Research Article

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Ultrasonography Knowledge and Practices among Obstetrics/Gynecology Practitioners; A Nationwide Survey in Jordan

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Abstract: Background: Ultrasonography is an indispensable tool in obstetric practice. This study aims to assess the ultrasonography-related knowledge, practices, and training aspects of Jordanian Obstetrics/Gynecology (OB/GYN) practitioners. This cross-sectional study was conducted in Jordan between September 2019 and January 2021 among OB/GYN medical practitioners. The study tool was based on a questionnaire composed of 25 closed-ended questions on demographic data and ultrasonography-related knowledge, practices, and training. Results: A total of 197 practitioners participated, and these were mostly female (N=126, 64.0%) and specialist (N=156, 79.2%). Most participants had sufficient knowledge on timing of detailed fetal scans (78.7%), nuchal translucency scans (89.3%) and aneuploidy markers (74%); these participants were mostly female (P=0.000, P= 0.04, respectively). On the other hand, insufficient knowledge was noted on other aspects, including the as-low-as-reasonably-achievable (ALARA) principle (25.9%) and meaning of the terms thermal index (25.4%) and mechanical index (23.9%), with no gender differences found. Only 45.2% of participants attended ultrasonography workshops in the past 2 years, and the attendees were mainly female (P=0.016). Regression analysis indicated that attending training courses on ultrasonography within past 2 years and routine practice of requesting detailed fetal scans between 18 and 22 weeks were the only significant predictor variables for high knowledge scores (P=0.002 and < 0.001, respectively). Conclusions: Educational courses on ultrasound safety and practices are warranted for OB/GYN practitioners working in Jordan, especially for male practitioners. Revising undergraduate medical curricula and increasing the number of qualified specialists in maternal-fetal medicine may be necessary, particularly in aspects relating to the introduction of advanced ultrasound physics and practice.

Keywords: Ultrasonography, Obstetrics, Gynecology, Knowledge, Maternal-fetal medicine, Jordan

1 Introduction

Ultrasonography remains the preferred imaging modality in obstetrics and gynecology (OB/GYN).[1] In low- and middle-income countries it is used as a diagnostic method for multiple conditions, such as obstructed labor, noncephalic presentation, single or multiple pregnancy, incomplete miscarriage, molar pregnancy, ectopic pregnancy, fetal abnormality, intrauterine growth restriction, placenta previa, as well as the measurement of the pelvic outlet and estimation of gestational age.[2] An inherent characteristic of ultrasonography is that it is clinician-dependent, and it requires high technical skills, necessitating effective training to ensure provision of high-quality healthcare services represented by high-quality images.[3] This highlights the importance of focused ultrasound training courses by qualified personnel to advance theoretical and practical skills of clinicians.[3] Lack of standardized training for ultrasound in OB/GYN is still a problem

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in many parts of the world,[4] including the United States and Europe, where recent studies report widespread variability in availability, quality, and methods of training and assessment. [1] Recently, the duration of postgraduate ultrasound training in OB/GYN throughout Europe was shown to be suboptimal, as it takes place during only a few months in the majority of countries, in addition to lacking a written curriculum. [5] A similar situation has been found in Jordan. It is a medically advanced country within the Arab region representing a desirable destination for medical tourism. Also, Jordan has been in the spotlight lately due to the surrounding political turbulence in neighboring countries, with the resultant continuous flow of refugees and consequent huge burden on the country's healthcare system. [6] Although there has been great improvement in the affordability of ultrasound equipment, insufficient education and training of practitioners is still a major issue. [2] Additionally, the number of maternal-fetal medicine units in public hospitals falls below expectations, and this is paralleled by the large numbers of pregnant women. [7] All these data highlight the importance of assessing the current situation of practitioner's knowledge and practices in ultrasonography. Therefore, we conducted this study to evaluate knowledge and practices of OB/GYN practitioners in Jordan in regard to ultrasonography during pregnancy and to assess national needs for maternal-fetal specialty and continuous ultrasonography training courses.

2 Methods

This was a cross-sectional, questionnaire-based survey among OB/GYN practitioners in Jordan. Inclusion criteria were all medical practitioners of both genders that work in the field of obstetrics and gynecology in Jordan and who are affiliated with either the public or private sectors. Names and contact information of eligible OB/GYN practitioners were obtained from the Jordanian Medical Association (N= 600). Exclusion criteria included Jordanian obstetrics and gynecology practitioners that work abroad.

A questionnaire was adapted from Sheiner et al., [8] with some modifications (Supplemental file-1). The questionnaire consisted of 25 items that included: 7 items on socio-professional demographics (gender, age, general practitioner [GP] or specialist, country of graduation, professional affiliation, geographic location of practice and years of experience); five items on training and practice aspects (attendance and location of workshops, perception of ultrasonography training during residency, referral pattern, and timing of fetal scans); and 13 items on knowledge aspects of ultrasonography. Correct answers to knowledge questions are shown in Supplemental file-2.

The questionnaire was entered in Google forms. Prior to distribution, a number of 10 OB/GYN practitioners were invited to participate to establish reliability and validity of the questionnaire. They completed the questionnaire on two occasions separated by one week. Their responses were compared, and the calculated Cronbach's alpha and kappa values were judged to be acceptable (0.72 and 0.77, respectively). Participants accessed the questionnaire through a link sent to their smart phones. The study was ethically approved by the scientific committee of the Jordanian Medical Association #10/1/8617/2413.

The Statistical Package for Social Science (SPSS) version 21 was used for statistical analysis (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to calculate frequencies and describe the study sample's socio-professional characteristics. Descriptives of the variables were expressed as means, standard deviations, frequencies and percentages. Chi-square testing was applied to explore the relationship between various variables. Finally, multiple linear regression analysis was carried out to find significant predictor independent variables. For that purpose, Pearson correlation was applied, and statistical significance was set at $P<0.05$.

3 Results

The questionnaire was initially sent to 600 practitioners who represented the full list of OB/GYN practitioners working in Jordan at the time of study. A total of 197 practitioners participated, resulting in a response rate of 32.8%.

3.1 Sociodemographics

Sociodemographic characteristics of the study sample are presented in Table 1. Most of the study sample were female specialists, aged 30-40 years, who were graduates of training programs in Jordan, worked in the private sector mainly in Amman, the capital, and had more than 10 years of experience (Table 1). Cross tabulation of gender with socio-professional characteristics showed that significantly more females were younger, were graduates of Jordanian training programs, and worked in the private sector ($P<0.05$) (Table 1).

Table 1: Socio-professional demographics of the study sample cross tabulated with gender

Socio-professional demographics	Female (n=126)	Male (n=71)	P value
How old are you? (years)			
< 30	16 (12.7%)	2 (2.8%)	
30-40	44 (34.9%)	26 (36.6%)	
40-50	27 (21.4%)	9 (12.7%)	0.005*
50-60	35 (27.8%)	24 (33.8%)	
> 60	4 (3.2%)	10 (14.1%)	
Are you a general practisioner or specialist?			
General practisioner	30 (23.8%)	11 (15.5%)	0.167
Specialist	96 (76.2%)	60 (84.5%)	
Where did you obtain your last academic degree?			
Eastern Europe	7 (5.6%)	9 (12.7%)	
Other Arab countries	15 (11.9%)	1 (1.4%)	0.001*
Jordan	95 (75.4%)	47 (66.2%)	
Western Europe and USA	9 (7.1%)	14 (19.7%)	
What sector do you practice in?			
Private practice	97 (77.0%)	28 (39.4%)	
Ministry of health	19 (15.1%)	38 (53.5%)	0.000*
Armed forces	3 (2.4%)	1 (1.4%)	
University hospital	7 (5.6%)	4 (5.6%)	
Where do you practice?			
Outside Amman	21 (16.7%)	17 (23.9%)	0.214
Amman	105 (83.3%)	54 (76.1%)	
Experience			
≤10 years	52 (41.3%)	24 (33.8%)	0.301
>10 years	74 (58.7%)	47 (66.2%)	

*Statistically significant difference

3.2 Training and practice

Nearly one in two participants attended continuing education courses in ultrasonography in the past two years, and these were held mainly in Jordan. A substantial majority believed that ultrasonography training during residency was inadequate. More than 90% referred their patients with a suspected abnormality to a maternal-fetal medicine specialist, and more than 75% ordered a detailed fetal scan between 18 and 22 weeks of gestation (Table 2). The effect of gender in these variables were explored (Table 2). Of note, significantly more females attended training workshops in the past two years in Jordan and abroad, and more females requested detailed fetal scanning between 18 and 22 weeks ($P<0.05$) (Table 2).

3.3 Knowledge of safety and technical aspects of ultrasonography

Participants' knowledge of technical and safety aspects of ultrasonography in obstetrics practice are shown in Table 3. Most participants stated that ultrasonography is safe during all stages of pregnancy; however, Doppler ultrasound should not be used during the first trimester. Participants were almost equally divided in determining frequency of examinations conducted during the antenatal period, and a substantial proportion did not know whether the M-mode is superior to pulsed Doppler in detecting heart beat during the first trimester. Further, most participants were not familiar with the term "TI", the term "MI", or the ALARA principle. The majority of respondents believed that TI of 1.0 means a potential elevation of temperature of 0 degrees. Finally, a substantial proportion considered that moderate hydronephrosis is not an aneuploidy marker during detailed scanning, and

Table 2: Frequency and percentages of participants in various training and practice aspects cross tabulated with gender.

Training/Practice aspects	No (%)	Female	Male	P value
Did you attend continuing education courses on US in the past two years?				0.016*
No	108 (54.8)	61 (48.4%)	47 (66.2%)	
Yes	89 (45.2)	65 (51.6%)	24 (33.8%)	
Where was the workshop (s) held?				0.005*
I did not attend any workshop	93 (47.2)	49 (38.9%)	44 (62.0%)	
Jordan	70 (35.5)	48 (38.1%)	22 (31.0%)	
Jordan and abroad	26 (13.2)	23 (19.3%)	3 (4.2%)	
Abroad	8 (4.1)	6 (4.8%)	2 (2.8%)	
Was ultrasonography training during residency program adequate?				0.078
No	158 (80.2)	106 (84.1%)	66 (93.0%)	
Yes	25 (12.7)	20 (15.9%)	5 (7.0%)	
Where do you refer a patient when an abnormality is suspected?				0.254
Maternal-fetal medicine	179 (90.9)	112 (88.9%)	67 (94.4%)	
Maternal-fetal medicine and radiology	4 (2.0)	4 (3.2%)	0	
Radiology	14 (7.1)	10 (7.9%)	4 (5.6%)	
Do you order detailed fetal scanning in weeks 18-22 of pregnancy?				0.000*
No	42 (21.3)	17 (13.5%)	25 (35.2%)	
Yes	155 (78.7)	109 (86.5%)	46 (64.8%)	

*Statistically significant difference

most of respondents answered that nuchal translucency (NT) scanning is performed between 11 and 13+6 weeks.

There were no statistically significant differences according to gender except significantly more females stated that timing for an NT scan is 11-13+6 weeks (P=0.04).

3.4 Regression analysis

Scores in knowledge questions were calculated: a total of 71 (36.0%) participants scored 1-3 correct answers, 99 (50.3%) participants scored 4-6 correct answers, 27 (13.7%) participants scored 7-8 correct answers; however, no participants scored 9 correct answers (the maximum possible score). Multiple linear regression analysis was used in this study to find significant predictors for the total score of correct answers to knowledge questions. The following independent variables were investigated as possible predictors:

- Attendance at an ultrasonography workshop in the past 2 years
- Routine request of detailed fetal scanning between 18 and 22 weeks
- Gender
- Age
- Practicing as a general practitioner or specialist
- Country of graduation for the last academic qualification
- Practice sector
- Practice location (Amman or outside)
- Number of experience years in OB/GYN

Table 4 shows the model summary where R is 0.415 (< 0.7) and the adjusted R^2 value is 0.132, which indicates that 13.2% of the variance of total scores occurs due to variations in the chosen independent (predictor) variables. There could be some sort of serial correlation or multicollinearity between independent variables as indicated by the low value of the Durban-Watson test (best between 1.5 and 2.5) in Table 4.

Table 6 shows that attending an ultrasonography training workshop within the last 2 years and routinely requesting detailed fetal scanning between 18 and 22 weeks were the only significant predictor variables in the regression model (P=0.002 and < 0.001, respectively). Table 6 (coefficients) also shows that the increase in attending a course in ultrasonography within the last 2 years will result in the likelihood of increasing the scores by about 8.661 scores (knowledge ranks), which is a huge impact on scores. Ordering a detailed scan will result in an increase in the scores by 13.099 scores.

Table 3: Knowledge of technical and safety aspects of ultrasonography throughout all stages of pregnancy

Knowledge aspects	No (%)	Female	Male	P value
Is ultrasonography safe throughout all stages of pregnancy?				
I do not know	6 (3)	5 (4.0%)	1 (1.4%)	
No	14 (7.1)	9 (7.1%)	5 (7.0%)	0.602
Yes	177 (89.8)	112 (88.9%)	65 (91.5)	
How many times should a pregnant be examined during antenatal care?				
≤ 3 times	103 (52.3)	67 (53.2%)	36 (50.7%)	0.739
> 3 times	94 (47.7)	59 (46.8%)	35 (49.3%)	
Doppler ultrasound should not be used during the first trimester unless there is an indication				
I don't know	21 (10.7)	14 (11.1%)	7 (9.9%)	0.765
No	35 (17.8)	24 (19.0%)	11 (15.5%)	
Yes	141 (71.6)	88 (69.8%)	53 (74.6%)	
Do you know the ALARA principle?				
No	146 (74.1)	90 (71.4%)	56 (78.9%)	
Yes	51 (25.9)	36 (28.6%)	15 (21.1%)	0.252
Is M-mode superior to pulsed Doppler in detecting fetal heart beat during first trimester of pregnancy?				
I do not know	68 (34.5)	41 (32.5%)	27 (38.0%)	0.515
No	35 (17.8)	21 (16.7%)	14 (19.7%)	
Yes	94 (47.7)	64 (50.8%)	30 (42.3%)	
Are you familiar with the term TI in ultrasonography?				
No	147 (74.6)	92 (73.0%)	58 (81.7%)	0.170
Yes	50 (25.4)	34 (27.0%)	13 (18.3%)	
Are you familiar with the term MI in ultrasonography?				
No	150 (76.1)	92 (73.0%)	58 (81.7%)	0.170
Yes	47 (23.9)	34 (27.0%)	13 (18.3%)	
When to adhere to the ALARA principle?				
I do not know	146 (74.1)	91 (72.2%)	55 (77.5%)	
Third trimester	7 (3.6)	3 (2.4%)	4 (5.6%)	
Second trimester	6 (3.0)	4 (3.2%)	2 (2.8%)	0.377
First trimester	38 (19.3)	28 (22.2%)	10 (14.1%)	
Which of the following is not an aneuploidy marker during detailed scan?				
Echogenic bowel	17 (8.6)	13 (10.3%)	4 (5.6%)	
Intracardiac echogenic focus	34 (17.3)	25 (19.8%)	9 (12.7%)	
Moderate hydronephrosis	70 (35.5)	40 (31.7%)	30 (42.3%)	0.392
Nuchal fold > 6 mm	43 (21.8)	28 (22.2%)	15 (21.1%)	
Short femur	33 (16.8)	20 (15.9%)	13 (18.3%)	
When should NT scan be performed during pregnancy?				
I do not know	6 (3.0)	1 (0.8%)	5 (7.0%)	
18 - 22 weeks	15 (7.6)	11 (8.7%)	4 (5.6%)	0.040
11 - 13+6 weeks	176 (89.3)	114 (90.5%)	62 (87.3%)	
What is a teratogenic temperature rise during 1st trimester?				0.348
0	133 (67.5)	80 (63.5%)	53 (74.6%)	
1	19 (9.6)	13 (10.3%)	6 (8.5%)	
1.5	18 (9.2)	12 (9.5%)	6 (8.5%)	
2	27 (13.7)	21 (16.7%)	6 (8.5%)	
A T1 of 1 means there is a potential temperature rise of:				
0	161 (81.7)	101 (80.2%)	60 (84.5%)	
1	27 (13.7)	21 (16.7%)	6 (8.5%)	0.270
1.5	5 (2.5)	2 (1.6%)	3 (4.2%)	
2	4 (2.1)	2 (1.6%)	2 (2.8%)	

Table 3 continued: Knowledge of technical and safety aspects of ultrasonography throughout all stages of pregnancy

Knowledge aspects	No (%)	Female	Male	P value
How to know T1 and M1 during examination?				0.225
Calculation is from frequency of transducer	9 (4.6)	4 (3.2%)	5 (7.0%)	
I don't know	102 (51.8)	60 (47.6%)	42 (59.2%)	
Look it up in a text	31 (15.7)	21 (16.7%)	10 (14.1%)	
Look it up on the monitor	45 (22.8)	33 (26.2%)	12 (16.9%)	
Refer to manufacturer's instructions	10 (5.1)	8 (6.3%)	2 (2.8%)	

NT: Nuchal translucency; TI: Thermal index; MI: Mechanical index

Table 4: Model summary.

R	R^2	Adjusted R^2	Std. Error of the Estimate	Durbin-Watson
0.415	0.172	0.132	18.57075	0.891

Although we included all independent variables in the regression model, a high F value and a highly significant model (P<0.001) were found, as presented in Table 5.

Table 5: ANOVA and significance

Model	Sum of Squares	Mean Square	F	Sig.
Regression	13385.847	1487.316	4.313	0.000
Residual	64491.183	344.873		
Total	77877.030			

Sig: significance

Tolerance values in Table 6 for all variables were > 0.3, which indicates that multi-collinearity is not a serious problem for these variables.

4 Discussion

In this study we analyzed important aspects of knowledge, practices and training of obstetric ultrasonography for practitioners in Jordan, with the aim of assessing aspects that may require improvement and promotion.

Most of the study sample were female specialists, aged 30-40 years, who graduated from training programs in Jordan, worked in the private sector mainly in Amman, and had more than 10 years of experience. This may indicate that female OB/GYN practitioners in Jordan are generally younger than their male peers and that more males are recruited into the public sector. This finding may highlight the need to recruit more female practitioners in the public sector. Gender diversity in the public healthcare sector should result in improved decision-making and anticipated advantages of the unique contributions of male and female practitioners. This is particularly important in maternity services in conservative societies like Jordan, where female patients may be inclined to seek health care from female practitioners. Also, we observed gender differences in ultrasonography training, resulting in higher achievement of female practitioners in practice and knowledge. Also, gender differences were noted in sociodemographic characteristics and in training aspects. However, there were no statistically significant differences between males and females in knowledge questions, except in determining timing of NT scanning, where more females were able to answer this question correctly.

Nearly one in two of participants recommended a maximum of only three antenatal visits for low-risk pregnancies, which complies with the international guidelines. Also, the vast majority of the sample referred their patients with a suspected abnormality to a specialist in maternal-fetal medicine and ordered a detailed fetal scan between 18 and 22 weeks of gestation. These results are aligned with international recommendations. The National Health Service (NHS) in the United Kingdom advises that a fetal anomaly screening scan should be performed between 18+0 and 20+6 weeks' gestation. The second trimester targeted scan is best performed between

Table 6: Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	21.999	12.92		1.703	.090	-3.486	47.48					
Variable 1	8.661	2.78	-.217	-3.116	.002	-14.14	-3.18	-.251	-.222	-.207	.915	1.09
Variable 2	13.099	3.51	.270	3.732	.000	6.18	20.02	.320	.263	.248	.847	1.18
Variable 3	3.259	3.02	.079	1.079	.282	-2.70	9.22	-.045	.079	.072	.833	1.20
Variable 4	-3.344	1.88	-.191	-1.78	.077	-7.06	.371	-.075	-.129	-.12	.381	2.62
Variable 5	1.130	3.63	.023	.312	.756	-6.03	8.29	.055	.023	.021	.807	1.24
Variable 6	2.650	2.11	.095	1.259	.210	-1.50	6.803	.128	.092	.084	.780	1.28
Variable 7	0.081	1.85	.003	.044	.965	-3.57	3.734	-.023	.003	.003	.816	1.23
Variable 8	0.705	3.59	.014	.196	.844	-6.38	7.787	.070	.014	.013	.873	1.15
Variable 9	6.625	4.28	.162	1.549	.123	-1.81	15.062	.037	.113	.103	.404	2.48

Variables: 1. Attendance at ultrasonography workshop in the past 2 years; 2. Routine request of detailed fetal scanning between 18-22 weeks; 3. Gender; 4. Age; 5. Practicing as a general practitioner or specialist; 6. Country of graduation for the last academic qualification; 7. Practice sector; 8. Practice location (Amman or outside); 9. Number of experience, years in OB/GYN, Sig: significance.

18 and 20 weeks, with the primary aims to conduct a thorough anatomical examination of the fetus and to optimize the identification of abnormalities that may be present .[9], [10] In some developing countries, the majority of antenatal practitioners do not regularly request prenatal anomaly screening, and the vast majority of pregnant women present for antenatal treatment after 22 weeks of gestation. [11] An average of 2.6-3 scans have been performed by clinicians in low-risk pregnancies in some countries [8], [11]. Our study showed that two aspects of ultrasonography practice were the only predictors for high knowledge scores: attending workshops and requesting fetal scans between 18 and 22 weeks of pregnancy. This indicates the strong correlation between knowledge and practice and highlights the importance of attending professional workshops to advance and promote knowledge and practice.

Regarding knowledge of safety and technical aspects of ultrasonography, most participants stated that ultrasonography is safe during all stages of pregnancy, while Doppler ultrasound should not be used during the first trimester. This finding is consistent with other regional studies [12]; however, it was in contradiction to studies conducted in other parts of the world where a minority of participants had the same perception [8], [13], [14]. Exposure to ultrasonography during pregnancy appears to be safe, according to the evidence available, [15] and for five decades there were no proven harmful effects [16]. It should be noted, though, that new ultrasound technology represented by Doppler, 3-D and 4-D ultrasound, has considerably higher energy output than older machines, casting doubts on its safety. [17] A recent review confirmed that there are no signs of deleterious effects, [16] but? in compliance with the International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) protection declaration, Doppler Fetal Vessel Analysis should not be carried out in the first trimester, the particularly vulnerable period of fetal life.[16]

Participants were almost evenly divided in determining frequency of examinations conducted during the antenatal period, and a substantial proportion did not know whether the M-mode is safer than pulsed Doppler in detecting heartbeat during the first trimester. The TI is an on-screen guide of the potential for tissue heating, whereas the MI is an on-screen guide to the probability of non-thermal effects and their severity, since ultra-

sound may cause an adverse biological effect through a non-thermal mechanism, like cavitation. However, the relative absence of gas bubbles (air) in the fetus may indicate that this index is possibly not applicable to obstetric screening. During scanning, users should remain aware of both indices, especially when changing scan modes or system controls to keep them as low as reasonably achievable (ALARA). Consideration of the ALARA principle is particularly important when patients are to be irradiated, because the exact effect of radiation on patient health is not yet totally understood and predictable. [18] This is particularly important when the TI exceeds 1.0. [19]

Pulsed Doppler can be correlated with high MI and TI. Importance of TI is closely linked to the duration of exposure. While TI is purely an indicator, errors in the measurement of TI values and the limitations of the simple models on which they are based mean that TI values can underestimate a factor of two or more increases in temperature.[20] The displayed TI should be approximately 1.0 when a Doppler examination is conducted at 11 to 13 + 6 weeks' gestation, and the exposure period should be kept as brief as possible (usually no longer than 5-10 minutes), definitely never exceeding 60 minutes. It is important to be aware that default Doppler settings mean that Doppler presets of TI greater than 3 are seen routinely on some new machines. However, with lower outputs, and thus with lower TI, it is possible to obtain sufficient spectral Doppler waveforms. Therefore, all obstetric scanners should be set up such that the acoustic output power control's default (switch-on) setting is low. The operator must also know how to reduce the output of the system, and with each new patient, a low setting should be selected and the spectral Doppler turned on each time. [20] Previous studies reported that some practitioners were not aware of the definition of MI and TI.[8], [12]–[14], [20]. Although the upper output limits have not been defined by the output display standards (ODS), a TI of 1.5 is widely regarded as the universal threshold. It illustrates the importance of end users being familiar with the safe operation of ultrasound equipment. [14]

Also, in this study we sought to determine the predictor independent variables. The study showed that attending workshops was the most important variable in determining knowledge scores. A substantial majority believed that ultrasonography training during residency was inadequate. However, a positive finding of this study is that most of the sample have updated their knowledge by attending courses held mainly locally in Jordan in the past two years. As more females are graduates of Jordanian institutions, this highlights what was reported in other studies about female practitioners in many Arabic countries; they prefer to receive academic training locally due to cultural restraints.[21]

The major limitation of this study is the low response rate, particularly from physicians working in the public sector probably due to work engagements. Low response rate is often encountered in studies conducted among physicians, with rates less than 40% often regarded usual. [22] However, it should be noted that response rate is not necessarily predictive of nonresponse bias, [23] and this was confirmed in studies conducted by Lee et al (2009). [24] Furthermore, sample size could be considered adequate compared to the total number of practicing doctors in Jordan. One of the more remarkable strengths of this study is that it provides for the first time an insight into Jordanian practitioners' knowledge, attitudes, and practices in the field of obstetric ultrasound. Furthermore, all health sectors (private, public, and non-governmental organizations) participated. Future studies would be required to tackle the different challenges and obstacles encountered by OB/GYN practitioners in attending educational courses and also to address ultrasonography training offered in residency programs.

5 Conclusions

Jordanian OB/GYN practitioners would benefit by expanding their knowledge of ultrasound in pregnancy. Specifically, undergraduate medical curricula should be revised to introduce advanced ultrasound physics and practice. More ultrasonography continuing education programs and workshops in Jordan should be conducted, preferably in association with international well-recognized bodies. Increasing the number of maternal-fetal medicine specialists is also urgently needed, especially in the public sector. The public sector in Jordan should benefit by recruiting more female practitioners to augment the desirable effects of gender diversity. A comprehensive prenatal anomaly screening program must be designed and implemented to increase maternal-fetal well-being.

List of abbreviations

Obstetrics/Gynecology (OB/GYN); "as low as reasonably achievable" (ALARA); Thermal index (TI); Mechanical index (MI); General practitioner (GP); Nuchal translucency (NT); International Society of Ultrasound in Obstetrics and Gynecology (ISUOG)

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Informed consent: Informed consent has been obtained from all individuals included in this study.

Ethical approval: The research related to human use has been complied with all the relevant national regulations, institutional policies and in accordance with the tenets of the Helsinki Declaration, and has been approved by the scientific committee of the Jordanian Medical Association #10/1/8617/2413.

Data availability statement: The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

[1] Alrahmani L, Codsi E, Borowski KS. The current state of ultrasound training in obstetrics and gynecology residency programs. J Ultrasound Med. 2018 Sep;37(9):2201–7.
[2] Kim ET, Singh K, Moran A, Armbruster D, Kozuki N. Obstetric ultrasound use in low and middle income countries: a narrative review. Reprod Health. 2018 Jul;15(1):129.
[3] Vrachnis N, Papageorghiou AT, Bilardo CM, Abuhamad A, Tabor A, Cohen-Overbeek TE, et al. International Society of Ultrasound in Obstetrics and Gynecology (ISUOG) - the propagation of knowledge in ultrasound for the improvement of OB/GYN care worldwide: experience of basic ultrasound training in Oman. BMC Med Educ. 2019 Nov;19(1):434.
[4] Leonardi M, Murji A, D'Souza R. Ultrasound curricula in obstetrics and gynecology training programs. Ultrasound Obstet Gynecol. 2018 Aug;52(2):147–50.
[5] Shah S, Bellows BA, Adedipe AA, Totten JE, Backlund BH, Sajed D. Perceived barriers in the use of ultrasound in developing countries. Crit Ultrasound J. 2015 Dec;7(1):28.
[6] Al Ryalat N, Ryalat S, AlyiAbdalla M, Al-Shayyab MH, Samara O, Taimeh D, et al. Women in maxillofacial surgery and otolaryngology; career obstacles and success factors. J Craniofac Surg. 2021 May;32(3):874-7.
[7] Thekrallah F, Qatawneh A, Basha A, Al-Mustafa M, Saleh S, Bata M, et al. Perceptions and expectations among pregnant women receiving second-trimester ultrasound scans at Jordan University Hospital. Al-Magallat al-Tibbiyyat al-Urdunniyyat. 2013;47(1):73–9.
[8] Sheiner E, Shoham-Vardi I, Abramowicz JS; S. E. What do clinical users know regarding safety of ultrasound during pregnancy? J Ultrasound Med. 2007 Mar;26(3):319–25.
[9] Harper LM, Wood SL, Jenkins SM, Owen J, Biggio JR; H. LM. The Performance of First-Trimester Anatomy Scan: A Decision Analysis. Am J Perinatol. 2016 Aug;33(10):957–65.
[10] Yagel S; Y. S. Re: effectiveness of 12-13-week scan for early diagnosis of fetal congenital anomalies in the cell-free DNA era. Ultrasound Obstet Gynecol. 2018 Oct;52(4):550.
[11] Akinmoladun JA, Ogbole GI, Lawal TA, Adesina OA; A. JA. Routine prenatal ultrasound anomaly screening program in a Nigerian university hospital: redefining obstetrics practice in a developing African country. Niger Med J. 2015 Jul-Aug;56(4):263–7.
[12] ElOlemy K, Almuwannis MS, Alamiri MS, Alkhudair KM. A., Almuwannis, M., Alamiri, M., & Alkhudair, "Knowledge attitude and practices of ultrasound safety in pregnancy among healthcare providers in Riyadh, Saudi Arabia: a survey study.,". Tanta Med J. 2015;43(3):98.
[13] Akhtar W, Arain MA, Ali A, Manzar N, Sajjad Z, Memon M, et al.; A. W et al. Ultrasound biosafety during pregnancy: what do operators know in the developing world?: national survey findings from pakistan. J Ultrasound Med. 2011 Jul;30(7):981–5.
[14] Mashiane S, van Dyk B, Casmod Y. Ultrasound biosafety: Knowledge and opinions of health practitioners who perform obstetric scans in South Africa. Heath. SA Gesondheid. 2019 Oct;24:a1028.
[15] Torloni MR, Vedmedovska N, Merialdi M, Betrán AP, Allen T, González R, et al.; ISUOG-WHO Fetal Growth Study Group. Safety of ultrasonography in pregnancy: WHO systematic review of the literature and meta-analysis. Ultrasound Obstet Gynecol. 2009 May;33(5):599–608.
[16] Salvesen KÅ, Lees C, Abramowicz J, Brezinka C, Ter Haar G, Maršál K; S. KÅ. Safe use of Doppler ultrasound during the 11 to 13 + 6-week scan: is it possible? Ultrasound Obstet Gynecol. 2011 Jun;37(6):625–8.
[17] Houston LE, Odibo AO, Macones GA; H. LE. The safety of obstetrical ultrasound: a review. Prenat Diagn. 2009 Dec;29(13):1204–12.
[18] Flint K, Bottenus M, Bradway D, McNaly P, Ellestad S, Trahez G. An automated ALARA method for ultrasound. J Ultrasound Med. 2021 Sep;40(9):1863-77.
[19] Van den Hof MC. No. 359-Obstetric Ultrasound Biological Effects and Safety. J Obstet Gynaecol Can. 2018 May;40(5):627–32.
[20] Salvesen KA; S. KA. Epidemiological prenatal ultrasound studies. Prog Biophys Mol Biol. 2007 Jan-Apr;93(1-3):295–300.
[21] Dar-Odeh N, Elsayed SA, Nourwali I, Ryalat S, Al-Shayyab MH, Abu-Hammad O. Social factors as career obstacles for female oral and maxillofacial surgeons in three Middle Eastern countries. Int J Oral Maxillofac Implants. 2019 Nov;48(11):1504–8.
[22] Markwell AL, Wainer Z. The health and wellbeing of junior doctors: insights from a national survey. Med J Aust. 2009 Oct;191(8):441–4.

[23] Meterko M, Restuccia JD, Stolzmann K, Mohr D, Brennan C, Glasgow J, et al. Response rates, nonresponse bias, and data quality: results from a National Survey of Senior Healthcare Leaders. Public Opin Q. 2015 Jan;79(1):130–44.
[24] Lee S, Brown ER, Grant D, Belin TR, Brick JM. Exploring nonresponse bias in a health survey using neighborhood characteristics. Am J Public Health. 2009 Oct;99(10):1811–7.