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Antibodies to Influenza Viruses in Military Recruits from Argentina, Brazil and Colombia

Their Relation to ABO Blood Group Distribution *

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In a large-scale seroepidemiological study, the prevalence was determined of antibodies to influenza A viruses in the sera of military recruits representative of the inhabited geographical regions of Argentina, Brazil and Colombia. The micro-haemagglutination-inhibition test was used against the Swine, PR/8, FM/1 and Asian antigenic strains. From each of the three recruit populations 500 sera were tested.

Positive titres to the FM/1 and Asian strains were found in 72 % and 80 % respectively of the Colombian sera, in 56 % and 69 % of the Argentinian sera, and in 49 % and 63 % of the Brazilian sera. Of these 1500 sera, 5 were positive to the PR/8 strain and 2 to the Swine strain.

This study also showed that there were highly significantly greater proportions of positive reactors to the FM/1 and Asian strains among persons of blood groups O and B than among those of blood group A in all three countries.

Influenza viruses and the disease syndromes these agents elicit in human as well as in animal hosts have been studied extensively (Francis & Maassab, 1965). The understanding of the epidemiological behaviour of influenza in populations has resulted partly from seroepidemiological studies and partly from characterization of the various strains and subtypes of viruses isolated from epidemics and pandemics. These investigative efforts have clearly defined the periodicity of appearance, the prevalence and the evanescence of various types and strains of influenza viruses (Bell, 1965).

Most of the accumulated knowledge on these topics has accrued from investigations undertaken by scientists in developed countries (Francis & Maassab, 1965). The serological status of populations in the United States of America, Great Britain and in other developed countries with regard to influenza viruses is well defined (Francis & Maassab, 1965; Davenport et al., 1953, 1955, 1964; Mulder & Masurel, 1958; Hennessy et al., 1955). However, this is not the case for most South American countries. A search of the literature indicates that only in a few isolated instances have reports originating from these countries described genuine outbreaks in human subjects due to the viruses of influenza (Flores, 1961; Taylor et al., 1942; Lacorte et al., 1951; De Medeiros, 1957; Travassos et al., 1957; Horwitz, 1961).

Sera which were obtained from military recruits in Argentina, Brazil and Colombia,[3] though representing a narrow age-group of individuals, offered the opportunity for comparison of various aspects of influenza with similar age segments of other populations (Francis & Maassab, 1965; Davenport et al., 1953, 1955, 1964; Mulder & Masurel, 1958; Hennessy et al., 1955).

The various factors for comparison would include: frequency of positive reactors, distribution of antibodies to various prototype strains (i.e., Swine,

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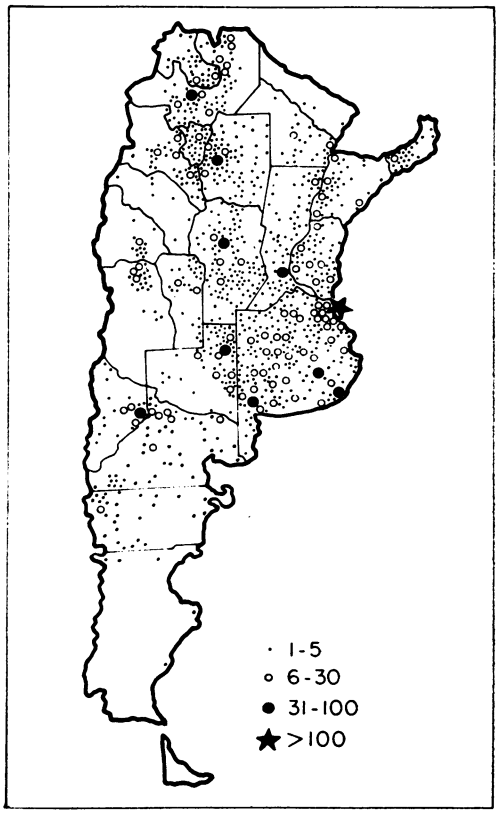
[3] These serum collections of army recruits were obtained through the courtesy of Professor J. R. Paul and Professor A. S. Evans, WHO Serum Reference Bank, Yale University, New Haven, Conn., USA.

FIG. 1
DISTRIBUTION OF ARGENTINIAN RECRUITS FROM WHOM SERA WERE DRAWN



PR/8, FM/1 or Asian) according to age, antibody titre, distribution of positive reactors according to population density, and the possible relationship between the distribution of ABO blood groups and presence of antibodies to influenza viruses.

MATERIALS AND METHODS

Types of population studied

Sera of military recruits from Argentina, Brazil and Colombia. Fig. 1, 2 and 3 show the geographical distribution of the sera obtained from military recruits in Argentina, Brazil and Colombia. Detailed information on these serum collections can be found elsewhere (Florey et al., 1967; Cuadrado, 1968).

Because influenza is considered to be such a widespread disease, it was deemed adequate to test a selected sample of each population rather than the entire serum collections. For this reason, random samples composed of 500 sera from each of these three national collections were made. The sera from each country were sampled in proportion to the number of recruits from each province.

The distributions by ABO blood group and population density, which closely approximated to those of the parent collections, are shown in Table 1.

Sera used to standardize the micro-haemagglutination-inhibition test. A control group of 90 human sera, from various age-groups, which had already been tested by the standard haemagglutination-inhibition (HI) test against a number of influenza viruses, was used for the standardization of the micro-HI method used in the present study. This group of sera was obtained from the Virus Laboratory, Department of Epidemiology, School of Public Health, The University of Michigan, Ann Arbor, Michigan. The age distribution of this serum collection is shown in Table 2 below.

Virus strains

Strains of virus used as antigen in the HI tests were: A/Swine/1976/31(M38,E43), A0/PR/8/34(F198, M593, E181), A1/FM/1/47(M37, E14, M3, E18), A2/Ann Arbor/6/60(CK20, E18), A/Equi-2/Milford/2/63(E4), Turkey/England/63—Evans Medical Ltd. Batch No. E-566-200 CCA units/ml, and Duck/England/59(E4). The letters F, M, E and CK, and the numerical indications following denote the numbers of passages in ferrets, mice, eggs, and chick-kidney tissue culture respectively.

Serological technique

Micro-HI tests were performed in disposable plates (V shape, No. 220-25, Cooke Engineering Co., Alexandria, Va.) using calibrated 0.025-ml wire loops and droppers. This technique has been described in detail elsewhere (McQueen, 1964).

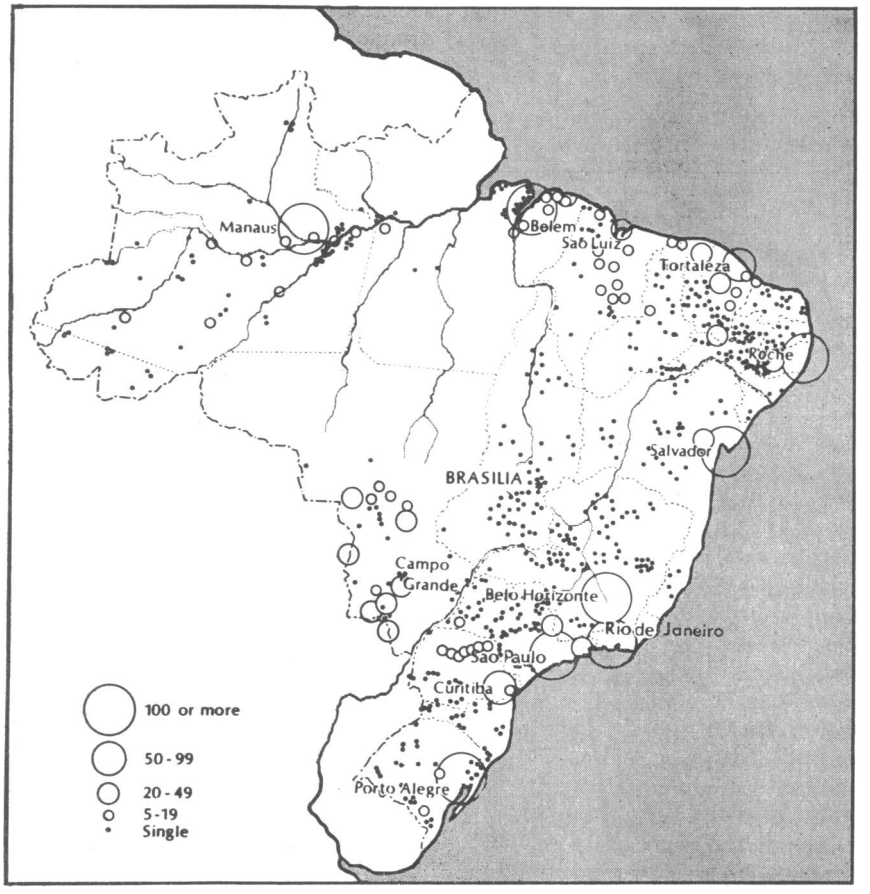
Treatment of sera

All the sera were treated with receptor-destroying enzyme (RDE) as described elsewhere (Davenport & Minuse, 1964). Each serum sample was tested twice against the various antigens by the HI method. The mean titre results can be seen below.

RESULTS

Both data and their interpretation will be discussed in this section.

FIG. 2
DISTRIBUTION OF BRAZILIAN RECRUITS FROM WHOM SERA WERE DRAWN

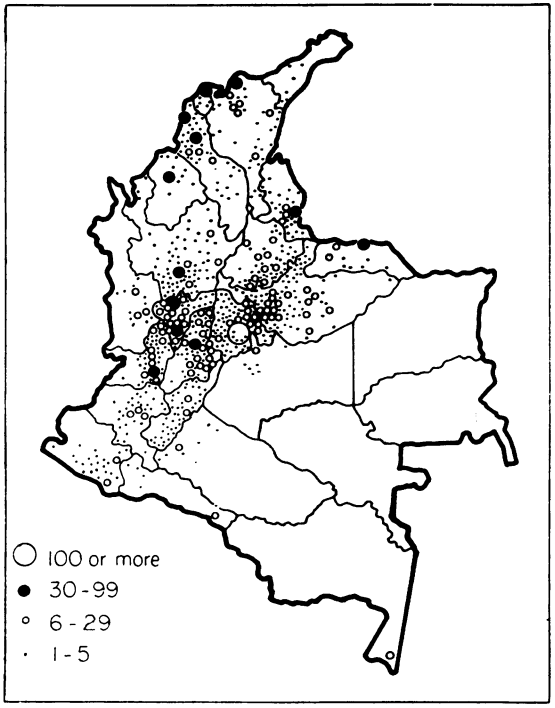


Antibodies to influenza in control serum sample

Table 2 shows the results obtained in 1964–65 using the standard HI test to examine the control serum sample for antibodies. Table 3 records the current results of the tests repeated with the same serum collection using the micro-HI method. As previously indicated, this serum collection comprised samples drawn from individuals of various age-groups. Varying titre levels were observed when these sera were tested against Swine, PR/8, FM/1 and Asian viruses, as previously observed by other workers, in accordance with the ages of individuals tested (Hennessy et al., 1955). Three additional influenza strains (Equi-2, Turkey/England/63, and Duck/England/59) were used in the present study; no positive reactors were found, which is consistent with the observations (Mulder & Masurel, 1955; Davenport et al., 1964) that antibodies against these three strains have been found only in human subjects over 70 years of age, of which there were none in the sample. In the 21–30-years age-group 2 sera which had shown titres of less than 1 : 10 to PR/8 antigen in the tests performed in 1964 showed titres of 1 : 10 in the current study. In the 31–40-years group 2 sera which had shown titres of less than 1 : 10 to the Swine antigen showed titres of 1 : 10 in the present study. These were 7 sera which differed (when comparing the standard HI with the micro-HI tests) by one tube dilution in the 1 : 40–1 : 160 range when tested against the Asian antigen. These minor differences were the only ones which occurred and are considered to be within the limits of usual error

of serological techniques (Davenport & Minuse, 1964). The micro-haemagglutination-inhibition method was therefore considered to be valid for use in all further testing.

FIG. 3
DISTRIBUTION OF COLOMBIAN RECRUITS FROM WHOM SERA WERE DRAWN



Antibodies to influenza viruses in military recruits

Antibody prevalence. Table 4 lists the results of the micro-HI tests observed with the proportional randomized samples from Argentina, Brazil and Colombia.

Published reports postulate the prevalence of Swine strains from before 1918 until 1922, and of the A0 strain (prototype, PR/8) of influenza virus during the years 1923–43. The A1 strains (prototype, FM/1) were the prevalent ones in 1947–57, and the Asian strains from 1957 to the present. Recent findings indicate that a virus similar to the Asian virus may have also been prevalent during the late 1880s (Mulder & Masurel, 1958; Davenport et al., 1964). It was expected that these populations of recruits, whose mean ages were 19 years (range 17–21 years) would prove to have had antigenic experience only with those strains of influenza virus (A1 and Asian) which had occurred in epidemic or pandemic form since the time of their birth. Indeed, the data now obtained support this assumption: antibodies against A1 and Asian strains were the predominant variety found in these serum samples.

The Swine antigen reacted positively with the sera of 2 Argentinian recruits, showing titres of 1 : 10 in both instances; sera of Brazilian and Colombian recruits did not show positive reactions against this antigen. One Colombian and 3 Argentinian sera showed titres of 1 : 10 to PR/8 and another Argentinian serum showed a titre of 1 : 20 to the same virus. The occasional antibody titres found in younger members of a population to strains prevalent before their birth may be due to a more recent but limited

TABLE 1
PERCENTAGE DISTRIBUTIONS OF MILITARY RECRUITS ACCORDING TO BLOOD GROUP AND POPULATION DENSITY

Recruit population (and No. tested)	Percentage distribution						
	ABO blood group				Population densities [a]		
	A	B	O	AB	Large urban	Small urban	Rural
Argentinian (500)	32.0	10.0	55.5	2.5	23.0	56.0	21.0
Brazilian (500)	37.0	11.0	51.0	1.0	37.0	46.0	17.0
Colombian (500)	24.0	10.0	64.0	2.0	17.0	59.0	24.0

[a] Large urban = >100 000 population; Small urban = 2 500–100 000 population; Rural = <2 500 population.

TABLE 2

RESULTS OF STANDARD HAEMAGGLUTINATION-INHIBITION TESTS WITH SERA COLLECTED IN 1964 DURING AN INTEREPIDEMIC PERIOD FROM UNIVERSITY HOSPITAL PATIENTS [a]

Age-group (years)	No. of sera tested	No. with indicated HI titre against influenza strain shown											
		Swine			PR/8			FM/1			Asian		
		<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20
0–10	10	9	1	0	9	1	0	4	0	6	1	2	7
11–20	20	20	0	0	18	2	0	1	0	19	1	1	18
21–30	25	16	7	2	0	4	21	1	1	23	0	0	25
31–40	15	3	2	10	0	0	15	0	0	15	1	0	14
41–50	10	0	2	8	1	0	9	1	0	9	2	1	7
50–65	10	1	0	9	0	1	9	0	0	10	0	0	10
Total	90	49	12	29	28	8	54	7	1	82	5	4	81

[a] These tests were performed at the Virus Laboratory, Department of Epidemiology, School of Public Health, The University of Michigan, Ann Arbor, Michigan, during the period September 1964 through January 1965.

TABLE 3

RESULTS OF MICRO-HAEMAGGLUTINATION-INHIBITION TESTS WITH SERA COLLECTED IN 1964 DURING AN INTEREPIDEMIC PERIOD FROM UNIVERSITY HOSPITAL PATIENTS [a]

Age-group (years)	No. of sera tested	No. with indicated HI titre against influenza strain shown											
		Swine			PR/8			FM/1			Asian		
		<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20
0–10	10	9	1	0	9	1	0	4	0	6	1	2	7
11–20	20	20	0	0	18	2	0	1	0	19	1	1	18
21–30	25	16	7	2	2	2	21	1	1	23	0	0	25
31–40	15	1	4	10	0	0	15	0	0	15	1	0	14
41–50	10	0	2	8	1	0	9	1	0	9	2	1	7
50–65	10	1	0	9	0	1	9	0	0	10	0	0	10
Total	90	47	14	29	30	6	54	7	1	82	5	4	81

[a] Same sera as in Table 2. They were also tested against equine, turkey and duck influenza viruses (see text) and reactions fell in the ≤1 : 10 range.

prevalence of these viruses or to crossing antibody, as previously inferred (Hennessy et al., 1955).

Significance of antibody prevalence and titre levels. The percentages of positive reactors to FM/1 and to Asian virus were highest in the sample from Colombia and lowest in that from Brazil (Table 4). With respect to FM/1 virus, it was found that the percentage of positive reactors from Colombia was higher than that from Argentina or Brazil. The differences between Argentinian and Brazilian positive reactors to FM/1 were not very great. When the percentage differences in positivity to the Asian strain were analysed a similar trend was found: the percentage of positive reactors in the serum collection from Colombians was different from those of Argentinians or Brazilians and no differences were noted between Argentinians and Brazilians with respect to reactivity to Asian influenza. There was also an apparent difference between the countries among reactors to FM/1 and to Asian virus when titre levels of HI antibodies were compared (Fig. 4 and 5).

TABLE 4

RESULTS OF MICRO-HAEMAGGLUTINATION-INHIBITION TESTS WITH SERA FROM MILITARY RECRUITS FROM ARGENTINA, BRAZIL AND COLOMBIA

Population group	No. of sera tested	Recruits with indicated HI titre to influenza strain shown											
		Swine			PR/8			FM/1			Asian		
		<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20	<1 : 10	1 : 10	⩾1 : 20
Argentinian recruits													
No.	500	498	2	0	496	3	1	220	73	207	156	49	295
%	100.0	99.6	0.4	—	99.2	0.6	0.2	44.0	14.6	41.4	31.2	9.8	59.0
Brazilian recruits													
No.	500	500	0	0	500	0	0	255	102	143	185	86	229
%	100.0	100.0	—	—	100.0	—	—	51.0	20.0	28.6	37.0	17.2	45.8
Colombian recruits													
No.	500	500	0	0	499	1	0	140	68	292	102	71	327
%	100.0	100.0	—	—	99.8	0.2	—	28.0	13.6	58.4	20.4	14.2	65.4
Total													
No.	1 500	1 498	2	0	1 495	4	1	615	243	642	443	206	85
%	100.0	99.9	0.1	—	99.7	0.27	0.07	41.0	16.2	42.8	29.5	13.7	56.7

Fig. 4 shows the percentage frequencies of HI titres to the FM/1 strain for the population samples from Colombia, Brazil and Argentina. For purposes of analysis the data were grouped by titre levels as follows: (*a*) low, $\leq 1 : 10$, (*b*) middle, 1 : 20 and 1 : 40, and (*c*) high, $\geq 1 : 80$. There were more negative and low reactors (group *a*) from Brazil (71.4%) than from Argentina (58.8%) or Colombia (41.6%). The middle-range values were 25.8% for Brazil, 33% for Argentina, and 46.4% for Colombia. The higher-range values were 2.8% for Brazil, 8.4% for Argentina and 12% for Colombia.

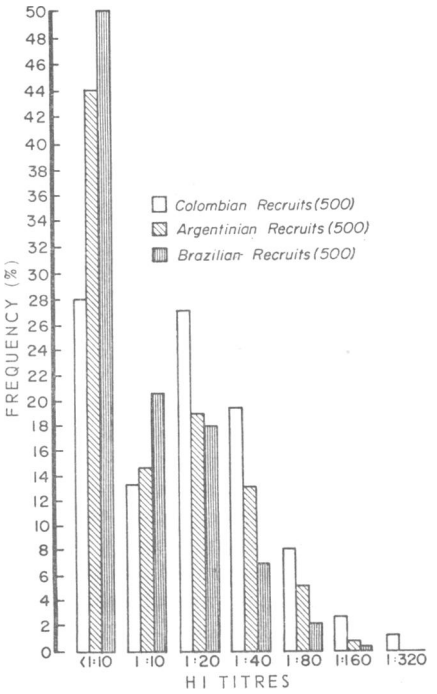
Fig. 5 shows the percentage frequencies of HI titres to the Asian strain in these samples.

These data demonstrate that at titres of 1 : 20 and greater to the FM/1 and the Asian strain, Colombian sera consistently exhibited a greater percentage positive than those from Argentina or Brazil.

The antibody patterns found in these samples of South American recruits are virtually certain to be due only to exposure to natural infection, for reliable sources [1] have stated that influenza vaccine is not used in these countries.

FIG. 4

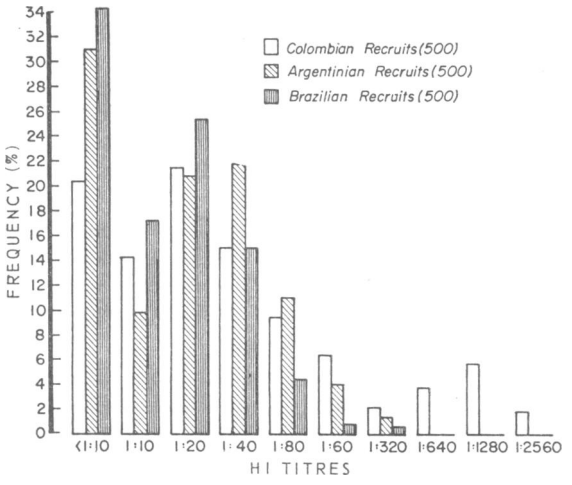
PERCENTAGE FREQUENCY OF HI TITRES TO FM/1 INFLUENZA STRAIN IN SERA FROM SOUTH AMERICAN RECRUITS



[1] General G. Ayerbe-Chaux, Minister of War, Colombian Armed Forces—personal communication, June 1966; General E. de Oliveira, Surgeon General, Brazilian Armed Forces—personal communication, July 1964; General Jorge Olivera, Surgeon General, Argentinian Armed Forces—personal communication, November 1965.

FIG. 5

PERCENTAGE FREQUENCY OF HI TITRES TO ASIAN INFLUENZA STRAIN IN SERA FROM SOUTH AMERICAN RECRUITS



As little is known of the occurrence of influenza in these countries the apparent differences between them cannot be reliably explained. In 1957 at the time of the Asian pandemic, virus isolation was successfully attempted in several South American countries, proving that the virus was indeed occurring there (Horwitz, 1961), but little more than a few isolations were made, providing no information as to the extent of infection. Moreover, systems of epidemiological intelligence for estimating the impact of Asian influenza in these countries were lacking.

However, conjectures may be made concerning the reasons for Colombians having higher percentages of positive reactors to FM/1 and to Asian virus than Argentinians or Brazilians. Two possibilities present themselves: that the Asian virus has occurred more recently in Colombia, or that the rate of infection in Colombia has been greater for some reason. It seems highly unlikely that influenza would not occur almost simultaneously in these contiguous countries with common routes of commerce and travel.[1] More plausible is the interpretation that, as in other studies on the comparative incidence of influenza, a difference in serological rates reflects a difference in the intensity of exposure (Davenport et al., 1955).

[1] These serum collections were made in Brazil in July 1964, in Colombia in June 1966, and in Argentina in July 1966.

This interpretation, if borne out by further studies, would tend to imply that social and environmental conditions are especially fertile for the transmission of influenza and perhaps other respiratory diseases in Colombia. Yet, such hypothetical conditions are probably subtle ones, since the present data do not support a relationship between population density and the serological prevalence rates. When the positive and negative reactors were analysed with respect to population density (large urban, small urban or rural—see Table 1), no significant differences were found in any country.

Candidate conditions to explain the higher serological rate in Colombians are: the difference in blood group distributions (see Discussion, below), the proximity to the Panama Canal and to North America, the varied climatic conditions present simultaneously and the related factor of topography (cool mountains and tropical, hot valleys), and the observed impressions [2] that the recruit population comes from the lower socio-economic groups in Colombia, whereas in Argentina it tends to come from all strata of society (recruiting practices in Brazil are less clear-cut). In addition, factors present in Argentina and Brazil but not in Colombia—such as the large proportion of Europeans and their descendants in those two countries and the resultant effects upon housing conditions, nutrition, education and life-style—may play a role.

Significance of ABO blood group distributions. These studies also showed a difference in the distribution of the ABO blood groups between the various countries. Colombia has a considerably higher proportion of individuals of blood type O. This has been observed to be the case in other population studies designed to determine blood group distribution (Mourant et al., 1958) and is supported by the data of this survey.

The subject of the relation of blood groups to infection with various agents has been amply reviewed by several writers (McDonald & Zuckerman, 1962; Potter & Schild, 1967; Tyrrell, 1967; Muschel, 1966; Allison, 1965; Harris et al., 1962; Springer & Tritel, 1962; Cohen, 1944; Beard et al., 1955; Raffel, 1961; Damian, 1964; Athreya & Coriell, 1967; Pettenkofer et al., 1962). Of special

[2] General G. Ayerbe-Chaux, Minister of War, Colombian Armed Forces—personal communication, June 1966; General E. de Oliveira, Surgeon General, Brazilian Armed Forces—personal communication July 1964; General Jorge Olivera, Surgeon General, Argentinian Armed Forces—personal communication, November 1965.

interest to virologists working with the influenza viruses have been the recent findings of possible relationships between the ABO blood group distributions in populations and infections due to these viruses (McDonald & Zuckerman, 1962; Potter & Schild, 1967; Tyrrell, 1967). A brief review of the pertinent literature concerning these variables will set the background for the analyses carried out.

McDonald & Zuckerman (1962), studying large numbers of paired sera and virus isolations from military recruits in Great Britain, showed that there was a substantial relative excess of group O individuals and a corresponding deficiency of group A among those who had been shown by laboratory data to have been infected with Asian influenza in 1957 ($P < 0.00001$); an opposite trend of lesser degree was seen in respect of the adenovirus infections ($P < 0.05$); in addition, the incidence of influenza A1, influenza B and coxsackievirus-21 infections among the different blood groups did not differ greatly from expectation. Potter & Schild (1967) found that the incidence of HI antibody to Asian influenza in a group of individuals of all ages from Great Britain was greater for persons of blood group O than for those of blood group A. The possibilities that naturally occurring anti-A or anti-B antibodies might interfere with the HI test mechanism or directly modify virus infectivity were excluded by their experimental data, and they concluded that genetic factors related to A or O blood groups but independent of blood group substance (isoantigen) or isoantibody might be responsible for the observed differential susceptibility. During the same year, Tyrrell (1967) stated, after studying a serum collection drawn from the inhabitants of Tristan da Cunha, " that subjects with blood group A are more likely to be infected with influenza and some other viruses than those of group O ".

The various ABO blood group distributions found in the South American collections, as well as the patterns of HI antibodies to influenza viruses which emerged as these populations were studied, lent themselves to analysis and comparison with the findings previously cited, and to re-examination of the accumulating evidence relating the significance of ABO groups in infection, antibody prevalence and/or natural resistance.

Table 5 shows the positive and negative HI reactors to A1 (FM/1), and Table 6 those to the Asian strain, by country and by individual ABO blood type.

Analysis of these data shows that the differences in ABO blood group distribution in these three populations are statistically significant ($\chi^2 = 20.5$; DF = 6), Colombia having the highest percentage of blood group O (64%) followed by Argentina (55%) and Brazil (51%). Blood group A shows a percentage distribution of 24, 32, and 37 for Colombia, Argentina, and Brazil, respectively. When analysing for differences between the positive (HI $>1:10$) and the negative (HI $<1:10$) reactors to A1 and to the Asian strain in these three populations by the individual ABO blood groups for each country (AB individuals were not included because of small numbers) significant differences ranging from $\chi^2 = 6.7$ to $\chi^2 = 35.09$ (DF = 2) were observed, consistently indicating that the greatest number of positive reactors was among those individuals with blood groups O and B, and the smallest number of positive reactors was among those with blood group A.

The fact that military recruits from Colombia showed the highest rates of antibodies to the A1 and to the Asian strain of influenza was found to be due to some factor other than different blood group distribution from the Argentinians and Brazilians. Analysis of the data showed that for all three blood groups examined (A, B and O) the proportions of positive reactors to both viruses were consistently higher in Colombia than in Argentina or Brazil (Tables 5 and 6).

The present findings in part support both the studies of Potter & Schild (1967) and those of McDonald & Zuckerman (1962) in that for Asian influenza a significantly higher proportion of group O individuals had antibodies than did those of group A; however, the latter workers found no significant difference with the A1 strain and none of these authors recognized the association with blood group B. The discrepancy in the results with A1 strains may be related to two differences in the design and conduct of McDonald & Zuckerman's (1962) study from that of the present one. Since their study of A1 influenza was based on attacks of clinical illness diagnosed virologically by complement-fixation tests and was limited to one year's observation (1956, at a time when the attack rate was low—129/1685 = 7.6%), their total number of cases was small: past infection was not evaluated and subclinical infection could not be detected because only those recruits admitted to sick quarters were available to donate specimens. It is conceivable that had their entire population been surveyed serologically for antibodies to A1 a larger number of previously infected subjects would have been identified and hence a correlation with blood groups similar to that

TABLE 5

COMPARISON OF REACTORS BY HAEMAGGLUTINATION-INHIBITION TO FM/1 INFLUENZA VIRUS ACCORDING TO BLOOD GROUP FOR MILITARY RECRUITS FROM ARGENTINA, BRAZIL AND COLOMBIA

Blood group	Recruits with indicated titres to FM/1									Over-all total		
	Argentina			Brazil			Colombia					
	<1 : 10	⩾1 : 10	Total	<1 : 10	⩾1 : 10	Total	<1 : 10	⩾1 : 10	Total	<1 : 10	⩾1 : 10	Total
A												
No.	92	66	158	113	73	186	47	73	120	252	212	464
%	58.2	41.8	100.0	60.8	39.2	100.0	39.2	60.8	100.0	54.3	45.7	100.0
B												
No.	18	37	55	29	24	53	12	38	50	59	99	158
%	32.7	67.3	100.0	54.7	45.3	100.0	24.0	76.0	100.0	37.3	62.7	100.0
O												
No.	103	170	273	111	143	254	78	243	321	292	556	848
%	37.7	62.3	100.0	43.7	56.3	100.0	24.3	75.7	100.0	34.4	65.6	100.0
AB												
No.	7	7	14	2	5	7	3	6	9	12	18	30
%	50.0	50.0	100.0	28.6	71.4	100.0	33.3	66.7	100.0	40.0	60.0	100.0
Total												
No.	220	280	500	255	245	500	140	360	500	615	885	1 500
%	44.0	56.0	100.0	51.0	49.0	100.0	28.0	72.0	100.0	41.0	59.0	100.0

shown in the present communication might have been demonstrated. (These authors did not study past infection as shown by HI or neutralization tests.)

In relation to the data presented by Potter & Schild (1967), the differences in HI antibodies to the Asian strain in individuals of blood groups A and O were found to be statistically significant in only 2 of 7 age-groups tested. In addition, because their study was admittedly prompted by the observations of McDonald & Zuckerman (1962), they collected data for analysis of the distribution of HI antibody titres for Asian influenza only on blood groups A and O: nowhere are the other blood groups even mentioned with regard to this type of analysis of HI titre and ABO distribution. It is evident from the design of their study that they failed to recognize the possible significance of blood groups B and AB.

The present findings appear to conflict with Tyrrell's (1967) conclusions. However, his observations, when applied specifically to influenza, cannot seriously be given equal weight with those of McDonald & Zuckerman (1962) because of certain obvious inadequacies in the analysis and interpretation of his data: it was only his combined data for three viruses (coxsackievirus 21, influenza B and influenza C) that "almost" showed a significantly higher likelihood that persons of group A would develop infection with any of these viruses. In addition, there were tests of significance done on data derived from numbers too small to be meaningful.

DISCUSSION

This study on influenza antibody prevalence in military recruits representative of all inhabited geographical regions of Argentina, Brazil and Colombia is the largest seroepidemiological survey of its kind thus far reported from South America.

The data derived correspond closely to the results of studies of the same cohort performed in other countries of well-documented epidemic history (Francis & Maassab, 1965). Because of the previously established relationship between antibody distributions by age and the periods of past prevalence of strains of influenza A and B, certain conclusions about the epidemiology of influenza in South America are warranted.

TABLE 6

COMPARISON OF REACTORS BY HAEMAGGLUTINATION-INHIBITION TO ASIAN INFLUENZA VIRUS ACCORDING TO BLOOD GROUP FOR MILITARY RECRUITS FROM ARGENTINA, BRAZIL AND COLOMBIA

Blood group	Recruits with indicated titres to Asian strain									Over-all total		
	Argentina			Brazil			Colombia					
	<1 : 10	⩾1 : 10	Total	<1 : 10	⩾1 : 10	Total	<1 : 10	⩾1 : 10	Total	<1 : 10	⩾1 : 10	Total
A												
No.	76	82	158	97	89	186	32	88	120	205	259	464
%	48.1	51.9	100.0	52.2	47.8	100.0	26.7	73.3	100.0	44.2	55.8	100.0
B												
No.	13	42	55	23	30	53	7	43	50	43	115	158
%	23.6	76.4	100.0	43.4	56.6	100.0	14.0	86.0	100.0	27.2	72.8	100.0
O												
No.	61	212	273	63	191	254	63	258	321	187	661	848
%	22.3	77.7	100.0	24.8	75.2	100.0	19.6	80.4	100.0	22.1	77.9	100.0
AB												
No.	6	8	14	2	5	7	0	9	9	8	22	30
%	42.9	57.1	100.0	28.6	71.4	100.0	0.0	100.0	100.0	26.7	73.3	100.0
Total												
No.	156	344	500	185	315	500	102	398	500	443	1 057	1 500
%	31.2	68.8	100.0	37.0	63.0	100.0	20.4	79.6	100.0	29.5	70.5	100.0

It seems clear from the serological data that two of the major subtypes of influenza A (Asian and influenza A1) have had periods of prevalence in South American populations studied similar to those of other areas of the world (Francis & Maassab, 1965). Moreover, it may be surmised that older and younger age-cohorts, although they were not included in the sample, would have shown serological evidence of involvement with type A and Swine strains at the same characteristic ages as found in studies of large populations throughout the world. Therefore, the implications are that the conditions requisite for the transmission of epidemic and pandemic influenza (as outlined by Francis & Maassab, 1965) are met in South America to the same or to a similar extent as they are globally (i.e., population densities, the capacity of the agent to be introduced into the continent, the physiological and nutritional status of the inhabitants as well as their susceptibility, the geography, climate and seasons, etc.).

Military recruits from Colombia showed the highest antibody prevalence to the A1 and Asian strains of influenza, in comparison with Argentina and Brazil. Some of the specific factors that might have played a role in a higher attack rate in Colombia have been mentioned above.

The present study also shows that the proportion of positive reactors to either the FM/1 or the Asian strain of influenza was significantly higher among individuals of blood groups O and B than among those of group A in all three countries studied. These data support and extend the view of others (Muschel, 1966; Allison, 1965) that genetic factors related in an undetermined manner to the ABO blood groups may play a role in the susceptibility to infection or the ability to make antibodies to influenza viruses, or both. The relationship of blood group B to increased antibody prevalence to Asian and A1 influenza, and of blood group O to increased antibody prevalence to A1 influenza has been demonstrated for the first time.

RÉSUMÉ

ANTICORPS ANTIGRIPPAUX CHEZ DES RECRUES D'ARGENTINE, DU BRÉSIL ET DE COLOMBIE: RELATION ENTRE LA PRÉSENCE DE CES ANTICORPS ET LA RÉPARTITION DES GROUPES SANGUINS DU SYSTÈME ABO

On a recherché par la méthode d'inhibition de l'hémagglutination la présence d'anticorps antigrippaux A dans les sérums prélevés chez 1500 recrues originaires de toutes les régions d'Argentine, du Brésil et de Colombie.

Parmi les 500 recrues colombiennes, on a relevé un taux de positivité des sérums de 72% pour la souche A1/FM/1/47 et de 80% pour la souche asiatique A2/AA/6/60. Chez les 500 recrues d'Argentine, les taux correspondants étaient de 56% et de 69%, et chez les 500 recrues brésiliennes, de 49% et de 63%. Sur les 1500 sérums examinés, 5 contenaient des anticorps pour la souche A0/PR/8/34 et 2 des anticorps pour la souche porcine A/Swine/1976/31.

Cette enquête séro-épidémiologique montre une similitude des tableaux d'anticorps antigrippaux A décelés dans des populations d'autres parties du monde et de ceux qui caractérisent certaines populations d'Amérique du Sud. Une analyse des résultats en fonction de la répartition des groupes sanguins révèle, dans les trois pays, une proportion plus élevée de porteurs d'anticorps dirigés contre les souches A1/FM/1/47 et A2/AA/6/60 parmi les recrues appartenant aux groupes O et B que parmi les recrues de groupe A. Ces observations appuient l'hypothèse selon laquelle des facteurs génétiques liés aux groupes sanguins influeraient sur la réceptivité à l'infection grippale et sur l'aptitude à la production des anticorps antigrippaux.

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