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

Judith Mathis¹, Yi Dong², Burghard Abendstein¹, Alois Hollerweger³, Christian Jenssen⁴, Sue Westerway⁶, Christoph F Dietrich⁷

¹Department of Gynecology and Obstetrics, State Hospital Feldkirch, Austria, ²Ultrasound Department, Zhongshan Hospital Fudan University, Shanghai, China, ³Department of Radiology and Nuclear Medicine, Barmherzige Brüder Hospital Salzburg, Austria, ⁴Department of Internal Medicine, Krankenhaus Märkisch Oderland GmbH, Strausberg/Wriezen, Germany, ⁵Brandenburg Institute for Clinical Ultrasound (BICUS) at Medical University Brandenburg „Theodor Fontane“, Neuruppin, Germany, ⁶Department of Dentistry and Health Sciences, Charles Sturt University, New South Wales, Australia, ⁷Department of General Internal Medicine, Kliniken Hirslanden Beau Site, Salem and Permanence, Bern, Switzerland

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...
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 cm³ 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 post-puberty 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 cm³, but can be anywhere between 1 and 3.6 cm³ [23,44]. The ovarian volume before an age of 6 years is below 1 cm³ 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 cm² 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., prepuberty 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 specificity than TAUS with high quality imaging of the endometrium, the uterus, and the bilateral ovaries.

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

| Author, study / values | 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|
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       |
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-

| Author, study / values |
|-------------------------|
| Pavlik et al (n=3963): mean ovarian volume according to age and menopausal status [53] |
| **Age (years)** | **Volume (cm³)** |
| ≤ 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 (cm³)** | **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 (cm³)** | **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 (cm³) | 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].
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

References

1. Bajka M, Berczaj G, Mueller RC, Schaer G, Tercanli S. Offizielle Leitlinie zur gynäkologischen Sonographie der Schweizerischen Gesellschaft für Ultraschall in der Medizin (SGUMGG) und der Schweizerischen Gesellschaft für Gynäkologie und Geburtshilfe. 2012. Available at: http://www.geburtshilfe.usz.ch/fachwissen/Documents/ultraschall-empf.pdf.
2. Mathis J. Gynäkologie. In: Blank W, Mathis G, Osterwalder J, eds. Kursbuch Notfallsonografie. Stuttgart: Thieme, 2019:279-288.
3. Asavoaie C, Fufezan O, Cosarca M. Ovarian and uterine ultrasonography in pediatric patients. Pictorial essay. Med Ultrason 2014;16:160-167.
4. Barreiros AP, Hirche TO, Ignee A, Nurnberg D, Dietrich CF. Indications and limitations of perineal ultrasound examination. Scand J Gastroenterol 2010;45:764-765.
5. Dietrich CF, Barreiros AP, Nurnberg D, Schreiber-Dietrich DG, Ignee A. Perianal ultrasound. Z Gastroenterol 2008;46:625-630.
6. Nuernberg D, Saftoiu A, Barreiros AP, et al. EFSUMB Recommendations for Gastrointestinal Ultrasound Part 3: Endorectal, Endoanal and Perineal Ultrasound. Ultrasound Int Open 2019;5:E34-E51.

7. Sienz M, Ignee A, Dietrich CF. Sonography today: reference values in abdominal ultrasound: aorta, inferior vena cava, kidneys. Z Gastroenterol 2012;50:293-315.

8. Sienz M, Ignee A, Dietrich CF. Reference values in abdominal ultrasound - biliopancreatic system and spleen. Z Gastroenterol 2011;49:845-870.

9. Sienz M, Ignee A, Dietrich CF. Reference values in abdominal ultrasound - liver and liver vessels. Z Gastroenterol 2010;48:1141-1152.

10. Lewicki A, Freeman S, Jedrzejczyk M, et al. Incidental Findings and How to Manage Them: Testis- A WFUMB Position Paper. Ultrasound Med Biol 2021;47:2787-2802.

11. Trenker C, Gorg C, Freeman S, et al. WFUMB Position Paper-Incidental Findings, How to Manage: Spleen. Ultrasound Med Biol 2021;47:2017-2032.

12. Dietrich CF, Abramowicz JS, Chammas MC, et al. World Federation for Ultrasound in Medicine and Biology (WFUMB) Policy Document Development Strategy - Clinical Practice Guidelines, Position Statements and Technological Reviews (on behalf of the WFUMB publication committee and Executive Bureau). Ultrasound Med Biol 2021;47:2779-2781.

13. Bialek EJ, Lim A, Dong Y, Fodor D, Gritzmann N, Dietrich CF. WFUMB position paper. Incidental findings of the salivary glands. Med Ultrason 2021;23:329-338.

14. Dietrich CF, Nolsoe CP, Barr RG, et al. Guidelines and Good Clinical Practice Recommendations for Contrast Enhanced Ultrasound (CEUS) in the Liver - Update 2020 - WFUMB in Cooperation with EFSUMB, AFSUMB, AIUM, and FLAUS. Ultraschall Med 2020;41:562-585.

15. Dietrich CF, Nolsoe CP, Barr RG, et al. Guidelines and Good Clinical Practice Recommendations for Contrast-Enhanced Ultrasound (CEUS) in the Liver-Update 2020 WFUMB in Cooperation with EFSUMB, AFSUMB, AIUM, and FLAUS. Ultrasound Med Biol 2020;46:2579-2604.

16. Dietrich CF, Correas JM, Dong Y, Nolsoe C, Westerway SC, Jenssen C. WFUMB position paper on the management incidental findings: adrenal incidentaloma. Ultrasonomography 2020;39:11-21.

17. Dietrich CF, Hoffmann B, Abramowicz J, et al. Medical Student Ultrasound Education: A WFUMB Position Paper, Part I. Ultrasound Med Biol 2019;45:271-281.

18. Dietrich CF, Averkiou M, Nielsen MB, Bet al. How to perform Contrast-Enhanced Ultrasound (CEUS). Ultrasound Int Open 2018;4:E2-E15.

19. Atkinson NS, Bryant RV, Dong Y, et al. WFUMB Position Paper. Learning Gastrointestinal Ultrasound: Theory and Practice. Ultrasound Med Biol 2016;42:2732-2742.

20. Dietrich CF, Sahai AV, D’Onofrio M, et al. Differential diagnosis of small solid pancreatic lesions. Gastrointest Endosc 2016;84:933-940.

21. Dietrich CF, Sharma M, Gibson RN, Schreiber-Dietrich D, Jenssen C. Fortuitously discovered liver lesions. World J Gastroenterol 2013;19:3173-3188.

22. Dietrich CF, Jenssen C. Focal liver lesion, incidental finding. Dtsch Med Wochenschr 2012;137:2099-2116.

23. Garel L, Dubois J, Grignon A, Filiatrault D, Van Vliet G. US of the pediatric female pelvis: a clinical perspective. Radiographics 2001;21:1393-1407.

24. Nussbaum AR, Sanders RC, Jones MD. Neonatal uterine morphology as seen on real-time US. Radiology 1986;160:641-643.

25. Hata K, Nishigaki A, Makihara K, Takamiya O, Hata T, Kitao M. Ultrasonic evaluation of the normal uterus in the neonate. J Perinat Med 1989;17:313-317.

26. Razzaghzy-Azar M, Ghasemi F, Hallaji F, Ghasemi A, Ghasemi M. Sonographic measurement of uterus and ovaries in premenarcheal healthy girls between 6 and 13 years old: correlation with age and pubertal status. J Clin Ultrasound 2011;39:64-73.

27. Salardi S, Orsini LF, Cacciari E, Bovicelli L, Tassoni P, Reggiani A. Pelvic ultrasonography in premenarcheal girls: relation to puberty and sex hormone concentrations. Arch Dis Child 1985;60:120-125.

28. Orsini LF, Salardi S, Pilu G, Bovicelli L, Cacciari E. Pelvic organs in premenarchal girls: real-time ultrasonography. Radiology 1984;153:113-116.

29. Stanhope R, Adams J, Jacobs HS, Brook CG. Ovarian ultrasonasessment in normal children, idiopathic precocious puberty, and during low dose pulsatile gonadotrophin releasing hormone treatment of hypogonadotrophic hypogonadism. Arch Dis Child 1985;60:116-119.

30. Gilligan LA, Trout AT, Schuster JG, et al. Normative values for ultrasound measurements of the female pelvis organs throughout childhood and adolescence. Pediatr Radiol 2019;49:1042-1050.

31. Kelsey TW, Binney E, Choudhry MM, Bath LE, Anderson RA, Wallace WH. A Validated Normative Model for Human Uterine Volume from Birth to Age 40 Years. PLoS One 2016;11:e0157375.

32. Kelsey TW, Dodwell SK, Wilkinson AG, et al. Ovarian volume throughout life: a validated normative model. PLoS One 2013;8:e71465.

33. Sample WF, Lippe BM, Gyepes MT. Gray-scale ultrasonography of the normal female pelvis. Radiology 1977;125:477-483.

34. Badouraki M, Christoforidis A, Economou I, Dimitriadis AS, Katzos G. Evaluation of pelvic ultrasonography in the diagnosis and differentiation of various forms of sexual precocity in girls. Ultrasound Obstet Gynecol 2008;32:819-827.

35. Piiroinen O. Studies in diagnostic ultrasound. Size of the ovaries in pre- and postmenopausal women. Ultrasound Obstet Gynecol 1996;7:38-42.
37. Verguts J, Ameye L, Bourne T, Timmerman D. Normative data for uterine size according to age and gravidity and possible role of the classical golden ratio. Ultrasound Obstet Gynecol 2013;42:713-717.
38. Bernaschek G, Lubec G, Schaller A. Sonographic study of the growth of the uterus and ovaries between the ages of 1 and 14. Geburtshilfe Frauenheilkd 1984;44:727-730.
39. Parmar AM, Agarwal DP, Hathi N, Singel TC. Sonographic measurement of uterus and its correlation with different parameters in parous and nulliparous women. Int J Med Sci Educ 2016;3:306-310.
40. Hagen CP, Mouritsen A, Mieritz MG, et al. Uterine volume and endometrial thickness in healthy girls evaluated by ultrasound (3-dimensional) and magnetic resonance imaging. Fertil Steril 2015;104:452-459.e2.
41. Nalaboff KM, Pellerito JS, Ben-Levi E. Imaging the endometrium: disease and normal variants. Radiographics 2001;21:1409-1424.
42. Gollub EL, Westhoff C, Timor-Tritsch IE. Detection of ovaries by transvaginal sonography in postmenopausal women. Ultrasound Obstet Gynecol 1993;3:422-425.
43. van Nagell JR Jr, Higgins RV, Donaldson ES, et al. Transvaginal sonography as a screening method for ovarian cancer. A report of the first 1000 cases screened. Cancer 1990;65:573-577.
44. Van Nagell JR Jr, DePriest PD, Puls LE, et al. Ovarian cancer screening in asymptomatic postmenopausal women by transvaginal sonography. Cancer 1991;68:458-462.
45. Higgins RV, van Nagell JR Jr, Donaldson ES, et al. Transvaginal sonography as a screening method for ovarian cancer. Gynecol Oncol 1989;34:402-406.
46. Goswamy RK, Campbell S, Royston JP, et al. Ovarian size in postmenopausal women. Br J Obstet Gynaecol 1988:95:795-801.
47. Campbell S, Goessens L, Goswamy R, Whitehead M. Real-time ultrasonography for determination of ovarian morphology and volume. A possible early screening test for ovarian cancer? Lancet 1982;1:425-426.
48. Cohen HL, Tice HM, Mandel FS. Ovarian volumes measured by US: bigger than we think. Radiology 1990;177:189-192.
49. Pavlik EJ, DePriest PD, Gallion HH, et al. Ovarian volume related to age. Gynecol Oncol 2000;77:410-412.
50. Granberg S, Wikland M. Comparison between endovaginal and transabdominal transducers for measuring ovarian volume. J Ultrasound Med 1987;6:649-653.
51. Andolf E, Jorgensen C. A prospective comparison of transabdominal and transvaginal ultrasound with surgical findings in gynecologic disease. J Ultrasound Med 1990;9:71-75.
52. Nazario AC, Nicolau SM, Nishimura CM. Comparison between pelvic endovaginal and transabdominal sonography in the measurement of the uterus and ovaries. Rev Paul Med 1991;109:51-54.
53. Goldstein SR. Modern evaluation of the endometrium. Obstet Gynecol 2010;116:168-176.
54. Paltiel HJ, Phelps A. US of the pediatric female pelvis. Radiology 2014;270:644-657.
55. Timmerman D, Van Calster B, Testa A, et al. Predicting the risk of malignancy in adnexal masses based on the Simple Rules from the International Ovarian Tumor Analysis group. Am J Obstet Gynecol 2016;214:424-437.
56. Buys SS, Partridge E, Black A, et al. Effect of screening on ovarian cancer mortality: the Prostate, Lung, Colorectal and Ovarian (PLCO) Cancer Screening Randomized Controlled Trial. JAMA 2011;305:2295-2303.
57. Henderson JT, Webber EM, Sawaya GF. Screening for Ovarian Cancer: Updated Evidence Report and Systematic Review for the US Preventive Services Task Force. JAMA 2018;319:595-606.
58. Jacobs JJ, Menon U, Ryan A, et al. Ovarian cancer screening and mortality in the UK Collaborative Trial of Ovarian Cancer Screening (UKCTOCS): a randomised controlled trial. Lancet 2016;387:945-956.