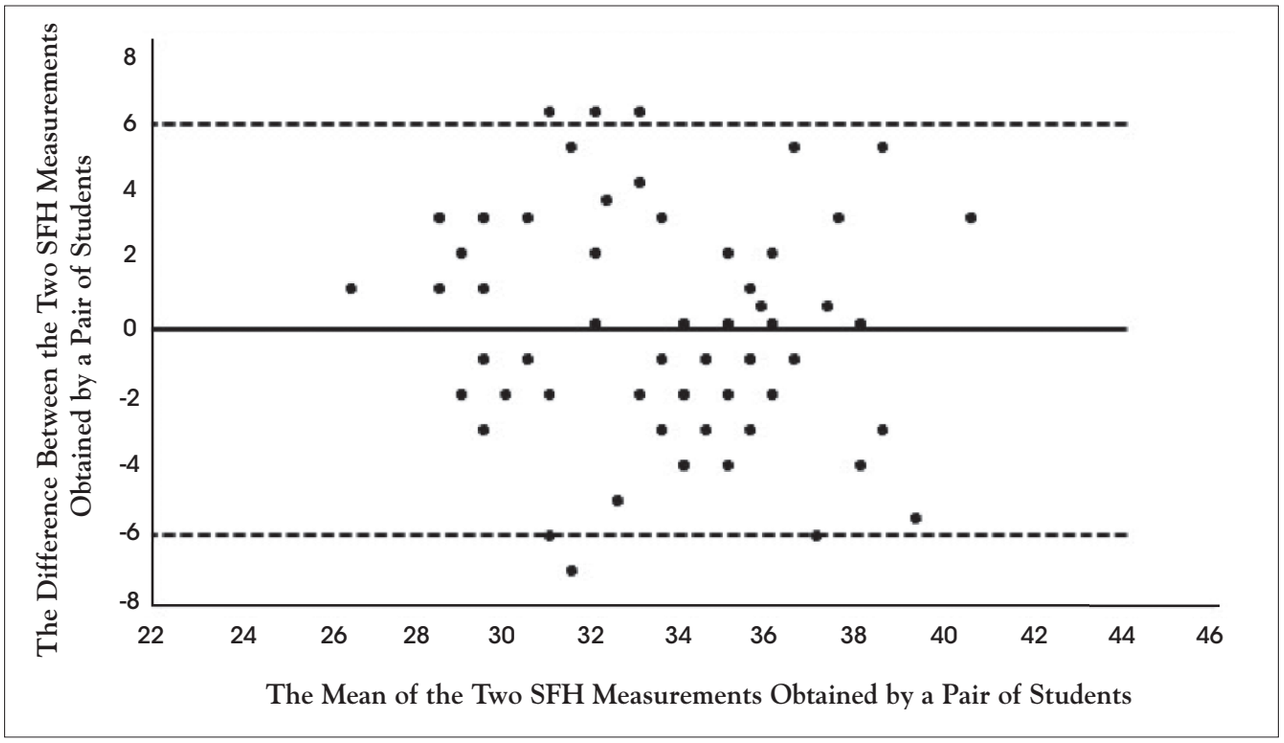

Figure 2: Limits of agreement between the two Symphysio Fundal Height (SFH) measurements obtained by a pair of students. (n= 77)

Note: The upper and lower dotted lines represent the limits of agreement (±2 standard deviations).

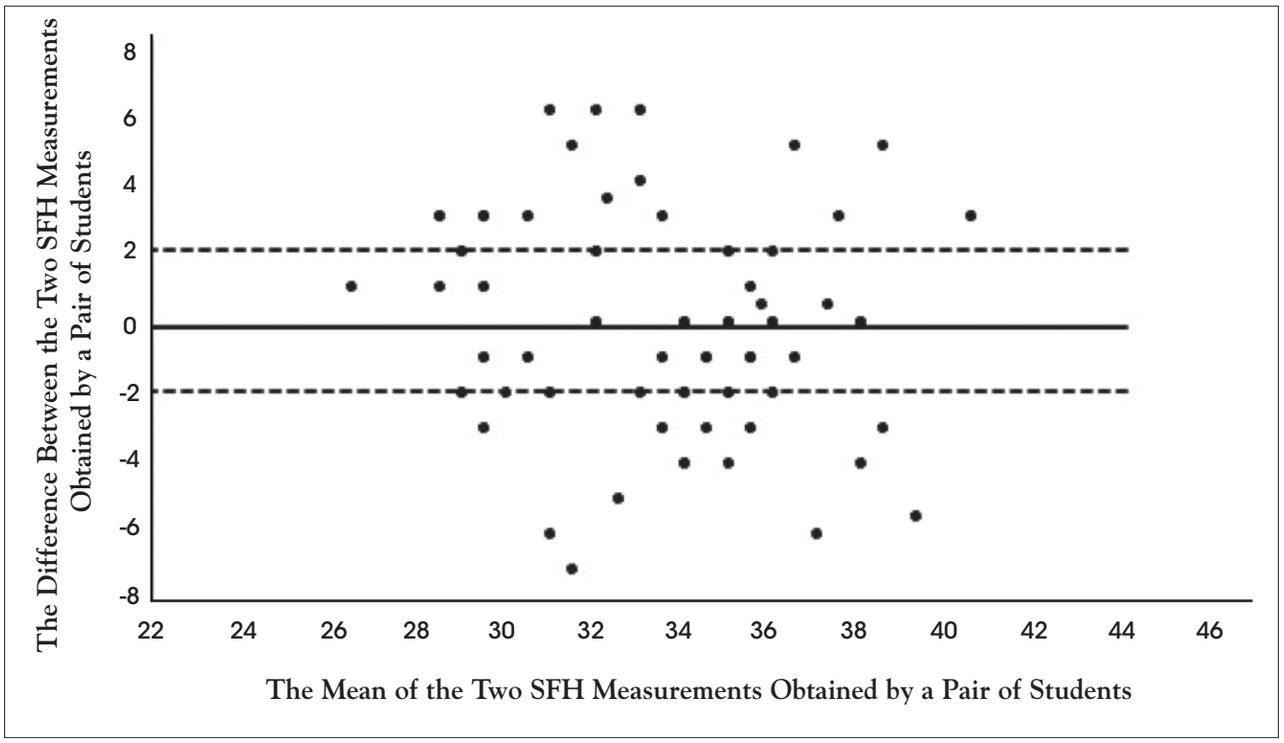

Figure 3: Clinically acceptable variation between the two Symphysio Fundal Height (SFH) measurements obtained by a pair of students. (n= 77)

Note: The data points in between the upper and lower dotted lines show inter-observer variations between two SFH measurements obtained by a pair of students which are within the clinically acceptable limits of –2cm to +2cm.

Table 3: Correlation of inter-observer variations with maternal and observer factors (n=77)

Factors	Pearson Correlation	
	Correlation	P value
Weight (kg)	0.114	0.324
Height (m)	-0.009	0.935
Body Mass Index (kg/m^2)	0.077	0.505
Gestational Age (weeks)	-0.262	0.021
Duration of training of a pair of students in the obstetrics & gynaecology posting (days)	-0.034	0.767

Note: kg= kilograms, m= metre

Table 4: Correlation of inter-observer variations with maternal and observer factors after removal of outliers (defined as values lying outside ±2 standard deviations)

Factors	Pearson Correlation	
	Correlation	P value
Weight in kg (n= 73)	0.107	0.369
Height in meters (n= 74)	-0.006	0.957
Body Mass Index in kg/m^2 (n= 75)	0.082	0.486
Gestational Age in weeks (n= 72)	-0.116	0.331
Duration of training of a pair of students in the obstetrics & gynaecology posting in days (n= 76)	-0.089	0.447

Note: kg= kilograms, m= metre

Table 5: Correlation of inter-observer variations with parity (n= 77)

Factors	Spearman's Rank Correlation	
	Correlation Coefficient	P
Parity	-0.097	0.404

The results presented in Tables 3-5, showed that there was no association between inter-observer variations in SFH and maternal height, weight, BMI, parity or the observers' duration of training in the O&G posting.

Discussion

The range of inter-observer variations and the limits of agreement between the SFH measurements of the same pregnant woman obtained by a pair of students were very wide. However, other maternal factors such as weight, height, BMI, parity and GA did not show any association with the inter-observer variations. Similarly, the duration of training of Semester 8 medical students in the O&G posting also did not show any association in the inter-observer variations of SFH measurements, although a negative correlation was expected.

Although a simple correlation coefficient shows that there is a strong positive correlation between the two SFH measurements obtained by a pair of students, this method of analysis is inappropriate for measurement of the agreement between one continuous variable measured by two observers[11,12]. The more appropriate Bland Altman method of analysis shows the very wide (–6.0cm to +5.6cm), clinically unacceptable inter-observer variations in the current study. As this study was focusing only on measuring the inter-observer variations and not on validating the SFH measurements or their interpretations, no effort was made to verify the accuracy or validity of the SFH measurements obtained by the students. Assuming that the SFH measured by Student A is more likely to be closer to the correct value, as this student would be biased by having prior

knowledge of the patient's data, the Student B who was blind to all these data of the patients was apparently significantly overestimating or under estimating the SFH measurement This could be due to errors in the technique of measurement of SFH, especially because these measurements were obtained without any supervision.

The Limits of Agreement in the SFH measurements obtained by IMU Semester 8 medical students, which would be clinically acceptable, were considered to be in between the range of –2.0cm to +2.0 cm. Approximately 66% of the data sets were outside of these Clinically Acceptable Limits of Agreement. Approximately 30% had variations > +2cm and 36% had variations > –2cm. This needs to be improved. With more experience, the limits of agreement should decrease. In the study carried out in Sri Lanka, which was similar to the current study, the Clinically Acceptable Limits of Agreement were set at –1.0 cm to +1.0cm. However, that study was conducted by postgraduate trainees in O&G.[10] Although no decrease of the inter-observer variations was seen with increased duration of training in the current study, as the mean duration of the training in the students was only approximately 24 days, we expect that when these IMU Semester 8 medical students complete Semester 10 (the final semester), the inter-observer variations in SFH measurement would have decreased due to increased experience. Although maternal factors could affect the SFH measurements,[2,5-10] in the current study, maternal height, weight, BMI and parity were not associated with the inter-observer variations.

Limitations

One possible limitation of our study is that measurement of SFH by the students were not carried out under direct supervision and therefore different techniques could have been used by the students, although all of them had been taught the correct technique, prior to starting their training in Semester 8, as well as on the first day of their posting in O&G. Consequently, human errors could have played a major role. However, this is what would happen in actual clinical practice. After the initial teaching/training of students, the students are expected to practise the procedure and gain further experience. Often they carry it out by themselves, with only intermittent supervision, until they have formal assessments of their techniques midway and at the end of their posting.

Conclusion and Recommendations

As assessment of foetal size and growth by measurement of SFH continues to be a simple and inexpensive clinical examination widely used during antenatal care in both high and low-resource settings, there should ideally be minimal inter-observer variation of SFH measurements obtained in the same woman by two observers. When considering IMU semester 8 medical students, the Limits of Agreement should probably be a maximum of –2cm to +2cm. However, in the current study, the Limits of Agreement were too wide and clinically not acceptable. Maternal and observer factors do not appear to affect the inter-observer variations in the SFH measurements obtained by IMU semester 8 medical students.

The Direct Observation of Procedural Skills on simulators should be extended to include SFH measurement in Semester 8. The Family Medicine posting in Semester 6 should include more than one session for physical examination and SFH measurement of pregnant women. SFH measurements should be included as a compulsory procedure in the Semester 6 Log Book. This would ensure increased experience and allow them to improve their SFH measuring skills prior to commencing their O&G Posting. IMU semester 8 medical students should gain more experience in the measurement of SFH measurement in pregnant women by practising measurement of SFH on as many patients as possible when undergoing their training in the O&G posting. They should practise in pairs, with one student blind to the patients' data, especially the GA and her obstetric problems if any. They would then be able to cross-check each other's technique and findings, improve their clinical skills and reduce inter-observer variations.

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