Association between ABO and RH blood groups and Hepatitis B virus infection among young Nigerian adults

BANKOLE HENRY OLADEINDE1, MATHEW FOLARANMI OLANIYI1, MUSA ABIDEMI MUHIBI1, FERDINAND UWAIPO1, OMOREGIE RICHARD2, NWONU OKIKE OMABE1, AMINAT DAUD1, ONOSEN PHEBEAN OZOLUA1

1Department of Medical Laboratory Science, Faculty of Basic Medical Sciences, College of Medical Science, Edo University Iyamho, Edo State, Nigeria; 2Medical Microbiology Division, Medical Laboratory Services, University of Benin Teaching Hospital, Benin City, Edo State, Nigeria; 3School of Medical Laboratory Sciences, University of Benin Teaching Hospital, Benin City, Edo State, Nigeria; 4Department of Microbiology, Faculty of Science, Edo University Iyamho, Edo State, Nigeria

Summary

Background. Several diseases are reported to be associated with ABO/Rh blood groups. Data on the association between ABO and Rh D blood group antigens in the Nigerian population is sparse. This study aimed at determining the prevalence of Hepatitis B Virus (HBV) infection as well as its association with ABO and Rh D antigens among young Nigerian adults.

Methods. Whole blood was collected from 496 students and screened for the presence of HBsAg using an immuno-chromatographic technique. The ABO and Rh D antigen status of participants were also determined using standard techniques.

Results. In this study, the prevalence of HBV infection was 10/496 (2.06%). Of all factors assessed, only age of participants was identified as a risk factor (P < 0.05) for HBV seropositivity. Over half (51.5%) of subjects were of the blood group O type, while 18/496 (3.6%) were of the AB blood type which was the least in occurrence. Rh D negative blood group was observed among 24/496 (4.8%) subjects. Those with the B blood type were observed to have an insignificantly (P > 0.05) higher prevalence of HBV infection. However, with respect to Rh D antigen alone, participants negative for the antigen were observed to have a five times higher risk of acquiring HBV infection than those positive for it (OR = 5.273, 95% CI = 1.056, 26.321, P > 0.05). Combining the ABO and Rh blood group systems, an association (OR = 20.174; P > 0.05) was found to exist between B Rh D negative status and HBV infection.

Conclusion. Possession of B antigen without Rh D antigen is associated with increased risk of acquiring HBV infection.

Key words

Hepatitis B Virus • Blood groups • ABO • Rh antigen • Adolescents • Nigeria
different groups in a population can give useful direction for the articulation and implementation of individualized approaches to management and prevention of diseases. Against this background, this study aimed at determining the prevalence as well as the association if any, between HBV infection and ABO and Rh blood group types among young Nigerian adolescents.

Methods

Study Population
The study was conducted among undergraduate students of Edo University Iyamho, Edo State, Nigeria. Established in 2016, the University presently has student strength of about 3500 distributed across six different faculties. A total of 496 students were enrolled for this study consisting of 302 females and 194 males. The age range of the participants was 18-25 years. The students were drawn from all faculties/college in the University.

Sample size determination
The sample size was determined using the formula

\[ n = \left( \frac{Z^2pqd^2}{0.05^2} \right) \]

where:
- \( n \) = sample size
- \( Z \) = Standard normal deviate = 1.96 at 95% confidence limit
- \( p \) = prevalence of HBV in a previous Nigerian study = 12.5% = 0.125 [13].
- \( q \) = 1-\( p \) = 1 - 0.125 = 0.875
- \( d \) = error margin = 0.05

Computing the value above will give

\[ N = (1.96)^2 \times 0.125 \times 0.875 / (0.05)^2 = 168. \]

Thus a sample size of 168 persons was obtained. However, to make room for non-responses and improperly filled and/or unreturned questionnaires, the sample size was increased to 496.

Ethical Clearance
Approval was sought and obtained from the Ethical Research Committee of Edo University Iyamho, Edo State, Nigeria. Informed consent was obtained from all consenting participants before commencement of collection of blood. Inclusion criteria was been registered as a student of Edo University Iyamho, Edo State, Nigeria. Approval was sought and obtained from the Ethical Research Committee of Edo University Iyamho, Edo State, Nigeria. Informed consent was obtained from all consenting participants before commencement of collection of blood. Inclusion criteria was been registered as a student of Edo University Iyamho, Edo State, Nigeria.

Sample Collection and Processing
Using a simple random sampling technique, a total of four hundred and ninety six (496) students were recruited for this study. Four milliliters of blood was collected from each consenting student and dispensed in an Ethylene-diamine Tetra acetic Acid (EDTA) container. Plasma obtained from the collected blood specimens were used for the serological detection of Hepatitis B surface antigen (HBsAg) using the immuno-chromatographic kits (Skytec Rapid Diagnostics USA), as previously described [14]. In brief, 20 ul of each participant’s serum was placed on the adsorbent portion of the Skytec Rapid Test Strip that had been removed from its foil and placed on a flat surface. This was allowed to stand for 5 minutes after which it was observed for the emergence of bands at strategic positions. The emergence of a single band at the control portion of strip indicated a negative result, while the appearance of a band on the control portion and another on the test region of strip was indicative of a positive result.

ABO and Rh D Blood Group Detection
The slide agglutination technique as previously described was used to determine the ABO and Rh blood groups [15]. Briefly, a drop of each participant’s blood was placed on three separate areas on a clean white tile. Each drop of blood was mixed with a drop of commercially prepared antisera A, B, and D, and observed for agglutination. Each mixture (blood plus antisera) was viewed microscopically to confirm agglutination.

Statistical Analysis
The data obtained were analyzed using Chi-square (\( \chi^2 \)) or Fischer’s exact test as appropriate and odd ratio analysis using the statistical software INSTAT®.

Result
The seroprevalence of HBV among study participants was 10/496 (2.01%). Age was identified as a risk factor (\( P < 0.05 \)) for HBV seropositivity, with participants within the age group of 24-26 years having the highest risk of infection. Although male participants had a higher prevalence of HBV than female, the difference failed to reach statistically significant proportion (\( P > 0.05 \)). With respect to marital status and religion, single students as well as those of the Moslem faith were observed to have a higher prevalence of HBV infection, albeit the difference was statistically insignificant (\( P > 0.05 \)). Similarly, student’s faculty/college did not significantly affect the prevalence of HBV infection in this study (\( P > 0.05 \)) (Tab. I).

Over half 257/496 (51.5%) of the total number of study subjects were of the blood group O type. The distribution of A, B and AB blood types were 132/496 (26.6%), 89/496 (17.9%) and 18/496 (3.6%) respectively. Study participants with the B blood type had the highest prevalence 24/496 (4.5%) of HBV infection. No infection was recorded among participants of the AB blood type. Generally, the prevalence of HBV infection did not differ significantly (\( P > 0.05 \)) with respect to ABO blood type. The absence of the Rh D antigen on red blood cell of study subjects was found to be associated with HBV seropositivity (Rh Negative vs. Rh Positive: 2/24 (8.33%) vs. 8/472 (1.69%); OR = 5.273, 95% CI = 1.056, 26.321) albeit, it failed to reach statistical significance (\( P > 0.05 \)) (Tab. II).

A combination of ABO and Rh D blood groups revealed that only blood group B Rh D negative status was associated (OR = 20.714 95%CI = 0.800, 536.26; \( P > 0.05 \)) with higher sero-prevalence of HBV infection (Tab. III).
Discussion

There is paucity of data on the prevalence and associated risk factors for HBV infection among young Nigerians. Although reports abound on the association of ABO and Rh blood group systems with disease, none have specifically focused on the relations between the blood group systems and HBV infection among young adults in Nigeria. Against this background this study was conducted. The finding of a HBV prevalence of 2.1% is consistent with a value of 3/300 (1.5%) recorded in an earlier Nigerian study [16]. Our finding is however at sharp variance with 37/800 (4.6%) and 47/407 (11.5%) reported in other African studies respectively [17, 18]. The observed variation in result may be due to

| Variables | N (%) | N. HBsAg positive (%) | OR | 95% CI | P value |
|-----------|-------|-----------------------|----|--------|---------|
| Age (years) |       |                       |    |        |         |
| 15-17     | 67 (13.5) | 0 (0.0) | | | 0.039 |
| 18-20     | 190 (38.5) | 3 (1.58) | | | |
| 21-23     | 138 (27.8)  | 2 (1.45) | | | |
| 24-26     | 101 (20.4)  | 5 (4.95) | | | |
| Gender | | | | | |
| Male | 175 (35.5)  | 4 (2.28) | 1.228 | 0.342, 4.413 | 0.7473 |
| Female | 321 (64.7)  | 6 (1.87) | | | |
| Marital status | | | | | |
| Single | 483 (97.4)  | 10 (2.07) | 0.5987 | 0.0333, 10.761 | 1.000 |
| Married | 13 (2.6)  | 0 (0.0) | | | |
| Religion | | | | | |
| Islam | 92 (18.5) | 2 (2.17) | 1.100 | 0.229, 5.270 | 1.000 |
| Christianity | 404 (81.5) | 8 (1.98) | | | |
| Faculty/college | | | | | |
| College of Medicine | 228 (45.9) | 5 (2.19) | | | 0.5891 |
| Faculty of Engineering | 57 (11.5) | 2 (3.51) | | | |
| Faculty of Arts Management and Social Sciences | 58 (11.7) | 0 (0.0) | | | |
| Faculty of Law | 93 (18.8) | 1 (1.08) | | | |
| Faculty of Science | 60 (12.1) | 2 (3.33) | | | |

Tab. I. Prevalence of Hepatitis B virus infection among study participants.

| Variables | N (%) | N. HBsAg positive (%) | OR | 95% CI | P value |
|-----------|-------|-----------------------|----|--------|---------|
| ABO blood type | | | | | |
| O | 257 (51.8)  | 4 (0.78) | | | 0.3105 |
| A | 132 (26.7)  | 2 (1.52) | | | |
| B | 89 (17.9)  | 4 (4.50) | | | |
| AB | 18 (3.6)  | 0 (0.00) | | | |
| Rhesus blood type | | | | | |
| Negative | 24 (4.8) | 2 (8.33) | 5.273 | 1.056, 26.321 | 0.079 |
| Positive | 472 (95.2) | 8 (1.69) | | | |

Tab. II. Prevalence of Hepatitis B virus infection with respect to ABO and Rh blood type.

| Blood group | N | No. HBsAg positive (%) | OR | 95% CI | P value |
|-------------|---|------------------------|----|--------|---------|
| A+ | 127 | 2 (1.57) | 0.578 | 0.026, 12.638 | 1.000 |
| A- | 5 | 0 (0.0) | ND | ND | ND |
| B+ | 84 | 2 (2.38) | 0.879 | 0.040, 19.275 | 1.000 |
| B- | 5 | 2 (40.0) | 20.714 | 0.800, 536.26 | 0.059 |
| AB+ | 18 | 0 (0.0) | ND | ND | ND |
| O+ | 243 | 4 (1.65) | 0.545 | 0.028, 10.623 | 1.000 |
| O- | 14 | 0 (0.0) | 1 | 1 | |

Tab. III. Prevalence of Hepatitis B virus infection with respect to ABO and Rh Blood grouping.

N: number of subjects; OR: odd ratio; CI: confidence interval; Test statistics used: Chisquare ($\chi^2$) or Fischer’s exact test.
differences in geographical location of studies as the studies by Ekouevi et al., 2015 [17], and Tesfa et al., 2021 [18], were conducted in Togo and Ethiopia respectively. Students within the age group of 24-26 years had a significantly higher risk of being infected by HBV while younger participants in the age group of 15-17 years recorded no HBV infection. This observation is at variance with findings from a previous Nigerian study where undergraduate students less than 18 years were reported to have a significantly higher risk of HBV seropositivity than older ones [13]. It is however in agreement with a Togolese one [17]. Nigeria commenced her universal HBV immunization program in 2004 [19]. Although, the HBV vaccination history of our study participants were not noted at time of research, it is possible that students in the age category of 15-17 years are better beneficiaries of the young Nigerian HBV vaccination program in Nigeria. This may have accounted for the zero prevalence of HBV infection observed among them. In this study, gender, religion and faculty/college of participants were not found to significantly affect the prevalence of HBV infection. Findings from other studies [13, 16], have supported our observations.

The distribution of ABO blood types among study participants was O 257/496 (51.8%), A 132/496 (26.6%), B 89/496 (17.9%) and AB 18/496 (3.6%). A similar pattern has been reported by other African studies [1, 20]. One Asian study [21] however, documented blood group B as the most predominant blood type followed by O. while others [22, 23, 24] reported blood group A as the most common among their study populations. Of all participants examined in this study, only 4.8 percent were found to lack the rhesus D antigen. A Rh D negative prevalence of 6%, 7.2% have been reported by studies from Nigeria [25] and Ethiopia [26] respectively. Asia and Africa are generally known to have a low number of Rh D negative individuals [27]. Blood group types are inherited and its frequencies vary from one population to another [25]. This may explain the observed variation in blood types in the aforementioned studies.

Studies have reported an association between certain diseases and the ABO/Rh blood group systems. In this study, the prevalence of HBV was observed to be highest among participants with B blood type, followed by blood type A. Participants with blood type AB had no incidence of HBV infection. A similar trend had been reported by an earlier study [28]. However, findings from a meta-analysis study of thirty-eight articles showed the contrary with blood group B individuals reported to have the lowest risk for HBV [11]. The variation in result could be due to several reasons. Firstly, the study by Jing and his colleagues [11], focused on a disproportionately higher number of non-African studies, with only seven of them being from the African continent, out of which just two were from Nigerian. Again all thirty articles analyzed by Jing and his colleagues [11] focused on either blood donors or patients from hospital settings in contrast to our study population which comprised of young undergraduate students. Other studies [29, 30] also had a different finding, with blood group A donors reported to have the highest prevalence of HBV infection. Reports have shown that blood antigens may serve as receptors for bacteria, parasites and viruses, leading to colonization and invasion of host or evasion of its immune system [31]. It is interesting to note that the preferences for histo blood group antigens by some microorganisms including norovirus and Helicobacter pylori are influenced by specific genotypes and subtypes [31, 32] As the genotypes of HBV are geographically diverse [33]. It is possible that the variation in these reports could be attributed to differences in preferences of histoblood group antigens by predominant HBV genotypes in these regions. Further investigations are however, needed to verify this.

Participants with blood type AB had the least prevalence of HBV infection in this study. Some studies [12, 28] have reported similar findings. The reason for this is unclear. Perhaps, the small size of samples of blood group AB tested may be responsible for this finding, or the co-existence of histo -antigens A and B on host cells may represent a resistance factor for HBV infection. This will definitely require further studies to verify. Generally, the prevalence of HBV was not significantly affected by ABO blood group system. This is contrasting to an earlier report [15].

The finding of a higher prevalence of HBV among Rh D negative subjects in this study has been previously reported by an Indian study [28]. Indeed, subjects that tested negative to the Rh D antigen in our study were observed to have a five times higher risk of acquiring HBV than their Rh positive counterparts in this study. It is however at variance a report elsewhere [15]. Basically, three molecular mechanisms have been reported for development of Rh D negativity namely, total deletion of the Rh D gene, (RHD), the presence of pseudo Rh D gene (RHDø) (inactive) in association with ce allele in the RHCE, and the presence of hybrid gene, with the latter two mechanisms leading to the production of a non-functional Rh protein [3]. Interestingly, the expression of these forms has been reported to vary vastly with respect to race, location and tribe [3]. Genetic variations in human populations plus environmental factors contribute to susceptibility to infectious diseases [34]. Perhaps this could explain the variation in observations earlier reported. Generally however, the prevalence of HBV was not significantly affected by Rh status. This is in line with findings from other studies [28, 30].

Combination of the ABO and Rh D blood group systems, revealed an association between HBV sero-positivity and B Rh D antigen negative blood group. Indeed, a twenty times higher risk (OR = 20.714) for HBV sero-positivity was observed among participants with B Rh D negative blood group status. Interestingly, no such association (OR = 0.879) was found amongst subjects with B and Rh antigens. Findings from some studies points to the protective effect of Rh D antigen against Hepatitis B virus infection [20, 35]. Also, studies have reported a generally lower health status among persons who lack the Rh D antigen [36, 37]. Differences in blood
group antigen expression can increase or decrease host susceptibility to many infections [31]. Thus the observed pattern of result in this study may be as result of the concomitant effect of the expression of B antigen and the lack of Rh D antigen on their red blood cell of host. This definitely requires further study to substantiate. The gold standard for diagnosis of hepatitis B virus infection is the detection of HBV nucleic acid in blood or liver [38]. This study focused on the detection of HBsAg in blood serologically. This is a limitation in this study.

Conclusion

Generally, the prevalence of HBV infection was 2.01% among study subjects. Age was identified as a risk factor for HBV seropositivity. Subjects with Blood group antigen B but lacking the Rh D antigen were more at risk of acquiring HBV infection. These findings may prove valuable to health managers and planners in articulating and implementing HBV infection control strategies.

Acknowledgement

Authors acknowledge with thanks all the students that took part in this study.

Conflict of interest statement

Authors have no conflict of interest to declare.

Disclosure statement

The authors report no conflict of interest.

Funding sources

No funding was received for this study.

Author’s contribution

All authors took part in the study design, generated and analyzed data and substantively took part in the drafting of manuscript.

References

[1] Anifowoshe AT, Owolodun OA, Akinseye KM, Iyiola OA, Oyeseyi BE. Gene frequencies of ABO and Rh blood groups in Nigeria: A review. Egypt J Med Hum Genet 2017;18:205-10. https://doi.org/10.1016/j.ejmhg.2016.10.004

[2] Yamamoto F, Clausen H, White T, Marken J, Hakomori S. Molecular genetic basis of the histo-blood group ABO system. Nature 1990;345:229-33. https://doi.org/10.1016/S1246-7820(94)80001-4

[3] Nardozza LMM, Szulman A, Barreto J, Junior EA, Moron AF. The molecular basis of rh system and its applications in obstetrics and transfusion medicine. Rev Assoc Med Bras 2010;56:724-8. https://doi.org/10.1590/S0104-4230201000060026

[4] Musa BM, Russell S, Borodo MM, Samaila AA, Femi OL. Prevalence of hepatitis B virus infection in Nigeria 2000-2013: A systematic review and meta-analysis. Niger J Clin Pract 2015;18:163-72. https://doi.org/10.4103/1119-3077.151035

[5] Ola SO, Odaibo, GN. Alpha-feto protein, HCV and HBV infections in Nigerian patients with primary hepatocellular carcinoma. Nigerian Med Pract 2007;51:13-5. https://doi.org/10.4314/nmp.v51i3.28903

[6] Eastlund T. The histo-blood group ABO system and tissue transplantation. Transf 1998;38:975-88. https://doi.org/10.1046/j.1537-2995.1998.381098440863.x

[7] Ewald RD, Sumner SCJ. Blood Type Biochemistry and Human Disease. Wiley Interdiscip Rev Syst Biol Med 2016;8:517-35. https://doi.org/10.1002/wsbm.1355

[8] Garratty G. Blood groups and disease: a historical perspective. Transfus Med Rev 2000;14:291-301. https://doi.org/10.1016/S1053-3706(00)90017-1

[9] Chen Y, Chen G, Chui CH, CH. ABO blood group and susceptibility to severe acute respiratory syndrome. JAMA 2005;293:1450-1. https://doi.org/10.1001/jama.293.1450-c

[10] Li Q, Yu CH, Yu JH, Liu L, Xie S, Li W, Yang X Fan W, Gai Z, Chen S, Kato N. ABO Blood Group and the Risk of Hepatocellular Carcinoma: A Case-Control Study in Patients with Chronic Hepatitis B. PLoS ONE 2012;7:e29928. https://doi.org/10.1371/journal.pone.0029928

[11] Jing W, Siyu Zhao, Jue Liu, Min Liu. ABO blood groups and hepatitis B virus infection: a systematic review and meta-analysis. BMJ Open 2020;10:e034114. https://dx.doi.org/10.1136/bmjopen-2019-031144

[12] Emeribe AO, Ejezie GC. ABO blood groups distribution in relation to hepatitis B surface antigen and the presence of lipoidal antibodies. East Afr Med J 1992;69:146-88.

[13] Aminu M, Okachi EE, Abubakaar SM, Yhaya A. Prevalence of hepatitis B virus surface antigen among healthy asymptomatic students in a Nigerian University. Ann Afr Med 2013;12:55-6. https://doi.org/10.4103/1596-3519.108257

[14] Nworie A, Nwadi LC, Boniface UN, Micheal EO, Ilechukwu Z, Chen S, Kato N. ABO Blood Group and the Risk of Hepatitis B Virus (HBV) Infection Amongst Staff of a Nigerian University. AFR J Biomed Res 2018;21:263-6. https://doi.org/10.9734/ahs.v14i2.13

[15] Aljoonai OAA, Al-Hayani NN, Mohammed MJ. The infection with HBV and HCV and their relationship to ABO blood group among blood donors. J Fac Med Baghdad 2012;54:52-6.

[16] Enitan SS, Adebola OK, Adejumo EN, Itodo GE, Ileoma E. Alfa-feto protein, HCV and HBV infections in Nigerian patients with primary hepatocellular carcinoma. Nigeria: A review. Egypt J Med Hum Gent 2017;18:205-10.

[17] Aljooani OAA, Al-Hayani NN, Mohammed MJ. The infection with HBV and HCV and their relationship to ABO blood group among blood donors. J Fac Med Baghdad 2012;54:52-6.

[18] Tesfa T, Hawulte B, Tolera A, Abate D. Hepatitis B virus infections in Nigerian pediatric patients: a systematic review and meta-analysis. Niger J Clin Pract 2015;18:163-72. https://doi.org/10.4103/1119-3077.151035

[19] Sadoh AE, Ofili A. Hepatitis B infection among Nigerian children admitted to a children’s emergency room. Afr J Epidemiol 2017;7:262-72. https://doi.org/10.4314/ahs.v14i2.13

[20] Hamed CT, Bollahi MA, Abdelhamid I, Mahmoud M, Gabber S, Habti N, Houmeida A. Frequencies and ethnic distribution of ABO and Rh (D) blood groups in Mauritania: results of first
nationwide study. Int J Immunogene 2012;39:151-4. https://doi.org/10.1111/j.1744-313X.2011.01064.x

[21] Handra T, Gupta A. Frequency of ABO and rhesus blood groups in blood donors. Asian J Trans Sci 2012;6:52-3. https://doi.org/10.4103/0973-6247.95057

[22] Shah H, Haram U, Naz F, Hasseb A, Ullah R, Jan A, Shah S. Distribution of Abo and Rhesus Blood Groups in general population of district Dir Upper. Pak J Physiol 2016;1212:37-9.

[23] Nazli R, Haider J, Haram U, Naz F, Hasseb A, Ullah R, Jan A, Shah S. Distribution of Abo and Rhesus Blood Groups in general population of district Dir Upper. Pak J Physiol 2016;1212:37-9.

[24] Nazli R, Haider J, Khan MA, Akhtar T, Aslam H. Frequency of ABO blood groups and RhD factor in the female population of District Peshawar. Pak J Med Sci 2015;31:984-6. https://doi.org/10.12669/pjms.314.66460

[25] Ullah S, Ahmad T. Distribution of ABO and Rh (D) Blood Groups in the population of district Dir Lower, Khyber Pakhtunkhwa Pakistan. World Appl Sci J 2015;33:123-35. https://doi.org/10.5829/idosi.wasj.2015.33.01.922

[26] Olugbemi O, Ajibola M, Ojone M, Joseph D, Denen A, Alexandra A. Blood group distribution pattern among adult who attended Federal Medical Centre, Lokoja, Kogi State, Nigeria. Am J Health Res 2013;1:95-8. https://doi.org/10.11648/j.ajhr.20130103.19

[27] Golassa L, Tsegaye A, Erko B, Mamo H. High rhesus (Rh(D)) negative frequency and ethnic-group based ABO blood group distribution in Ethiopia, BMC Res Notes 2017;10:330. https://doi.org/10.1186/s13104-017-2644-3

[28] Behal R, Jain R, Behal KK, Bhagolivai A, Aggarwal N, Dhote TN. Seroprevalence and risk factors for hepatitis b virus infection among general population in northern India. Arq Gastroenterol 2008;45:137-40. https://doi.org/10.1590/s0044-28032008000200009

[29] Zuckerman AJ, McDonald IC. ABO Blood Groups and Acute Hepatitis. Bri Med J 1963;2: 537-8. https://doi.org/10.1136/bmj.2.5356.537

[30] Pourhassan A. Association Between ABO Blood/ Rhesus Grouping and Hepatitis B and C: A Case-control Study. Pak J Biol Sc 2014;17:686-71. https://doi.org/10.3923/pjbs.2014.686.871

[31] Cooling L. Blood Groups in Infection and Host Susceptibility. Clin Microbiol Rev 2015;28: 801-70. https://doi.org/10.1128/CMR.00109-14

[32] Yamamoto F, Cid E, Yamamoto M, Blanchar A. ABO research in the modern era of genomics. Transfus Med Rev 2012;26:103-11. https://doi.org/10.1016/j.tmrv.2011.08.002

[33] Pourkarim MR, Amini-Bavil-Olyaee S, Kurbanov F, Rast MV, Tacke F. Molecular identification of hepatitis B virus genotypes/subgenotypes: Revised classification hurdles and updated resolutions. World J Gastroenterol 2014;20:7152-68. https://doi.org/10.3748/wjg.v20.i23.7152

[34] Burgner D, Jamieson SE, Blackwel JM. Genetic susceptibility to infectious diseases: big is beautiful, but will bigger be even better?. Lancet Infect Dis 2006;6:653-63. https://doi.org/10.1016/S1473-3099(06)70601

[35] Agrawal A, Tiwari AK, Mehta N, Bhattacharya P, Wankede R, Tulsiani S et al. ABO and Rh (D) group distribution and gene frequency; the first multicentric study in India. Asian J Transfus Sci 2014;8:121-5. https://doi.org/10.4103/0973-6247.137452

[36] Kaňková Š, Šulc J, Flegr J. Increased pregnancy weight gain in women with latent toxoplasmosis and RhD-positivity protection against this effect. Parasitol 2010;137:1773-9. https://doi.org/10.1017/S0031182010000661

[37] Flegr J, Geryk J, Volny J, Klose J, Cernochova D. Rhesus factor modulation of effects of smoking and age on psychomotor performance, intelligence, personality profile, and health in Czech soldiers. PLoS ONE 2012;7:e49478. https://doi.org/10.1371/journal.pone.0049478

[38] Valsamakis A. Molecular Testing in the Diagnosis and Management of Chronic Hepatitis B. Clin Microbiol Rev 2007;20:426-39. https://doi.org/10.1128/CMR.00009-07

Received on January 14, 2022. Accepted on March 16, 2022.

Correspondence: Bankole Henry Oladeinde - Tel: +2348053096120 - E-mail: oladeinde.bankole@edouniversity.edu.ng - bamenzy@yahoo.com

How to cite this article: Oladeinde BH, Olaniyin MF, Muhibi MA, Uwaifo F, Richard O, Omabe NO, Daud A, Ozolua OP. Association between ABO and RH blood groups and Hepatitis B virus infection among young Nigerian adults. J Prev Med Hyg 2022;63:E109-E114. https://doi.org/10.15167/2421-4248/jpmh2022.63.1.1967

© Copyright by Pacini Editore Srl, Pisa, Italy

This is an open access article distributed in accordance with the CC-BY-NC-ND (Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International) license. The article can be used by giving appropriate credit and mentioning the license, but only for non-commercial purposes and only in the original version. For further information: https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode