Cardiovascular and demographic characteristics in whole blood and plasma donors: results from the Donor InSight study

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BACKGROUND: Within blood establishments little comparative information is available about donors versus the general population. In this study, a description of the donor pool was made in terms of demographic factors and cardiovascular risk factors. The general Dutch population was used as a reference group.

STUDY DESIGN AND METHODS: The Donor InSight study provided information on donors. Extensive information has been gathered by a self-administered questionnaire addressing various topics, like demographics, lifestyle, and health. Aggregated donor responses were compared with general population summary data.

RESULTS: The study population consisted of 15,076 donors. The median age was 46.3 years and 47.3% were men. Donors were more likely to be highly educated (34.6%), married (71.7%), and of Dutch origin (97.4%), when compared to the general population. Donors were less often smokers (donors, 17.1%; general population, 31.8%), more often moderate drinkers (donors, 82.8%; general population, 74.7%), and physically more active (donors, 2.0 hr/week; general population, 1.0 hr/week). Male donors were more often moderately overweight (47.7%) than men from the general population (39.9%). In donors, 0.9% reported to have Type 2 diabetes versus 1.9% in the general population. In donors, 3.4% reported high cholesterol versus 4.6% in the general population.

CONCLUSION: The study provided important knowledge about demographic distributions and cardiovascular risk factors within donors. A proper understanding of demographic characteristics of donors will help us to focus recruitment and retention strategies. The reported beneficial cardiovascular profile suggests a need for further research on the role of blood donation in cardiovascular risk reduction.

The donor population in the Netherlands consists of approximately 400,000 nonremunerated donors. Due to an aging population, the number of potential blood donors is falling and shortages are forecast. Germany, the United Kingdom, and the United States face similar threats due to a gradual and substantial reduction of active donors and related demographic changes of the donor population.[1-3]

To safeguard the future blood supply it is crucial to keep and recruit donors. Knowledge about donor characteristics is required to describe the composition of the donor population. Insight into donor characteristics and opinions about blood donation are essential for targeted donor recruitment and donor retention. Moreover, accurately characterizing donors will be helpful in tailoring services for them, which may contribute to a higher donor satisfaction and donor retention. So far, much blood bank research has focused on blood components and blood products, instead of on donors themselves. Only few studies on donor characteristics have been done, mainly outside Europe.[4,5] Due to differences in blood bank practice and blood donor populations, characteristics from one particular donor population cannot automatically be extrapolated to donor populations in other countries. As a result, characterizations of donors within the Netherlands and other European countries are still lacking.

The donor population can be described in many ways, for instance, by means of demographic profiles.

ABBREVIATIONS: BMI = body mass index; NBS = Nijmegen Biomedical Study.

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Previous research investigated demographic profiles associated with specific donor groups, like multigallon donors versus occasional donors and lapsed donors versus active donors.[6] Earlier research also emphasized the need for proper knowledge about demographic factors in relation to donation behavior, to better understand donors.[7-10] Therefore, an overall demographic description of the donor pool will be very useful in targeting retention and recruitment strategies.

Another way to describe donors is in terms of health and disease. By virtue of passing screening procedures before blood donation, the donor population reflects a relatively healthy subset of individuals.[11] To gain insight into the health status of donors, a description of the donor pool in terms of lifestyle factors and health profiles may bring added value in donor profiling. Cardiovascular disease is an attractive area to examine, because it is one of the most common causes of mortality in the Netherlands.[12] In 2007, approximately one-third of all deaths in men and women could be attributed to cardiovascular disease.[12] Moreover, it has been suggested that donating blood decreases cardiovascular disease risk.[13,14]

This report describes the overall donor population in terms of donor demographics, cardiovascular risk factors, and donation characteristics. To put findings into perspective, demographic and cardiovascular characteristics of donors were compared with those of the general Dutch population.

MATERIALS AND METHODS

Study population

The overall Dutch donor population consists of approximately 400,000 nonremunerating donors. To secure both donor and blood safety, Sanquin Blood Bank has adopted several safety measures and deferral criteria according to European guidelines.[15] Donors must be between 18 and 70 years of age, and before each blood donation donors must fill out an eligibility questionnaire to identify known health conditions and high-risk behavior. Additionally, body weight, pulse rate, blood pressure, and hemoglobin level are measured.

Between April 2007 and April 2009 Sanquin Blood Bank conducted the Donor InSight study, after approval by the Medical Ethical Committee Arnhem-Nijmegen in the Netherlands. The aim of this study was to gain insight into characteristics and motivation of the Dutch donor population. Donors who were not permanently deferred at time of invitation for the Donor InSight study were eligible to take part in the study. Approximately 50,000 randomly selected whole blood and plasma donors were invited to participate. Each month a random sample of active donors was selected from the donor population and invited. Donors received an information brochure and questionnaire by regular mail. Donors who refused to take part were asked to fill in a reply card, to indicate the reason for refusal, and to return the card by mail. Donors who agreed to participate in the Donor InSight study were asked to fill in the questionnaire and return it by mail.

This report is based on data collected from April 1, 2007, until March 31, 2008. During this year, a total of 24,179 donors were invited to participate, of which 15,249 returned the questionnaire and gave informed consent for participation. Of these responding donors, 12,886 were whole blood donors, 2190 were plasma donors, and 173 were newly registered donors. The latter group did not make a donation yet and therefore data, such as donation type and blood group, were not yet available for these donors. For that reason, all newly registered donors were excluded, leaving 15,076 donors for the final analyses.

Donor InSight study

The self-administered questionnaire gathered detailed information on the following topics: demographics, lifestyle, nutrition, physical activity, medical history, reproductive factors, and donor motivation. This report focuses on demography and cardiovascular risk factors. Demographic variables were age, sex, educational level, marital status, and origin of birth. Age was treated as a continuous and as a categorical variable. Level of education was defined as the highest level of education which a person completed, being primary education, prevocational secondary education and lower general secondary education, senior secondary vocational training, senior general secondary education and preuniversity education, or higher professional education and university. Marital status comprised four categories: married, divorced, never married, or widowed. Origin of birth was divided into Dutch and non-Dutch. A donor was classified as being Dutch when both parents were born in the Netherlands.

Classical risk factors for cardiovascular disease included smoking, alcohol use (heavy drinkers and abstainers), overweight, physical inactivity, diabetes, high blood pressure, high cholesterol, and family history of myocardial infarction.[16-20] Smoking was defined as either current smoking or nonsmoking. Alcohol use was classified in three groups: abstention, less than three alcoholic drinks daily (moderate drinkers), and three or more alcoholic drinks daily (heavy drinkers). The body mass index (BMI) is a measure to compare a person's weight and height. The BMI was calculated as weight divided by height squared (kg/m^2). A BMI of less than 18.5 kg/m^2 was considered as underweight, 18.5 to 24.9 kg/m^2 as normal weight, 25.0 to 29.9 kg/m^2 as moderate overweight, and a BMI of 30.0 kg/m^2 or greater as obesity. Physical activity was defined as the number of hours spent on sports weekly, such as running, cycle racing, tennis, and football. Cycling to work and walking were not regarded as sports. Type 2 diabetes, high blood pressure, and high cholesterol,

were defined as present when diagnosed by a physician ever during life and when specific medications were used for these conditions at time of filling out the questionnaire, as reported by the donor. Family history of myocardial infarction was defined as the occurrence of myocardial infarction ever among parents, siblings, and offspring, as reported by the donor.

Questionnaire data were linked with donation data. Variables extracted from the blood bank information system included donation type, lifetime number of donations, and blood group. Donation type refered to the last whole blood donation or last plasma donation. Lifetime number of donations, the total number of donations ever in a donor career, were analyzed as a continuous variable and in three categories; one donation, two to five donations, or more than five donations.[6] Blood group was divided in non-O, O+, and O–. O– donors are universal donors and therefore important to blood establishments. Moreover, group O individuals have been reported to have a decreased cardiovascular disease risk in comparison to individuals having non-O blood type.[21,22]

General Dutch population

Statistics Netherlands collects census data by surveys in random representative samples of the general Dutch population.[23] Prevalence rates of demographic characteristics and cardiovascular risk factors are calculated annually. For this study, the general Dutch population between 18 and 70 years in the year 2007 served as reference population. Demographic and cardiovascular variables in Donor InSight were classified in the same way as variables used from Statistics Netherlands, to make valid comparisons possible between donors and the general population.

Equivalent data on diabetes, high blood pressure, high cholesterol, and family history of myocardial infarction were not available in the files provided by Statistics Netherlands. Therefore, this information was obtained from the Nijmegen Biomedical Study (NBS), a population based cross-sectional study conducted in Nijmegen, the Netherlands, by the Radboud University Nijmegen Medical Center.[24,25] In accordance with age limits of the donor population, 6981 NBS participants between 18 and 70 years of age were included. Similarly to Donor InSight, data were based on self-reports as collected by a questionnaire. NBS variables were classified in the same way as in Donor InSight. Individuals having insulin-dependent diabetes are not allowed to give blood. Therefore, persons on insulin were excluded from the NBS sample, when estimating Type 2 diabetes prevalence.

Statistical analyses

Donors and the general population were compared on categorical and continuous factors. Data from the general Dutch population and the Donor InSight data were presented in an identical manner to make valid comparisons. Results for continuous variables were presented as mean or median values with 5th to 95th percentiles, where median values were used in case of a skewed distribution. Additionally, continuous variables were divided in categories. Results for categorical variables were reported as proportions.

Differences in proportions between donors and the general population were statistically tested by means of a chi-square test. Observed numbers in the donor group were compared with expected numbers in the general population. Expected numbers for the general population were calculated by applying proportions retrieved from Statistics Netherlands and NBS on the donor sample size ($n = 15{,}076$). Due to the large numbers nearly all comparisons were significant ($p < 0.001$), even when differences were very small. We therefore decided not to include p values in the tables, but to focus on proportion differences.

RESULTS

Of 24,179 invited donors, 15,249 returned the questionnaire (63.1%). The response was significantly lower in men (60.1%) than in women (65.9%). Response rates significantly increased from almost 55% in individuals younger than 25 years up to almost 67% in individuals older than 55 years. The response rate among plasma donors was significantly higher (72.3%) compared to whole blood donors (62.4%). The response rate was 50.9% in first-time donors, 59.3% in donors with two to five donations, and 66.7% in donors with more than five donations. Of the 15,249 donors, 173 newly registered donors were eliminated from the analyses, leaving 15,076 donors in the final statistical analysis.

Table 1 presents demographic characteristics of whole blood donors, plasma donors, and the general Dutch population. The mean age of donors was 46.3 years (5th-95th percentile, 23.9-64.9 years) and higher compared to the general population (44.8 years; 5th-95th percentile, 19.8-65.0 years). In the donor population, 47.3% was men and 52.7% women as opposed to a 50-50 distribution in the general Dutch population. Among donors, 34.6% had higher professional education or university compared to 25.1% in the general Dutch population. The percentage of married donors (71.7%) was higher than in the general population (54.7%). In the donor population, 97.4% was of Dutch origin, that is both parents born in the Netherlands, versus 80.2% in the general population.

Whole blood donors and plasma donors differed by age, sex, and marital status. Whole blood donors were 3.6 years younger than plasma donors. Whole blood donors were predominantly female (53.8%), in contrast to plasma donors who were mainly male (53.7%). Furthermore,

TABLE 1. Demographic characteristics in whole blood donors, plasma donors, and the general population

Characteristics	All donors (n = 15,076)	Whole blood donors (n = 12,886)	Plasma donors (n = 2190)	General Dutch population*
Age at entry, years (%)				
18-24	5.1	5.8	1.4	12.2
25-34	14.5	15.4	9.0	18.5
35-44	21.1	21.2	20.2	23.4
45-54	28.1	27.4	31.6	21.3
55-64	24.9	24.1	30.3	18.3
65-69	6.3	6.1	7.5	6.4
Mean (P_5-P_{95})†	46.3 (23.9-64.9)	45.8 (23.4-64.8)	49.4 (29.3-65.4)	44.8 (19.8-65.0)
Sex (%)				
Male	47.3	46.2	53.7	50.3
Female	52.7	53.8	46.3	49.7
Educational level (%)				
Primary education	3.0	2.9	3.1	8.9
Prevocational secondary education and lower general secondary education	27.7	27.5	28.9	24.2
Senior secondary vocational training	23.5	23.5	23.3	31.0
Senior general secondary education and preuniversity education	10.8	11.0	9.7	10.2
Higher professional education and university	34.6	34.6	34.5	25.1
Unspecified	0.4	0.5	0.5	0.6
Marital status (%)‡				
Married	71.7	71.1	75.6	54.7
Divorced	5.3	5.1	6.3	8.3
Never married	21.1	22.1	15.4	34.8
Widowed	1.8	1.7	2.7	2.2
Origin of birth (%)‡				
Dutch	97.4	97.5	97.3	80.2
Non-Dutch	2.6	2.5	2.7	19.8

* Figures for age, sex, marital status, and origin of birth were retrieved from Statistics Netherlands and based on the general Dutch population 18 to 70 years in 2007. Figures of education level in the general Dutch population were retrieved from Statistics Netherlands data obtained from the Dutch population between 15 and 65 years in 2006.
† P_5-P_{95} = 5th-95th percentile.
‡ Proportions based on valid cases, less than 1% missing values.

plasma donors were more often married (75.6%) compared to whole blood donors (71.1%).

Table 2 shows cardiovascular risk factors for whole blood donors, plasma donors, and the general population. There were clear differences between the donor population and the general population. The percentage of smokers was lower in the donor population (men, 17.5%; women, 16.7%) than in the general population (men, 34.7%; women, 28.8%). With respect to alcohol use, donors were in general moderate drinkers (men, 82.0%; women, 83.5%). In the general population these proportions were 74.1% in men and 75.2% in women. Proportions in the group abstainers and heavy drinkers were lower compared to those in the general population. Male donors were less obese (8.8%), more often moderately overweight (47.7%), and less often underweight (0.1%) than men from the general population (9.7, 39.9, and 1.0%, respectively). Donors were physically more active than the general population; female donors spent 1.5 hours (median) on sports weekly, male donors 2.0 hours weekly, and men and women from the general population 1.0 hour weekly. Type 2 diabetes was present in 1.3% of male donors and 0.6% of female donors as opposed to 2.4% of men and 1.5% of women in the general population. High blood pressure was reported by 9.8% of men and 6.9% of women in donors compared to 8.3% of men and 7.5% of women in the general population. High cholesterol was reported less by donors (men, 4.8%; women, 2.1%) than by individuals from the general population (men, 6.3%; women, 3.3%). No material differences in family history of myocardial infarctions existed. No substantial differences were found in cardiovascular risk factors between plasma and whole blood donors.

Table 3 shows donation characteristics across age in male and female donors. Overall, the study population included 83.5% of whole blood donors and 16.5% of plasma donors. In men, the proportion of plasma donors increased from 5.4% (18-24 years) to 19.0% (64-69 years). In women, these percentages increased from 3.4% (18-24 years) to 14.4% (64-69 years). In male donors, the median lifetime number of whole blood donations varied from four (5th-95th percentile, 1-13) in the age group 18 to 24 years to 60 (5th-95th percentile, 15-109) in the age group of 64 to 69 years. In female donors, this number ranged from three (5th-95th percentile, 1-8) in the lowest age group to 33 (5th-95th percentile, 6-67) in the age group 64 to 69 years. Approximately one-third of all donors were O+, approximately 10% O–, and more than 50% non-O. No

TABLE 2. Cardiovascular risk factors in whole blood donors, plasma donors, and the general population

	All donors		Whole blood donors		Plasma donors		General Dutch population*	
Risk factor	Men (n = 7136)	Women (n = 7940)	Men (n = 5959)	Women (n = 6927)	Men (n = 1177)	Women (n = 1013)	Men	Women
Current smoking (%)†								
Yes	17.5	16.7	17.7	17.0	16.4	14.5	34.7	28.8
No	82.5	83.3	82.3	83.0	83.6	85.5	65.3	71.2
Alcohol consumption (%)†								
Abstention	5.0	14.2	5.0	13.9	4.8	15.6	9.6	20.9
Less than three drinks per day	82.0	83.5	81.7	83.6	83.6	82.8	74.1	75.2
Three or more drinks per day	13.0	2.3	13.3	2.4	11.6	1.6	16.3	3.9
BMI, kg/m^2 (%)†								
<18.5	0.1	0.8	0.1	0.8	0.1	0.8	1.0	2.7
18.5-24.9	43.3	59.4	43.6	60.0	41.8	54.3	49.3	60.0
25.0-29.9	47.7	28.9	47.5	28.9	48.7	29.2	39.9	25.6
≥30	8.8	10.8	8.7	10.2	9.4	14.7	9.7	11.6
Physical activity (hr sports/week)								
Median	2.0	1.5	2.0	2.0	2.0	1.5	1.0	1.0
(P_5-P_{95})	(0.0-7.0)	(0.0-5.5)	(0.0-7.0)	(0.0-6.0)	(0.0-8.0)	(0.0-6.0)	(0-6.6)	(0-10)
Type 2 diabetes (%)†								
Yes	1.3	0.6	1.3	0.5	1.4	1.1	2.4	1.5
No	98.7	99.4	98.7	99.5	98.6	98.9	97.6	98.5
High blood pressure (%)†								
Yes	9.8	6.9	9.9	6.6	9.2	9.0	8.3	7.5
No	90.2	93.1	90.1	93.4	90.8	91.0	91.7	92.5
High cholesterol (%)†								
Yes	4.8	2.1	4.9	2.0	4.4	2.5	6.3	3.3
No	95.2	97.9	95.1	98.0	95.6	97.5	93.7	96.7
Family history myocardial infarction (%)†								
Yes	26.7	24.5	26.4	24.1	28.1	27.1	26.7	25.6
No or unknown	73.3	75.5	73.6	75.9	71.9	72.9	73.3	74.4

* Proportions for smoking, alcohol consumption, BMI, and physical activity were retrieved from Statistics Netherlands and based on the general Dutch population aged 18 to 70 years in 2007. Proportions for diabetes, high blood pressure, high cholesterol, and family history myocardial infarction were retrieved from the NBS in subjects aged 18-70 years (n = 6981).

† Proportions based on valid cases, less than 1% missing values.

clear patterns in blood group distributions could be distinguished within sex and age groups.

DISCUSSION

Donor InSight has been designed as a large, cross-sectional study to gain knowledge about donor characteristics and to learn more about donor motivation and reasons to donate. This report focused on demographic and cardiovascular characteristics of Dutch donors. In comparison to the general Dutch population, donors had a higher education and were more often married and of Dutch origin. Overall, donors appeared to have a more favorable cardiovascular profile. Donors were more often nonsmokers and moderate drinkers. They appeared to be less often obese, but slightly more often moderately overweight. Donors were physically more active. Finally, donors had slightly less prevalent diabetes and high cholesterol.

The demographic description of donors in this study showed that certain groups, substantially present within our society, are markedly less present in the donor population. This was mainly the case for unmarried persons, young persons, and minorities. Earlier research from our own group already showed that different demographic profiles could be distinguished for specific groups of donors. More specifically, multigallon donors were older, more often men, had a higher income, and appeared to live in urbanized areas in comparison with occasional donors.[6] In line with our findings, other studies showed that demographic factors like wedded state and Caucasian origin are strongly associated with blood donation.[7,9]

These findings justify the need for targeted recruitment and retention strategies. However, the direction of these strategies is a complex and delicate issue. The focal point could be on those types of donors that are underrepresented or conversely on those types of donors that are overrepresented in the donor pool. When aiming at individuals who are underrepresented in the donor population, compared to the general population, there is much to gain in terms of the number of persons to address. However, the question emerges whether these groups are willing to become and stay a donor. Instead, focusing on those individuals who are most present in the donor population may also be effective, because these persons show a willingness to register and return for donation. A drawback of this approach might be the high representation these groups already have in the donor population,

TABLE 3. Donation characteristics across age in male and female blood donors

Characteristics	All ages	Age (years) 18-24	25-34	35-44	45-54	55-64	65-69
Men (n = 7136)							
Donation type (%)							
Whole blood	83.5	94.6	90.4	86.5	82.2	80.8	81.0
Plasma	16.5	5.4	9.6	13.5	17.8	19.2	19.0
Lifetime number of donations,* median (P_5-P_{95})†							
Whole blood	32 (3-85)	4 (1-13)	9 (1-30)	20 (2-51)	35 (5-77)	47 (7-92)	60 (15-109)
Plasma	70 (15-158)	11 (5-25)	29 (3-64)	43 (13-93)	70 (19-149)	86 (29-176)	94 (30-178)
Classes (%)							
One donation	1.8	16.5	5.9	2.2	1.2	0.5	0
Two to five donations	6.9	45.1	21.3	9.5	3.9	2.9	0.9
More than five donations	91.3	38.4	72.7	88.3	94.9	96.6	99.1
Blood group* (%)							
Non-O	54.0	55.7	51.9	54.8	53.7	54.5	53.2
O+	36.5	36.2	38.4	35.5	36.3	36.5	37.2
O–	9.5	8.1	9.5	9.7	9.9	8.9	9.5
Women (n = 7940)							
Donation type (%)							
Whole blood	87.2	96.6	91.1	85.8	85.2	84.7	85.6
Plasma	12.8	3.4	8.9	14.2	14.8	15.3	14.4
Lifetime number of donations,* median (P_5-P_{95})†							
Whole blood	14 (1-49)	3 (1-8)	6 (1-20)	12 (1-33)	21 (2-48)	26 (3-60)	33 (6-67)
Plasma	39 (7-105)	7 (2-22)	19 (4-48)	32 (7-80)	47 (12-107)	53 (12-130)	58 (17-127)
Classes (%)							
One donation	5.3	23.1	8.4	4.5	2.8	1.8	1.0
Two to five donations	18.0	60.1	32.5	16.1	9.3	7.5	2.9
More than five donations	76.6	16.8	59.1	79.3	87.9	90.7	96.1
Blood group* (%)							
Non-O	54.7	54.5	52.5	56.3	56.7	52.3	54.8
O+	34.5	34.9	34.9	33.1	33.7	35.9	37.9
O–	10.8	10.5	12.5	10.4	9.7	11.8	7.3

* Less than 3% missing values, proportions based on valid cases.
† P_5-P_{95} = 5th-95th percentile.

leaving fewer persons available for recruitment. Furthermore, it should be noted that the absolute number of individuals in specific subgroups from which future donors are recruited is also an important point of consideration. For instance, if the number of particular individuals in the general population is low, not much can be gained in absolute numbers from recruiting these donors, even if the percentage increase in recruitment is high. If, however, the number of particular individuals in the general population is high, only a small percentage increase in participating donors will result in a substantial absolute number of donors. These issues should be taken into account when questioning how to bring recruitment and retention strategies at a higher level, a key topic that needs to be cautiously considered and discussed.

Furthermore, findings clearly pointed to an underrepresentation of minorities in the Dutch donor pool, which is in line with the current distribution of minorities in the US donor pool. Minorities in the US, defined as a race or ethnicity other than non-Hispanic white, apply substantially less for blood donation.[26] These findings have important implications for blood establishments and transfusion practices, since minority groups have special needs in terms of blood transfusion. Most problems have involved finding red blood cells (RBCs) with phenotypes not present in majority populations.[27] This may lead to important divergences in RBC phenotypes between minority groups and the overall donor population.[27] To meet the needs of patients with hemoglobinopathies, such as sickle cell anemia, distributions of different racial groups in the donor pool should mirror the demographic composition of the target population. Because minorities are underrepresented in the Dutch donor pool, recruitment strategies should be aimed at different ethnic groups. However, the ways to do so are not easy to identify. In Europe, only 1 of 10 blood establishments directs special attention toward designing recruitment campaigns targeting ethnic minority blood donors and/or cultural minority blood donors.[28] For example, it is demonstrated that an anthropologic approach and cultural-based marketing campaigns will increase the awareness of the need for blood in minority groups.[27,29]

With respect to cardiovascular characteristics, donors appear to be healthier than individuals from the general population. The application of deferral criteria obviously plays an important role. Eligibility criteria may cause the donor population to be a selective and healthy group of individuals. Furthermore, reported differences might be

explained by a healthier lifestyle of donors. Presented results showed that donors are more likely to be nonsmokers, moderate drinkers, and physically active than members of the general population. Donors are less obese, slightly more often overweight (especially men) and less often underweight, compared to the general population. These findings can at least partially be clarified by the fact that individuals with a body weight below 50 kg are excluded from donation. As a result, BMI distributions may slightly change, leading to relatively less donors in the underweight BMI category and relatively more donors in the overweight category. Another explanation for the high proportion of overweight persons may lie in the fact that low weight is an important risk factor for adverse events during and after donation, especially in first-time donors. It has been reported that the heavier a person is, the lower the risk on adverse reactions.[30,31] Moreover, it is known that the experience of an adverse event negatively influences donor return. Donors are less willing to come back for donation after having had an unpleasant and unsuccessful donation.[32] In general, this means that donors with low body weight will have more adverse reactions and consequently drop out more often. As a result, weight and thus BMI distributions may shift upward in the donor population, which explains the higher proportions of donors in the moderate overweight category, compared to the general population.

Another reason for the reported health difference between donors and the general population is the potential protective health effect of donation in itself. Several studies have been performed on blood donation, iron levels, and risk factors for cardiovascular disease.[33-41] Blood donation may lead to iron depletion, which in turn may favor a more healthy cardiovascular profile. High ferritin levels, a measure of body iron, have been found to be associated with an increased risk of coronary heart disease.[42] Excess body iron is associated with cardiovascular-related disorders like diabetes, insulin resistance, nonalcohol fatty liver disease, and increased levels of cholesterol oxidation products.[33-37] Moreover, there are indications that giving blood might improve insulin sensitivity, a key factor in diabetes.[38-41] The abovementioned studies used cardiovascular risk factors as outcome. Additionally, research has been done on the relation between blood donation and cardiovascular disease as primary end point. However, these studies reported conflicting results, not uniformly supporting the hypothesis of a protective effect of blood donation in cardiovascular disease.[13,43-46] This implies that the effect of blood donation on cardiovascular disease risk has still not been fully elucidated. Due to the descriptive nature of the study, results from this report do not allow us to draw conclusions on causation. However, this study does provide reasons to postulate that donors are in fact healthier in terms of cardiovascular risk. To disentangle the complex relationships between the effects of blood donation and cardiovascular disease, future studies should aim at the occurrence of cardiovascular disease and cardiovascular risk factors within donors.

The strength of this study was the large amount of available data and the comparability with census data from Statistics Netherlands and the NBS. Furthermore, the overall response rate in this study was high (63%). Given the fact that women and elderly were slightly more eager to return the questionnaire than men and young individuals, our sample might not be fully representative to the overall donor population. We compared age and sex distributions in the Donor InSight sample with those in the overall donor population and concluded that groups were fairly similar on both factors. Therefore, reported results are not likely to be influenced by this minor selective response.

A limitation of the study was the absence of blood variables and confirmed cardiovascular end points. All data from donors and the general population presented in this report were based on self-reports being prone to recall errors. However, the same errors, if present, would have been made in both populations. Any recall errors that have occurred are therefore likely to be random, which diminishes the change of bias in the study.

Up till now, only few studies have been performed to gain insight into donor characteristics. In the United States, the Retrovirus Epidemiology Donor Study (REDS) has been conducted to address important blood safety issues involving human retroviruses, to gain insight into demographic factors describing the donor population and to better understand reasons for donating and responses to various incentives.[4,47-49] In New Zealand, the Blood Donor's Health Study was initiated with the primary aim to investigate lifestyle and psychologic determinants of serious injury among blood donors.[5] Due to different blood bank systems and divergent objectives of these studies, results are not easy applicable to other donor populations. Therefore, the Donor InSight study has been initiated in the Netherlands. The overall aim of Donor InSight is to get to know our donor. The study will provide important knowledge on a broad spectrum of topics, such as demographics, donor's lifestyle, donor health and disease, donor motivation, and donor career. The present study provided important information about donor characteristics. A proper understanding of donor demographics will enable us to focus recruitment and retention strategies, carefully considering which specific groups of donors should be the center of attention. This study also demonstrated that donors tend to maintain a better cardiovascular health profile than individuals from the general population. Explanations for this health benefit in donors are not easily formulated. Blood bank deferral criteria and lifestyle factors are likely to play a role, but may not be the only explanation. Donation in itself might play

a role in decreasing cardiovascular risk. In future studies, underlying mechanisms responsible for these presumed health differences should be further investigated with the aim of gaining a comprehensive understanding of the interplay between blood donation and cardiovascular risk reduction.

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CONFLICT OF INTEREST

None.

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