

Ethnic Influence on Internal Jugular Vein Diameter: A Comparative Ultrasonographic Study Between Turkish Citizens and Syrian Refugee-Migrant Adults

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Abstract

Purpose: This study aimed to investigate differences in internal jugular vein (IJV) diameter between adult Turkish citizens and Syrian refugee-migrant individuals, considering variables such as ethnicity, age, gender, body position, anatomical side (right/left), and the Valsalva maneuver. **Methods:** A total of 156 volunteers (80 Turkish citizens, 76 Syrian refugee-migrant) with no history of neck masses, surgery, or trauma were evaluated between September 2022 and September 2023. Bilateral IJV diameters were measured via ultrasonography at the level of the cricoid cartilage, both at rest and during the Valsalva maneuver, using a 7 MHz linear transducer. **Results:** The mean age of the Syrian group was significantly lower than that of the Turkish group. No gender-based differences in IJV diameter were observed. However, IJV diameter increased with age (particularly over 50 years), and right-sided measurements were consistently larger than left-sided ones. Turkish participants exhibited greater IJV diameters across all parameters, with statistically significant differences identified in four out of eight measurements. **Conclusion:** Ethnicity, age, and anatomical side significantly influence IJV diameter. This study offers novel insights into racial variations in IJV size and demonstrates the need for accurate ultrasonographic evaluation to reduce procedural risks in central venous interventions.

Keywords: Internal Jugular Vein; Ultrasonography; Ethnicity; Vascular Access; Valsalva Maneuver

1. Introduction

The internal jugular vein (IJV) is a principal venous conduit that facilitates a significant amount of venous return from cranial tissues to the heart.^{1,2} Owing to its large diameter and superficial positioning, it is often favored for central venous catheterization for intravenous medication and blood product delivery, hemodialysis, and volume resuscitation.³ During cervical lymph node dissection in oncological procedures, it is especially important as an anatomical identifier in the head and neck region.⁴

Utilizing the IJV for central venous access necessitates an understanding of its anatomical features, as the vessel's diameter fluctuates according to age, gender, and positioning. As the diameter of the vessel grows, the probability of successful cannulation on the initial attempt increases.⁵ An augmentation in the cross-sectional area (CSA) of the internal jugular vein correlates with enhanced cannulation success and a decrease in mechanical problems.⁶

Recently, it has been demonstrated that IJV diameter may be a potential determinant of central venous pressure.^{7,8} Ultrasonography (USG) has emerged as the primary imaging technique for vascular disorders due to its noninvasive characteristics, convenience of use, cost efficiency, and favorable patient tolerability. It also serves a guiding function in catheterization procedures.⁹ Interventions conducted under ultrasound guidance facilitate the safe and successful placement of the catheter in the internal jugular vein.¹⁰

The diameter of the IJV may fluctuate depending on physiological factors, including age, gender, side, rest, or the Valsalva maneuver. Protecting the vascular systems in the cervical region during interventional treatments is crucial; thus, understanding these anatomical variations aids in surgical planning and diminishes complication rates. Consequently, our study aimed to prospectively investigate whether the average diameter of the IJV fluctuates based on age, gender, resting state, Valsalva maneuver, side variations, and ethnic features.

2. Materials and Methods

2.1. Study Design and Setting

This single-center, prospective observational study was conducted from September 2022 to September 2023, after being approved by the local ethics committee (Approval Date: 30.05.2022; Approval No: 106/1955). This study was conducted in accordance with ethical standards of the Declaration of Helsinki. All volunteers involved in the study were thoroughly told about its objective and protocol, and written informed consent was obtained from all individual participants included in the study.

The study included 156 healthy participants, comprising 80 inhabitants of the Republic of Türkiye and 76 Syrian refugees, all aged 18 and above, who presented at our medical clinic. Participants under eighteen years of age, individuals with anemia, those with a history of cervical trauma, those with a history of neck masses or swelling, and individuals who had previously undergone cervical surgery were excluded from the study.

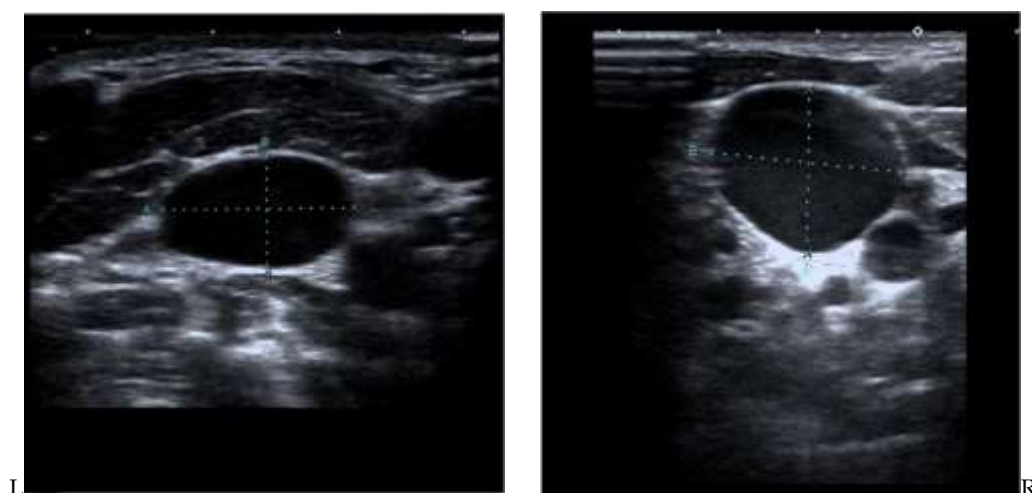


Figure 1. L: Transverse (A) and antero-posterior (B) diameter measurement of the right IJV at rest. R: Transverse (A) and antero-posterior (B) diameter measurement of the right IJV during the Valsalva maneuver.

2.2. Study Procedure and Measurements

All ultrasonographic analyses were conducted by one physician. Volunteers were assessed in a supine position with their heads rotated approximately 30° to the contralateral side. Ultrasound assessments were conducted using a 7 MHz linear transducer, positioned at the level of the cricoid cartilage perpendicular to the skin, with little pressure used to avoid vascular distortion. The maximal transverse and longitudinal diameters of both internal jugular veins were measured independently at rest and during the Valsalva maneuver. Measurements were documented in millimeters (mm). The research investigated differences in average internal jugular vein dimensions according to age, gender, resting/Valsalva maneuver, ethnicity, and directional (right-left) factors.

Figures 1 exhibit sample ultrasonographic pictures of the internal jugular vein.

2.3. Statistical Analysis

The data research was performed utilizing IBM SPSS Statistics 26.0 software. Categorical variables are summarized using counts and percentages. Comparisons between the two groups were assessed using an independent samples t-test, while comparisons among several groups were analyzed using one-way ANOVA. Correlation analysis was employed to investigate the correlations among continuous variables. In all experiments, the threshold for statistical significance was established at $p < 0.05$.

3. Results

The study comprised 156 healthy people, consisting of 86 women and 70 males. The average age of the Syrian refugee-immigrant group was 34.59 ± 13.51 years, whereas the average age of the Turkish citizen group was 47.85 ± 15.02 years. No statistically significant difference in gender distribution was detected between the two groups ($p > 0.05$). Upon comparison of average ages, it was ascertained that the Syrian refugee-immigrant group was markedly lower than that of the Turkish citizen group ($p < 0.001$) (Table 1).

Table 1. Demographic Data

Parameter	Syrian Refugee-Immigrant (n=76)	Turkish Citizen (n=80)	p
Female, n (%)	38 (44.2)	48 (55.8)	0.209
Male, n (%)	38 (54.3)	32 (45.7)	0.209
Age, years	34.59 ± 13.51	47.85 ± 15.02	<0.001

Table 2. Comparison of IJV Diameter Measurements of the Groups at Rest and During the Valsalva Maneuver

Parameter	Syrian Refugee-Immigrant (n=76)	Turkish Citizen (n=80)	p
Right Resting Anterior-Posterior Diameter (mm)	8.96 ± 3.18	9.58 ± 2.83	0.202
Right Resting Transverse Diameter (mm)	13.03 ± 4.01	13.98 ± 4.02	0.138
Left Resting Anterior-Posterior Diameter (mm)	8.14 ± 2.45	9.09 ± 2.48	0.018
Left Resting Transverse Diameter (mm)	11.69 ± 2.96	12.60 ± 3.10	0.063
Right Valsalva Anterior-Posterior Diameter (mm)	10.83 ± 2.95	11.26 ± 3.17	0.388
Right Valsalva Transverse Diameter (mm)	15.45 ± 4.72	17.04 ± 4.17	0.027
Left Valsalva Anterior-Posterior Diameter (mm)	9.68 ± 2.80	10.85 ± 2.94	0.013
Left Valsalva Transverse Diameter (mm)	12.80 ± 3.41	14.84 ± 3.92	0.001

Evaluation of internal jugular vein (IJV) diameter measurements revealed that the average IJV diameters in the Turkish citizen group exceeded those of the Syrian refugee-immigrant group across all parameters. Statistically significant differences were observed between the groups in four of the eight parameters. The left resting anterior-posterior

diameter ($p=0.018$), left Valsalva anterior-posterior diameter ($p=0.027$), left Valsalva transverse diameter ($p=0.013$), and right Valsalva transverse diameter ($p=0.001$) were significantly larger in the Turkish citizen group. No significant differences were observed in other measurements ($p>0.05$). Both the Syrian refugee-immigrant and Turkish citizen groups exhibited an increase in anterior-posterior and transverse diameters during Valsalva compared to the resting state; however, no statistically significant difference was found. The analysis revealed that the diameters of the right internal jugular vein (IJV) were greater than those of the left IJV in both groups, observed at rest and during the Valsalva maneuver (Table 2).

No statistically significant difference was observed between male and female volunteers across all eight evaluated factors related to gender ($p>0.05$) (Table 3). No substantial difference was seen between male and female volunteers for the examined characteristics based on gender in both the Syrian refugee-immigrant group and the Turkish citizen group ($p>0.05$) (Table 4) (Table 5).

Table 3. Comparison of IJV Diameter Measurements of All Volunteers at Rest and During the Valsalva Maneuver by Gender

Parameter	Female (n=86)	Male (n=70)	p
Right Resting Anterior-Posterior Diameter (mm)	9.27 ± 2.91	9.29 ± 3.15	0.956
Right Resting Transverse Diameter (mm)	13.46 ± 3.59	13.59 ± 4.53	0.843
Left Resting Anterior-Posterior Diameter (mm)	8.75 ± 2.42	8.47 ± 2.61	0.479
Left Resting Transverse Diameter (mm)	12.20 ± 2.82	12.10 ± 3.34	0.848
Right Valsalva Anterior-Posterior Diameter (mm)	10.80 ± 2.80	11.37 ± 3.35	0.251
Right Valsalva Transverse Diameter (mm)	15.83 ± 4.10	16.80 ± 4.93	0.181
Left Valsalva Anterior-Posterior Diameter (mm)	10.51 ± 2.75	10.00 ± 3.12	0.282
Left Valsalva Transverse Diameter (mm)	14.00 ± 3.72	13.66 ± 3.95	0.575

Table 4. Comparison of Syrian Refugee-Immigrant IJV Diameter Measurements by Gender

Parameter	Female (n=39)	Male (n=37)	p
Right Resting Anterior-Posterior Diameter (mm)	8.78 ± 3.10	9.15 ± 3.30	0.611
Right Resting Transverse Diameter (mm)	12.84 ± 3.58	13.22 ± 4.45	0.682
Left Resting Anterior-Posterior Diameter (mm)	8.02 ± 2.20	8.26 ± 2.71	0.663
Left Resting Transverse Diameter (mm)	11.57 ± 2.58	11.81 ± 3.34	0.729
Right Valsalva Anterior-Posterior Diameter (mm)	10.44 ± 2.90	11.25 ± 3.00	0.237
Right Valsalva Transverse Diameter (mm)	14.92 ± 4.53	16.00 ± 4.92	0.32
Left Valsalva Anterior-Posterior Diameter (mm)	9.61 ± 2.34	9.77 ± 3.24	0.802
Left Valsalva Transverse Diameter (mm)	12.49 ± 3.53	13.12 ± 3.30	0.43

The analysis of the age factor revealed that all eight assessed parameters were significantly elevated in those over 50 years old compared to those aged 50 and below ($p<0.005$) (Table 6).

Table 5. Comparison of Turkish Citizen IJV Diameter Measurements by Gender

Parameter	Female (n=48)	Male (n=32)	p
Right Resting Anterior-Posterior Diameter (mm)	9.68 ± 2.68	9.43 ± 3.07	0.706
Right Resting Transverse Diameter (mm)	13.85 ± 3.62	14.19 ± 4.60	0.709
Left Resting Anterior-Posterior Diameter (mm)	9.35 ± 2.42	8.68 ± 2.56	0.238
Left Resting Transverse Diameter (mm)	12.74 ± 2.91	12.38 ± 3.41	0.611
Right Valsalva Anterior-Posterior Diameter (mm)	11.22 ± 2.82	11.33 ± 3.67	0.882
Right Valsalva Transverse Diameter (mm)	16.75 ± 3.75	17.46 ± 4.76	0.460
Left Valsalva Anterior-Posterior Diameter (mm)	11.29 ± 2.84	10.18 ± 3.01	0.096
Left Valsalva Transverse Diameter (mm)	15.29 ± 3.39	14.18 ± 4.58	0.215

Table 6. Comparison of IJV Diameter Measurements of All Volunteers at Rest and During the Valsalva Maneuver by Age

Parameter	50 Years and Below (n=108)	Over 50 Years (n=48)	p
Right Resting Anterior-Posterior Diameter (mm)	8.67 ± 2.80	10.64 ± 3.05	<0.001
Right Resting Transverse Diameter (mm)	12.82 ± 3.99	15.10 ± 3.67	0.001
Left Resting Anterior-Posterior Diameter (mm)	8.14 ± 2.35	9.71 ± 2.52	<0.001
Left Resting Transverse Diameter (mm)	11.60 ± 2.84	13.40 ± 3.18	0.001
Right Valsalva Anterior-Posterior Diameter (mm)	10.62 ± 2.93	12.04 ± 3.16	0.007
Right Valsalva Transverse Diameter (mm)	15.44 ± 4.24	18.11 ± 4.57	0.001
Left Valsalva Anterior-Posterior Diameter (mm)	9.89 ± 2.86	11.15 ± 2.89	0.013
Left Valsalva Transverse Diameter (mm)	13.25 ± 3.84	15.18 ± 3.43	0.003

4. Discussion

Assessing the diameter of the IJV is essential for patient management and treatment across multiple medical disciplines. This information is especially significant for surgery and internal medicine due to its clinical consequences. Literature indicates that right IJV cannulation exhibits a superior success rate and a reduced frequency of complications relative to left IJV.¹¹ The probable explanation for these findings is that the right internal jugular vein typically possesses a bigger anatomical diameter; this characteristic favors the right-side during cannulation and catheterization treatments. Tartière et al. reported that the right internal jugular vein (IJV) diameter was significantly larger than the left IJV in 190 CT scans. These scans were conducted to confirm the hypothesis that there is asymmetry between the right and left IJV and to evaluate the IJV diameters.¹² Jeon et al. assessed the circumferences of the right and left internal jugular veins (IJV) using contrast-enhanced neck CT scans from 313 individuals; the study's findings indicated that the right IJV was considerably greater than the left IJV in all positions.¹⁰ Mangano et al. analyzed MR venography pictures of 193 patients, revealing that the cross-sectional size of the right IJV was considerably larger than that of the left IJV at all cervical levels.¹³ Lim et al. documented the average right internal jugular vein diameter as 14.1 mm and the left IJV diameter as 11.74 mm based on 176 CT exams.¹⁴ Botero et al. indicated that the cross-sectional size of the right IJV is greater than that of the left IJV.¹⁵ Mortenson et al. observed that the right internal jugular vein exhibited a somewhat greater diameter; however, they indicated that this disparity lacked statistical significance.¹⁶ This study revealed that the diameter of the right IJV was considerably larger than that of the left IJV in both groups, both at rest and during the Valsalva maneuver.

Diverse imaging techniques are employed to assess the size of the internal jugular vein (IJV). Color Doppler ultrasonography (USG), magnetic resonance imaging (MRI), and computed tomography (CT) are the predominant non-invasive modalities for assessing vein diameters, recognizing structural alterations, and detecting potential diseases.^{10,12-14,17} CT-based studies generally determine the greatest diameter, whereas ultrasound evaluates the anteroposterior, transverse, or lateral diameters. Multiple studies in the literature indicate that the average diameter values obtained via ultrasound are inferior to those acquired through computed tomography; this difference is believed to stem from the partial compression of the IJV caused by probe pressure during measurement.^{12,18,19} This study assessed IJV diameters in two groups, Syrian refugee-immigrants and Turkish citizens, using ultrasonography, a non-invasive, radiation-free, and cost-effective technique.

Ultrasonographic assessment of the IJV diameter can be conducted from various locations. At three separate anatomical levels—the hyoid bone, the cricoid cartilage, and the first thoracic vertebra—Jeon et al. measured the internal jugular vein (IJV).¹⁰ In their study,

Kalkan et al. measured in three different locations: under the mandibular angle, at the level of the cricothyroid membrane, and in the supraclavicular area in particular.²⁰ In the study by Sayin et al., measurements were taken at the sternoclavicular joint and cricoid cartilage.²¹ Internal jugular vein cross-sectional areas at cervical levels C2/C3, C4, C5/C6, and C7/T1 were studied by Magnano et al.¹³ In this study, IJV diameters were assessed using an ultrasonography (USG) probe positioned perpendicularly to the skin at the level of the cricoid cartilage, ensuring the vessel's morphology remained undisturbed and providing minimal pressure.

Ultrasonography imaging, with hemodynamic alterations such as the Valsalva maneuver, digital compression, Trendelenburg position, lower extremity elevation, and hepatic compression, has been observed in literature to determine the maximum diameter of the IJV.^{17,18,20,22,23} The Valsalva maneuver was identified as the most effective measurement technique in the study conducted by Verghese et al.²³ Kalkan et al. demonstrated that the diameter of the IJV was greatest during the Valsalva maneuver in their assessments conducted at rest, during deep breath holding, and while performing the Valsalva maneuver.²⁰ Digital compression in conjunction with the Valsalva technique significantly enhanced distal IJV expansion, according to Seong et al.²⁴ Karazincir et al. and Yildirim et al. conducted research on the pediatric population and discovered that the Valsalva maneuver resulted in a significant increase in the diameter of the internal jugular vein.^{17,18} This study examined internal jugular vein diameters at rest and during the Valsalva maneuver, revealing a substantial increase in diameter. Some investigations favored MRI and CT because of the pressure exerted by the ultrasound probe and the impact of movements on diameter. Nonetheless, the real-time imaging, hemodynamic evaluation, and appropriateness for bedside uses of ultrasound present considerable benefits in interventional catheterization procedures.

The impact of gender on the dimensions of the IJV has been a topic of discussion in the literature. Some research indicates a possible relationship between gender and IJV size, while others observe no significant differences. Jeon et al. indicated that gender did not significantly influence the size of the internal jugular vein (IJV).¹⁰ Kalkan et al. and Mangano et al. found that the diameter and CSA of the IJV were greater in men compared to women.^{20,13} Conversely, Erkan et al. identified no statistically significant disparity in IJV diameter across genders in their research.²⁵ This study revealed that the variations in IJV diameter parameters across genders were not statistically significant ($p > 0.05$).

Literature research indicates that the size of the internal jugular vein (IJV) may vary with age. Jeon et al. reported a significantly greater IJV cross-sectional area associated with increasing age.¹⁰ Mangano et al. observed this difference particularly in individuals over 40 years of age.¹³ Valecchi et al. reported an analogous trend in a study of 462 patients aged 21–92 years but did not achieve statistical significance.²⁶ Erkan et al. reported no significant disparity in IJV diameter between individuals aged above and under 60 years.²⁵ Kalkan et al. found no significant age-related differences in the cross-sectional areas of the right and left internal jugular veins.²⁰ This study revealed that the IJV diameter was greater in the group aged over 50. The findings may pertain to the emergence of low-flow and volume venous congestion in the internal jugular vein due to decreased atrial discharge pressure.

The Turkish Statistical Institute indicates that the mean age of the Turkish populace is 34.²⁷ The mean age of Syrians residing in Turkey is believed to be 23.²⁸ The average age of the Turkish citizen group was 47.85, whereas the Syrian refugee-immigrant group had a mean age of 34.59. This study assessed the impact of racial variations, location, gender, laterality (right-left), and age on the diameter of the internal jugular vein (IJV). Although gender did not have a significant impact on IJV diameter, it was observed that IJV diameter became larger in individuals over the age of 50, with the right IJV exhibiting greater

width than the left. The mean internal jugular vein (IJV) diameter was greater in the Turkish citizen group compared to the Syrian refugee-migrant group across all parameters; statistically significant differences were observed in four of the eight parameters (left anterior-posterior IJV diameter at rest and during the Valsalva maneuver, and transverse IJV diameter during right and left Valsalva maneuvers). This disparity was attributed to the enlarged vessel diameter resulting from venous stasis associated with the older average age of the Turkish citizen group.

Our study has a few disadvantages the most important of which are the relatively small sample size and the significant age gap between the groups. Moreover, it offers a distinctive contribution to the literature, being the only study assessing internal jugular vein (IJV) diameter concerning racial disparities. The ultrasonography (USG) employed offers the benefit of real-time structural and hemodynamic visualization; nevertheless, the precision and consistency of measurements are significantly influenced by the operator's expertise. A further weakness of the study is the absence of a standardized pressure application on the ultrasound probe.

5. Conclusions

This study is significant as it demonstrates the variation in internal jugular vein (IJV) diameter between Turkish citizens and Syrian immigrant-refugee populations. The study assessed the impact of position, gender, side (right versus left), age, and race on the diameter of the IJV and provides a unique contribution, as there is no existing literature comparing IJV diameter among different races. Accurate ultrasonographic measures are essential in clinical practice to mitigate interventional and surgical risks.

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Institutional Review Board Statement: This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Adana City Training and Research Hospital Clinical Research Ethics Committee (Adana, Türkiye) (Approval Date: 30.05.2022; Approval No: 106/1955).

Informed Consent Statement: All participants provided their consent for anonymized data to be published as part of this research.

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