

Anatomical Consideration of Nasopharyngeal and Oropharyngeal Swab Tests of COVID-19 among the Population in the Area Jazan, Kingdom of Saudi Arabia

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ABSTRACT

Background and Aim: In conducting nasopharyngeal and oropharyngeal swab tests of suspected COVID-19 infection, one should expect variations in depth of nasopharynx and oropharynx among different categories of sex and ethnic groups. This study aims to describe the length of the nose to nasopharynx and mouth to oropharynx in the local population of the area of Jazan, Kingdom of Saudi Arabia. **Methods:** Participants in this study were asymptomatic Saudi adults. Seventy participants underwent oropharyngeal swab test, and 25 underwent nasopharyngeal swab test. Swab test stick was measured (length of stick out of the nose and out of the mouth) to estimate the nasopharynx and oropharynx's depth, respectively. Also, we measured the nasopharynx and oropharynx depth in 42 cadaveric heads with a mid-sagittal section for comparative purposes. We analyzed the data to show the correlation in measurements of (1) male to female, (2) oropharynx depth to nasopharynx depth, and (3) cadaveric (Caucasian) to the living (local) population. **Results:** In the local population, our finding shows an average depth of the nasopharynx to be 9.82 ± 0.48 cm in males and 8.99 ± 0.35 cm in females, with the difference to be significant, and an average depth of the oropharynx to be 9.12 ± 0.44 cm in males, and 8.45 ± 0.34 cm in females, also with the difference to be significant: We found Caucasian cadaveric specimens to have lengthier measurements in both nasopharynx and oropharynx depths than the local population.

Conclusion: We concluded that there is significant difference in the measurements of the depth of the nasopharynx and oropharynx. Also, sex and race factors have significant effect on these measurements.

Key words: COVID-19, Nasopharyngeal depth, Oropharyngeal depth, Swab test, Saudi population.

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INTRODUCTION

The routine nasopharyngeal swab test of suspected COVID-19 infection should consider the nasal cavity and nasopharynx anatomy to increase patient comfort and diagnostic yield.^[1] The same is applied to the oropharyngeal swab test concerning the oral cavity and oropharynx. Among the many ways to test COVID-19 nasopharyngeal swab test is the best and more sensitive than the oropharyngeal swab test^[2] and the use of the nasopharyngeal airway has some advantages over the use of oropharyngeal airway.^[3] However, some studies reported that lingual swab is convenient and may achieve the same effect.^[4] Variations in structure and size of the nasal cavity and nasopharynx are expected among different age, sex, and ethnic groups. The size might be affected by the paranasal sinuses' shape and pneumatization, especially the Sphenoid sinus.^[5]

The total number of cases per million is lower in Saudi Arabia when compared to UK.^[6] Saudi Arabia is obliged to protect the health of not only its

citizens and residents but also all visitors from around the world.^[7,8] Like many other countries, most health programs have prioritized and delayed elective procedures in an effort to reduce the burden on the health care system and to mobilize resources in the event of a pandemic surge.^[9] Active settings for testing COVID-19 were established for free and easy access to help in the control of the disease in the area of Jazan because so far, there is barely any report on the prevalence of respiratory viruses in this region of the country and no serological evidence of MERS-CoV circulation before this pandemic of COVID-19.^[10] The population and the staff in Saudi Arabia prefer the oropharyngeal swab test over the nasopharyngeal swab test because it is easily applied and less painful.^[7] Oropharyngeal swab test for COVID-19 is a common practice in many other countries.^[11] Adverse effects of nasopharyngeal swabs include epistaxis, nasal discomfort, headache, ear discomfort, and rarely rhinorrhoea.^[12] People are

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obliged for nasopharyngeal swab test when they travel out or come to the Kingdom or for employment. The problem is that the swab devices are manufactured outside the Kingdom and have different sizes.

A study evaluated 160 swab designs and 48 materials from 24 companies.^[13] These multiple swab designs may not take into consideration the ethnic variations of the local population. This study aim to describe the length of the nose to nasopharynx and mouth to oropharynx in the local population so that the procedure of nasopharyngeal and oropharyngeal swab tests will be modified accordingly.

MATERIALS AND METHODS

Participants in this study were asymptomatic Saudi adults who visited two COVID-19 test centers in the City of Jazan, Kingdom of Saudi Arabia. We included 70 participants who were suspected for COVID-19 or with primary contacts of COVID-19 infected persons from Al Rashid Mall Center for oropharyngeal test. We included 25 participants from Al Borj Laboratories Center for nasopharyngeal test.

We calibrated the swab test sticks for total length, and then mark was kept on each stick just outside the nose and outside the mouth for the nasopharyngeal test and the oropharyngeal test, respectively. After the test, part of each stick was broken out and put safely in the test vial by the practitioner.

We measured the length of the remaining portion of the stick from the point marked to the outer end using a digital caliper equipped with an LCD screen. Then we subtracted the outer part that we have measured from the stick's total length to estimate the nasopharynx depth (NPD) and oropharynx depth (OPD). Ethical issues and safety measurements were considered. We also used 42 cadaveric specimens of heads with mid-sagittal sections to measure both NPD and OPD as comparative data.

Statistical Analysis of Data

The data obtained were analyzed using SPSS software (IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp. USA). Student's *t* test was used to estimate the significant differences. *P*<0.05 was considered significant.

RESULTS

The participants who performed the nasopharyngeal swab test included in this study were 25 adults (8 males, and 17 females), with an average depth of nasopharynx in males 9.82±0.48 cm, and in females 8.99±0.35 cm as shown in Table 1.

The participants who performed the oropharyngeal swab test were seventy adults (39 males and 31 females). The average OPD for males was 9.12±0.44 cm, and for females was 8.45±0.34 cm as shown in Table 2.

Table 1: Nasopharyngeal swab test measurements in males and females.

Group	Male	Female
Mean	9.82363	8.99012
SD	0.46086	0.35231
SEM	0.16294	0.12456

Table 2: Oropharyngeal swab test measurements in males and females.

Group	Male	Female
Mean	9.12306	8.45484
SD	0.44097	0.34503
SEM	0.07920	0.06197

The average NPD for all the 25 participants was 9.44±0.57 cm, and that of OPD for all the 70 participants was 8.85±0.52 cm. as shown in Table 3. Correlation between nasopharyngeal to OPD revealed that *P*-value was less than 0.0001, and this difference was considered to be extremely statistically significant.

In the 42 cadaveric specimens (Figures 1, 2) we found NPD in the range of 8.3-10.5cm (mean 9.4cm) and the oropharynx depth in the range of 7.56-9.8cm (mean 8.7cm). We used the NPD and OPD measurements in the cadaveric specimens (Caucasian) to compare with the participants from the local population (Figure 3). We found the Caucasian to be deeper in all measurements.

DISCUSSION

Our study aimed to provide measurements of the Saudi population that could be useful in the nasopharyngeal and oropharyngeal swab test for COVID-19. In our findings, the average NPD was greater than the average OPD and the difference was found to be significant. And males have greater measurements in both NPD and OPD than females. Previous studies stated that other structures like tongue and soft palate are even greater in men than women,^[14] and also the same for the distances from nares to larynx.^[15,16]

Table 3: Average measurements of nasopharyngeal and oropharyngeal swab test.

Group	Nasopharynx depth	Oropharynx depth
Mean	9.44448	8.73268
SD	0.57379	0.55830
SEM	0.11476	0.11166

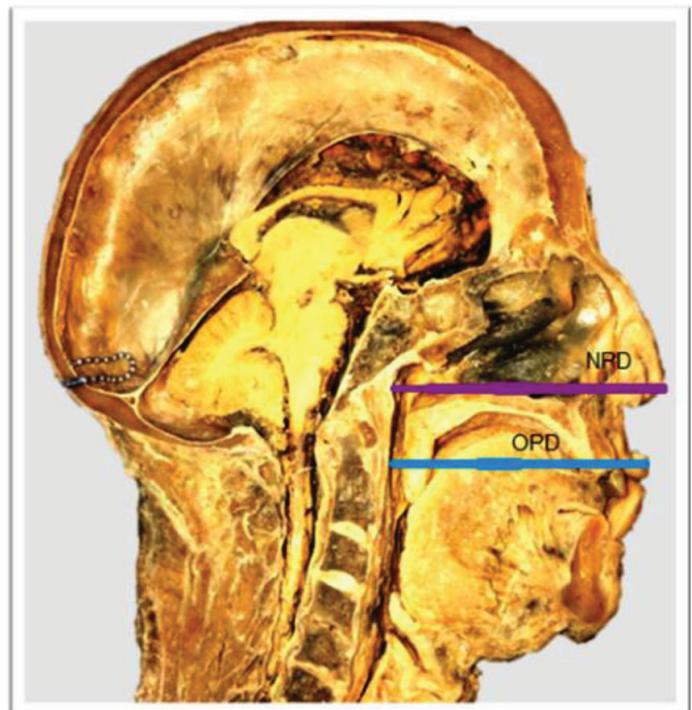


Figure 1: Nasopharynx, nose, oropharynx and mouth in the cadaveric specimens.

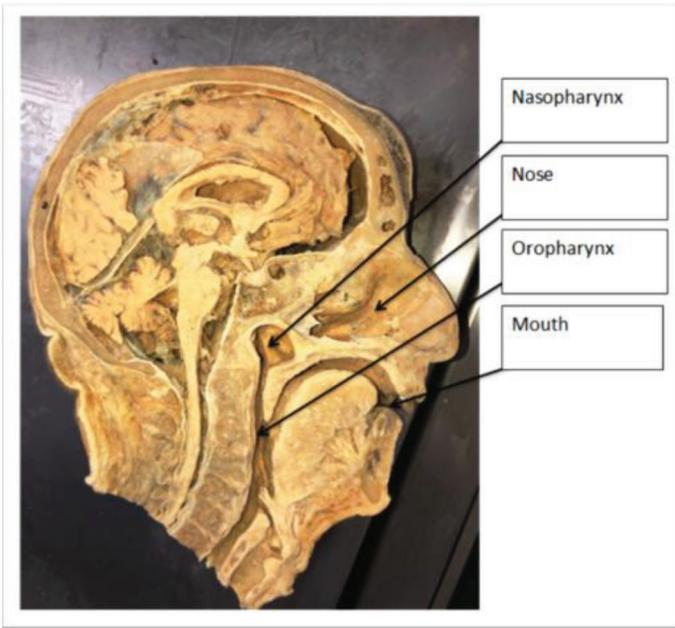


Figure 2: Nasopharyngeal depth (NPD) and oropharyngeal depth (OPD) in the cadaveric specimens.

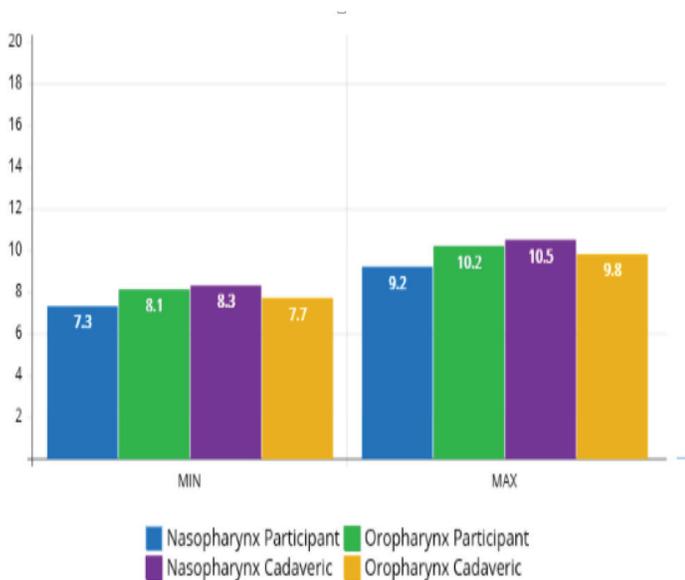


Figure 3: Comparison of depth of nasopharynx and oropharynx in the living participants and the cadaveric specimens. Notice that cadaveric measurements (Caucasian) were lengthier than local measurements.

In comparison with other races, we found that the depth of nasopharynx and oropharynx in the local population was less than that of the cadaveric samples (Caucasian). In a previous study aimed to define nasal anthropometric measurements in Saudi Arabia, the intercanthal distance of Saudi men is significantly smaller than that in women (the reverse is true for other races). Hence, Saudi women (and not men) have significantly wider intercanthal distance than do whites.^[17] The nasal widths of Saudi men and women lie between the whites and the Chinese.

A unique feature of the nose of the Saudi population is the significantly larger nasofrontal angle of Saudi men and women than all other races.

Within the Saudi race, the nasofacial angle of men is so much larger than that of women. Since the emergence of the coronavirus disease 2019 (COVID-19) pandemic, more than 200 million cases have been diagnosed worldwide. These diagnoses were made using material collected with nasopharyngeal swabs, which provide the highest sensitivity for detecting severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection during early infection.^[18]

A nasopharyngeal swab is an FDA class I exempt medical device roughly 15cm in length and 2 to 3 mm in diameter designed to collect secretions from the posterior nasopharynx. The nasal valve area is the narrowest portion of the nasal passage, with cross-sectional areas of $0.54 \pm 0.13 \text{ cm}^2$.^[19,20] and swab stick has to pass through this area with the least pain. The size measurements of the head, neck, shaft, and break-point, requirement of ~15 cm to reach the posterior nasopharynx; head diameter of 1 to 3.2mm to pass into the mid inferior portion of the inferior turbinate and be able to maneuver appropriately without catching on anatomical variants such as septal spurs or a deviated nasal septum.^[21] Same swab devices are used for the oropharyngeal swab test. Health authorities in the Area of Jazan, Kingdom of Saudi Arabia, have set peripheral test centers for free in all of the Area's 14 provinces for easy access. These centers use oropharyngeal swabs and serve those suspected to acquire the disease, or more dangerous, those suspected to be carriers^[22] or those who had come in contact with the diseased. The peripheral centers preferred oropharyngeal swab tests. They are easy to use and chosen by the population because they cause less pain and discomfort.

Nasopharyngeal swab test is conducted in private centers for those in hurry to travel or employment. In central hospitals, those who have the disease must be admitted and isolated. Scope-guided swabs are often ideal for better visualization and comfort for the patient. However, in view of potential transmission via airborne droplets and upper respiratory tract endoscopy procedures, many international Ear, Nose, and Throat (ENT) organizations have advised against endoscopic procedures.^[23] Oropharyngeal swabs allow the use of tongue visualization to the depth of the oropharynx.

In the nasopharyngeal swab test, only the estimation of the distance by an expert is helpful. The nasopharynx situated behind the nasal cavities, and the estimation of the distance from the nares to the nasopharynx is more than 10mm shorter than the distance from the nares^[24] to the tragus. However, even experienced operators in performing the procedure in patients with a higher risk of epistaxis, with anatomical anomalies or nasal pathologies that contraindicate the execution may present difficulties.^[25] As in all those conditions like advanced stage sinonasal neoplasms or unfavorable anatomical characteristics, the nasopharyngeal swab may not be feasible.^[26]

Knowledge of the NPD and OPD of local ethnic groups such as the population in the Area of Jazan, Kingdom of Saudi Arabia, can help perform the procedure accurately. Also, many studies described in detail the structure and geometry of the human nasal cavity.^[27] We recommend that these facts should be considered in the manufactured swab test devices to fit the different lengths of the nasopharynx and oropharynx and the difference between males and females.

CONCLUSION

We concluded that there is significant difference in the measurements of the depth of the nasopharynx and oropharynx. Also, sex and race factors have significant effect on these measurements

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

NPD: Nasopharyngeal Depth; **OPD:** Oropharyngeal Depth.

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