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Normative values of the internal genital organs of the female pelvis in transvaginal and transabdominal ultrasound

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Abstract

Aim: To conduct a systemic review of published data on reference values for both transabdominal and transvaginal ultrasound in gynecology. **Materials and methods:** Literature from 1970 to 2020 of reference values for the female pelvis in healthy subjects was reviewed. According to the determination of reference intervals for laboratory values reference values are generally determined using 95%-reference intervals and their associated 90%-confidence intervals. The list of articles was supplemented with extensive crosschecking of the reference lists of all retrieved articles. **Results:** A total of 33 studies were included and analyzed. The diagnostic performance of transvaginal ultrasound (TVUS) has a higher sensitivity and specificity than transabdominal ultrasound (TAUS) for high quality imaging of the uterus and the bilateral adnexa. The length of normal uterus is about 50-80 mm in fertile age. There is no consensus about the cut off value of the thickness of the endometrium in asymptomatic postmenopausal women, while a measurement of >5 mm and postmenopausal bleeding is suspect and requires further examination. The distribution of normal ovarian volumes is narrow with small volumes in postmenopausal women. **Conclusion:** Normal values are helpful in delimiting the pathological changes in the female pelvis. While sonomorphologic criteria are more important than the ovarian size for the assessment of ovarian masses and reference values of the uterus in adults have little impact on routine practice, normative values in pediatric patients are important for the detection of pathologies. Normative values of the internal genital organs in females are sufficiently validated; still further research is required to assess the role of normative values in routine clinical practice and in sonographic screening for endometrial and ovarian cancer.

Keywords: transvaginal ultrasound; transabdominal ultrasound; uterus; ovary; normal values

Introduction

The female pelvis may be examined by both transvaginal (TVUS) and transabdominal ultrasound (TAUS). In rare cases transrectal sonography is performed using the vaginal probe and transperineal ultrasound (US) is often used for the diagnosis of urogenital pathologies of the vulva and lower genital lesions.

TAUS examination is usually preferred as the clinical routine imaging modality in the interdisciplinary emergency room. However, many studies showed that the transvaginal examination is superior to TAUS for the evaluation of the uterus and adnexa. Therefore, the routine gynecological ultrasound examination starts with TVUS and TAUS may be used additionally if the size of a mass exceeds the field of the view of the transvaginal probe (e.g. an adnexal tumor/myomatous uterus) or

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artefacts impair the visualization (e.g. bowel gas, fibroids). TAUS is performed with sagittal and cross sectional views [1,2]. For the investigation of the female pediatric pelvis TAUS represents the method of choice. Several studies have been performed to demonstrate the normal appearance of the female pelvis and the changes that occur during the various stages of development [3]. The transvaginal approach is not recommended for use on virgins and women with vaginal malformations (i.e. vaginal aplasia). For perineal US, linear or curved array probe with 5-7.5 MHz are used, while introitus sonography is performed with curved linear probes with 3.5-5 MHz. These techniques are mainly used in urogynecology, where real-time imaging helps to assess the movements of the bladder floor and the urethra while pressing, coughing and the contraction of the pelvic floor as well as to evaluate the funneling or kinking of the urethra while increase of abdominal pressure. The assessment of these pictures is descriptive and therefore clear values are missing to diagnose for instance a rotatoric descensus or a cystocele. Diagnosis can be established only combining sonographic measurements and clinical symptoms. For the quantitative assessment of the sonographic images the retrovesical angle beta can be measured and the location of the internal urethral meatus has to be identified [1,4-6].

Normal values of extrapelvic abdominal organs have been published [7-9], whereas summarized data on female pelvic organs are missing. The aim of this work was to conduct a systematic review of the literature on reference values for the female pelvic organs measured both with TAUS and TVUS. The published knowledge on normal values have impact for the World Federation for Ultrasound in Medicine and Biology (WFUMB) paper series on clinical management of incidental finding [10-22].

Materials and methods

Search strategy

Literature research was conducted in the PubMed Database (up to May 2020) with the following keywords: "normal values" or "standard values" or "normative values" and "gynaecology" or "gynecology" or "female genital organs" or "uterus" or "ovary" and "ultrasound" or "sonography". We electronically searched for books with the same keywords in the web. The list of articles was supplemented with extensive crosschecking of the reference lists of all retrieved articles.

Study eligibility

Eligibility criteria: (1) TVUS or TAUS examination with measurement of normal values of healthy female subjects; (2) no language restriction was used. Exclusion criteria: letters, comments, case reports, unpublished articles.

Data extraction

Two investigators independently evaluated potential studies and a checklist was used to determine final eligibility. Disagreements about inclusion or exclusion were resolved by consensus.

Statistical analysis

According to the determination of reference intervals for laboratory values, reference values are generally determined using 95%-reference intervals and their associated 90%-confidence intervals.

Results

Characteristics of the included studies

By electronic and hand search we found 43 articles and books fulfilling the defined eligibility criteria. There were a total of 21 articles concerning normal values of the uterus [23-43] and 19 articles about normal values of the ovaries [23,25-28,30,36,38,44-54] and 5 comparative articles about normal values of uterus and ovaries with TAUS and TVUS [30,35,36,55,56].

Normal values of the uterus

Regarding the measurement of the size of the uterus, the different proportions between corpus with fundus and cervix uteri have to be regarded depending on age. The length of the uterus includes the cervix.

Garel et al demonstrated in their review, that during the neonatal period the uterus appears large, has a spade-shaped appearance with a prominent cervix (fundus to cervix ratio 1:2) due to the influence of the maternal and placental hormones. The mean length of the uterus is 34 mm, the thickness can be as much as 14 mm and there is often an echoic endometrial ring present. In a study of Nussbaum et al, the uterus was visualized in 31 of 35 (89%) infant girls in the neonatal period examined with real-time US [23,24]. Hata et al showed, that the neonatal uterus could be imaged in 89.1% of cases (41/46 infants aged 0-7 days) [25]. In toddlers and preschoolers both the uterus and ovaries decrease in size and volume and remain rather constant until the age of approximately 6 years, when they start to grow. Significant changes in size and shape will occur beginning with the age of 8 years [23].

Before puberty starts, the normal uterus has a tubular shape, with a 1:1 fundus to cervix ratio. The prepubertal uterus has a length of approximately 25-40 mm and is 10 mm or less thick. The endometrial line is usually not seen at this age [23]. Razzaghy-Azar et al showed a positive correlation of uterine volume and body length with chronologic age and stage of puberty. In this study with

240 girls (range 6-13.5 years) uterine volume was <3.5 cm^3 in 98% of prepubertal girls. The results of this study demonstrated that the uterine size shows little change from infancy until about 7 years of age, afterwards the uterine parameters significantly increase [26]. Other studies revealed that the size and morphology of the uterus and ovaries are quite stable between the ages of 1-2 and 8-9 but there is a progressive increase in the size of the internal genital organs from the age of 9 onward. After 14 years of age the size of the uterus, ovaries and endometrial stripe thickness stay stable up to the age of 20 years [27-32]. A previous study by Sample et al concluded, that the uterine length in prepubertal girls should not exceed 30 mm [33]. A later study postulated that this cut off value should be increased to 40 mm, since in their study more than 97% of the uterine parameters in prepubertal girls were under this limit [34].

The pubertal uterus starts to resemble the adult uterus, having a pear-shaped appearance (fundus to cervix ratio 2:1 or 3:1). After menarche the endometrium is also seen as its thickness varies with the phases of menstrual cycle. The uterine measurements after the onset of puberty are: 50-80 mm long, 30 mm wide and 15 mm thick [23].

Piiroinen et al found the prepubertal uterus to be 41 mm long and 9 mm deep on average. In fertile age the length of the uterus is described with 76+/-7 mm and a depth of 29+/-4 mm for a nullipara. The uterus length can be greater in size in multiparas in all dimensions about 12 mm with a length of 89+/-9 mm and a depth of 38+/-6 mm [35]. Merz et al found smaller sizes using TVUS [36]. In this study it was demonstrated that the uterine size shows a progressive growth in length and width when correlated with parity. Uterine length was 7.3+/-0.8 cm in the group of nulliparas, 83+/- 0.8 cm in the group of primiparas and 9.2+/-0.8 cm in the group with two or more deliveries. Statistically there was a significant difference between the group of nulliparas and primiparas and the group of multiparas. Significant changes in uterine size could also be found in women who had delivered once and those who had delivered twice or more. However, no age-correlated differences could be observed [36]. Verguts et al showed similar values with an increase of the mean uterine length up to 72 mm at the age of 40 and decrease to 42 mm at the age of 80 years [37]. Comparison of TAUS and TVUS data in nulli- and multipara [35,36] are shown in Table I.

In ovulatory cycles the size of the uterus varies, with the greatest extent on cycle day 27. After menopause the uterus decreases in size, with the late postmenopausal uterus measuring 45 mm length and 15 mm depth. In TVUS the cervix can be depicted and demarcated from the uterus fine, whereas with TAUS this can be difficult [35,36]. The mean endometrial thickness obtained in prepubertal girls was 1 mm in comparison to 6 mm in postpuberty in the study of Gilligan et al, confirming prior research results [30,41,42]. In the group of premenopausal women mean endometrial thickness ranged from 3 mm on day 4 to 7 mm on day 8 of the menstrual cycle. Endometrial thickness in the postmenopausal group did not exceed 5 mm (mean 3.6 mm) [36].

Gilligan et al compared in their study with 5647 subjects (range 0-20 years of age) the measurement of endometrial thickness with TAUS versus TVUS and showed no significant differences when corrected for patient age with a mean endometrial thickness of 4.3+/-3.6 mm with the transabdominal approach versus 5.5+/-4.0 mm with TVUS [30].

There is no consensus about the cut off value of the thickness of the endometrium in asymptomatic postmenopausal women. In symptomatic patients with postmenopausal bleeding the critical value measures >5 mm. Measurements above 5 mm are suspect and require further examination [43]. In cases of postmenopausal bleeding and a measurement of ≤4 mm endometrial thickness the risk of malignancy is only approximately 1:900 [57]. In premenopausal women values >14 mm are suspicious depending on the phase of the menstrual cycle [43].

Normal values of the ovaries

Ovarian morphology and volume during childhood and puberty were investigated transabdominally by different authors. In neonates, ovaries show a mean volume slightly over 1 cm^3, but can be anywhere between 1 and 3.6 cm^3 [23,44]. The ovarian volume before an age of 6 years is below 1 cm^3 and the ovaries may show small follicles. The presence of small, microcystic follicles (<9 mm diameter) is considered normal throughout childhood and they are found on sonograms in the vast majority of cases [23].

Table I. Comparison of transvaginal (TVUS) and transabdominal ultrasound (TAUS) [35,36]

Biometry of the uterus (mm)	**TAUS**		**TVUS**	
	Nullipara	Multipara	Nullipara	Multipara
Length	90	100	83	92
Anterior-posterior diameter	50	60	32	43
Transverse diameter	60	70	40	51

Bernaschek et al studied ovarian growth in 76 young girls and reported a continuous increase in ovarian volume from 2 (mean volume 0.26 cm³) to 14 years of age (mean volume 1 cm³) [38]. Salardi et al similarly showed in a study of 114 girls (age 2-13) that the ovarian growth correlates with age [27]. Gilligan et al confirmed this correlation in their study with 5647 patients and found the mean right ovarian volume to be significantly larger than left ovarian volume throughout childhood (p=0.0126) [30]. An increase in ovarian size was shown with the onset of functional changes in the ovaries [25]. An increased number of follicles larger than 5 mm in diameter were observed from 7-9 years of age. With the onset of puberty (at about 10 years of age), further enlargement in ovarian volume was reported [45]. After puberty the mean volume of the mature ovary is around 8 cm³, but ranges anywhere between 2.5 and 20 cm³, depending on the phase of the menstrual cycle [23].

In females of reproductive age, the results of Merz et al showed no significant parity-related changes in ovarian volume. The mean volume of ovaries in premenopausal women measures 7.8+/-2.6 cm³, in postmenopausal women 3.4+/-1.3 cm³ [36]. Gollub et al reported similar results with TVUS in postmenopausal women (3.1+/-2.9 cm³). They demonstrated that the distribution of ovarian volumes was narrow and volumes were small in postmenopausal women [46]. This finding agrees with the prevalence of enlarged ovaries (2-7%) found by previous investigators [47-50]. Campbell et al, in a group of postmenopausal women with normal ovarian morphology reported a mean ovarian volume of 4.33+/-1.91 cm³ at TAUS, with no correlation between either right or left ovarian volume nor years since menopause [51].

In a large study with 725 patients, Cohen et al found an average ovarian volume of 9.8, 5.8, and 3.0 cm³ for the menstruating, postmenopausal, and premenarchal groups, respectively. A significant difference between the volumes of the three groups was shown. US visualization of both ovaries showed a peak in the second decade and declined over the next decades, with a significant drop in the 7th decade. Volumes were as well different, when the women were grouped by decades of life as they peaked in the 3rd decade and declined over the subsequent decades.

Significant volume differences were noted when pregnant (11.1 cm³) and non-pregnant menstruating (9.4 cm³) patients (p<0.0001). No significant differences in volume were noted between right and left ovaries or when the variables of weight, presence of a leiomyomatous uterus or phase of the menstrual cycle were evaluated [52]. In the study of Merz et al with TVUS, the detection rate of both ovaries in premenopausal women (n=155) was 96% and in postmenopausal women (n=108) 64% [36].

In a study with 3963 women between 25 and 91 years of age, Pavlik et al showed an upper limit of normal for ovarian volume of 20 cm³ in premenopausal women and 10 cm³ in postmenopausal women. A significant decrease in ovarian volume with each decade of life from age 30 to age 70 was demonstrated. It was shown that the use of exogenous estrogens was associated with a significant reduction in ovarian volume in women of 40-59 years of age, but not in women ≥ 60 years. Ovarian volume was higher in taller women than in shorter women but unrelated to patient weight [53].

Gollub et al found the detection of both ovaries possible in 49% of 230 postmenopausal women, of only one ovary in 31% of the women. No ovaries were imaged in 20% of cases. Thus, at least one ovary was imaged in 80% of the subjects [46]. Similar results were reported by Higgins et al [49,52,54]. In contrast, Goswamy et al, using TAUS, reported an imaging rate of over 99% [50]. The data have been summarized in Table II and III.

Discussion

TAUS and TVUS are the most useful modalities for imaging pediatric and adult female genital organs due to their superior spatial resolution, lack of ionizing radiation, ability to assess blood flow and relative low cost [26,30,43]. Our literature research revealed that numerous data are available about the normative values in the US of the female internal genital organs. Furthermore, we found eighteen studies concerning normal references of the internal female genitalia in premenarchal healthy girls. A continuous increase in size of internal female genitalia in premenarchal girls in relation to age was shown. The reference values can serve to investigate girls with suspected abnormalities of pubertal development or monitoring them after confirmation of the diagnosis [26,30].

Only five studies were found to compare normal values of TVUS and TAUS. They showed no significant differences in uterine and ovarian volumes of adults obtained transabdominally versus transvaginally. Gilligan et al showed in girls up to 20 years of age, no significant differences in uterine volume, ovarian volume (left or right) or endometrial thickness measured via a transvaginal or transabdominal approach when corrected for patient age. These findings support the results of prior studies showing the same in adults. The authors conclude that further investigation is warranted in girls and adolescents [30,35,36,55,56].

The size of the uterus depends on parity, age, body weight, height, body surface and hormone level, i.e., prepuperty vs. fertile age vs. postmenopausal. Moreover, benign diseases can lead to an increase in size without

the need for intervention. Therefore, the impact of the knowledge of normative values of the adult uterine size in routine practice is limited.

The diagnostic performance of TVUS has a higher sensitivity and specifity than TAUS with high quality imaging of the endometrium, the uterus, and the bilateral

Table II. Normal values of ovaries (mean ovarian volume)

Author, study / values						
Cohen et al (n=77): mean ovarian volume in the neonatal period [52]						
Age group	***n***	***N***	***Ovarian volume (cm³)***			
			Mean±SD	***95% CI***		
1 day to 3 months	34	34	1.06±0.96	0.03-3.56		
4-12 months	21	34	1.05±0.67	0.18-2.71		
13-24 months	22	30	0.67± 0.35	0.15-1.68		
Gilligan et al (n=31): ovarian volume in patients <1 year by age group [30]						
Age group	***n***	***Right ovary (cm³)***	***Left ovary (cm³)***			
< 1 month	4	1.9±2.2	0.3±0.4			
1-2 months	7	2.9 ±2.6	3.3±3.8			
2-4 months	9	0.6±0.4	0.8±0.4			
4-12 months	11	0.9±0.8	0.6±0.4			
Orsini et al (n=114): mean ovarian volume in childhood [28]						
Age (y)	***Volume (cm³)***					
1	1.05±0.7					
2	0.67±0.35					
3	0.7±0.2					
4	0.8±0.4					
5	0.9±0.02					
6	1.2±0.4					
7	1.3±0.6					
8	1.1±0.5					
9	2.0±0.8					
10	2.2±0.7					
11	2.5±1.3					
12	3.8±1.4					
13	4.2±2.3					
Salardi et al (n = 114): mean ovarian volume by age and pubertal status [27]						
Age (years)	***All patients***	***n***	***Prepubertal girls***	***n***	***Pubertal girls***	***n***
2	0.75±0.41	5	0.75±0.41	5	-	-
3	0.66±0.17	6	0.66±0.17	6	-	-
4	0.82±0.36	14	0.82±0.36	14	-	-
5	0.86±0.03	4	0.86±0.03	4	-	-
6	1.19±0.36	9	1.19±0.36	9	-	-
7	1.26±0.59	8	1.26±0.59	8	-	-
8	1.06± 0.50	10	0.90±0.27	8	1.68±0.87	2
9	1.98±0.76	11	2.15±0.92	7	1.69±0.27	4
10	2.22±0.69	12	2.23±0.86	7	2.20±0.47	5
11	2.52±1.30	12	2.32±0.39	2	2.56±1.43	10
12-13	3.95±1.70	10	-	-	3.95±1.70	10

Author, study / values

Razzaghy-Azar et al (n = 240): ovarian volume according to age [26]

Age, years	*n*	*Right ovary, cm³*	*Left ovary, cm³*
6	3	4.4±4.0	2.5±1.6
7	41	2.2±3.2	1.8±1.0
8	55	2.4±1.8	2.4±1.6
9	53	2.3±1.7	2.2±2.6
10	29	4.2±2.6	4.4±3.4
11	33	3.6±1.9	3.9±3.0
12	21	5.1±2.4	5.7±3.0
13	5	5.6±3.1	5.7±3.4

Bernaschek et al (n=66): mean ovarian volume by age [38]

Age (years)	*Volume (cm³)*
2y	0.26
8y	0.70
12-14y	1

Gilligan et al. (n=5647): mean ovarian volume by age [30]

Age (years)	*Left ovary (cm³)*		*Right ovary (cm³)*	
	N	*Mean*	*N*	*Mean*
0	31	1.2±2.1	31	1.4±1.7
1	30	0.6±0.4	30	0.6±0.5
2	21	0.6±0.4	21	0.8±0.5
3	32	0.8±0.5	32	0.9±1.5
4	32	0.9±1.2	32	0.9±0.6
5	35	0.9±0.8	35	0.8±0.4
6	36	1.0±0.7	36	1.1±0.7
7	46	1.4±1.3	46	1.7±2.1
8	45	1.7±1.4	45	1.7±1.2
9	35	2.0±1.1	35	2.1±1.0
10	35	2.6±2.1	35	2.7±2.1
11	37	4.7±4.2	37	4.7±3.3
12	36	4.9±2.6	36	6.2±3.5
13	37	5.6±2.8	37	6.9±3.6
14	45	7.1±5.0	45	9.5±7.3
15	40	7.1±4.4	40	7.4±4.6
16	47	7.2±4.0	47	8.2±5.5
17	45	7.0±4.2	45	8.0±4.5
18	40	6.7±4.3	40	7.5±4.1
19	36	6.7±5.4	36	7.5 +/-4.5
20	37	7.2±3.8	37	7.9±4.3
Total	**778**	**4.0±4.1**	**778**	**4.5±4.7**

Merz et al (n= 263): mean ovarian volumes (cm³) in premenopausal and postmenopausal women (≤5 or >5 years since menopause) [36]

	Para 0 (n=52)	*Para 1 (n=50)*	*Para ≥ 2 (n=53)*	*MP ≤5y (n=44)*	*MP >5y (n=64)*
Right ovary	7.8±2.6	7.8±2.3	7.8±2.6	3.4±1.3	2.5±1.3
Left ovary	7.4±2.4	7.7±2.3	7.5±2.3	3.8±1.6	2.5±1.1

Author, study / values

Pavlik et al (n=3963): mean ovarian volume according to age and menopausal status [53]

Age (years)	*Volume (cm^3)*
≤ 30 years	6.6±0.19
30-39 years	6.1±0.06
40-49 years	4.8±0.03
50-59 years	2.6±0.01
60-69 years	2. 1±0.01
≥ 70 years	1.8±0.08
Premenopausal women	4.9±0.03
Postmenopausal women	2.2±0.01

Cohen et al (n = 762): mean ovarian volume by menstrual status [52]

Group	*Volume (cm^3)*	*N*	*95% CI*
Premenarchal	3.0±2.3	32	0.2-9.1
Menstruating	9.8±5.8	866	2.5-21.9
Postmenopausal	5.8±3.6	100	1.2-14.1

Cohen et al (n = 762): mean ovarian volume by decade [52]

Decade	*Volume (cm^3)*	*N*	*95% CI*
1	1.7±1.4	19	0.2-4.9
2	7.8±4.4	83	1.7-18.5
3	10.2±6.2	308	2.6-23.1
4	9.5±5.4	358	2.6-20.7
5	9.0±5.8	206	2.1-20.9
6	6.2±3.6	57	1.6-14.2
7	6.0±3.8	44	1.0-15.0

Granberg et al (n=38): Ovarian volume as measured by transvaginal (TVUS) and transabdominal ultrasound (TAUS) [54]

	TVUS		*TAUS*	
	Menstruating	*Non-menstruating*	*Menstruating*	*Non-menstruating*
N	43	10	43	15
Volume (cm^3)	3.7±2.4	1.3±0.6	4.4±3.2	1.2±0.9

Data are expressed as mean, mean±standard deviation. n, number of patients; N, number of ovaries; CI, Confidence Interval; MP, menopause

adnexa. Therefore the transvaginal approach is the routine technique for the visualization of the internal genital organs of women [1]. For virginal females or when TVUS is not tolerated or not possible, the transabdominal approach is the routine approach providing lower-quality images [1,30,58].

The strength of US in gynecology is shown in symptomatic patients, as benign diseases of the uterus including malformations, fibroma or adenomyosis, as well as intracavitary pathologies such as polyps or submucosal fibroma that can be detected using TAUS and in particular TVUS. US is the method of choice for the differential diagnosis of adnexal masses; hereby, sonomorphological criteria of the IOTA group are the most important classification system. For the differentiation between benign and malign adnexal tumors pattern recognition is important, with the size of the mass being one of the five signs for malignancy of the simple rules of the IOTA concept [43,59].

Up to now there is no evidence that in low-risk groups the US screening can achieve early detection nor reduce mortality of endometrial or ovarian carcinoma. Therefore, the implementation of US screening programs in low-risk groups for endometrial or ovarian carcinoma cannot be generally recommended [43,57,60].

To date, ovarian cancer screening with US alone or in combination with annual CA125 screening has not proven effective in low-risk groups, due in part to its relative-

Table III. Rates of visualisation of the ovaries

Author, study / values			
Cohen et al (n=762): Visualisation of both ovaries in three dimensions (analysis by decade of life) [52]			
Decade	***% of patients***		
1 (0 – 9 y)	75		
2 (10 - 19 y)	94		
3 (20 – 29 y)	73		
4 (30 - 39 y)	77		
5 (40 – 49 y)	61		
6 (50 - 59 y)	51		
7 (≥ 60 y)	26		
Cohen et al (n=77): percentage of ovaries imaged with sonography in girls 1 day to 24 months old [52]			
Age group	**No ovaries imaged**	**One ovary imaged**	**Both ovaries imaged**
1 day to 3 months	10 (29)	14 (41)	10 (29)
4-12 months	0 (0)	8 (38)	13 (62)
13-24 months	2 (9)	10 (45)	10 (45)
Granberg et al (n= 38): Success in identifying ovaries by transvaginal (TVUS) and transabdominal ultrasound (TAUS) [54]			
	TVUS menstruating	**TAUS menstruating**	
N	54	54	
Successfully measured	43	43	
Unsuccessfully measured	10 (19)	11 (20)	

Data are expressed as number (%) or %. n, number of patients; N, number of ovaries

ly low incidence rate, its pathophysiology and the diagnostic test performance of currently available screening tools. The data of the PLCO trial and a further Systematic Review showed, that simultaneous annual CA-125 screening and TVUS does not reduce disease-specific mortality in women at average risk for ovarian cancer but does increase invasive medical procedures and associated harm (with major surgical complications) with a long-term median follow-up period of 12.4 years [60,61].

In contrast, the randomized controlled UKCTOCS trial with 202 000 participants demonstrated a relative mortality reduction of 15% in the multimodal screening group (MMS group with CA125 and US screening) and 11% in the US screening group (USS group), but these reductions were not significant with the primary prespecified Cox analysis. The secondary subgroup analysis with exclusion of prevalent cases in the MMS group was significant, suggesting that the long-term effect of an MMS screening program is about a 28% mortality reduction after 7 years of screening. We agree with the conclusion of the authors of the UKCTOCS trial, that further follow-up is needed to assess the extent of the mortality reduction before firm conclusions can be reached on the long-term efficacy and cost-effectiveness of ovarian cancer screening [62].

As a **conclusion**, the knowledge of normal values is important for any kind of sonographic judgment. Still the impact on routine gynecological clinical practice needs to be further evaluated.

Conflict of interest: none

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