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The Gc Serum System and ABH Antigen Secretion

A Mother-Child Study

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1. Introduction

Reinskou (1965) has carried out genetical studies on a family material and came to the conclusion that further mother-child studies were desirable in order to ascertain the inheritance of the Gc serum system.

This work is concerned with the mother-child correlation in the Gc serum system and in the secretors and nonsecretors of ABH antigen in the saliva. The present material consists of 160 men and 87 mothers with 45 boys and 42 girls. Their ability to secrete antigen was tested by the author by a method described earlier (1963). Commercial preparations were used as anti-A and anti-B serum. Anti-H serum was produced from seeds of Ulex europeus by extraction with a physiological saline solution (Boyd and Shapleigh, 1954; Cazal and Lalaurie, 1952). Every paternity case (everyone examined is patient in a paternity case) has first gone through serological tests at the State Institute for Blood Group Serology and the Gc data obtained are extracts from these official blood group records from 87 different cases, examined by Hirschfeld's method (1960).

2. Results

The results of the mother-child study on the secretor-nonsecretor material are shown in Tab. I (45 mothers with boys) and Tab. II (42 mothers with girls). There is a good agreement between observed and expected values.

The results of the mother-child study on the Gc material are listed in Tab. III (45 mothers with boys) and Tab. IV (42 mothers with girls). There is a good agreement between observed and expected numbers of children.

Tab. V shows the offspring distributed with respect to the Gc and secretor state of their mothers. The table shows no significant discrepancy from the expected values.

The distribution of the adult material is listed in Tab. VI.

The frequencies of the genes se and Gc^2 in some investigated populations are listed in Tabs. VII and VIII, respectively.

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Tab. I. The ability to secrete ABH antigen in 45 mother-boy combinations

Mothers	Boys			
	Secretors		Nonsecretors	
	obs.	exp.	obs.	exp.
Secretors	33	29.97	4	7.79
Nonsecretors	5	5.75	3	1.49

$\chi^2 = 3.1187$ (3 df); $0.5 \leq P \leq 0.3$

Tab. II. The ability to secrete ABH antigen in 42 mother-girl combinations

Mothers	Girls			
	Secretors		Nonsecretors	
	obs.	exp.	obs.	exp.
Secretors	28	27.98	8	7.27
Nonsecretors	2	5.36	4	1.39

$\chi^2 = 7.0779$ (3 df); $0.1 \leq P \leq 0.05$

Tab. III. The Gc types of 45 mother-boy combinations

Mothers	Girls					
	Gc 1-1		Gc 2-1		Gc 2-2	
	obs.	exp.	obs.	exp.	obs.	exp.
Gc 1-1	19	15.4	2	4.1	0	0.0
Gc 2-1	6	8.7	13	11.	3	2.3
Gc 2-2	0	0.0	2	2.8	0	0.7

$\chi^2 = 4.3065$ (4 df); $0.5 \leq P \leq 0.3$

Tab. IV. The Gc types of 42 mother-girl combinations

Mothers	Girls					
	Gc 1-1		Gc 2-1		Gc 2-2	
	obs.	exp.	obs.	exp.	obs.	exp.
Gc 1-1	14	14.3	3	3.8	0	0.0
Gc 2-1	6	8.1	14	10.3	1	2.2
Gc 2-2	0	0.0	4	2.6	0	0.7

$\chi^2 = 4.1221$ (4 df); $0.5 \leq P \leq 0.3$

Tab. V. Antigen secretion among 87 children related to their mothers

Mothers		Boys		Girls	
		Secretors	Nonsecretors	Secretors	Nonsecretors
Secretors	Gc 1-1	17	2	13	2
	Gc 2-1	15	2	13	4
	Gc 2-2	1	0	3	0
Nonsecretors	Gc 1-1	2	0	1	1
	Gc 2-1	3	2	2	2
	Gc 2-2	1	0	0	1

Tab. VI. Gc types and secretor states of 247 adults

Gc 1-1	Gc 2-1	Gc 2-2	Frequency of the gene Gc^2	Secretors	Nonsecretors	Frequency of the gene se
140	92	16	0.251	200	47	0.435

Tab. VII. Frequencies of the gene se in different populations

Population	N. of individuals	se	Investigator
Egypt	114	0.504	Moharram (1943)
Yoruba, Nigeria	300	0.503	Ball (1962)
Washington, USA	3144	0.491	v. Arsdel (1958)
Middlesex, Great Britain	669	0.478	Glynn et al (1959)
Liverpool, Great Britain	1118	0.477	McConnel (1952)
Central Sweden	2093	0.470	G. Nerell (1963)
South Sweden	1000	0.452	Grubb (1951)
Sweden	247	0.435	H. Nerell, present paper
Milano, Italy	518	0.426	Ceppellini (1955)
Habe, Nigeria	100	0.412	Lawler et al (1960)
Copenhagen, Denmark	1369	0.386	Andersen (1951)
Fulani, Nigeria	45	0.333	Lawler et al (1960)
Alberta, Canada	60	0.000	Chown and Lewis (1955)

Tab. VIII. Frequencies of the gene Gc^2 in different populations

Population	N. of individuals	Gc^2	Investigator
Aland, Finland	100	0.385	Hirschfeld et al (1963)
Greenland eskimos	581	0.376	Persson (1963)
Prague, Czecho-Slovakia	228	0.316	Korinek and Kout (1963)
East Germany	1922	0.296	Marek et al (1963)
Schleswig-Holstein, Germany	400	0.295	Hallerman and Stürner (1963)
Bern, Switzerland	400	0.287	Hess and Bütler (1962)
England	49	0.286	Hirschfeld (1962)
Vienna, Austria	1000	0.278	Herbich (1963)
Denmark	1312	0.275	Nerstrom (1963)
Ireland	138	0.275	Baitsch et al (1963)
Greece	463	0.272	Omoto (1963)
Hessen, Germany	210	0.265	Wendt and Theile (1963)
Norway	2549	0.265	Reinskou (1965)
Bavaria, Germany	4403	0.263	Klose (1962)
Sweden	2259	0.254	Hirschfeld and Heiken (1963)
Sweden	247	0.251	H. Nerell, present paper
Iceland	93	0.241	Walter and Palsson (1962)
Helsinki, Finland	200	0.230	Hirschfeld et al (1963)
Norwegian lapps	412	0.225	Reinskou and Kornstad (1963)
Swedish lapps	79	0.127	Hirschfeld and Beckman (1961)

Summary

The ability to secrete ABH antigen in the saliva has been determined in 160 men and 87 mothers with 45 boys and 42 girls. Mother-child studies on the secretor-nonsecretor distribution and Gc serum types showed a good agreement between observed and expected numbers in the different classes.

References

Andersen A. (1951). Om H-receptorns forekomst og dens betydning for retsmedicinen. Copenhagen: Dansk videnskaps forlag.

Arsdel v. P. P. (1958). The usefulness of the plant-lectin, Ulex europeus, in a large-scale blood group study. Vox. Sang., **3**: 448.

Ball P. A. J. (1962). Influence of the secretor and Lewis on susceptibility to duodenal ulcer. Brit. Med. J., 948.

Baitsch H., Ritter H., Goedde H. W., Atland K. (1963). Zur Genetik der Serumproteine: Hp-Serumgruppen, Gc-Faktor, Gm-Serumgruppen und Pseudocholinesterase-Varianten in europäischen Populationen. Vox. Sang., **8**: 594.

Boyd W. C., Shapleigh E. (1954). Separation of individuals of any blood group into secretors and nonsecretors by use of a plant agglutinin (lectin). Blood, **9:** 1195.
Cazal P., Lalaurie M. (1952). Recherches sur quelques phytoagglutinins spécifiques des groupes sanguins ABO. Acta Haemat., **8:** 73.
Ceppellini R. (1955). On the genetics of secretor and Lewis characters: a family study. Proc. 5th Int. Congr. Blood Transf., 207.
Chown B., Lewis M. (1955). The inheritance of the blood group and secretor genes in the Blood Indians of Alberta, Canada. Amer. J. Phys. Anthrop., **13:** 473.
Glynn A. A., Glynn L. E., Holborow E. J. (1959). Secretion of blood group substances in rheumatic fever. A genetic requirement for susceptibility? Brit. Med. J., **2:** 266.
Grubb R. (1951). Observations on the human blood group system Lewis. Acta Path. Microbiol. Scand., **28:** 61.
Hallerman W., Stürner K. H. (1963). Die Verteilung der Gc (Post-albumin)-Typen in Schleswig-Holstein. Blut, **9:** 185.
Herbich J. (1963). Häufigkeit der Gc-Gruppen in der Bevolkerung von Wien und Umgebung. Brauchbarkeit dieses Systems in der forensischen Serologie. Wien. Klin. Wschr., **75:** 803.
Hess M., Bütler R. (1962). Untersuchungen über die Gc-Gruppen von Hirschfeld. Schweiz. Med. Wschr., **92:** 1351.
Hirschfeld J. (1962). The Gc-system. Immunoelectrophoret ic studies of normal human sera with special ref erence to a new genetically determined serum system (Gc). Progr. Allerg., **6:** 155.
— Jonsson B., Rasmusson M. (1960). Inheritance of a group-specific system demonstrated in normal human sera by means of an immunoelectrophoretic technique. Nature, **185:** 931.
— Beckman L. (1961). Distribution of the Gc serum groups in northern and central Sweden. Acta Genet. Basel, **11:** 185.
— Heiken A. (1963). Application of the Gc system in paternity cases. Amer. J. Hum. Genet., **15:** 19.
— Seppälä M., Eriksson A. W., Forsius H. (1963). Distribution of the group-specific components (Gc) in Finland. Ann. Med. Exp. Biol. Fenn., **41:** 382.
Klose J. (1962). Untersuchungen zur Populationsgenetik der gruppen-spezifischen Komponente (Gc) in Südbayern. Med. Diss., München.
Korinek J., Kout M. (1963). Beitrag zum Nachweis der Gc-gruppen-spezifischen Komponente in menschlichen Seren. Z. Immunitaetsforsch., **125:** 191.
Lawler S. D., Marshall R., Roberts D. F. (1960). The Lewis and secretor characters in the Fulane and Habe. Ann. Hum. Genet. London, **24:** 271.
Marek Z., Bundschuh G., Kerde C., Geserick G. (1963). Untersuchungen über die Anwendbarkeit der menschlichen Gc-Komponenten in der forensischen Serologie. Ärztl. Lab., **9:** 228.
McConnel R. B. (1962). Cit. Race and Sanger (1962).
Mohiarram I. (1943). The group properties in the saliva of the Egyptian population. Lab. Med. Progr., **4:** 1.
Nerell G. (1963). Secretors of ABH antigen in a central Swedish population. Ann. Hum. Genet. London, **27:** 119.
Nerström B. (1963). Further investigations of the inheritance of the Gc-system. A Danish mother-child material. Acta Genet. Basel, **13:** 150.
Omoto K. (1963). Vergleichende Untersuchungen zur Allelenhäufigkeit des Gc-Systems bei asiatischen und europäischen Populationen. Med. Diss., München.
Persson I. (1963). The Gc-system in Greenland Eskimos. Acta Genet. Basel, **13:** 84.
Race R. R., Sanger R. (1962). Blood Groups in Man. IV Ed. Blackwell Scientific Publications, Oxford.
Reinskou T. (1966). Application of the Gc system in 1338 paternity cases. Vox. Sang., **11:** 59.
— (1965). Distribution of the Gc types in Norway. Acta Genet. Basel, **15:** 33.
— (1965). Genetics of the Gc serum types: family- and mother-child studies. Acta Genet. Basel, **15:** 234.
— Kornstad L. (1965). The Gc types of the Norwegian Lapps. Acta Genet. Basel, **15:** 126.
Walter H., Palsson J. (1962). Zur Häufigkeit der Serumgruppen in Island. Vox. Sang., **7:** 732.
Wendt G. G., Theile U. (1963). Untersuchungen über den Gc-Faktor. Deutsch. Med. Wschr., **88:** 696.

RIASSUNTO

È stato studiato il fattore secretore (antigene ABH) in 160 uomini e 87 madri con 45 figli e 42 figlie. Lo studio madri-figli e figlie sulla distribuzione del fattore secretore—non-secretore e sul gruppo Gc mostra una buona concordanza tra casi osservati e attesi nelle diverse classi.

RÉSUMÉ

Le facteur sécréteur (antigène-ABH) a été étudié chez 160 hommes et 87 mères avec 45 fils et 42 filles. L'étude mères-enfants sur le facteur sécréteur—non-sécréteur et les groupes Gc démontre une bonne conformité entre valeurs observées et expectées dans les différentes classes.

ZUSAMMENFASSUNG

Die Sekretoreigenschaft für ABH-Antigene in Speichel wurde bei 160 Männer und 87 Mütter mit 45 Knaben und 42 Mädchen festgestellt. Mutter-Kind Studium bei Sekretoren Nonsekretoren-Verteilung und Gc-Gruppen des menschlichen Serums hat zwischen beobachtete und erwartete Anzahl in die verschiedene Klasse einen guten Übereinstimmungswahrscheinlichkeit bewiesen.

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