ABO and Rh Blood Groups in Relation to Blood Donors' Sibs

T. M. ALLAN

From the North-East Scotland Blood Transfusion Centre, Royal Infirmary, Aberdeen

Several authors have studied the possibility that the ABO and Rh blood groups of adults may be associated with differences in the sex ratio of their newborn offspring (Hirszfeld and Zborowski, 1925; Haselhorst, 1930; Sanghvi, 1951; Johnstone, 1954; Cohen and Glass, 1956; Shield, Kirk, and Jakobowicz, 1958; Allan, 1958, 1959), with resulting evidence of a possibly higher sex ratio in babies of AB than non-AB mothers (Allan, 1959). Hitherto, however, no evidence has appeared on the related possibility that the ABO and Rh blood groups of adults may be associated with differences in the sex ratio of their sibs at birth, and accordingly some exploratory data on this possibility are presented here.

The data have been obtained from replies to a questionnaire completed by 5785 blood donors, aged 20–65, of the Aberdeen and North-East Scotland Blood Transfusion Service. (The questionnaire and its covering letter are reproduced in an Appendix.) The data have been examined from every aspect, but for reasons of space the only tables presented below are those which give either a statistically significant result, or a nearly significant result, or basic data not otherwise shown. The selective nature of such presentation must be given the fullest weight in any assessment of the findings, and its implications, accordingly, are discussed in a Statistical Note by Mr. William Brass.

Results

Sex Ratio of Blood Donors' Sibs. Table I gives the number (at birth) of the donors' brothers and sisters, by the donors' ABO and Rh blood groups. It shows that the descending order of ratios of brothers to sisters in this particular series is B—A—O for both male and female Rh-positive donors, i.e. donors defined, for transfusion purposes as D, C, or E-positive, and also for both male and female Rh-negative (CDE-negative) donors.

Even for the Rh-positive and Rh-negative donors combined, however, the differences between the ABO ratios are, collectively, not very close to significance in respect of males ($\chi^2=5.99$ for 3 d.f.; $p>0.10$) and are far from significance in respect of females.

Table II gives the number of the brothers and sisters of the O and A male donors, by the donors' marital status, age-group, and ABO blood group. It shows that, for both married and single male donors, the ratio of brothers to sisters in this particular series is appreciably higher for As than Os in all three age-groups, except in the case of single male donors aged 35–49. For the combined married and single male donors of all three age-groups combined the difference between the ratio for As and that for Os is just significant ($\chi^2=3.94$; $p<0.05$).

Table III gives the number of the donors' brothers and sisters, by the donors' sex, marital status, and Rh blood group. It shows that the ratio of brothers to sisters in this particular series falls, for both married and single donors, from Rh-negative males to Rh-positive females to Rh-positive males to Rh-negative females. The fall in the percentage of brothers, from that for Rh-negative males to that for Rh-negative females, is significant ($\chi^2=9.14$ for 3 d.f.; $p<0.05$), and the difference between the percentages for male and female Rh-negatives alone is also significant ($\chi^2=7.49$; $p<0.01$).

Table IV gives the number of donors' brothers and sisters, by the donors' age-group and Rh blood group. It shows that in the age-groups 20–34 and 35–49 the ratio of brothers to sisters in this particular series is appreciably, though not significantly, higher for Rh-positive than for Rh-negative donors, but that in the age-group 50–65 the ratio is substantially higher for Rh-negative than for Rh-positive donors. For the Rh-negative donors the variation in the percentage of brothers with age-group of donors is significant ($\chi^2=8.13$ for 2 d.f.; $p<0.02$).

Received July 16, 1968.

ABO and Rh Blood Groups in Relation to Blood Donors' Sibs

TABLE I

SEX RATIO (AT BIRTH) OF THE SIBS OF N.E. SCOTLAND BLOOD DONORS, BY DONORS' SEX AND ABO AND Rh BLOOD GROUPS

Donors' Sex	Donors' ABO Group	Rh-positive Donors			Rh-negative Donors			Total			
		Brothers	Sisters	B/S	Brothers	Sisters	B/S	Brothers	Sisters	B/S	% Brothers
Male donors	AB	176	172	1.02	59	49	1.20	235	221	1.06	51.5
	B	615	565	1.09	106	86	1.23	721	651	1.11	52.6
	A	1909	1822	1.05	404	334	1.21	2313	2156	1.07	51.8
	O	2796	2862	0.98	641	598	1.07	3437	3460	0.99	49.8
Total		5496	5421	1.01	1210	1067	1.13	6706	6488	1.03	50.8
Female donors	AB	134	109	1.23	13	26	0.50	147	135	1.09	52.1
	B	472	446	1.06	95	96	0.99	567	542	1.05	51.1
	A	1687	1611	1.05	308	316	0.97	1995	1927	1.04	50.9
	O	2398	2324	1.03	486	508	0.96	2884	2832	1.02	50.5
Total		4691	4490	1.04	902	946	0.95	5593	5436	1.03	50.7

TABLE II

SEX RATIO (AT BIRTH) OF SIBS OF A AND O MALE N.E. SCOTLAND BLOOD DONORS, BY DONORS' MARITAL STATUS, AGE-GROUP, AND ABO BLOOD GROUP

Male Donors' Marital Status	Male Donors' Age-group	Male A Donors			Male O Donors		
		Brothers	Sisters	B/S	Brothers	Sisters	B/S
Married Male Donors	20-34	403	372	1.08	608	604	1.01
	35-49	881	811	1.09	1206	1231	0.98
	50-65	599	566	1.06	1060	1059	1.00
Total		1883	1749	1.08	2874	2894	0.99
Single Male Donors	20-34	288	272	1.06	366	363	1.01
	35-49	100	101	0.99	112	104	1.08
	50-65	42	34	1.24	85	99	0.86
Total		430	407	1.06	563	566	0.99
Total Male Donors	20-34	691	644	1.07	974	967	1.01
	35-49	981	912	1.08	1318	1335	0.99
	50-65	641	600	1.07	1145	1158	0.99
Total		2313	2156	1.07	3437	3460	0.99

TABLE III

SEX RATIO (AT BIRTH) OF THE SIBS OF N.E. SCOTLAND BLOOD DONORS, BY THE DONORS' SEX, MARITAL STATUS, AND Rh BLOOD GROUP

Donors' Rh Group and Sex	Married Donors			Single Donors			Total			
	Brothers	Sisters	B/S	Brothers	Sisters	B/S	Brothers	Sisters	B/S	% Brothers
Rh - males	1018	899	1.13	192	168	1.14	1210	1067	1.13	53.1
Rh + females	3252	3164	1.03	1439	1326	1.09	4691	4490	1.04	51.1
Rh + males	4520	4479	1.01	976	942	1.04	5496	5421	1.01	50.3
Rh - females	650	677	0.96	252	269	0.94	902	946	0.95	48.8
Total	9440	9219	1.02	2859	2705	1.06	12,299	11,924	1.03	50.8

TABLE IV

SEX RATIO (AT BIRTH) OF SIBS OF N.E. SCOTLAND BLOOD DONORS, BY DONORS' AGE-GROUP AND Rh BLOOD GROUP

Donors' Age-group	Male plus Female Rh-positive Donors				Male plus Female Rh-negative Donors			
	Brothers	Sisters	B/S	% Brothers	Brothers	Sisters	B/S	% Brothers
20-34	2584	2485	1.04	51.0	489	507	0.96	49.1
35-49	3846	3684	1.04	51.1	803	810	0.99	49.8
50-65	3757	3742	1.00	50.1	820	696	1.18	54.1
Total	10,187	9911	1.03	50.7	2112	2013	1.05	51.2

TABLE V

SEX RATIO (AT BIRTH) OF SIBS OF N.E. SCOTLAND BLOOD DONORS AGED 50-65, BY DONORS' SEX AND ABO AND Rh BLOOD GROUP

Donors' Sex	Donors' ABO Group	Rh-positive Donors aged 50-65				Rh-negative Donors aged 50-65			
		Brothers	Sisters	B/S	% Brothers	Brothers	Sisters	B/S	% Brothers
Male donors	AB	48	45	1.07	51.6	21	11	1.91	65.6
	B	203	195	1.04	51.0	21	20	1.05	51.2
	A	533	523	1.02	50.5	108	77	1.40	58.4
	O	913	974	0.94	48.4	232	184	1.26	55.8
Total		1697	1737	0.98	49.4	382	292	1.31	56.7
Female donors	AB	66	56	1.18	54.1	11	20	0.55	35.5
	B	224	213	1.05	51.3	47	42	1.12	52.8
	A	716	673	1.06	51.5	141	126	1.12	52.8
	O	1054	1063	0.99	49.8	239	216	1.11	52.5
Total		2060	2005	1.03	50.7	438	404	1.08	52.0

TABLE VI

MEAN NUMBER (AT BIRTH) OF SIBS OF N.E. SCOTLAND BLOOD DONORS, BY DONORS' SEX, MARITAL STATUS, AND ABO BLOOD GROUP

Donors' Sex	Donors' ABO Blood Group	Married Donors			Single Donors			Total		
		No. of Donors	No. of Sibs	Mean No. of Sibs per Donor	No. of Donors	No. of Sibs	Mean No. of Sibs per Donor	No. of Donors	No. of Sibs	Mean No. of Sibs per Donor
Male donors	AB	83	391	4.71	18	65	3.61	101	456	4.51
	B	255	1125	4.41	75	247	3.30	330	1372	4.16
	O	1358	5768	4.25	324	1129	3.49	1682	6897	4.10
	A	873	3632	4.16	228	837	3.67	1101	4469	4.06
Total		2569	10,916	4.25	645	2278	3.53	3215	13,194	4.11
Female donors	AB	36	151	4.20	29	131	4.52	65	282	4.34
	A	578	2754	4.76	316	1168	3.70	894	3922	4.39
	O	857	3989	4.65	483	1727	3.58	1340	5716	4.26
	B	195	849	4.35	77	260	3.38	272	1109	4.08
Total		1666	7743	4.65	905	3286	3.63	2571	11,029	4.29

TABLE VII

MEAN NUMBER (AT BIRTH) OF SIBS OF N.E. SCOTLAND BLOOD DONORS, BY DONORS' SEX, MARITAL STATUS, AND Rh BLOOD GROUPS

Donors' Marital Status	Donors' Rh Group	Male Donors			Female Donors			Total		
		No. of Donors	No. of Sibs	Mean No. of Sibs per Donor	No. of Donors	No. of Sibs	Mean No. of Sibs per Donor	No. of Donors	No. of Donors	Mean No. of Sibs per Donor
Married donors	Rh - Rh +	449 2120	1917 8999	4.27 4.24	276 1390	1327 6416	4.81 4.62	725 3510	3244 15,415	4.47 4.39
Total		2569	10,916	4.25	1666	7743	4.65	4235	18,659	4.41
Single donors	Rh + Rh -	537 108	1918 360	3.57 3.30	752 153	2765 521	3.68 3.41	1289 261	4683 881	3.63 3.37
Total		645	2278	3.53	905	3286	3.63	1550	5564	3.59

Table V gives the number of brothers and sisters of donors aged 50-65, by the donors' sex and ABO and Rh blood groups. It shows that, in this particular series, the ratio of brothers to sisters is higher for Rh-negative than Rh-positive donors aged 50-65 in respect of both sexes and in respect of all four ABO blood groups, except for AB female donors. The difference between the Rh-positive and Rh-negative ratios is significant for total male donors ($\chi^2 = 11.59$; $p < 0.001$) and for O male donors alone ($\chi^2 = 7.15$; $p < 0.01$).

Mean Number of Blood Donors' Sibs.

Table VI gives the number of donors' sibs, by the donors' sex, marital status, and ABO blood group. It shows that, in this particular series, the descending order of mean numbers of sibs is B—O—A for married male donors and A—O—B for single male donors, for married female donors, and for single female donors. None of the blood group differences between these mean numbers is significant, however; and the same is true in respect of the married and single females combined, and in respect of the male and female single donors combined.

Table VII gives the number of donors' sibs, by the donors' sex, marital status, and Rh blood group. It shows that, in this particular series, the mean number of sibs of female Rh-negative married donors is slightly greater than that of female Rh-positive married donors. It also shows that, in this particular series, the mean number of sibs of Rh-positive single donors is appreciably greater, both for males and females, than that of Rh-negative single donors. None of these differences is significant, however.

Statistical Note*

Though some of the above results are interesting, none are conclusive and some are puzzling. It is

* This note was written by W. Brass.

difficult to assess the implications of the fact that this was an exploratory survey, in which a large number of differences was examined. Furthermore, an unknown proportion of the participating donors must be sibs of other participating donors, and this duplication will have inflated, to some extent, the χ^2 values for the sex ratios of the donors' sibs. In these circumstances the appearance of a few variations which are improbably great with reference to a particular facet of the observations—notably that shown in Table II—is not necessarily strong evidence of heterogeneity of the data in general. On the whole it is probable that real variations are present, but that, if they are, their size is such that a second, and much larger, survey would be needed to establish them unambiguously and conclusively. Comment on individual results would, therefore, be premature.

Summary

From a series of 5785 Aberdeen and North-East Scotland blood donors completing a questionnaire, the following statistically significant results have been obtained, along with many non-significant ones.

The ratio of brothers to sisters differs significantly between Rh-negative male, Rh-positive male, Rh-positive female, and Rh-negative female donors.

The ratio of brothers to sisters is significantly higher for Rh-negative donors aged 50-65 than for those aged 20-49.

The ratio of brothers to sisters is significantly higher for male Rh-negative than for male Rh-positive donors aged 50-65.

The conclusion is reached that, on the whole, it is probable that real variations are present, but that, if they are, their size is such that a second, and much larger, survey would be needed to establish them unambiguously and conclusively.

This survey was part of a research programme supported by the Scottish Hospital Endowments Research Trust and the Scottish National Blood Transfusion Association. I am grateful to these two organizations for their generosity; to Professor Raymond Illsley for advice on the questionnaire; to the Aberdeen and N.E. Scotland blood donors for their replies; to Mrs. Rosaleen Noble for the care which she devoted to the large amount of clerical work involved; to Mr. William Brass for statistical analysis of the data; and to Dr. H. B. M. Lewis for helpful comment on the draft.

The answers to these questions would be a valuable contribution to medical knowledge, and I should be very grateful indeed if you would be willing to help us find them. For this purpose a short list of questions is set out below. If you wish to help, and are unmarried, please complete the first section of the questionnaire.

Please accept in advance both my own thanks and that of the Scottish Hospital Endowments Research Trust for your interest and help.

Yours sincerely,

REFERENCES

- Allan, T. M. (1958). Rh blood groups and sex ratio at birth. *Brit. med. J.*, **2**, 248.
 — (1959). ABO blood groups and sex ratio at birth. *ibid.*, **1**, 553.
 Cohen, B. H., and Glass, B. (1956). The ABO blood groups and the sex ratio. *Hum. Biol.*, **28**, 20.
 Haselhorst, G. (1930). Blutgruppenuntersuchungen bei Mutter und Kind in 2300 Fällen. *Z. KonstitLehre*, **15**, 177.
 Hirsfeld, L., and Zborowski, H. (1925). Gruppenspezifische Beziehungen zwischen Mutter und Frucht und elektive Durchlässigkeit der Placenta. *Klin. Wschr.*, **4**, 1152.
 Johnstone, J. M. (1954). Sex ratio and the ABO blood group system. *Brit. J. prev. soc. Med.*, **8**, 124.
 Sanghvi, L. D. (1951). ABO blood groups and sex-ratio at birth in man. *Nature (Lond.)*, **168**, 1077.
 Shield, J. W., Kirk, R. L., and Jakobowicz, R. (1958). The ABO blood groups and masculinity of offspring at birth. *Amer. J. hum. Genet.*, **10**, 154.

Appendix

Copy of Letter and Questionary

1. Letter

Dear Sir or Madam,

Under the auspices of the Scottish Hospital Endowments Research Trust, and with the co-operation of the North-East Scotland Blood Transfusion Service, research is being done in Aberdeen to find if there is a connexion between a person's blood group, the number and health of his or her sons and daughters, and the number of his or her brothers and sisters.

2. Questionary

Group	When were you born?	Day	Month	Year
What is the total number of your brothers or half-brothers, including any who may have died?		What is the total number of your sisters or half-sisters, including any who may have died?		
Are you unmarried?				
What is the total number of your sons, including any who may have died?		What is the total number of your daughters, including any who may have died?		
Have any of your sons died?		Have any of your daughters died?		
If so, how many?		If so, how many?		
At what age or ages did they die? (See footnote)		At what age or ages did they die? (See footnote)		

Please put a circle round the age of any of your sons or daughters who have died by enemy action or as the result of an accident of any kind.