Changing age distribution of the blood donor population in the United States

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BACKGROUND: The American Red Cross has been maintaining a research database of all blood donors. Such a database provides a unique opportunity for monitoring changes over time in donor and donation patterns.

STUDY DESIGN AND METHODS: Changes in age distribution among blood donors were analyzed through comparison of the volunteer donor population in 1996, 1999, 2002, and 2005, before and after adjustment for demographic changes of the general population in the United States.

RESULTS: Donations by repeat donors 50 years or older as a proportion of total donations increased from 22.1 percent in 1996 to 34.5 percent in 2005, or 1.4 percent per year, whereas donations from repeat donors of 25 to 49 years decreased from 49.1 percent in 1996 to 37.1 percent in 2005, or 1.3 percent per year. After adjusting for general population trends, the effective number of donors decreased by more than 10 percent in female and male repeat donors of age 20 to 49 years and male first-time donors of age 25 to 49 years from 1996 to 2005; female and male repeat donors of age 25 to 39 years decreased by greater than 40 percent. Prevalence rates of major infectious disease markers decreased by 3.3 percent or more per year for first-time donations and by 6.4 percent or more per year for repeat donations.

CONCLUSION: The aging patterns of blood donors suggest the need for improved recruitment and retention in the young adult and middle-aged groups. A severe shortage of blood and blood components may be forecast in the foreseeable future unless offset by significant increased supply or reduced usage of blood and blood components.

With changing population demographics and implementation of various more restrictive donor screening policies, the composition and donation patterns of US blood donors may have changed over time. Knowledge of any such changes not only impacts on donor recruitment but also provides essential information for monitoring risks of major transfusion transmissible agents among blood donors and transfusion recipients. Wu and colleagues[1] reported the demographic trends of first-time blood donors based on data collected from three American Red Cross Blood Services (ARCBS) regions and two other US blood centers participating in the National Heart, Lung, and Blood Institute's Retrovirus Epidemiology Donor Study between 1991 and 1996.[1] There have also been studies on status of blood collection and transfusion in the United States from 1982 to 1999 but they were mostly focused on the overall supply of blood rather than donor and donation patterns.[2-7]

Annually, more than 4 million individuals donate more than 6 million blood units to ARCBS, which represents approximately half of the blood supplies in the United States. ARCBS has been maintaining a database of all ARC blood donations since 1995.[8] Such a database provides a unique opportunity for monitoring changes over time in donor composition, donation patterns, and other characteristics of the blood collection process. This report

ABBREVIATION: ARCBS = American Red Cross Blood Services.

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describes an evolutionary pattern of age among blood donors between 1996 and 2005, which suggests a possible shortage of blood and blood components in the foreseeable future in the United States.

MATERIALS AND METHODS

The ARCBS consists of 35 regional blood centers located across the country. All ARCBS regions use a standard donor record to register every blood donor at each donation. The record contains demographic information, such as sex and date of birth, physical signs, and donation and procedure types and is coupled with donation history as well as testing results for blood type and infectious disease markers in a centralized ARCBS database.[8,9] The data for this report were extracted from the centralized database.

The numbers of donors and donations by sex, age group, and donor or donation type for 1996, 1999, 2002, and 2005 were generated from the database with computer software (SAS, SAS Institute, Inc., Cary, NC).[10] The database contains data for several years before 1996 and has complete data for the entire ARCBS system for 1995. This study, however, started with data in 1996 to have equal distance between each 2 years and to avoid any potential weakness in donation history before 1996. Only volunteer blood donors and donations, whole blood or apheresis, were included in this study. A first-time donor is a donor with no prior record of donation in the ARCBS database whereas a repeat donor had donated at least once before the last donation in a given year. For each year, a first-time donor or repeat donor was defined according to his or her last voluntary donation during the year. If a donor donated the first time in a given year and did not return within the same year, the donor was counted as a first-time donor; if a donor donated the first time in a given year and donated again within the same year, the donor was counted as a repeat donor.

Data on the general population in the United States in 1996, 1999, 2002, and 2005 were obtained from the Census Bureau of the US government (http://www.census.gov/popest/estimates.php). The number of people in each sex and age group (within 15-79 years, because blood donors are 16 years or older and there are few donors older than 79 years) was extracted and a ratio was calculated for each group between each year of 1999, 2002, or 2005, and 1996. The ratio was then used to divide the percentage changes in number of donors between two corresponding years to adjust for impact of demographic changes of the general population on the blood donor population.

The difference in average age among blood donors of different years was analyzed by analysis of variance with a general linear model procedure, with sex and first-time or repeat status included in the model.[10] Age difference in different years was also analyzed with Mantel-Haenszel Chi-square, stratified by sex and first-time or repeat status.[10] A p value of less than 0.05 indicates that a difference is significant. Trend analysis was performed with linear regression. Prevalence rates of infectious disease markers among blood donations in different years were analyzed with Poisson regression. For other comparisons, statistical testing was not performed due to the fact that the large numbers will generate a p value less than 0.05 even when an actual difference may be meaningless.

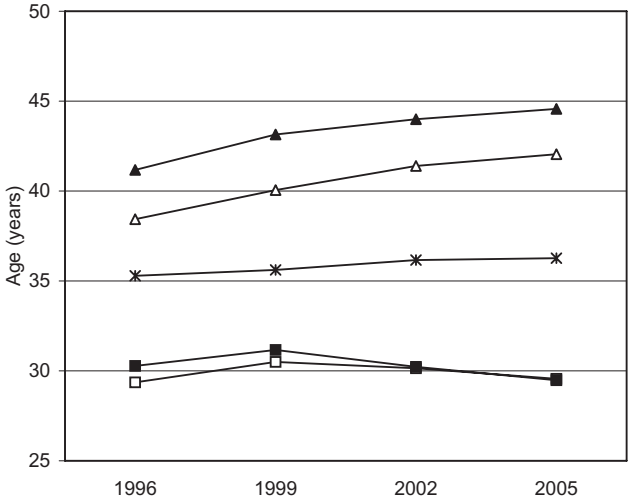

Fig. 1. Mean age of blood donors in different years by first-time (FT) or repeat (RP) donor and by sex (F = female; M = male). (□) FT-F donors; (■) FT-M donors; (△) RP-F donors; (▲) RP-M donors; (✳) all donors.

RESULTS

Mean age of blood donors in different years

A total number of 4,483,553, 4,749,679, 4,654,851, and 4,358,518 volunteer blood donors donated 6,105,007, 6,597,101, 6,964,561, and 6,824,073 units of blood to ARCBS in 1996, 1999, 2002, and 2005, respectively. The mean age of blood donors increased from 35.3 years in 1996, 35.6 years in 1999, and 36.2 years in 2002 to 36.3 years in 2005 ($p < 0.02$ for all). Further breakdown by first-time or repeat status showed that the increase in mean age occurred mostly among repeat donors: from 38.4, 40.1, and 41.4, to 42.1 years for female donors and from 41.2, 43.2, and 44.0 to 44.6 years for male donors (Fig. 1). Although mean ages differed between female and male donors, increasing trends among repeat donors were similar for both sexes ($p = 0.02$ for females and $p = 0.04$ for males).

Age composition of donors and donations

Data on age of donors were further analyzed to explore the specific nature of the increasing trends in donor age. Figure 2 shows the changing age composition of donors and changing composition of donations by donors of

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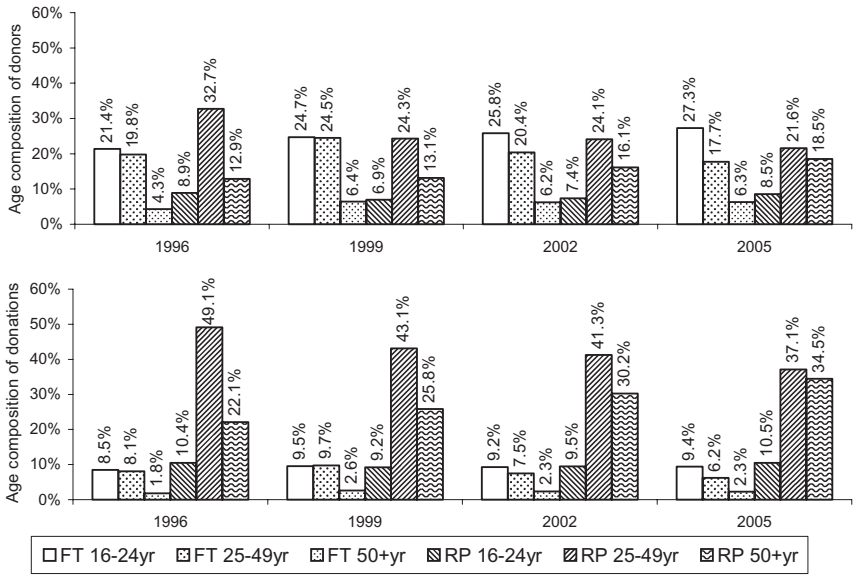

Fig. 2. Age composition of donors and contribution to donations by donors of different age groups (FT = first-time donors; RP = repeat donors).

TABLE 1. Mean donation frequency of repeat donors, by sex and age group, in comparison with 1996

	Age (years)					
	Female			Male		
	16-24	25-49	50+	16-24	25-49	50+
1996	1.60	1.90	2.18	1.55	2.03	2.42
1999	1.76	2.16	2.47	1.70	2.31	2.74
2002	1.75	2.11	2.42	1.76	2.38	2.82
2005	1.78	2.15	2.52	1.80	2.43	2.89

different age groups. The proportion of repeat donors of 25 to 49 years decreased from 1996 to 2005 while the proportion of repeat donors of 50 years or older increased over the period. More importantly, the proportion of blood units donated by repeat donors of 50 years or older increased from 22.1 percent in 1996 to 34.5 percent in 2005, at 1.4 percent per year ($p < 0.01$), whereas the proportion of blood units donated by repeat donors of 25 to 49 years decreased from 49.1 percent in 1996 to 37.1 percent in 2005, at 1.3 percent per year ($p < 0.02$). In 2005, repeat donors of all ages combined, who accounted for 48.6 percent of all donors, contributed 82.1 percent of total donations. Donation frequency of repeat donors increased in all sex and age groups from 1996 to 2005 (Table 1). Linear regression analyses showed that mean annual donation frequency increased by 0.018, 0.025, 0.030, 0.028, 0.044, and 0.047 times per donor per year from 1996 to 2005 for female repeat donors of 16 to 24, 25 to 49, and 50 years or older and male repeat donors of 16 to 24, 25 to 49, and 50 years or older, respectively ($p < 0.01$ for all). Female donors 50 years or older made a mean of 2.52 donations and males gave 2.89 donations.

Percentage change in number of donors compared to 1996

To further reflect the magnitude of changes in donor age over the years, the number of donors in 1999, 2002, and 2005 by sex and first-time or repeat status was compared to that in 1996 (Fig. 3). For both female and male donors, a greater than 40 percent decrease in number of repeat donors of 25 to 39 years occurred in 2005 in comparison with 1996. To account for possible impact of demographic changes in the general population, the above stated percentage changes were adjusted by the sex and age (15-79 years) composition of the US population in the corresponding years and the results are shown in Fig. 4. Excluding the effect of demographic trends of the general population, the only donor groups that showed an increase of 10 percent or more in 2005 in comparison with 1996 were female first-time donors of 16 to 19 and 50 years or older, male first-time donors of 16 to 19 and 60 years or older, female repeat donors of 60 years or older, and male repeat donors of 16 to 19 and 60 years or older. A decrease by more than 10 percent occurred for male first-time donors of 25 to 49 years and female and male repeat donors of 20 to 49 years, with a greater than 40 percent decrease for those of 25 to 39 years, during the 10-year period.

Shift of peak age group of blood donors

Figure 5 shows the shifting pattern of age groups of donors from 1996 to 2005—a shifting toward older donors of 50 to 59 years or older. Both first-time and repeat donors are included in Fig. 5, with the first peak reflecting more of first-time donors and the second peak more of repeat donors. Donors of 30 to 39 years used to account for the largest proportion of donors in 1996 by age group whereas those of 40 to 49 years became the peak age group for the second peak and those of 50 to 59 and 60 years or older accounted for much larger proportions of donors in 2005. The result suggests that many of the repeat donors might have come from the same cohorts of blood donors who formed a major proportion of the donor pool in 1996 and moved to the older age groups 9 years later in 2005.

Change in prevalence of infectious disease markers among donations

Prevalence rates of infectious disease markers among blood donations in 1996, 1999, 2002, and 2005 were analyzed through Poisson regression with gender and age of

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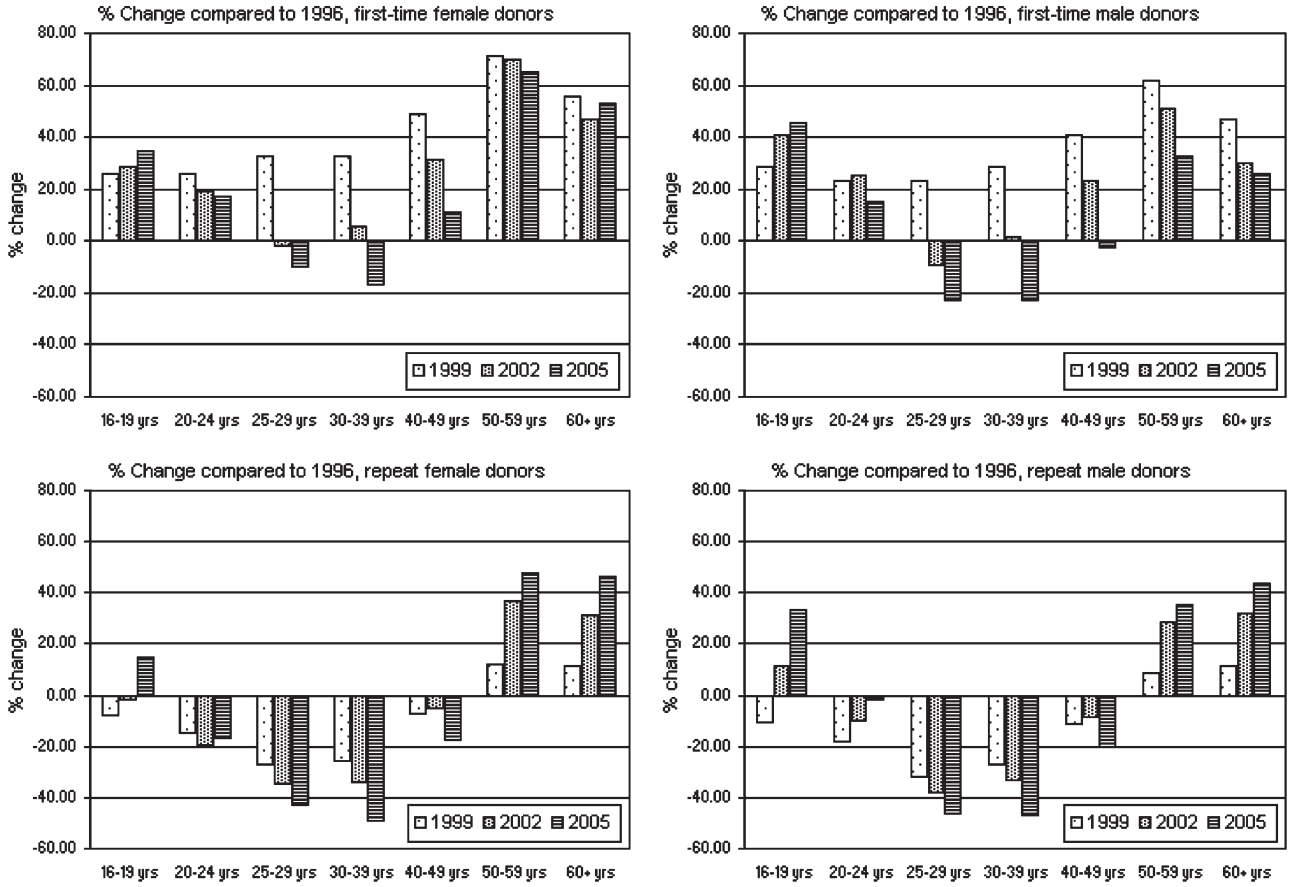

Fig. 3. Percentage change in number of donors, by first-time or repeat status, sex, and age group, compared to 1996.

donors included in the model. Table 2 shows the prevalence rates for first-time or repeat donations as well as regression analysis results. The ratio of marker prevalence rate in a year versus that in a previous year was derived from estimates for variable "year" in Poisson regression. The ratio equals 1 if the prevalence of a marker does not change from year to year. Obviously this is a measurement of mean changes from year to year between 1996 and 2005. Therefore (Ratio – 1) reflects the degree of average change per year and (Ratio – 1)/1 expresses such change as a proportion of 1. The mean change per year multiplied by 100 becomes annual percent change. With differences in donor age and sex accounted for, prevalence rates of all major infectious disease markers among donated blood units decreased by a mean of 3.3 percent or more per year for first-time donations and by 6.4 percent or more per year for repeat donations, from 1996 to 2005.

DISCUSSION

The temporal patterns of donors and donations may suggest future needs and directions in improvement on donor recruitment and retention. In recent years, donors from older age groups of 50 years or more increasingly contribute to a larger proportion of the donor pool, especially the repeat donor pool that accounts for 82 percent of the total number of current donations. Donation frequency increased among repeat donors, especially those of age 50 years or older. People of these age groups will gradually move to the recipient side of the supply/demand equation whereas the less than 50 years groups that used to account for the majority of the repeat donors are shrinking in their share of the total donations from 59 percent in 1996, 52 percent in 1999, and 50 percent in 2002 to 48 percent in 2005. Part of the shrinkage could be due to demographic changes of the general population in the United States. After adjustment for changes in population size, the number of both female and male repeat donors of 20 to 49 years and male first-time donors of 25 to 49 years had nevertheless decreased significantly (by 15.66% to 47.68%) from 1996 to 2005 (Fig. 4). The increased number of first-time donors of 16 to 19 years did not translate into an increased number of repeat donors for the same or older age groups (Fig. 4). Apparently, those first-time donors simply did not come back to donate again or in other words were not retained. Results from this study suggest the need for improved recruitment and retention especially in the younger age groups of the

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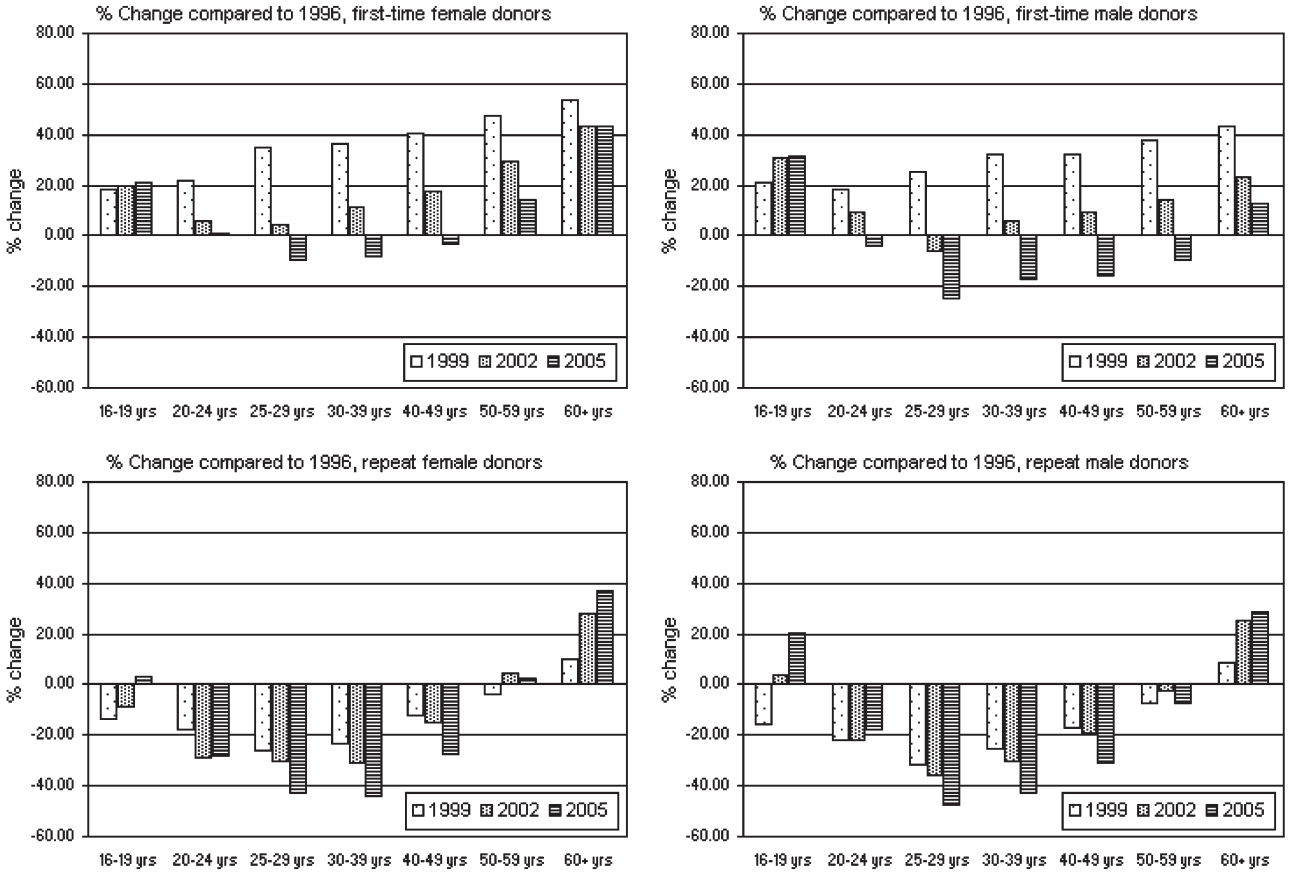

Fig. 4. Percentage change in number of donors compared to 1996, adjusted by change in US population.

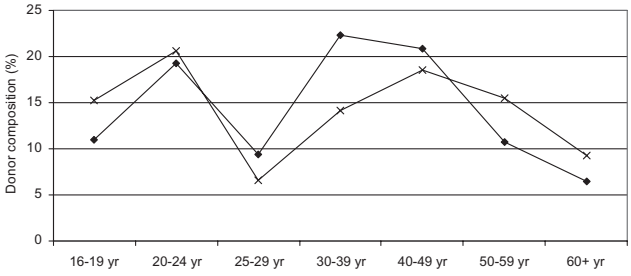

Fig. 5. Shifting pattern of donor age, 2005 (×) compared to 1996 (◆).

population. A severe shortage of blood and blood components may be forecast in the foreseeable future unless there will be significant increased supply or efforts to reduce the usage of blood and blood components are effective. Many studies have suggested ways to improve recruitment and retention of blood donors and to increase donation frequency by donors.[11-15] Most recently, a study showed that the eligible donor pool in the United States is not as large as previously believed because an estimated 66 million supposedly eligible individuals are ineligible due to known exclusionary factors.[16]

Although the data available do not allow assessment of potential cohort effects on the age evolution of blood donors over the years, comparison of donor age composition in 2005 with that in 1996 nevertheless showed a clear shift (Fig. 5), suggestive of a cohort effect. It is possible that the increased number of blood donors, especially repeat blood donors, in the older age groups reflects the aging process over the years of certain groups of donors. Recruitment and retention efforts could have been targeting such cohorts of blood donors or simply those cohorts could be more committed to donate their blood. In either case, many of such donors will surely become nondonors in the years to come.

The changing pattern of donors and donations may also have implications for estimating and projecting risks of transmissible diseases and the safety of blood and blood components. Although blood donors are not representative of risks of blood-borne infections in the general population, different risks of such diseases in various groups of the population certainly affect the risks among blood donors. For example, levels of hepatitis B and hepatitis C infections are higher in males than in females and the highest anti-hepatitis C virus (HCV) prevalence rates are in 30- to 39-year-old donors compared to other age groups.[17-20] With implementation of nationwide immunization against hepatitis B, mostly in children, it is expected that the risk posed by this virus will gradually

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TABLE 2. Prevalence rate of infectious disease markers per 100,000 donations in 1996, 1999, 2002, and 2005, by donation status

	Anti-HIV		Anti-HCV		HBsAg		Anti-HTLV		Syphilis		Anti-HBc	
	FT	RP	FT	RP	FT	RP	FT	RP	FT	RP	FT	RP
1996	15.70	1.80	435.77	18.05	101.16	3.03	27.65	1.99	183.83	21.49	1683.54	250.32
1999	11.87	1.23	344.41	6.58	77.53	1.23	11.43	0.36	169.22	7.75	1309.96	158.99
2002	11.88	0.91	255.67	5.07	70.43	1.18	17.39	0.26	135.43	5.39	1170.62	137.65
2005	11.16	0.91	183.36	3.22	58.70	0.86	14.23	0.11	134.53	4.88	1084.45	137.47
Ratio*	0.967	0.935	0.909	0.821	0.944	0.879	0.937	0.690	0.960	0.826	0.952	0.936
p Value	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Percentage change†	−3.3	−6.5	−9.1	−17.9	−5.6	−12.1	−6.3	−31.0	−4.0	−17.4	−4.8	−6.4

* Ratio of marker prevalence rate in a year versus that in a previous year, derived from Poisson regression.
† Mean percentage change per year ((Ratio − 1)/1) × 100.
FT = first-time donations; RP = repeat donations.

decrease over the coming years. Changes in age and sex composition of blood donors need to be built into attempts to estimate or project risks of infectious diseases among blood donors and also the residual risk of the blood supply. Results from this study showed that, with changes in donor age and sex accounted for, the current blood supply has become increasingly safer with time.

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