# To Study the Sexual Dimorphism in the Neck Parameters of North Indian Population

**Vibha Singh[1], Nidhi Sharma[2], S. K. Jain[3], Rohin Garg[4*], Hina Nafees[4]**

**[1]PG Student (MSc Medical Anatomy), [2]Professor, [3]Professor & Head, [4]Associate Professor,
Department of Anatomy, Teerthanker Mahaveer Medical College & Research Centre, Moradabad, UP, India.**

## ABSTRACT

**Background:** Thyromental distance (TMD), sternomental distance (STMD), ratio of height to thyromental distance (RHTMD) and neck circumference (NC) were measured pre-operatively for predicting the difficult laryngoscopy/intubation. The present study was conducted to study the sexual dimorphism in the neck parameters of North Indian population.

**Materials and Methods:** The Cross-sectional study to the sexual dimorphism in the neck parameters of North Indian population. The study was conducted in Teerthanker Mahaveer Medical University Moradabad over a period of 2 years. Sample consists of 200 students (100 male & 100 female) of North Indian population. Following parameters will be measured in centimeters:-Thyromental distance (TMD), Sternomental distance (STMD), Ratio of height to thyromental distance (RHTMD), Neck circumference (NC). The data obtained was recorded on Microsoft excel sheet Mean, Standard deviation and standard error was calculated. The 'p' value of less than 0.05 was considered statistically significant.

**Results:** The results of the study showed that In male subjects mean age taken was 19.65±2.07, height 1.68±6.39, weight 62.05±8.7 and BMI 21.93±3.2, in females subjects mean age was 19.15 ± 1.69, height 1.57± 7.5, weight 55.02 ± 10.45 and BMI 22.09 ± 3.55. Difference in height and weight of both genders was statistically significant (<0.05). Whereas difference in age and BMI of both genders was statistically insignificant (>0.05). In male population the mean and standard deviation for TMD was 8.67 ± 1.39, STMD was 18.19 ± 1.34, NC was 36.79 ± 3.11, RHTMD was 19.89±2.93. In female population the mean and standard deviation for TMD was 8.89 ± 1.11, STMD was 17.27± 1.65, NC was 32.93 ± 2.31, RHTMD was 18.01 ± 2.16. A statistically significant difference (<0.05) was found in STMD, NC, RHTMD in both genders but in TMD no significant difference was found. In both genders, the correlation between age and neck parameters was statistically Insignificant. (>0.05). In males TMD and STMD are

significantly (<0.05) positively correlated with height of subjects whereas in females STMD and NC are significantly (<0.05) positively correlated with height. In males STMD and NC are significantly (<0.05) positively correlated with Weight Whereas in female only NC is significantly (<0.05) positively correlated. In both genders only NC is significantly (<0.05) positively correlated with BMI of the subjects.

**Conclusion:** The study concluded that a statistically significant difference was found in STMD, NC, RHTMD in both genders but in TMD no significant difference was found. In both genders, the correlation between age and neck parameters was statistically insignificant. In males TMD and STMD are significantly positively correlated with height of subjects whereas in females STMD and NC are significantly positively correlated with height. In males STMD and NC are significantly positively correlated with Weight whereas in females only NC is significantly positively correlated. In both genders only NC is significantly (<0.05) positively correlated with BMI of the subjects.

**Keywords:** Sexual Dimorphism, Neck Parameters, Thyromental Distance, Sternomental Distance, Ratio of Height to Thyromental Distance and Neck Circumference (NC).

**\*Correspondence to:**
**Dr. Rohin Garg,**
Associate Professor,
Department of Anatomy,
TMMC & RC, TMU, Moradabad, UP, India.

## INTRODUCTION

The neck is the elongated structure which connects the head to the trunk and extends anteriorly from the inferior border of the mandible to the superior surface of the manubrium of sternum and posteriorly from the superior nuchal line on the occipital bone of

the skull to an intervertebral disc in between the two vertebrae of C7 and T1. During development of the neck, the tube is divided into four compartments with longitudinal organization.[1] Endotracheal intubation is a curative procedure in which a tube is

placed into the windpipe (trachea) through the oral cavity or nose. In emergency situations, it is placed through the mouth. Insertion of endotracheal tube helps in giving medicine to patient whether patient is conscious or not. It is also easier to place patient on a breathing machine after endotracheal intubation.[2]

There are different parameters to access the difficult airway assessment based on various anatomic parameters of upper airway, much of it being concentrated on oral cavity and the pharyngeal structure. It is found that misidentification of the cricothyroid membrane is common and particularly in the female population.[3,4] A study was conducted on 341 adult patients scheduled to receive general anaesthesia. Thyromental distance (TMD), sternomental distance (STMD), ratio of height to thyromental distance (RHTMD) and neck circumference (NC) were measured pre-operatively. Several bedside screening tests - with the most popular being the Mallampati classification, mouth opening, thyromental distance, upper lip bite and head-neck mobility have been used in clinical practice for predicting the difficult laryngoscopy/intubation.[3, 5-7] The present study was conducted to study the sexual dimorphism in the neck parameters of North Indian population.

## MATERIALS AND METHODS
The Cross-sectional study to the sexual dimorphism in the neck parameters of North Indian population. The study was conducted in Teerthanker Mahaveer Medical University Moradabad over a period of 2 years.

Sample consists of 200 students (100 male & 100 female) of North Indian population. Sample was selected using Simple random sampling. Subjects from North Indian population between 18 to 25 years of age and both genders were included in the study. Subjects of age < 18 and > 25 years, severe obesity (BMI more than 35 kg/m^{2}), cervical spine abnormalities, swelling in neck, not giving consent for the study were excluded from the study.

Following parameters were measured in centimeters:-
1. Thyromental distance (TMD),
2. Sternomental distance (STMD),
3. Ratio of height to thyromental distance (RHTMD)
4. Neck circumference (NC)

Measurements of the thyromental distance (TMD), sternomental distance (STMD), ratio of height to thyromental distance (RHTMD) and neck circumference (NC) was performed in all students by the same Investigator using a measuring tape. The measurements were performed twice and the average of the two results was adopted.

**TMD**: The TMD is defined as the straight-line distance (cm) from the lower border of the thyroid notch to the bony point of the mentum, with the head extended and the mouth closed. **STMD:** The STMD is defined as the straight-line distance (cm) from the bony point of the mentum to the upper border of the manubrium sterni, with the head extended and the mouth closed. **NC**: NC (cm) is measured with the head erect and eyes facing forward, by using a flexible tape positioned horizontally at the upper margin of the laryngeal prominence. **RHTMD**: It is defined as the ratio of height to thyromental distance. Stature was measured as the vertical distance between the point vertex (highest point of the head when the head is held in the Frankfurt horizontal plane and the floor. The subject was made to stand bare foot in an anatomical position on the base board. Then the height was recorded in centimeter from the standing surface to the vertex using a stadiometer. The landmarks are marked by the marker and the scales are aligned on it parallel to the floor. The distance between the two scales was measured[8]. The data obtained was recorded on Microsoft excel sheet Mean, Standard deviation and standard error was calculated. The comparison of the means of the dimensions was made using 2-tailed't' test. The association between variables was investigated by means of pearson's correlation coefficient. The 'p' value of less than 0.05 was considered statistically significant.

## RESULTS
Data in table – 1 depicts that the mean age subjects for male was 19.65 ± 2.076, height was 1.686 ± 6.397, similarly to weight was 62.05 ± 8.707 and mean BMI subjects was 21.93 ± 3.206. The mean age subjects for female was 19.15 ± 1.695, height was 1.577 ± 7.506, similarly weight was 55.02 ± 10.45 and mean BMI was 22.09 ± 3.556.

Table – 2 reflected that Comparison between both genders according to the age the t value was 1.865 (p value 0.064), for the height t value was 10.99 (p value 0.0001) and followed by for the weight t value was 5.171 (p value 0.001), for BMI t value was – 0.334 (p value 0.738). The result showed that p value of height and weight of both gender was statistically significant (<0.05). Whereas the difference in age & BMI was statistically in significant (>0.05). Descriptive statistic value for male result showed in table – 3 that mean and standard deviation for TMD was 8.67 ± 1.39, STMD was 18.19 ± 1.34, NC was 36.79 ± 3.11, RHTMD was 19.89±2.93. Descriptive statistic value for female result showed that mean and standard deviation for TMD was 8.89 ± 1.11, STMD was 17.27± 1.65, NC was 32.93 ± 2.31, RHTMD was 18.01 ± 2.16.

**Table 1: Demographic profile for Male and females**

| Demographic profile | Descriptive statistics Males (n= 100) | | Descriptive statistics Females (n= 100) | |
|---|---|---|---|---|
| | **Mean** | **Std. Deviation** | Mean | **Std. Deviation** |
| **Age** | 19.65 | 2.076 | 19.15 | 1.695 |
| **Height** | 1.686 | 6.397 | 1.577 | 7.506 |
| **Weight** | 62.05 | 8.707 | 55.02 | 10.45 |
| **BMI** | 21.93 | 3.206 | 22.09 | 3.556 |

**Table-2: Comparison of demographic profile in both genders**

| Demographic profile | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | F | Sig | t | Df | P-value | Mean Difference | Std. Error Difference | 95% confidence interval difference | |
| | | | | | | | | Lower | Upper |
| Age | 3.910 | 0.049 | 1.865 | 198 | 0.064 | 0.500 | 0.268 | -.0286 | 1.029 |
| | | | | 190.42 | | | | | |
| Height | 1.125 | 0.290 | 10.99 | 198 | 0.0001 | 10.839 | 0.986 | 8.8941 | 12.784 |
| | | | | 193.15 | | | | | |
| Weight | 0.345 | 0.557 | 5.171 | 198 | 0.0001 | 7.03500 | 1.361 | 4.3519 | 9.7180 |
| | | | | 191.73 | | | | | |
| BMI | 0.331 | 0.566 | -0.334 | 198 | 0.738 | -16010 | 0.479 | -1.1042 | 0.7840 |
| | | | | 195.91 | | | | | |

**Table-3: Descriptive statistics for male and female**

| Neck Parameters | Males | | Females | |
|---|---|---|---|---|
| | Mean | Std. Deviation | Mean | Std. Deviation |
| TMD | 8.6750 | 1.39634 | 8.8990 | 1.11342 |
| STMD | 18.1950 | 1.34753 | 17.2720 | 1.65829 |
| NC | 36.7970 | 3.11962 | 32.9360 | 2.31497 |
| RHTMD | 19.8949 | 2.93639 | 18.0194 | 2.16765 |

**Table 4: Comparison of Neck Parameters in both genders**

| Demographic profile | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | F | Sig | T | Df | P-value | Mean Difference | Std.Error Difference | 95% confidence interval difference | |
| | | | | | | | | Lower | Upper |
| TMD | 0.890 | 0.347 | -1.25 | 198 | 0.211 | -0.224 | 0.17859 | -0.576 | 0.128 |
| | | | | 188.650 | | | | | |
| STMD | 3.911 | 0.049 | 4.32 | 198 | 0.000 | 0.923 | 0.21368 | 0.501 | 1.344 |
| | | | | 190.04 | | | | | |
| NC | 0.384 | 0.536 | 9.94 | 198 | 0.000 | 3.861 | 0.38847 | 3.094 | 4.627 |
| | | | | 182.66 | | | | | |
| RHTMD | 3.861 | 0.051 | 5.14 | 198 | 0.000 | 1.875 | 0.36498 | 1.155 | 2.595 |
| | | | | 182.19 | | | | | |

The comparison of neck parameter in both genders in Table -4 result showed that the t value of TMD: -1.25 (P=0.211), for STMD t value was 4.32 (p = 0.000), for NC t value was 9.94 (p = 0.000), for RHTMD t value was 5.14 (p =0.000). A statistically significant difference was found in STMD, NC, RHTMD in both genders but in TMD no significant difference was found.

Table: 5 result indicated that there was a no correlation significant of neck parameters TMD (0.005), STMD (0.072) & NC (0.090) with age of male at the level of p value >0.05 and negative correlation significant of neck parameters of RHTMD (-0.060) at the level of p value > 0.05.

Table: 6 results find out that there was a positive correlation significant of neck parameters TMD (0.211) with height of male at the level of p value <0.05, similarly STMD (0.351) with height of male at the level of p value< 0.01, there was no correlation significant of neck parameters of NC (0.063) & RHTMD (0.090) at the level of p value of > 0.05 or > 0.01.

Table 7 results showed that there was a positive correlation significant of neck parameters STMD (0.228*), NC (0.361**) with weight of male at the level of p value<0.05 & <0.01 with weight of male at the level of p value <0.01, there was negative correlation significant of neck parameters of RHTMD (-0.098) and no correlation significant at the level of p value of 0.05 or 0.01.

Table: 8 result revealed that there was a positive correlation significant of neck parameters NC (0.302**) with BMI of male at the level of p value < 0.01, no correlation significant of neck

parameters TMD (0.097), STMD (0.049) with BMI of male at the level of p value >0.05 or >0.01, there was negative correlation significant of neck parameters of RHTMD (-182) at the level of p value of 0.05 or 0.01.

Table 9 result showed that there was a negative correlation significant of neck parameters TMD (-0.098) & STMD (-0.192) with age of female at the level of p value 0.05 and no correlation significant of neck parameters of NC (0.159) & RHTMD (0.071) at the level of p value >0.05.

Table: 10 results revealed that there was a positive correlation significant of neck parameters of STMD (0.458*), NC (0.352*) with height of female at the level of p value <0.05. There is no correlation significant of TMD (0.237), RHTMD (0.160) of neck parameters with height of female at the level of p value >0.05.

### Table-5: Correlation of Neck parameters according to age for male

| Neck parameters | Pearson Correlation | P value |
|---|---|---|
| TMD | 0.005 | >0.05 |
| STMD | 0.072 | >0.05 |
| NC | 0.090 | >0.05 |
| RHTMD | -0.060 | >0.05 |

### Table-6: Correlation of Neck parameters according to height for male

| Neck parameters | Pearson Correlation | P value |
|---|---|---|
| TMD | 0.211* | <0.05 |
| STMD | 0.351** | <0.01 |
| NC | 0.063 | >0.05 |
| RHTMD | 0.090 | >0.05 |

### Table-7: Correlation of Neck parameters according to weight for male

| Neck parameters | Pearson Correlation | P value |
|---|---|---|
| TMD | 0.158 | >0.05 |
| STMD | 0.228* | <0.05 |
| NC | 0.361** | <0.01 |
| RHTMD | -0.098 | >0.05 |

### Table-8: Correlation of Neck parameters according to BMI for male

| Neck parameters | Pearson Correlation | P value |
|---|---|---|
| TMD | 0.097 | >0.05 |
| STMD | 0.049 | >0.05 |
| NC | 0.302** | <0.01 |
| RHTMD | -182 | >0.05 |

### Table-9: Correlation of Neck parameters according to age for female

| Neck parameters | Pearson Correlation | P value |
|---|---|---|
| TMD | -0.098 | >0.05 |
| STMD | -0.192 | >0.05 |
| NC | 0.156 | >0.05 |
| RHTMD | 0.071 | >0.05 |

### Table-10: Correlation of Neck parameters according to Height for female

| Neck parameters | Pearson Correlation | P value |
|---|---|---|
| TMD | 0.237 | >0.05 |
| STMD | 0.458* | <0.05 |
| NC | 0.352* | <0.05 |
| RHTMD | 0.160 | >0.05 |

### Table-11: Correlation of Neck parameters according to weight for female

| Neck parameters | Pearson Correlation | P value |
|---|---|---|
| TMD | 0.090 | >0.05 |
| STMD | 0.108 | >0.05 |
| NC | 0.590* | <0.05 |
| RHTMD | 0.122 | >0.05 |

### Table-12: Correlation of Neck parameters according to BMI for female

| Neck parameters | Pearson Correlation | P value |
|---|---|---|
| TMD | -0.053 | >0.05 |
| STMD | -0.156 | >0.05 |
| NC | 0.475* | <0.05 |
| RHTMD | 0.057 | >0.05 |

Table: 11 result indicated that there was a positive correlation significant of neck parameters of NC (0.590*) with weight of female at the level of p value <0.05. There is no correlation of TMD (0.090), STMD (0.108) & RHTMD (0.122) of neck parameters with weight of female at the level of p value >0.05.

Table: 12 results indicated that there was a positive correlation significant of neck parameters of NC (0.475*) with BMI of female at the level of p value < 0.05. There is negative correlation significant of TMD (-0.053), STMD (-0.156) and no correlation significant of RHTMD (0.057) of neck parameters with BMI of female at the level of p value > 0.05.

### DISCUSSION

The study showed that mean age of subjects of male was 19.65 ± 2.076, height mean score was 1.686 ± 6.397, mean weight was 62.05 ± 8.707. The mean BMI for male was 21.93 ± 3.206.

The mean age of subjects of female was 19.15 ± 1.695, height mean score was 1.577 ± 7.506, mean weight was 55.02 ± 10.45. The mean BMI was 22.09 ± 3.556.

In the study done by Hornarmand et al[9] the age of subjects taken was 44±17 yrs. Weight of the subjects was 68±11 kg.

The table reflected that Comparison between both gender according to the age the t value was 1.865 (p value 0.064), for the height t value was 10.99 (p value 0.0001) and followed by for the weight t value was 5.171 (p value 0.001), for BMI t value was – 0.334 (p value 0.738). The result showed that p value of height and weight of both gender was statistically significant (<0.05). Whereas the difference in age & BMI was statistically in significant (>0.05).

Chara et al[10] did a study in 2014, in which anatomic features of neck were studied for difficult intubation. The age of the patients

considered for study was > 18 years and BMI of the patients was 35 Kg/m$^2$. The descriptive statistic anatomical neck parameters for male. The result shows mean and standard deviation values for TMD as 8.67 ± 1.39, STMD was 18.19 ± 1.34, NC was 36.79 ± 3.11, RHTMD was 19.89±2.93.

Honarmand et. al[9] measured NC, ratio of NC to TMD and ratio of height to TMD in year 2015. The value of NC was found to be 37±4 cm in male population which is higher than the Indian population. The descriptive statistic anatomical neck value for female. The mean value and standard deviation for TMD was 8.89 ± 1.11, STMD was 17.27± 1.65, NC was 32.93 ± 2.31, RHTMD was 18.01 ± 2.16.

Shah PJ et. al[11] did the study on South Indian population and found the values of TMD (8.5 cm) and RHTMD (20.5 cm). Both the value was comparable to our study. According to them the frequency of difficult laryngoscopy is not gender dependent but, it was relatively high in females, possibly due to difference in assessing the laryngoscopic view without applying any external manoeuvres.

The comparison of neck parameter in both genders showed that the t value of TMD: -1.25 (P=0.211), for STMD t value was 4.32 (p = 0.000), for NC t value was 9.94 (p = 0.000), for RHTMD t value was 5.14 (p =0.000). A statistically significant difference was found in STMD, NC, RHTMD in both genders but in TMD no significant difference was found.

Chara et al[10] in the population of Greece compared the parameters (TMD, STMD, NC and STMD) in both the genders and found no significant difference. According to them difference in frequency of difficult intubation in males and females is statistically insignificant. But in our study significant difference was seen in the parameters STMD, NC and RHTMD.

According to the existing literature, these neck parameters are used for assumption of various clinical conditions.

Naguib M et al[12] stated that these parameters have better inter-observer reproducibility as compared to other tests like head-neck mobility, Mallampati test and interincisor gap etc.

Nafiu OO et al[13] showed in his study that neck circumference and degree of adipocity has strong positive correlation. Along with it this study also showed the relation between adipocity and waist circumference in children.

Straznicki NE et al[14] found that Neck Circumference was independently linked with increased Muscle Sympathetic Nerve Activity and hyperinsulinemia, and thus may be related to prediction of cardio-metabolic risk. Men with higher value of Neck Circumference had significantly elevated fasting and post-glucose plasma insulin levels. Neck Circumference alone explained 12%, and together with insulin levels, it explained 22% of MSNA in male. In female, Neck Circumference was linked with anthropometric parameters but not with metabolic indices.

Stabe C et al[15] stated that neck circumference is an alternative approach for determining distribution of body fat. The NC is positively correlated with Metabolic Syndrome risk factors and Insulin Resistance.

Dai Y et al[16] studied that Neck Circumference is linked with incidence of Cardio-vascular disease. A positive relationship is present between NC and CVD events in future. An increased value of NC indicates a higher incidence of CVD events and mortality. NC could be a superior, simpler, and more consistent indicator of CVD and related mortality in the high risk population.

## CONCLUSION

The study concluded that a statistically significant difference was found in STMD, NC, RHTMD in both genders but in TMD no significant difference was found. In both genders, the correlation between age and neck parameters was statistically insignificant. In males TMD and STMD are significantly positively correlated with height of subjects whereas in females STMD and NC are significantly positively correlated with height. In males STMD and NC are significantly positively correlated with Weight whereas in females only NC is significantly positively correlated. In both genders only NC is significantly (<0.05) positively correlated with BMI of the subjects.

## REFERENCES

1. Le Douarin NMK. The Neural Crest. 1999.
2. Adamas M, Vavreckova T, Hrabalek L, Zapletalova J, Gabrhelik T, et al. Inter-observer reproducibility of 15 tests used for predicting difficult intubation. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub 2011; 155: 275 – 81.
3. Schoenwolf G, Bleyl S, Brauer P, Francis-West P. Larsen's Human Embryology, 4th edn. Churchill Livingston, New York, Edinburgh Waldhausen J Branchial cleft and arch anomalies in children. Semin Pediatr Surg 2006;15:64–9.
4. D'Souza A, Uppal H, De R, Zeitoun H Updating concepts of first branchial cleft defects: a literature review. Int J Pediatr Otorhinolaryngol 2012; 62:103–9.
5. Drake R L, Vogl AW, Mitchell A W, editors. Gray´s Anatomy for students.3rd ed. Philadelphia: Churchill Living stone Elesevier,2015 p.1000.
6. Begbie J, Brunet JF, Rubenstein JL, Graham A. Induction of the epibranchial placodes. Development. 1999 Feb;126(5):895–902.
7. Sadler TW,editor.Langman´s Medical Embryology.12th ed. philadalphia: Wolter Kluwer,2012.p262.
8. Mallampati SR, Gatt SP, Gugino LD, Desai SP, Waraksa B, Freiberger D, et al. A clinical sign to predict difficult intubation: A prospective study. Can Anaesth Soc J 1985;32:429-34.
9. Azim Honarmand, Mohammadreza Safavi, Ahmad Yaraghi, Mohammadali Attari, Mehdi Khazaei, and Majid Zamani Comparison of five methods in predicting difficult laryngoscopy: Neck circumference, neck circumference to thyromental distance ratio, the ratio of height to thyromental distance, upper lip bite test and Mallampati test, Adv Biomed Res. 2015; 4: 122. 40.
10. Liaskou Chara, Vouzounerakis Eleftherios, Moirasgenti Maria, Trikoupi Anastasia, and Staikou Chryssoula , Anatomic features of the neck as predictive markers of difficult direct laryngoscopy in men and women: A prospective study, Indian J Anaesth. 2014 Mar-Apr; 58(2): 176–82.
11. Pratibha Jain Shah, Kamta Prasad Dubey, Jai Prakash Yadav Predictive value of upper lip bite test and ratio of height to thyromental distance compared to other multivariate airway assessment tests for difficult laryngoscopy in apparently normal patients. Journal of Anaesthesiology Clinical Pharmacology. April-June 2013; 29(2): 191-5
12. Naguib M, Scamman FL, O'Sullivan C, Aker J, Ross AF, Kosmach S et al. Predictive performance of three multivariate difficult tracheal intubation models: a double-blind, case-controlled study. Anesth Analg. 2006 Mar;102(3):818-24.
13. Nafiu OO, Burke CC, Gupta R, Christensen R, Reynolds PI, Malviya S. Association of neck circumference with perioperative

adverse respiratory events in children. Pediatrics. 2011 May;127(5):e1198-205.

14. Straznicky NE, Mariee T. Grima, Carolina I. Sari, Nina Eikelis, Paul J. Nestel, John B. Dixon et. al. Neck Circumference Is Associated with Muscle Sympathetic Nerve Activity in Overweight and Obese Men but Not Women, Front Physiol. 2017; 8: 203.

15. Stabe C, Vasques AC, Lima MM, Tambascia MA, Pareja JC, Yamanaka A et al. Neck circumference as a simple tool for identifying the metabolic syndrome and insulin resistance: results from the Brazilian Metabolic Syndrome Study. Clin Endocrinol (Oxf). 2013 Jun; 78(6): 874-81.

16. Dai Y, Wan X, Xin Li, Enze Jin, and Xueqi Li et al. Neck circumference and future cardiovascular events in a high-risk population—A prospective cohort study. Lipids Health Dis 2016 Mar 5;15:46. doi: 10.1186/s12944-016-0218-3.