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Specific demographic factors could predict deceased potential cornea donors
A retrospective study from Beijing Tongren Hospital Eye Bank

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Abstract

Compared with evident cornea donors (ECDs), deceased potential cornea donors (DPCDs) have no obvious donor identifications to reference, which causes many eligible cornea tissues to be wasted. The demographic characteristics of DPCDs might be different from those of ECDs owing to the following different features: donation consent provided by relatives and willingness to donate before death. Thus, the aim of this study is to reveal the demographic characteristics of DPCDs by comparing DPCDs and ECDs.

The demographic factors of 138 donors (both DPCDs and ECDs) were collected from the Beijing Tongren Hospital Eye Bank database and analyzed. To differentiate DPCDs from ECDs using the above-mentioned features, we interviewed the relatives of the donors by telephone. The relatives' attitudes toward cornea donation and their suggestions for our donation service were also acquired during the interview. Two logistic regressions were performed to reveal the demographic factors influencing the 2 features and indicate DPCDs.

The donors had certain demographic characteristics (elderly, secondary, or tertiary education level, central district resident), and the most frequent cause of death for the donors was a malignant tumor (n = 56, 43.1%). All the relatives had positive attitudes toward cornea donations, and they hoped to increase publicity efforts to encourage more people to donate and establish more convenient and efficient access for cornea donation. In univariate regressions, age ($P = .004$, >50 years: odds ratio [OR] = 6.89, 95% confidence interval [CI]: 1.82–26.05), marital status ($P = .043$, divorced: OR = 9.00, 95% CI: 1.33–60.80) significantly influenced relative consent, whereas age ($P = .001$, >50 years: OR = 15.00, 95% CI: 3.00–74.98), and family address ($P = .001$, central district: OR = 1) were significant factors influencing the willingness to donate before death. In multivariate regression, age ($P = .021$, >50 years: OR = 8.14, 95% CI: 1.37–48.41) was the only significant factor influencing relative consent. Similarly, age ($P = .02$, >50 years: OR = 7.55, 95% CI: 1.21–47.25) was the only factor influencing willingness to donate before death.

In conclusion, specific demographic factors could indicate DPCDs and might reveal directions and methods for cornea donation coordination in the future.

Abbreviations: DPCD = deceased potential cornea donor, ECD = evident cornea donor.

Keywords: cornea donation, donation decision, eye bank, relative consent, sociodemographic

1. Introduction

Approximately 4,000,000 people with corneal blindness in either one or both eyes live in China,[1] whereas only 5000 corneal transplants are carried out in the country each year.[2] The lack of donated corneas has prevented these people from recovering their eyesight. Although researchers have been exploring alternatives to human corneas,[3] encouraging more people to donate is the only means to solve this dilemma.

Sociopsychological factors, such as conventional or religious restrictions, fear of disfigurement and worries about cornea commerce, could affect people's decision to donate their corneas,[4–7] but it is impossible to eliminate these factors and encourage more people to donate in the short term. In addition, it is impractical to immediately harvest corneas from the general population because most people are healthy and have long life spans. In contrast, requesting corneas from deceased potential cornea donors (DPCDs) is a direct way to get more corneas in a short time frame; however, many eligible corneal tissues have been wasted because coordinators could not identify these DPCDs timely and effectively.[8] Unlike evident cornea donors (ECDs), who explicitly express willingness to donate (e.g., by donor cards or donation consent forms), DPCDs have no donor

identifications. Thus, how to effectively identify DPCDs is a critical and difficult question. Luckily, some studies have indicated that the demographics of ECDs are significantly different from those of individuals unwilling to donate.[9–11] In other words, ECDs are characterized by specific demographic factors (e.g., age, sex, and education level), which indicates that we may identify DPCDs by these specific demographic factors. However, the demographic characteristics of DPCDs might be slightly different from those of ECDs because of the following features that differ between DPCDs and ECDs: consent is provided by relatives rather than by the donors themselves; willingness to donate is stated before death instead of in the past (and the willingness may come from either relatives or the donors themselves). Based on our hypothesis, we compared DPCDs with ECDs to find demographic factors that influence these 2 different features; these factors might predict future DPCDs. Thus, the aim of this study is to reveal the demographic factors that predict DPCDs by investigating donors who have fulfilled their donations at the Beijing Tongren Hospital Eye Bank.

2. Materials and methods

This study was approved by the Academic and Ethics Committee of Beijing Tongren Hospital in accordance with the principles of the Declaration of Helsinki.

Demographic factors for 138 cornea donors (both DPCDs and ECDs) between 2005 and 2016 were collected from the Beijing Tongren Hospital Eye Bank database; these factors included sex, age, family address, educational level, occupation, marital status, and religion. In addition, the cause of death was recorded. To differentiate DPCDs from ECDs among these donors, a telephone interview of each donor's relative was conducted after acquiring oral informed consent. Information regarding the 2 different features between DPCDs and ECDs were obtained using the following questions: "who gave consent to donate, the relatives or the donor him/herself?" (Question 1) and "when was the permission to donate granted, before death or in the past?" (Question 2). To understand the relatives' attitudes toward cornea donation and improve our donation service, the following questions were asked: "Why did the donor or relatives want to donate?" (Question 3), "What is your attitude toward the donation?" (Question 4), and "Are there any suggestions for our donation service?" (Question 5). Responses from the relatives were recorded and summarized as concise items. To increase the response rate, phone calls were mainly made between 7:00 and 8:00 PM. Except for disconnected and wrong numbers, numbers without a response were redialed up to 3 times on different days before being regarding as "non-contacted."

Demographic factors of the donors were described statistically. The age of the donors was divided into 5 stratifications (<18, 18–35, 35–50, 50–65, >65 years) and expressed as the mean ± standard deviation (SD). Independent Student t test was used to compare the mean age between females and males. Based on the educational system and social division of labor in China, education levels and occupations were classified into 8 different ranks and 11 common categories, respectively. Categorical variables were described as proportions. To reveal demographic factors that influence the consent provided by relatives (one feature of DPCDs), we performed logistic regression. Based on the information obtained from Question 1, consent provided by the relatives (DPCDs) was set as "1 (reference)", whereas consent provided by donors themselves (ECDs, i.e., not by relatives) was set as "0." To reveal the demographic factors that influence

willingness to donate before death (the other feature of DPCDs), we performed a second logistic regression. According to the information obtained by Question 2, we set the willingness to donate before death (DPCDs) as "1 (reference)" and set willingness generated in the past (ECDs, i.e., not before dying) as "0." Before conducting regression analysis, some variables (e.g., education level, occupation, family address, and cause of death) were simplified or combined appropriately to easily calculate and interpret the results. Univariate logistic regressions were completed first to select related factors, and these factors were pooled into multivariate regressions to further determine significant factors using a backwards elimination process. Statistical analyses were conducted using IBM Statistical Package for the Social Sciences (SPSS, version 21.0; SPSS Inc, Chicago, IL), and $P < .05$ was the significance threshold.

3. Results

3.1. Response rate

In total, 83 (60.1%) relatives responded to our questions. Incomplete interviews were because of the following: non-contact (n=27, 19.6%), unable to connect (n=15, 10.9%), refusal to complete the interview (n=12, 8.7%), and missing phone number (n=1, 0.7%).

3.2. Demographic characteristics of the donors

Table 1 shows the demographic characteristics of the donors. The overall mean age of the donors was 65.8 years (SD=17.4). There was no significant difference (P=.52) in the mean age between females (64.8 years, SD=18.5) and males (66.7 years, SD=16.5). Elderly donors (>50 years) were the predominant proportion of the sample (n=117, 85.0%); donors with a tertiary education level (n=44, 41.5%) were less likely than donors with secondary or primary education levels (n=61, 57.5%). Regarding family address, most of the donors (n=122, 89.7%) were distributed across the 13 administrative districts of Beijing, whereas the remaining donors (n=14, 10.3%) came from other places. The donors who had lived in Beijing were mainly distributed in 6 central administrative districts (n=101, 73.2%; Xi Cheng, Dong Cheng, Chao Yang, Feng Tai, Hai dian, and Shi Jingshan).

3.3. Cause of death

Except for 8 donors without an explicit cause of death, the cause of death for the other donors was categorized into the following classifications: malignant tumor (n=56, 43.1%), organ failure (n=31, 23.8%), cardiovascular disease (n=24, 18.5%), cerebrovascular disease (n=16, 12.3%), and accidental death (n=3, 2.3%).

3.4. Responses from the relatives

Table 2 shows the responses from relatives regarding the 5 questions. Willingness to donate granted a long time ago was a significantly higher than willingness granted before death (P=.002), and consent provided by the donors themselves was significantly higher than consent provided by relatives (P <.0001). The main reasons to donate were summarized as "to help others," "give back to society," and "nostalgia for the world." All interviewees had a positive attitude (very supportive, supportive, and acceptable) toward the donations. Although nearly half of the interviewees had no suggestions for our donation service, the other half hoped to increase publicity efforts

Table 1

Demographic characteristics of the donors.

Demographic	n (%)
Sex	
Female	63 (45.7%)
Male	75 (54.3%)
Age stratification, y	
<18	3 (2.3%)
18–35	5 (3.8%)
35–50	12 (8.9%)
50–65	46 (33.4%)
>65	71 (51.6%)
Marital status	
Married	69 (83.1%)
Divorced	6 (7.2%)
Widowed	3 (3.6%)
Single	5 (6.1%)
Religion	
None	81 (97.6%)
Christianity	2 (2.4%)
Education level	
Illiteracy	1 (0.9%)
Primary school	9 (8.5%)
Junior high	24 (22.6%)
Senior high	20 (18.9%)
Second specialized school	8 (7.5%)
Junior college	7 (6.6%)
College	35 (33.0%)
Postgraduate	2 (1.9%)
Occupation	
White collar	7 (5.5%)
Civil servant	41 (32.3%)
Engineer	13 (10.2%)
Doctor	5 (3.9%)
Teacher	7 (5.5%)
Self-employed	4 (3.1%)
Unemployed	5 (3.9%)
Student	4 (3.1%)
Worker	34 (26.8%)
Farmer	2 (1.6%)
Army man	5 (3.9%)
Family address	
Beijing	
Xi cheng	25 (18.4%)
Hai dian	22 (16.2%)
Chao yang	21 (15.4%)
Feng tai	17 (12.5%)
Dong cheng	13 (9.6%)
Tong zhou	7 (5.2%)
Da xing	7 (5.2%)
Shi jingshan	3 (2.2%)
Fang shan	3 (2.2%)
Men tougou	1 (0.7%)
Huai rou	1 (0.7%)
Chang ping	1 (0.7%)
Shun yi	1 (0.7%)
non-Beijing	14 (10.3%)

Table 2

Responses from the relatives regarding the 5 questions.

Question and response	n (%)	P^*
Q1. "Who gave consent to donate, the relatives or the donor him/herself?"		
Donor-self	68 (81.9%)	<.0001
Relative	15 (18.1%)	
Q2. "When was the permission to donate granted, before death or in the past?"		
Long time ago	55 (66.3%)	.002
Before dying	28 (33.7%)	
Q3. "Why did the donor or relatives want to donate?"		
To help others	48 (57.8%)	<.0001
Give back to society	25 (30.1%)	
Nostalgia for the world	8 (9.6%)	
Others	2 (2.5%)	
Q4. "What is your attitude toward the donation?		
Very supportive	44 (53.1%)	<.0001
Supportive	30 (36.1%)	
Acceptable	9 (10.8%)	
Unacceptable	0 (0%)	
Opposed strongly	0 (0%)	
Q5. "Are there any suggestions for our donation service?"		
No suggestion or advice	38 (45.8%)	<.0001
To promote more people donating their corneas	15 (18.1%)	
Hope to know the situation of cornea usage and cornea recipient information	12 (14.5%)	
To establish more convenient and efficient access for donation	8 (9.6%)	
Donated cornea should use for poor people without any charge	3 (3.6%)	
Hope to show more humanistic care during the process of donation	3 (3.6%)	
Hope to only cornea excision rather than enucleation	2 (2.4%)	
To cancel funeral grant for reflecting pure voluntariness	2 (2.4%)	

* P value compared by χ^2 test shows distribution imbalance among different items in each question.

consent. In univariate logistic regression, age ($P=.004$) and marital status ($P=.043$) were significant factors. However, when multivariate logistic regression was performed, elder age (>50 years) was the only significant factor that influenced consent provided by the relatives (odds ratio [OR]=8.14; 95% confidence interval [CI]: 1.37–48.41).

3.6. Demographic factors influencing the willingness to donate before death

Table 4 shows the logistic regression of the demographic factors that influenced willingness to donate before death. The following factors were significant via univariate logistic regression: age ($P=.001$) and family address ($P=.001$); however, family address was no longer a significant factor when multivariate logistic regression was performed. According to the adjusted odds ratios, donors older than 50 years (OR=9.60; 95% CI: 1.71–53.86) was the only significant demographic factor influencing willingness to donate before death.

4. Discussion

To the best of our knowledge, this study is the first to show that donor demographic factors, including age, family address, and marital status, could predict 2 significant features of DPCDs compared with ECDs. These findings might help coordinators

to encourage more people to donate and establish more convenient and efficient access for cornea donation.

3.5. Demographic factors that influence consent provided by relatives

Table 3 shows the logistic regression predicting demographic factors of the donors that influenced the relatives to provide

Table 3

Logistic regression for filtrating the demographic factors influencing the relatives to provide consent.

Variable	Univariate logistic regression		Multivariate logistic regression	
	Odds ratio (95% CI)	P*	Adjusted odds ratio (95% CI)	P**
Sex		.855		
Female	Ref (1)			
Male	0.90 (0.24–2.76)			
Age, y		.004		.021
<50	Ref (1)		Ref (1)	
>50	6.89 (1.82–26.05)		8.14 (1.37–48.41)	
Educational level		.822		
Primary	Ref (1)			
Secondary	1.46 (0.25–8.61)			
Tertiary	1.80 (0.28–11.60)			
Occupation		.547		
Brain worker	Ref (1)			
Manu worker	1.44 (0.44–4.66)			
Family address		.119		
Central district	Ref (1)			
Peripheral district	0.39 (0.12–1.28)			
Marital status		.043		.187
married	Ref (1)		Ref (1)	
divorced	9.00 (1.33–60.80)		6.53 (2.48–53.97)	
single	0.11 (0.02–0.75)		0.67 (0.06–7.35)	
Widowed	0.08 (0.007–1.00)		0.06 (0.005–0.77)	

Consent provided by the relatives (DPCDs) was set as "1 (reference)," whereas consent provided by donors themselves (ECDs, i.e., not by relatives) was set as "0." CI = confidence interval.
* P values calculated by univariate logistic regression.
** P values calculated by multivariate logistic regression. Only significant variables were taken into multivariate logistic regression and shown in the table.

identify DPCDs in hospitals in a timely and effective manner. Additionally, we explored the attitudes and suggestions from relatives regarding cornea donation; this information may help us improve donation services in the future.

Specific demographic factors could identify ECDs, which has been suggested in several studies. Chen et al[10] found that older

age (>65 years), secondary educational level (9–11 years), and urban residence were significant factors influencing successful cornea donation when compared with those with unfulfilled registers in their eye bank in Nanjing, China. Another survey conducted in Nanjing by Chu et al[11] showed that older age (>58 years), male sex, white-collar occupation, higher educational

Table 4

Logistic regression for filtrating the demographic factors influencing willingness to donate before death.

Variable	Univariate logistic regression		Multivariate logistic regression	
	Odds ratio (95% CI)	P*	Adjusted odds ratio (95% CI)	P**
Sex		.093		
Female	Ref (1)			
Male	0.45 (0.18–1.14)			
Age, y		.001		.020
<50	Ref (1)		Ref (1)	
>50	15.00 (3.00–74.98)		7.55 (1.21–47.25)	
Educational level		.825		
Primary	Ref (1)			
Secondary	1.39 (0.29–6.67)			
Tertiary	1.10 (0.21–5.19)			
Occupation		.681		
Brain worker	Ref (1)			
Manual worker	0.824 (0.33–2.10)			
Family address		.001		.076
Central district	Ref (1)		Ref (1)	
Peripheral district	0.165 (0.06–0.49)		0.29 (0.08–1.12)	
Marital status		.366		
Married	Ref (1)			
Divorced	0.64 (0.10–4.13)			
Single	0.29 (0.04–1.84)			
Widowed	0.21 (0.02–2.50)			

Willingness to donate before death (DPCDs) was set as "1 (reference)," whereas willingness generated in the past (ECDs, i.e., not before dying) was set as "0." CI = confidence interval.
* P values calculated by univariate logistic regression.
** P values calculated by multivariate logistic regression. Only significant variables were taken into multivariate logistic regression and shown in the table.

level, and being a party member were factors related to becoming a cornea donor ($P < .05$). Additionally, Krieglstein et al[12] found that cornea donation refusals were significantly lower in urban residents than in rural residents, which indicated that the family address of donors was an important factor influencing willingness to donate. In this study, in addition to age and family address, we found that marital status was a significant factor predicting DPCDs, which is consistent with our hypothesis that the demographic characteristics of DPCDs might be slightly different from those of ECDs.

In addition to demographic factors, the cause of death may be another important factor influencing cornea donation. Chen et al[10] found that donors who died of natural causes showed more willingness to donate (OR = 1, set as reference) than did donors who died of cardio/cerebrovascular diseases or tumors (OR = 0.44) and accident injuries (OR = 0.29). Krieglstein et al[12] indicated that donors who died of natural causes or suicide accounted for a larger proportion of their donors. In contrast to these studies, the donors who died of malignant tumors (n = 56, 43.1%) were the largest proportion in this study. Unlike people who die of cardio/cerebrovascular diseases, donors who die of malignant tumors suffer more pain for a relatively longer time, so their willingness to help others or nostalgia for the world might be greater. Hence, we assume this reason is why more donors who died of malignant tumors in our study donated their corneas.

To be honest, Chinese people are more reluctant to donate their corneas than other ethnicities. In China, Confucianism, Buddhism, and Daoism play pivotal roles in the willingness to donate corneas. Confucianism is the most important reason Chinese refuse donations; filial piety, the belief that the body comes from parents, is advocated by Confucianism and has influenced Chinese people deeply over thousands of years.[13] Alternatively, cornea donation is an altruistic behavior that is respected as a virtue based on the traditional culture of China. In this study, altruism was reflected by "to help others" and "give back to society"; these were the main reasons to donate and paralleled some questionnaire-based studies investigating motivations for cornea donation.[5,14,15] Thus, similar to the suggestions from our interviewees, more marketing regarding cornea donation should be advocated in mass media and newly emerging social platforms; more promotion campaigns should be arranged to improve the public perception and the awareness regarding cornea donation.

As one of the largest eye banks in China, Beijing Tongren Hospital Eye Bank provides approximately 1000 corneas every year, but most of them are imported or obtained from other Organ Procurement Organizations, whereas corneas recovered ourselves are very scarce. To recover more corneas, it is essential to harvest more corneas from DPCDs. In most cases, requesting corneas is a passive process in China. Donors or their relatives usually initiate contact with the eye bank to donate rather than coordinators actively communicating with potential donors or their families. This passive process results in low procurement rates because many DPCDs cannot be identified in a timely manner, even though they or their families have a strong desire to donate. For those ECDs whose willingness to donate was granted a long time ago, there is enough time to donate, whereas for DPCDs, there is no more time, so it is important for coordinators to identify them and communicate with their relatives actively. This passive pattern could explain why most donors in our eye bank were ECDs instead of DPCDs. One feature of DPCDs is that donation consent is generally made by their relatives, but communication with them on the issue is very hard when they are in mourning,[16] which suggests that communication skills are critical for a successful donation. This importance of communication was shown by Hermann et al,[8] who found that approximately 90% of unfulfilled cornea donations were related to inadequate communication with the relatives. Although it could cause excessive sadness to relatives to talk about this issue during a painful time, some studies have demonstrated that well-trained coordinators and skillful communicative strategies could increase the success rate to a large extent.[16,17]

Although there is no legislation on organ and tissue donation in China, "opt in" and "de facto veto" are the most important principles that all Chinese eye banks comply with based on the following issued regulations: *Regulation on human organ transplantation* and *Regulation on procurement and distribution of human organ*.[18] Therefore, the relatives of donors determine the final decision to donate, even if the donor has expressed explicit willingness to donate before death. This fact could explain why all the interviewees in our study exhibited positive attitudes toward cornea donation.

This study has some unavoidable limitations. This study failed to collect the demographic factors of the relatives, which may also influence donations by DPCDs. Furthermore, the small sample size and imbalanced binary distributions for the dependent variables of the 2 regression models (consent provided by relatives or by donors themselves, and willingness to donate granted before death or in the past) could cause certain bias and reduce the validity in predicting DPCDs. To confirm our conclusions, large comparative studies should be conducted in the future. In addition, demographic factors of relatives and other influential factors for DPCDs should be investigated.

In conclusion, specific demographic factors could indicate DPCDs and might reveal directions and methods for cornea donation coordination in the future.

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