**Comparison of donor and general population demographics over time: A BEST Collaborative group study**

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Abstract

Background: We compared donor and general population demographics over time to provide insight into current donation patterns and the future adequacy of the blood supply.

Study design and methods: Seventeen blood center members of the Biomedical Excellence for Safer Transfusion Collaborative (BEST) from twelve countries provided the number of donors and people in the general population by demographic category for 2001 and 2011, changes in age criteria, and percentage of first time donors. We calculated the median age of donors and the general population and determined the percentage of each group in age and sex cohorts.

Results: Age criteria vary, with upper limits recently liberalized in several countries. In 2011, the percentage of first time donors ranged from 10% to 41%. The median age of the donor and general population increased from 2001 to 2011 in most countries, as did the percentage of the general population over 60. The youngest donor cohort is overrepresented to a variable degree; this tendency increased over time. Although still underrepresented, older donors contributed more in 2011. A large middle-aged cohort is aging at a rate exceeding the progression of time, while 25 to 45 year olds are relatively underrepresented.

Conclusions: All participating countries are experiencing aging of their general population. Donor demographics differ substantially between countries; this can be only partly explained by population demographics and age criteria. Many countries have an aging middle aged donor and population cohort, and are increasingly relying on their youngest donors to contribute disproportionately to the blood supply.

Introduction

Predicting the future need for blood components is a difficult undertaking, and predicting the future response of the population to appeals to donate blood is even more problematic. While many developed countries have seen a sharp decrease in the demand for red blood cells in the last few years, these same countries anticipate that needs may change again as their population demographics shift1. Studies performed in Canada, Spain, Northern Ireland, England, Germany, Japan, the Netherlands and the US indicate that per capita blood use starts increasing in individuals over age 50, and over 50% of red cells are currently transfused to individuals over age 602-9. In most developed countries, the proportion of the population in this older age group is rapidly increasing and therefore the need for blood may rapidly increase along with them.

Equally difficult to prognosticate is the stability of the blood supply10. The blood supply depends on dedicated volunteer donors, often drawn from younger age groups. With falling birth rates in many developed countries, these younger age groups are decreasing as a percentage of the overall population. First time donors in particular are often young adults. At the same time, current middle-aged/older dedicated donors are aging and may become ineligible to donate due to arbitrary age limits or intercurrent morbidity. Therefore, there is concern that in the next few years, demographic trends in the general population and donor population may converge to result in blood shortages6-13. Examining data on general population and blood donor trends over time can help assess if these predicted patterns seem likely in all countries or in only selected countries. The Biomedical Excellence for Safer Transfusion Collaborative (BEST) brings together an international group of scientists, physicians, and industry members to perform collaborative studies in transfusion medicine. We surveyed blood center members of BEST regarding the number of donors and members of the general population in their jurisdiction by age and sex for 2001 and 2011. This data was then used to determine demographic changes in the two time periods in both donors and the general population. We also compared donor demographics in different countries, illustrating commonalities and differences based on variation in recruitment and retention policies.

Methods

Blood center members of BEST were asked to provide the number of male and female allogeneic whole blood and double red cell apheresis donors by year of age using a standard data table. The number of males and females in the general population by age for the same time points was determined from national statistics. Only members of the general population over the minimum age for blood donation (16, 17 or 18 depending on the country) were included; no maximum age for the general population was set since they varied even in a single jurisdiction for first time or repeat donors and varied over time in several jurisdictions. Data were collected for 2001 and 2011. Centers also provided their minimum and maximum donor age criteria, changes to donor age criteria over the time of the study, the percentage of all donors that were donating to their organization for the first time, and any particular donor practices that might influence demographics in their jurisdiction.

The number of donors was sorted into age group categories for males and females, and the percentage of each demographic category was calculated as the percentage of total donors; this was also done for general population data. Differentials were calculated as the difference between the percentage of the donor population and the percentage of the general population for each age and sex grouping.

Data was received from 17 blood centers in 12 countries, although several were not able to provide data for 2001. Participants collect well over 15 million blood donations annually, and included national blood operators responsible for the totality of the blood supply in their jurisdiction for Canada (Canadian Blood Services and Héma-Québec), Australia (Australian Red Cross Blood Services), England and North Wales (National Health Blood Services and Transplant), Ireland (Irish Blood Transfusion Service), France (Établissement Français du Sang), Japan (Japanese Red Cross Society), the Netherlands (Sanquin), New Zealand (New Zealand Blood Services), and Singapore (Health Sciences Authority). Other participants collect blood in a geographic area in their country (Red Cross Flanders Blood Transfusion Centre in Belgium; German Red Cross covering the states of Niedersachsen, Bremen, Sachen-Anhalt, and Thüringen, in the northern region of Germany). In addition, five blood centers in the US collecting a significant percentage of the US blood supply participated (American Red Cross, Blood Systems Inc., BloodWorks Northwest, New York Blood Center, and Institute for Transfusion Medicine (ITXM)).

Results

Table 1 shows the donor age criteria in various jurisdictions, the percentage of first time donors in 2011, and additional comments regarding extra requirements for older donors and recruitment practices; these differences explain some of the differences in donor demographics seen between countries. The lower age for donation ranges from 16 to 18. There is considerable variability in upper age limit: many countries have no upper age limit, some require recent donation or medical approval to continue past a given age, while others have a firm upper age limit ranging from 69 to80. Several countries, including Canada, England and North Wales and Germany, have modified their criteria to permit older individuals to continue donating. In 2011, the percentage of first time donors ranged from a low of 10% in Japan and the Netherlands, to a high of 29% in the US and 41% in Singapore.

The median age and interquartile range of blood donors changed from 2001 to 2011 at different rates in different countries (Table 2). In order to facilitate the comparison with the donor population, the general population median was calculated starting at the lowest age of permissible blood donation in a given country (for example, 16 in the US), and did not have an upper limit. In 2001, the median age of donors was significantly younger than the general population, with the exception of the Netherlands (donors one year older). The difference in median age between donors and the general population ranged from one year in New Zealand, to seven years in France and Singapore. In 2011, the median age of donors had increased by one to four years in most countries for which a comparison is possible, with the exception of New Zealand and Singapore (no change), and the US (donors one year younger than 2001). The median age of the general population also increased by from one year to four years, in all countries for which a comparison is possible. The percentage of the general population over age 60 ranged from 12.4% (Singapore) to 28.3% (northern states of Germany) in 2001; by 2011, it had increased by 1 to 3% in all countries. Except for England and North Wales, the median age of the general population increased more than the median age of the donor population.

Although results vary in different jurisdictions, in general, the youngest cohort of the population is overrepresented in the donor group, and this tendency increased in 2011 compared to 2001. The 16 to 25 age group (or 17 or 18 to 25 age group) represents from 11 to 17% of the general population in participating countries. Figure 1 shows the percentage of donors in the youngest age cohort in 2001 and 2011, for countries with data available for both time periods; the percentage of the general population in the youngest cohort is shown by a grey line. Not surprisingly, countries with higher percentages of first time donors, such as Singapore and the US, have the highest percentage of donors in the youngest age category. The differences between countries are greater than the differences in the same country between the two time periods. In the US, there was a major increase in the participation of this age cohort in the donor pool in 2011 compared to 2001. In most countries, female donors are slightly over-represented compared to male donors in the youngest age cohort, while in older age cohorts, representation is equal, or males are over-represented. The exceptions are Singapore and Japan, where male donors are over-represented in all age cohorts; male donors are preferred since they can more often donate a 400 ml rather than 200 ml unit, based on donor weight.

Although more younger donors are participating in donation, the oldest cohort of donors is also contributing an increasing proportion of the overall blood supply (Table 3). The differential (percentage of the donor population minus percentage of the general population) is shown in each age and sex cohort for the various countries in 2011. Positive numbers indicate over-representation of donors, negative numbers under-representation of donors, while numbers close to zero indicate that the percentage of donors is roughly equivalent to the general population in a given cohort. For countries where data was available for 2001 and 2011, numbers in bold indicate increased representation of donors compared to the general population in 2011 compared to 2001. Over-representation of younger donors is seen in most countries, and has increased from 2001 to 2011. Although donors over 61 are under-represented, they are contributing more to the blood supply in 2011 compared to 2001 in many countries. This may be due in part to changes in donor eligibility criteria in several countries, in addition to the aging of the donor pool.

Some of these changes are better seen in graphical form. In Figure 2, the distribution of the general population and donors by age in 2001 and 2011 is shown for the Netherlands, the US, England and North Wales, and Singapore. There is a middle-aged cohort that is aging in the US, England and North Wales, and the Netherlands, in both the general population and the donor population. The increased prominence of collections from younger donors in 2011 compared to 2001 is seen in the US. Finally, there is decreased representation of individuals in the 26 to 50 year old cohort.

Discussion

Much of modern medical practice depends on the availability of blood components. Red cell use per capita has declined in many countries in the past few years, due to improvements in surgery and modifications in transfusion practice, such as patient blood management1,14. However, demand appears to be stabilizing or increasing slightly in many jurisdictions. In all developed countries that have performed a detailed analysis of red cell use, per capita use of blood products correlates very closely with population age2-9. After an initial spike in the “birth to age four” cohort, demand is low and relatively flat until individuals reach age 45 to 50, and then rises exponentially with age. For example, Greinacher et al showed that in eastern Germany, red cell transfusion rates per capita were 3.7 times higher in 60 to 79 year olds and 6.5 times higher in individuals 80 and over compared to 40 to 59 year olds7,8. An aging demographic bulge of baby boomers is now entering their sixties and seventies in many developed countries. On the other hand, they are followed by a smaller population in younger age cohorts that provide most blood donations. There is concern that the ratio of individuals in high donation cohorts compared to individuals in high use cohorts is declining1,10.

The composition of the donor base is influenced by many factors. It reflects the recruitment and retention practices of the blood centers which may be targeting donors based on age. It may also be affected by the composition of the general population, as well as social values and motivation to donate, which may differ in different population cohorts by age, sex, and geographic location10-12. This study brings together data on donor and population demographics from many large national and regional blood centers for the first time. In all jurisdictions with available data for both time points, both the median age and the percentage of the general population over age 60 increased from 2001 to 2011. The median age of blood donors in both time periods is a few years younger than the median age of the general population.

Donor demographics differ substantially between countries, and can only partly be explained by population demographics and donor age criteria. For example, aligning with general population demographics, the percentage of first time donors and contribution of the youngest donor cohort to the donor pool is high in Singapore, which has the youngest general population, and low in the Netherlands and Belgium, that have older general populations. However, the US had a much higher percentage of first time donors and a greater contribution of the youngest cohort of donors to the donor pool than New Zealand, even though these countries have very similar general population demographics. Similarly, donor demographics in the two different time periods in the same country can be partly attributed to changes in population demographics. In most countries, the median age of both the general population and the donor population increased by from one to four years in the decade between 2001 and 2011. In many countries, there is an aging middle aged donor cohort effect, which is most prominent in the Netherlands and other European countries. This may reflect both the size of the general population cohort in this age group, as well as donation practices in this loyal group of donors. The 25 to 45 year old age group is relatively under-represented in the donor pool. Many countries, particularly the US, rely increasingly on younger donors. The 2013 National Blood Collection and Utilization Survey Report provides more information in this regard, with approximately 20% of US donations from individuals in the 16 to 24 year old age group, and 9.9% of all donations coming from 16 to 18 year olds14. The number of US states allowing donation by 16 year olds increased substantially from 2001 to 2011. Donor demographics therefore reflect not only population demographics and donor criteria, but recruitment practices, location of blood drives, and the emphasis placed on new donor acquisition compared to retention of regular donors.

Older donors are underrepresented compared to the general population in all countries, partly since individuals develop medical conditions that might result in deferral from donation. Opportunities to donate may be limited if clinics are primarily held in the workplaces and increased leisure travel may result in high travel deferral rates8,11,13,15. However, age expectancy has increased, as has the number of healthy individuals in their 70s and 80s. Several countries have changed upper age limits and decreased administrative barriers, such as additional medical assessments, to allow healthy older donors to continue donation. This may result in continued donation by a subset of aging baby boomers as they enter their late sixties and seventies.

Our study has several limitations. Our data demonstrate the number of donors in each demographic cohort, but does not include donation frequency or proportion of first time vs. repeat donors in each cohort. However, donation frequency varies by sex and age, with males donating more frequently than females, and donors in middle aged cohorts usually donating more often than younger or older donors6-12. Therefore the contribution of a given donor cohort to the blood supply cannot be fully assessed. Data for 2001 were not available from several centers, limiting comparison of the two time points to a subset of participants. In summarizing data from so many blood centers, we were not able to provide the level of detail shown in elegant studies performed in a single jurisdiction, or to transform multiple data sets to the World Health Organization Standard population6-9,11,12. The strengths of our study include collecting and summarizing data using common definitions and data analysis. We believe that this is the first time that data on donor and population demographics over time have been examined on such a broad scale using uniform methods that allow more accurate comparisons between countries.

In summary, demographic data suggest that reliance upon young people to replenish donor loss and build the donor base is a general trend across many developed countries. This may have implications for donor health, since preliminary data suggest that teenage donors have lower iron stores and deplete their iron stores more rapidly on donation than older adult donors.16 At the same time, in many countries there is a dedicated middle-aged cohort of donors moving toward the time when they are likely to drop out of the donor pool. Future research should focus on comparisons of recruitment and retention practices in different countries in order to identify ways of encouraging initial and repeat donation among all age groups.

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16. AABB Association Bulletin #17-02: Updated strategies to limit or prevent iron deficiency in blood donor [Internet]. Bethesda: AABB; 2017 [cited 2017 May 30]. Available from: http://www.aabb.org/programs/publications/bulletins/Docs/ab17-02.pdfTable 1 Age criteria for donation and percentage of first time donors, 2011.

|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | **Age range (years)** | **% of first time donors** | **Additional comments** |
| Australia | 16-80 | 24 | First time donors < 71Regular donors > 80 may donate at discretion of blood center MD |
| Belgium\* | 18-70 | 11 | >66 must have donated in last 3 years |
| Canada Canadian Blood Services | 17 & over | 22 | Until 2004, ≤61 1st time, ≤71 repeat donors |
|  Héma-Québec | 18 & over | 21 | Until 2004, ≤61 1st time, ≤71 repeat donors |
| England & N. Wales | 17 & over | 13 | If donated in last 2 years, can continue >70Until 2006, ≤70. |
| France | 18-70 | 25 |  |
| Germany† | 18 & over | 11 | >68 may donate at discretion of blood center MD |
| Ireland | 18 & over | 22 |  |
| Japan | 16-69 | 10 | 16-18 for 200 ml donation, >17 (males) or >18 (females) for 200 ml or 400 ml donation65-69 must have donated once between 60-64Males favored due to size, donor must be ≥50 kg for 400 ml donation |
| Netherlands | 18-70 | 10 | First time donors ≤65Until 1996-7, mandatory military service for males included a day off for donation |
| New Zealand | 16-75 | 20 |  |
| Singapore | 16-70 | 41 | First time donors ≤60Many donors are expatriates |
| US‡ | 16 & over | 29 | May vary by state and blood service, many more states allowed donation from 16 year olds in 2011 compared to 2001Focus on high school clinics |

\*Belgium Red Cross Flanders Blood Transfusion Center

†States of Nidersachsen, Bremen, Sachsen-Anhalt, and Thüringen in Northern Germany

‡American Red Cross, Blood Systems Inc, BloodWorks Northwest, New York Blood Center, and ITXM

Table 2 Age and upper and lower quartile of donors and general population, 2001 vs. 2011.

|  |  |  |
| --- | --- | --- |
|  | **2001** | **2011** |
| **Country** | **Donors** | **General Population\*** | **Donors** | **General Population** |
|  |  | **Median** | **% over 60** |  | **Median** | **% over 60** |
| Belgium‡ | 41 (32-49) | 45 (32-61) | 26.3 | 43 (30-51) | 48 (33-63) | 28.3 |
| Canada | 40 (28-49) | 43 (31-57) | 20.2 | 43 (27-53) | 46 (31-60) | 23.6 |
| France | 38 (27-49) | 45 (31-61) | 25.4 | 39 (26-51) | 47 (32-62) | 27.5 |
| Netherlands | 45 (36-54) | 44 (32-58) | 21.9 | 48 (36-57) | 47 (33-62) | 26.6 |
| New Zealand | 41 (28-51) | 42 (30-57) | 20.2 | 41 (26-53) | 45 (30-59) | 22.9 |
| Singapore | 32 (22-45) | 39 (29-51) | 12.4 | 32 (23-42) | 42 (30-55) | 14.9 |
| England & N. Wales | 40 (31-50) | 45 (32-61) | 25.1 | 44 (30-54) | 46 (31-62) | 26.6 |
| US‖AustraliaGermany§IrelandJapanSummary | 40 (27-51)NA†NANANA40 | 43 (30-57)43 (30-57)46 (33-62)NANA43 | 20.420.728.3NANA22.0 | 39 (21-53)41 (26-54)45 (31-54)39 (28-49)39 (29-49)41 | 45 (30-59)44 (30-59)50 (36-65)42 (30-57)50 (35-66)46 | 22.522.831.520.135.025.2 |

\* general population starts at age of earliest donation, no upper limit

‡ Flanders

† NA = not available

‖ US donors from American Red Cross, Blood Systems Inc, BloodWorks Northwest, New

 York Blood Center, and ITXM

§ for both donors and the general population, northern States of Niedersachsen, Bremen, Sachsen

 -Anhalt, and Thüringen

Table 3 Differential (% donor − % general population) by country and category, 2011. For countries where data from 2001 is available (Belgium to US), increased representation of donors in 2011 compared to 2001 for a given cohort is shown in bold.

\* Lower age limit for each jurisdiction was used

Male

Female

Male

Female

Male

Female

Male

Female

Belgium

**1.7**

**4.1**

2.4

0.7

10.9

**3.5**

**-9.4**

-13.9

Canada

**2.0**

**5.8**

-1.2

-0.4

4.8

**2.8**

**-4.9**

**-8.8**

France

**3.5**

**6.5**

1.8

**3.7**

3.8

1.0

-7.6

-12.7

Netherlands

**-3.2**

**1.1**

-3.1

**1.4**

8.2

**5.9**

**-1.9**

**-8.4**

New Zealand

**1.2**

**6.0**

**-0.4**

**0.4**

2.7

3.8

-5.8

**-7.8**

Singapore

9.5

**5.3**

**11.2**

**-1.1**

-0.3

**-10.6**

-6.3

-7.8

England & N. Wales

**-0.5**

**2.4**

-1.6

1.5

6.3

**6.5**

**-5.9**

**-8.8**

US\*\*\*

**6.6**

**7.5**

-2.8

-1.8

0.4

-0.03

**-3.0**

**-6.8**

Australia

1.1

5.2

-1.0

-0.5

2.8

2.4

-3.8

-6.2

Germany

3.4

3.5

0.7

0.5

7.2

4.3

-6.5

-13.1

Ireland

1.6

4.1

2.6

-0.8

8.2

-0.2

-6.1

-9.3

Japan

3.8

1.9

12.8

-0.1

15.1

-4.2

-11.5

-17.9

16-25\*

26-40

41-60

61 and older\*\*

Country

\*\* All age groups were included irrespective of upper age limit

\*\*\* US donors from American Red Cross, Blood Systems Inc, BloodWorks Northwest, New York Blood Center, and ITXM

Figure 1. Percentage of donors in the youngest age cohort (16, 17, or 18, indicated on x axis, to 25), gray line shows the corresponding % in the general population - A) 2001 B) 2011.



 A

\*Canadian Blood Services 17, Héma-Québec 18

 B

Figure 2. Age distribution of the general population and donor population (in years) in the Netherlands (A and B respectively), the US (C and D respectively), England & N. Wales (E and F respectively) and Singapore (G and H respectively) in 2001 ( ) and 2011 ( ).

