Annals of Science and Technology - A, Vol 8 (1): 1-7, 2023
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ISSN: 2 544 6320

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ARTICLE

Frequency of ABH secretor status: a cross-sectional study in Lagos, Southwestern Nigeria

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Received 21st September, 2022, Accepted 24th December, 2022
10.2478/ast-2023-0001

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Abstract

The mucosa contains soluble antigens of the ABO blood group system. Secretor status as a trait has been linked to a variety of clinical diseases and is determined by the individual's fucosyltransferase 2 (FUT2) allele. The distribution of secretor status in relation to ABO blood group phenotypes varies from region to region, with medicolegal significance. There is a dearth of information on the secretor status of the studied population. The aim of the present study was to evaluate the secretor status of the ABH in a Nigerian population. To achieve this, fresh saliva samples (~5 ml) were collected from 325 (181 males and 144 females) apparently healthy individuals in the urban city of Lagos. Secretor status was determined by haemagglutination inhibition test with the saliva samples of participants. Results showed that 85% of the participants were secretors and 15% were non-secretors with no statistically significant differences ($p>0.05$) between male and female gender. The frequencies of the Secretor, Se and Non-secretor, se genes were 0.543 and 0.457, respectively while the frequencies of the SeSe, Sese, and sese genotypes were 0.294, 0.496, and 0.209, respectively. The participants' ABO blood group distributions were 65.5% group O, 16.6% group A, 15.1% group B, and 2.8% group AB. The incidence of secretors across blood group was 89% in group O, 85% in A, 79% in B and 67% in AB. However, there were no statistically significant variations in secretor status and ABO blood group ($p>0.05$). In conclusion, the study shows that there are more secretors than non-secretors, and the ability to secrete the ABH antigens are independent of ABO blood of individuals.

Keywords: haemagglutination inhibition test, saliva, secretor status, medicolegal investigation, Lagos.

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1.0 Introduction

The ABO blood group antigens are found on the surfaces of the red blood cells (RBCs). These water-soluble antigens can also be found on some other cell types such as the epithelial cells, in mucosal secretions and bodily fluids including saliva, urine, semen, and breast milk (Jaff, 2010). With respect to the secretion of the ABO antigens in bodily fluids, a person can either be a secretor (SeSe/Sese) or non-secretor (sese). 'Secretors' connote individuals whose blood group antigens are expressed in their body fluids, while 'non-secretors' refer to persons whose body fluids are not expressed or found in the body fluids and other secretions.

The Secretor fucosyltransferase 2 (*FUT2*) gene is involved in the secretion of the ABO blood group antigens. The gene, which codes for α-1,2 fucosyltransferase enzyme and responsible for the expression of the ABH antigens on RBCs, is located on chromosome 19q13.3 (Dean, 2005). However, the secretion of the ABH antigens and inheritance ABO blood group is independent of each other in individuals (Pal et al., 2007; Woike et al., 2017). Approximately 80% of the world population are secretors (Se) and 20% are non-secretors (se) based on the mutation events in the second exon of the *FUT2* gene (Ferrer-Admetlla *et al*., 2009; Sen *et al*., 2015).

The secretor is inherited in an autosomal dominant manner. The Se gene is the dominant form while se is the recessive (D'Adamo and Kelly, 2001; Metgud et al., 2016). Hence, genotypically, secretors are either homozygous (SeSe) or heterozygous (Sese) with the latter believed to secrete less amount of the 1,2 fucosyltransferase protein compared to the homozygous individuals. Secretor status and antigens from the ABO and Rh systems had previously been associated with the risk of developing a number of diseases including viral infections (Oussalah et al., 2012; Prystajecky et al., 2014), oral lesions (Lamey et al., 1991; Campi et al., 2012; Hallikeri et al., 2014), peptic ulcer (Suadicani et al., 1999), dental caries (Holbrook and Blackwell, 1989) and gingivitis (Kárpáti et al., 2014).

In the field of forensic serology, evaluation of bodily fluids remains an invaluable method in suspect identification and crime unraveling. Although molecular biology techniques have revolutionized the field of forensic genetics including its application in criminal investigations, analysis of blood groups and the detection of blood substances remain critical in forensic investigation. Secretor status and blood type analyses are however not as informative as the existing DNA typing systems in forensic investigation partly owing to the limited numbers of groups into which suspects can be categorized, for instance the expression/presence of a certain gene/antigens or not, and also to the fact many people can produce a match result. Consequently, these types of evidence are mostly suitable to rule out a suspect (negative evidence) rather than confirmatory (positive evidence). The aim of the present study was to determine the prevalence of ABH secretor status in relation to ABO blood types and gender in Lagos, Southwestern Nigeria.

2.0 Methods

2.1 Ethics clearance

Ethics clearance was granted by the Health Research Ethic Committee of College of Medicine of the University of Lagos (CMUL/HREC/05/21/854). Before the investigation began, all participants were made to understand the aim and scope of the research. Only those who gave their consent were recruited for the study. The privacy of all participants was ensured throughout.

2.2 Study design and subjects

This is a cross sectional-based study involving students and individuals residing in and around the University of Lagos (6 °30'55'' N, 3°23'57'' E). A total of 325 male and female individuals aged 18 years and above were recruited for the study using a random sampling technique. Sample size was determined according to Charan and Biswas (2013) based on 80% global prevalence rate of secretors and 5% confidence interval. Individuals who participated in the study were of age 18 and above. For eventual inclusion, all participants signed an informed consent document and provided a valid information of their blood group. Individuals with oral lesion were outrightly excluded from the study.

2.3 Sample collection

Before the laboratory procedure, each participant was provided with a 5 ml plain tube for saliva collection by spitting after they must have rinsed their mouth with water. Participants' saliva samples were then taken to the laboratory to determine their secretor status. Saliva samples were tested within 24 hrs of collection. ABO blood group of individual participants was ascertained from medical records in the health facility of subjects.

2.4 Determination of secretor status

The determination of secretor and non-secretor phenotypes was based on the haemagglutination inhibition technique described by Waters (1994) and adapted from Igbeneghu et al. (2015). To do this, 2-3 ml of saliva sample was boiled for 10 mins to inactivate salivary enzymes. The boiled saliva samples were then cooled and centrifuged at 2000 rpm for 5 mins, and the supernatant was used for the test. For each sample, six test tubes were set up. Three of the tubes were labeled A, B, H and respective anti-sera i.e., anti-A, anti-B anti-H

(Lorine Laboratories Ltd, Berks, UK) were added and the remaining 3 tubes were used for the control experiment. To each tube containing the antisera, a drop of clarified/centrifuged supernatant was added while one drop of normal saline was added to the control test tubes. The set ups were incubated for 10 mins at room temperature after which 2-5% suspension of red cells (A, B, or O) was added to each tube depending on blood group of the sample donor. The mixtures were homogenized, allowed to stand for 2 hrs, and then observed macroscopically for agglutination.

Interpretation: If there is agglutination in the "test" tubes, the person is a *Secretor*; if there is no agglutination (i.e., agglutination inhibition) the person is regarded as a *Non-secretor*.

2.5 Analysis of data

Chi square analysis was performed to determine the significance of differences of variables at 5% significance level. Genetic parameters were computed assuming Hardy-Weinberg Equilibrium (HWE). Statistical analyses were performed with the aid of IBM SPSS Statistics, ver26 (IBM Inc., New York, USA).

3.0 Results

A total of 325 subjects participated in the study out of which 181 (55.7%) were males and 144 (44.3%) were females. Table 1 shows the distribution of blood group among the study subjects.

Among the subjects, there were 213 (65.5%) individuals of the blood group O, 54 (16.6%) group A, 49 (15.1%) group B, and 9 (2.8%) were blood group AB. Out of the 181 male individuals who participated in the study, 63.0% had blood group O, 14.9% had group A while 17.7% and 4.4% of the males had blood groups B and AB, respectively. Whereas, for the 144 female subjects, there were 68.89% blood group O individuals, 18.8% group A, 11.8% group B and 0.7% group AB. Gender-based differences for blood group showed no significant values ($\chi^2 = 6.971$, df = 3, $p>0.05$).

The frequency distribution of secretors and non-secretors across the gender of the study population is presented in Table 2. In the study, 257 subjects representing 79.1% and 68 (20.9%) were ABH secretors and non-secretors, respectively. Among a total of 181 male participants, 143 (79.0%) were secretors and 38 (21.0%) were non-secretors. The 144 female participants however had 114 (79.2%) secretors and 30 (20,8%) non-secretors among them. Again, the difference between gender and secretor status was not statistically different ($\chi^2 = 0.001$, df = 3, $p>0.05$).

The highest number of secretors was recorded among the blood group A with 81.5% followed by blood groups O subjects (80.3%), group B (73.5%), and blood group AB with the least number of secretors (66.7%). Results show that there was no statistically significant difference between ABH secretor status and ABO blood group ($p>0.05$).

Table 3 depicts probable frequencies of secretor (*Se*) and non-secretor (*se*) genes and the corresponding genotypes based on HWE theory. The observed phenotypic frequency for secretor status was 79.1% while non-secretor status had a prevalence of 20.9%. The gene frequencies for Se and se were 54.3% and 45.7%, respectively, whereas the genotypic frequencies were 29.4% for SeSe genotype, 49.6% for Sese and 20.9% for the homozygote genotype, sese. Among the dominant secretor phenotype however, the heterozygotes (Sese) had a higher frequency compared to homozygotes (SeSe).

4.0 Discussion

The ABO blood group system was divided into four phenotypes i.e., A, B, AB, and O following its discovery by Karl Landsteiner in 1990. Antigens of the ABO blood group can be found in bodily fluids such as the salivary and digestive fluids. There are variations in the global distribution of the ABO blood group system with differences existing even among individuals of the same population. The fact that bodily fluids such as blood and saliva are man's absolute and unchangeable sources of identity testing is a universal truth. In spite the fact that nearly 400 subgroups have been identified, the ABO and Rhesus blood antigens are considered clinically significant with forensic implications.

The use of ABO blood group is medico-legal examination is premised on the fact that once a blood group is established in an individual, it remains unchanged throughout life. Saliva, as forensic evidence, may be recovered from different sources including envelopes, cigarette butts, stamps, and when subjected to agglutination analysis it can be used to ascertain specific substances (ABH secretion, Rhesus factor, etc) present in it. This may be helpful in determining who may be included or excluded in the dragnet of suspects (Nandy, 2005). Moreover, investigation of body fluids and tissues may be used to corroborate corresponding findings from blood samples and may also be pivotal in the absence of blood (Dean, 2005).

This study was carried out to determine the frequency of ABH secretor status in Lagos metropolis, Southwestern Nigeria in relation to gender and ABO blood group. Out of 325 participants recruited for the study, 257 (79.1%) were secretors and 68 (20.9%) were non-secretors. The higher percentage of secretor reported in this study is in tandem with previous studies of secretor status in different populations. Our finding is somewhat similar to the study conducted

Table 1: Distribution of ABO blood group across gender

	Gender		
Blood Group	Male	Female	Total
O	114	99	213
A	27	27	54
B	32	17	49
AB	8	1	9

Table 2: Frequency distribution of secretor and non-secretor status by gender

	Gender		
Secretor Status	Male	Female	Total
Secretors	143 (79.0%)	114 (79.2%)	257 (79.1%)
Non-secretors	38 (21.0%)	30 (20.8%)	68 (20.9%)
Total	181	144	325

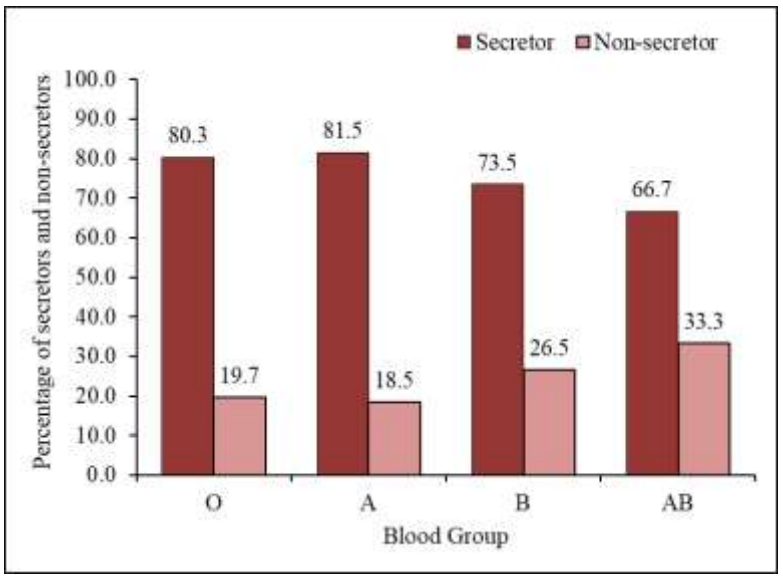


Figure 1: Percentage distribution of secretor and non-secretor status among blood groups

Table 3: Phenotypic, gene and genotypic frequencies of secretor status in Lagos, Nigeria

	Phenotype		Gene		Genotype	
Status	Observed	Frequency	Gene	Frequency	Genotype	Frequency
Secretors	257	0.791	*Se*	0.543	SeSe	0.294
					Sese	0.496
Non-secretors	68	0.209	*se*	0.457	sese	0.209

by Igbeneghu et al. (2015) which reported 78.1% secretors and 21.6% non-secretors among the residents of Osogbo, Southwestern Nigeria. In Gujarat, western coast India, Vyas et al. (1962) reported 79.6% secretors in the population while Kulkarni and Venkatesh (2004) reported an incidence of 76.8% secretors in Karnataka, southwest India. Other studies in which a higher incidence of secretors was reported in tandem with our findings include 60% secretors reported by Akhter et al. (2011) in Dhaka, Bangladesh and 82.3% prevalence of secretors reported by Imoru et al. (2020) in Sokoto, Northern Nigeria. Furthermore, Woike et al. (2017) reported a higher prevalence of secretors among Gwalior, Central Indian residents. In general, our finding aligns with the global prevalence of secretor status which is estimated to be 80% (Waters, 1994). In contrast, a lower incidence of secretors (31.8%) was reported by Muddathir *et al.* (2015) among

Sudanese population. Also, Devi et al. (2015) conducted a study on the secretor status of Manipuri population and reported a higher percentage (59.5%) of the population are non-secretors compared to secretors' 49.5%. The wide variation in secretor status across studies may be attributed to several factors such as geographical and racial differences as well as sample size. Secretor status was found to be independent of gender in this study. This agrees with the reports of several authors who found no significant difference in the occurrence of secretor status in males and females in their respective population of study (Jaff, 2010; Saboor et al. 2014; Igbeneghu et al. 2015).

A larger proportion of sampled individuals in our study belongs to blood group O, accounting for 65.5% while the least observed blood group is the AB group with 2.8%. These findings support a study conducted in Osogbo that highlighted the highest percentage of blood group O with 52.7% Igbeneghu et al. (2015). Other populations in which the prevalence of blood group O have been reported include a study conducted by Rodriguez et al. (2017) in Lima, Peru with a total 102 participants, out which 76% were of blood group O phenotype. Also, Akhter et al. (2011) in their study carried out in Dhaka, Bangladesh reported a prevalence of 36.0% groups O among 42 sampled individuals. On the contrary, the prevalence of other blood groups apart from group O has been reported in several studies. These include the prevalence of group A (48.5%) in a study of 1351 individuals in Turkish population (Demir et al., 2007) as well as blood group A (36.36) among Indians Hallikeri et al. (2014). In addition, a study carried out by Saboor et al. (2014) in Karachi, Pakistan reported 36 (35.6%) blood group B individuals among 101 subjects who participated in the study.

In this study, the incidence of secretor status was more prevalent among blood group A individuals compared to any other blood group but the difference was not statistically significant ($p>0.0.5$). Variation in the prevalence of secretor status among the different blood groups is supported by several studies (Jaff, 2010; Igbeneghu et al., 2015; Salih et al., 2015; Woike et al., 2017). Furthermore, Imoru et al. (2020) in a similar study concluded that the differences in the frequencies of secretors and non-secretors with respect to ABO blood group system were not statistically significant. Also, Bakhtiari et al. (2020) who investigated ABH secretor status in a defined group of Iranian patients with pemphigus vulgaris found no association between ABO blood group and secretion of ABO antigens in blood groups. There may exist a favourable interaction between the ABO blood type gene and the ABH secretor gene resulting in a synergy that makes certain blood type to be more prevalent across ethnic populations or groups of individuals with significant medico-legal implications.

5.0 Conclusions

In this study, secretors are more than non-secretors. The ability to secrete ABH substances are independent of the ABO blood group and blood group A individuals are more likely to be secretors than any other blood group. The findings of the study could be used to explain the occurrence and distribution pattern of secretor status in the studied population.

List of Abbreviations

FUT2: Fucosyltransferase 2 gene

HWE: Hardy-Weinberg equilibrium.

RBC: Red blood cell

Conflict of interest – None

Authors contributions

Conception: STF, KOA and BO

Design: STF and KOA

Execution: SAS and STF

Interpretation: STF, KOA and SAS

Writing the paper: All authors

References

Akhter, S., Kabria, G. M., Akhter, N. R., Habibullah, M. M., Islam, S. M. K., and Zakariah, M. (2011). ABO and Lewis Blood Grouping with ABH Secretor and Non-secretor status: A cross sectional study in Dhaka. Faridpur Medical College Journal. 6(1): 38-40.

Bakhtiari, S., Yadegari, Z., Kaviyani, M., Namazi, Z., and Bakhshi, M. (2020). Secretor Status of ABO Antigens in Saliva of a Defined Group of Iranian Patients with Pemphigus Vulgaris: A Case-Control Study. Scientifica . ArticleID2950856, https://doi.org/10.1155/2020/2950856

Campi, C., Escovich, L., Moreno, A., Racca, L., Racca, A., Cotorruelo, C., and Biondi, C. (2012). Expression of the gene encoding secretor type galactoside 2 α fucosyltransferase (FUT2) and ABH antigens in patients with oral lesions. Medicina Oral, Patologia Oral y Cirugia Bucal. 17(1): 63-68, https://doi.org/10.4317/medoral.17239

Charan, J., and Biswas, T. (2013). How to calculate sample size for different study designs in medical research. Indian Journal of Psychological Medicine. 38(2):121-126, https://doi.org/10.4103/0253-7176.116232

D'Adamo, P. J., and Kelly, G. S. (2001). Metabolic and immunologic consequences of ABH secretor and lewis subtype status. Alternative Medicine Review .6(4):390-405, https://pubmed.ncbi.nlm.nih.gov/11578255/

Dean, L. (2005). Blood Groups and Red Cell Antigens [Internet]. National Center for Biotechnology Information (US), Bethesda (MD), Chapter 4,Hemolytic Disease of the Newborn. http://www.lm.nih.gov/books/NBK2266/

Demir, T., Tezel, A., Orbak, R., Eltas, A., Kara, C., and Kavrut, F. (2007). The Effect of ABO Blood Types on Periodontal Status. European Journal of Dentistry. 1(3):139-143, http://www.ncbi. nlm.nih.gov/pmc/ar ticles/pmc2638241/

Devi, A. S., Meera, T., Singh, K. P., Nabachandra, H., and Shah, I. (2015). Secretors in Manipuri population: a study. Journal of Indian Academy of Forensic Medicine. 37(2): 127-130, https://doi.org/10.5958/0974-0848.2015.00031.7

Ferrer-Admetlla, A., Sikora, M., Laayouni, H., Esteve, A., Roubinet, F., Blancher, A., Calafell, F., Bertranpetit, J., and Casals, F. (2009). A Natural history of FUT2 polymorphism in humans. Molecular Biology and Evolution. 26(9):1993-2003, https://doi.org /10.1093/molbev/msp108

Hallikeri, K., Udupa, R., Guttal, K. and Naikmasur, V. (2014). Analysis of salivary secretor status in patients with oral submucous fibrosis: a case-control study. Journal of Investigative and Clinical Dentistry. 6(4): 261-266, https://doi.org/10.1111/jicd.12100

Holbrook, W. P., and Blackwell, W. P. (1989). Secretor status and dental caries in Iceland. FEMS Microbiology Immunology. 47(6-7): 397-399, https://doi.org/10.1111/j.1574-6968.1989.tb02427.x

Igbeneghu, C., Chebudum, S., Olisekodiaka, J. M., Alabi, T., Onuegbu, J. A., Adesiyan, A., and Odaibo, A. B. (2015). ABH secretors status in Osogbo, Southwestern Nigeria. International Journal of Modern Biological Research. 3: 6-10.

Imoru, M., Ikhuenbor, D., and Muhammad, A. (2020). Evaluation of secretor status of ABH Antigens in the saliva of Sokoto Residents in Northern Nigeria: A complementary Evidence of ABO Blood Groups in Forensic Science. Tropical Journal of Health Sciences. 27: 14-19.

Jaff, M. (2010). Higher frequency of secretor phenotype in O blood group - its benefits in prevention and/or treatment of some diseases. International Journal of Nanomedicine. 5: 901-905, https://doi.org/10.2147/ijn.s13980

Kárpáti, K., Braunitzer, G., Toldi, J., Turzó, K., Virág, K., Reiche, W. T., Rakonczay, Z., and Nagy, K. (2014). Caries and ABO secretor status in a Hungarian population of children and adolescents: an exploratory study. Caries Research. 48(3):179-185, https://doi.org/10.1159/000356851

Kulkarni, D. G., and Venkatesh, D. (2004). Non-secretor status; a predisposing factor for vaginal candidiasis. Indian Journal of Physiology and Pharmacology. 48(2): 225-229, https://pubmed.ncbi.nlm.nih.gov/15521563/

Lamey, P. J., Darwazeh, A. M., Muirhead, J., Rennie, J. S., Samaranayake, L. P., and MacFarlane, T. W. (1991). Chronic hyperplastic candidosis and secretor status. Journal of Oral Pathology & Medicine. 20(2): 64-67, https://doi.org/10.1111/j.1600-0714.1991.tb00891.x

Metgud, R., Khajuria, N., and Mamta, R. G. (2016). Evaluation of the secretor status of ABO blood group antigens in saliva among southern Rajasthan population using absorption inhibition method. Journal of Clinical and Diagnostic Research. 10(2): 1-3, https://doi.org/10.7860%2FJCDR%2F2016%2F11598.7161

Muddathir, A. R. M., Fadl-Elmula, I., Abdelgadir, R. E., and Bashir, A. S. I. (2015). Frequencies of secretors and non-secretors of ABH group substances among Sudanese population. American Journal of Research Communication. 4(5681): 457-459.

Nandy, A. (2005). Principles of Forensic Medicine. 2nd ed. Calcutta: New Central Book Agency (P) Ltd. p. 131.

Oussalah, A., Besseau, C., Chery, C., Jeannesson, E., Gueant-Rodriguez, R., and Anello, G. (2012). Helicobacter pylori serologic status has no influence on the association between fucosyltransferase 2 polymorphism (FUT2 461 G->A) and vitamin B-12 in Europe and West Africa. The American Journal of Clinical Nutrition. 95(2): 514-521, https://doi.org/10.3945/ajcn.111.016410

Pal, S. K., Sharma, K., Pathak, A., and Prabhakar, S. (2007). Frequency of ABO (H) antigen on Red Blood Cells and Saliva of Epilepsy Patients. In Sharma K et al. (eds.): Genes, Environment and Health: Anthropological Perspectives. New Delhi: Serials Publications. Pp. 211-221.

Prystajecky, N., Brinkman, F., Auk, B., Isaac-Renton, J., and Tang, P. (2014). Personalized Genetic Testing and Norovirus Susceptibility. Canadian Journal of Infectious Diseases and Medical Microbiology. 25(4): 222-224, https://doi.org/10.1155%2F2014%2F708579

Rodriguez, L., Murillo, A., Rúa, J., Bernal, C., Contreras, E., Quispe, J., Mallqui, H., Colona, E., Alzamora, L. (2017). Assessment of secretor status in Peruvian university students. Revista Científica Ágora. 04(01): e4

Saboor, M., Ullah, A., Qamar, K., Mir, A., and Moinuddin. (2014). Frequency of ABH secretors and non-secretors: a cross sectional study in Karachi. Pakistan Journal of Medical Sciences. 30: 89-193, https://doi.org/10.12669/pjms.301.4194

Salih, K., Jouda, J., Al-Jaff, S., El-Haboby, B., and Shaker, E. (2015). Frequency of ABO blood groups and secretor status and their relation with dental decay in a section of students and employees of Al-Mustansiriyiah University in Iraq. World Journal of Experimental Biosciences. 3(2): 108-112.

Sen, M. P., Vanishree, M., Hunasgi, S., Surekha, R., Koneru, A., and Manvikar, V. (2015). A comparison of absorption inhibition and absorption elution methods for estimation of ABO blood groups in saliva. Journal of Medicine Radiology Pathology & Surgery. 1: 1-4, https://doi.org/10.15713/INS.JMRPS.1

Suadicani, P., Hein, H. O., and Gyntelberg, F. (1999). Genetic and lifestyle determinants of peptic ulcer. A study of 3,387 men aged 54 to 74 years: the Copenhagen Male Study. Scandinavian Journal of Gastroenterology. 34(1):12-17, https://doi.org/10.3109/003655297709025057

Vyas, G. N., Bhatia, H. M., Sukumaran, P. K., Balkrishnan, V., and Sanghvi, L. D. (1962). Study of blood groups, abnormal hemoglobin and other genetical characters in some tribes of Gujarat. American Journal of Physical Anthropology. 20(3):255-265, https://doi.org/10.1002/ajpa.1330200310

Waters, A. H. (1994). Red cell blood-group antigens and antibodies. In Practical Haematology. Ed. Dacie J. V. & Lewis S. 8th edition. Churchill, Livingstone. London. Pp. 445-481.

Woike, P., Iyengar, S., Sharma, D. C., and Gaur, R. (2017). Frequency of ABH secretors/non-secretors and its clinical significance: A cross sectional study in Gwalior. IOSR Journal of Dental and Medical Sciences. 16(6): 116-124, 10.9790/0853-160602116124, https://doi.org/10.9790/0853-160602116124