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Rates of eye donation amongst multi-organ donors over a decade (2013–2022) in new Zealand/Aotearoa

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To ascertain rates of eye donation amongst multi-organ donors and to evaluate the potential factors that make eye donation more likely. Data were collected from all multi-organ donors facilitated by Organ Donation New Zealand (ODNZ) from January 2013 to December 2022. Gender, age, ethnicity and cause of death were collected. This was cross-referenced with all eye donors accepted by the New Zealand National Eye Bank (NZNEB) over the same period. Predictors of positive eye donation were examined with a multivariate logistic regression model. There were 638 multi-organ donors of which 54.9% were male and 77.3% were New Zealand European. Amongst these 40.4% ($n=258$) were also eye donors. Amongst the eye donors, 149 were male (57.8%), 210 NZ European (81.4%), 22 Māori (8.5%), 12 Asian (4.7%), 9 Middle Eastern, Latin American, African (3.5%), 4 Pasifika (1.6%) and 1 unknown (0.4%). On logistic regression, older age was found to be associated with an increased likelihood of eye donation (OR 1.021 $p < 0.001$). Asian ethnicity (OR 0.483, $p = 0.048$) was associated with a reduced likelihood of eye donation compared to NZ Europeans. There was no statistically significant increased likelihood of eye donation by gender. This is the first study in New Zealand / Aotearoa to quantify the relationship between eye donors and multi-organ donors. 59.6% of multi-organ donors do not donate their eyes. Addressing the underlying reasons for this could help eliminate New Zealand's reliance on imported ocular tissue.

Corneal transplantation is one of the most common types of tissue transplant, second only to skin¹. As the cornea is immune privileged, corneal transplants have relatively low allograft rejection rates and no blood or antibody matching is typically required^{2,3}. Corneal transplants can transform the vision of individuals who suffer from blinding corneal pathology but require the generous donation of eyes after death. Unfortunately, there is a global shortage of organ donors and eye donors are no exception^{4–7}. Globally, there is approximately only one donated cornea available for every 70 patients requiring a corneal transplant⁸.

New Zealand/Aotearoa performs an average of 350 corneal transplants per year, a number which has been steadily increasing over the past two decades^{9,10}. Of all eye donations, 81.4% are coordinated by Organ Donation New Zealand (ODNZ), the co-ordinators of multi-organ donors¹¹. Multi-organ donors include donation of organs including the heart, lung, pancreas, liver, and kidneys, and/or tissue including eyes, heart valves, and skin. The remaining eye donors are direct referrals from rest homes, hospices, or other community centres. In New Zealand, the decision to donate organs and tissues is made by the immediate family of a deceased individual. Following brain death or before circulatory death in an intensive care unit, a health professional will discuss donation with the individual's family, and obtain written informed consent if the family agrees to donation. The family also decides which organ(s) and/or tissue(s) to donate. Individuals can indicate their wish to be donors on their personal national driver's licence, but this is not an official organ donation registry; therefore individuals must discuss their donor wishes with their families. There is no official donor register in New Zealand and the primary referral pathway for eye donation is via the multi-organ donor process. ODNZ is funded by the NZ Government, whereas, the New Zealand National Eye Bank (NZNEB) is largely a self-funded charity.

This study aims to examine the rate of eye donation amongst those who consented to multi-organ donation in New Zealand, and whether there are effects by gender, ethnicity, year, age and cause of death.

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Methods

Ethics approval for this study was granted by the New Zealand Health and Disability Ethics Committee on 26/02/2024. Study number 19,611. All methods were performed in accordance with both the relevant guidelines and the Declaration of Helsinki.

Data were collected from all multi-organ donations facilitated by Organ Donation New Zealand (ODNZ) for the 10 years from January 2013 to December 2022. Gender, ethnicity and cause of death were collected. This was cross-referenced with eye donation data from the New Zealand National Eye Bank (NZNEB) over the same period to determine which multi-organ donors were also eye donors. Gender and ethnicity were self-identified. Ethnicity was grouped as per the New Zealand Census classifications into “New Zealand European” (NZ European), “Māori” (the Indigenous people of NZ), “Pasifika” (people from the Pacific Islands who are residing in NZ), “Asian”, “MELAA” (Middle Eastern, Latin American, and African), “Other” or “Not otherwise included”. Age was analysed as a continuous variable in years.

Data were entered into an Excel (Microsoft etc.) spreadsheet and analysed in STATA version 15 (StataCorp 2017, College Hill, TX). Categorical variables were reported as n (%). Proportions of eye donation were calculated for gender, cause of death and ethnicity, and expressed as percentages of each population. Chi-square test for trend was used to evaluate eye donation over time. Logistic regression was used to calculate the univariate and multivariate relationship between gender, ethnicity, cause of death and likelihood of becoming an eye donor. On univariate and multivariate analysis, ethnicity was compared to “NZ European”. All tests were two-tailed and a p-value of < 0.05 was considered statistically significant.

Results

There were 638 multi-organ donors processed by ODNZ from January 2013 until December 2022. The median age was 50 years [IQR 31–59] and 54.9% were male. NZ European donors made up 77.3% ($n=493$). Of these multi-organ donors, 40.4% ($n=258$) were also eye donors. The median age of those who were eye donors was 52.5 compared with 44.0 for the non-eye donors. Of those who were multi-organ and eye donors, 81.4% ($n=210$) were NZ European, 8.5% ($n=22$) were Māori, 4.7% ($n=12$) were Asian, 3.5% ($n=9$) were MELAA, 1.6% ($n=4$) were Pacific Peoples, and 1 donor was an unknown ethnicity. The ratio of those who donated both their eyes and other organs by ethnicity is shown in Fig. 1. The most common cause of death in multi-organ donors was intracranial haemorrhage ($n=282$) as demonstrated in Table 1.

The univariate and multivariate analysis of predictors of eye donation amongst multi-organ donors is presented in Table 2. On univariate analysis, older age (OR 1.024, $p<0.001$), cerebral hypoxia (OR 0.511, $p=0.002$), and traumatic brain injury (OR 0.623, $p=0.029$) were associated with increased likelihood of eye donation. Pacific ethnicity (OR 0.299, $p=0.031$) had a reduced likelihood of eye donation. However, on multivariate analysis, older age (OR 1.021, $p<0.001$) and other neurological causes of death (OR 3.026, $p=0.041$) were the only predictors of increased likelihood of eye donation and Asian ethnicity (OR 0.483, $p=0.048$) was

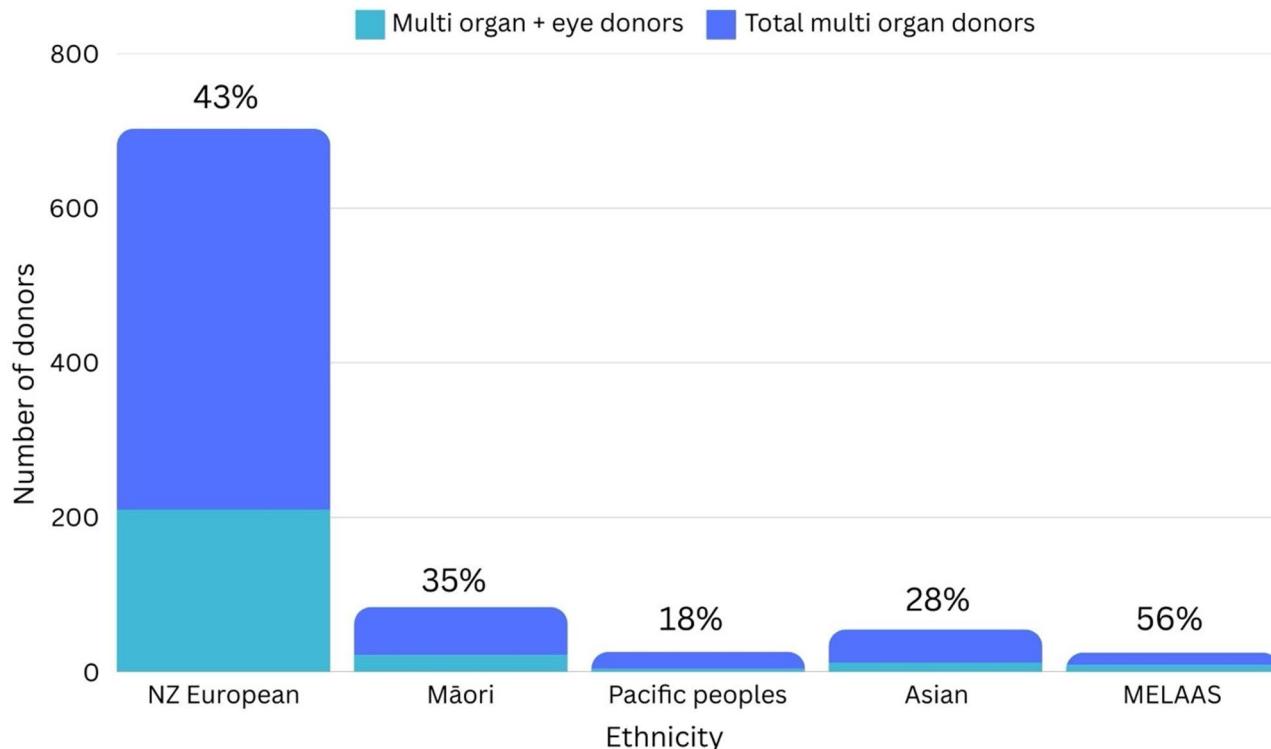


Fig. 1. Percentage of eye donors among multi-organ donors by ethnicity.

	Total (n = 638)	Eye donor (n = 258)	Non-eye donor
			(n = 380)
Age	Median 50 (IQR 31–60)	Median 52.5 (IQR 41–62)	Median 44 (IQR 26.5–59)
	Female	288 (45.1%)	109 (42.2%)
Male	350 (54.9%)	149 (57.8%)	201 (52.9%)
Ethnicity total population			
NZ European	68%	493 (77.3%)	210 (81.4%)
Māori	18%	62 (9.7%)	22 (8.5%)
Asian	17%	43 (6.7%)	12 (4.7%)
Pacific peoples	9%	16 (2.5%)	4 (1.6%)
MELAAs	2%	16 (2.5%)	9 (3.5%)
Unknown	2 (0.3%)	1 (0.4%)	1 (0.3%)
Cause of death			
Intracranial haemorrhage	282 (44.2%)	131 (50.8%)	151 (39.7%)
Cerebral hypoxia	153 (24.0%)	47 (18.2%)	106 (27.9%)
Traumatic brain injury	134 (21.0%)	47 (18.2%)	87 (22.9%)
Cerebral infarct	42 (6.6%)	22 (8.5%)	20 (5.3%)
Other neurological cause	17 (2.7%)	10 (3.9%)	7 (1.8%)
Non-neurological cause	8 (1.3%)	1 (0.4%)	7 (1.8%)

Table 1. Subject demographics for all donors, eye donors and non-eye donors. *MELAA Middle Eastern, Latin American and African.

	Univariate	Multivariate	OR	P value
	OR			
Age	1.024	<0.001	1.021	<0.001
Female	0.821	0.227	0.764	0.124
Ethnicity				
Māori	0.741	0.286	0.896	0.708
Pacific peoples	0.299	0.031	0.378	0.089
Asian	0.522	0.064	0.483	0.048
Other	1.732	0.283	1.956	0.2
Unknown	1.348	0.833	0.893	0.937
Cause of death				
Cerebral infarct	1.268	0.474	1.244	0.529
Cerebral hypoxia	0.511	0.002	0.676	0.096
Non neurological cause	0.165	0.094	0.178	0.112
Other neurological cause	1.647	0.325	3.026	0.041
Traumatic brain injury	0.623	0.029	0.797	0.351

Table 2. Predictors of eye donation amongst multi-organ donors.

associated with reduced likelihood of eye donation compared to NZ Europeans. A likelihood ratio test indicated a significant overall effect on cause of death on likelihood of eye donation ($\chi^2(df) = 13.28 p = 0.021$), suggesting that cause of death contributes meaningfully to variation in donation likelihood. Pairwise comparisons were conducted to identify which causes of death differed significantly from others, with intracranial haemorrhage used as the reference category.

The relationship between the total number of multi-organ donors and those who also donated their eyes over time is demonstrated in Fig. 2. The interaction between year and multi-organ donors was significant ($p = 0.003$), but the interaction between year and eye donors was not significant ($p = 0.77$). There appears to be an increasing gap between total multi-organ donors and those who also donate their eyes, with a 57.9% difference in 2013 increasing to a 65.3% difference in 2022, however, this did not reach statistical significance ($p = 0.14$).

Discussion

Eye donation is essential in restoring vision for those with debilitating corneal blindness. Unfortunately, a lack of corneal tissue results in substantial waiting lists and delayed treatment. This study highlights a marked gap between organ donation and ocular donation, with 59.6% of multi-organ donors in New Zealand in the

Eye donors amongst multi-organ donors over time

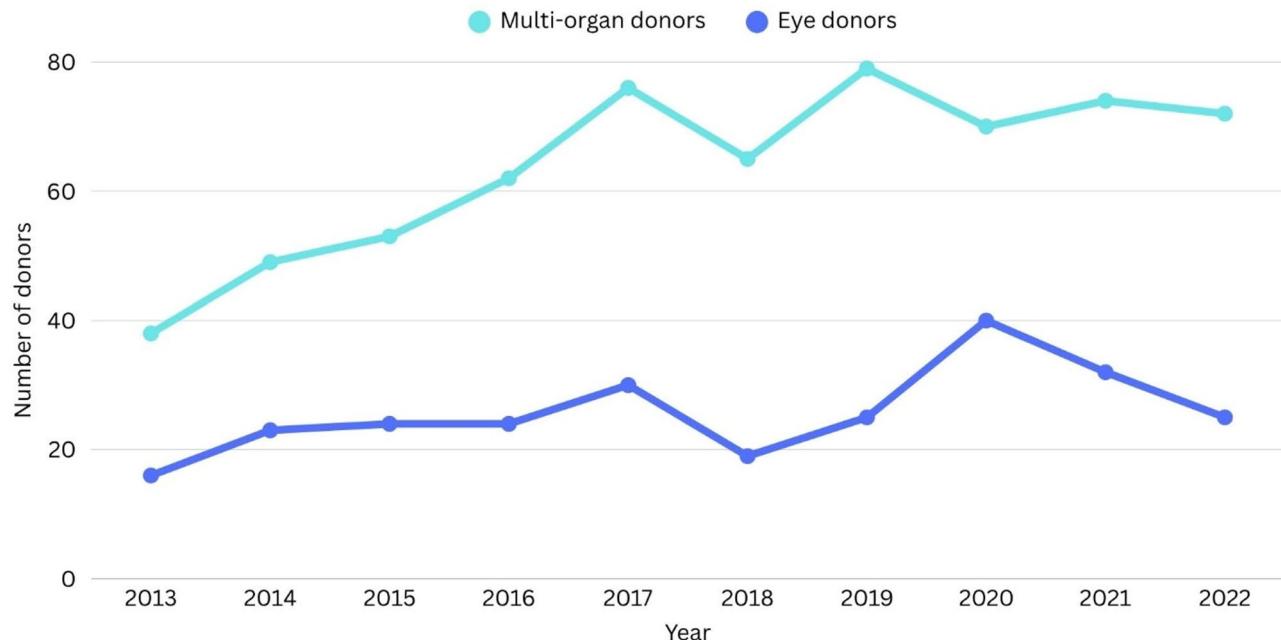


Fig. 2. Number of eye donors ($n=258$) among multi-organ donors ($n=638$) over time.

last 10 years not donating their eyes. This is the first study, to the authors' knowledge, to actively quantify this discrepancy in Oceania. Amongst those willing to donate their organs, increased age was associated with positive eye donation. Other neurological causes of death were also found to be a positive predictor. Asian organ donors were less likely to donate their eyes compared to Europeans. No differences were observed between genders.

The decision to donate organs/tissue is complex and multifactorial. Systemic, cultural, religious and circumstantial factors likely contribute to the hesitancy of an individual or their family to donate^{5,12,13}. Both donation after brain death and donation after circulatory death require specific circumstances, such as sudden, traumatic neurological death, always in intensive care settings¹⁴. Therefore, the psychology of hesitancy in organ/tissue donation is a difficult topic to investigate as the majority of deaths do not meet the criteria for multi-organ donation. However, a recent paper from Mexico demonstrated that despite these restrictions, 38.0% of all organs procured from an ICU were corneas, second only to kidneys at 40.1%¹⁵. This suggests high rates of eye donation among organ donors is possible. In New Zealand, the expected number of potential eye donors vastly outweighs the number of other potential multi-organ donors, but the number of corneal donors remains relatively low^{11,16,17}.

The COVID-19 pandemic had a significant but complex impact on organ donation in New Zealand, and particularly on eye donation. During the initial 2020 lockdowns, elective surgeries, including many corneal transplants were paused, and eye tissue procurement was temporarily halted, causing immediate drops in donations. Despite low COVID-19 case numbers, strict infection control protocols were implemented by the NZNEB in line with global recommendations¹⁸. However, once lockdown eased, the NZNEB resumed activity, leading to a compensatory "catchup" phase in corneal procurement, with eye donation peaking in 2020. This may be because staff previously allocated to elective care became available for retrieval operations, or that a decrease in ICU patients¹⁹ enabled staff to have longer discussions with families around donation^{20,21}. Additionally, increased family member availability during lock-downs may have facilitated increased eye donation, as younger individuals are more likely to consent to eye donation on behalf of family members¹¹.

Studies suggest there is a greater aversion to ocular donation compared to other organs^{22,23}. Compared to other organs, the primary reason for public disinclination or a psychological aversion to eye donation appears to be concerns about the disfigurement of the deceased. A qualitative study from the UK suggested the predominant reason for family refusal of eye donation to be the physical appearance of their family member and eyes being "the window to the soul"²⁴. An Australian survey found most respondents "didn't like the idea of someone cutting into their eyes" or could not give a specific reason for their reluctance²³. This may explain the difference in eye donation by cause of death, as families may perceive this differently depending on whether the individual had other overt signs of physical trauma. However, notably some multi-organ donors are not suitable for eye donation, such as those who have had recent tattoos or those who are Hepatitis B positive. Although this study demonstrates only 40.4% of multi-organ donors also donated their eyes, this is still substantially more than the 0.01% rate of eye donation in the general population¹¹. This study therefore corroborates the understanding that well-organised donor pathways have a greater impact on donor volume than psychological factors^{11,13,16,25}.

The literature around age and organ/tissue donations suggests that younger individuals tend to be more interested in organ donation with regards to consenting to organ donation on their driver's licence and joining organ donation registries^{12,26}. Increasing age may be associated with lower rates of tissue/organ donation^{8,11,27}. However, this study demonstrated that eye donation correlated with increasing age. This may have been due to the process of consenting by the family. For younger donors, the close family might include older members who may be less inclined to donate their loved one's eyes. For older donors, close family members may be younger and more open to the idea of eye donations¹³.

The relationship between organ donation and gender is complex. There were no differences in eye donation noted between genders in our study, but there are established trends in the literature. Women are more likely to volunteer to join organ donation registries than men²⁸. However, in multi-organ donations, there tend to be more male donors than females. This may be due to those who qualify for multi-organ donation being more likely to be men. Also, the decision around organ donation is often made by a spouse. If a wife pre-deceases, her husband is less likely to donate her organs, particularly her eyes, however, if the husband pre-deceases, the wife is far more likely to agree to organ donation^{7,29}.

In keeping with reported ethnic disparities in both tissue and multi-organ donation rates^{11,30} our results demonstrate that amongst multi-organ donors, there is some ethnic variation in eye donation. There have been several changes in the ethnic distribution of the New Zealand population over this time period. Between 2013 and 2022 these ratios have changed from 74 to 68% NZ European, 15% to 18% Māori, 12–17% Asian, 7–9% Pacific peoples, and 1–2% MELAA respectively³¹. Asian organ donors were less likely to donate their eyes on multivariate analysis (OR 0.483 $p=0.048$)²⁸. It has been recognised that Asian donors particularly from China, have a decreased trust in eye donation due to potential "misuse"⁷. However, it was previously reported that Māori and Pasifika were less likely to donate their eyes than NZ Europeans. This was attributed to systemic healthcare inequities and bias¹¹. The lack of significant association in this analysis suggests that the Indigenous cultural inequities in organ/tissue donation rates appear to diminish under the correct circumstances with sufficient systemic infrastructure. This has profound implications for the development and targets of organ/tissue donation campaigns.

This study highlights the requirement for improved donation pathways for eye donation within New Zealand. There are currently no formal guidelines on how to discuss eye donation specifically with families. Donor link nurses are also only in ICU settings. There are minimal clear pathways for ocular donation in the community associated with very poor public awareness.

The findings of our study must be appreciated in conjunction with its limitations. Only a small proportion of individuals are potential multi-organ donors at the time of death and as mentioned, these are more likely younger, male individuals. This makes our age and gender data more challenging to interpret as it was skewed. The "other neurological cause" of death being linked with an increased likelihood of eye donation is difficult to quantify as with deidentified data the exact causes of death for these individuals are unknown. There is also no data on individuals who were approached for organ/tissue donation and declined, nor do we have exact data on the demographics of intensive care units within New Zealand. The organ/tissue donation consent process is not uniform across centres; therefore, it is unclear if all potential organ donors are asked about eye donation specifically.

Conclusion

This study highlights a potential specific aversion to eye donation which has been alluded to in qualitative surveys internationally but never formally quantified. Among multi-organ donors, increased age and "other neurological cause" of death were predictors for eye donation. Asian ethnicity was associated with decreased likelihood of eye donation. There is significant potential to improve eye donation rates and reduce New Zealand's reliance on overseas ocular tissue with public education and infrastructure. Further qualitative evaluation of the reasons for the specific aversion towards eye donation may ameliorate this gap in eye donation among multi-organ donors.

Data availability

The datasets generated and/or analysed during the current study are not publicly available due to ethics and confidentiality guidelines held by the University of Auckland but are available from the corresponding author upon reasonable request.

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Author contributions

NEA prepared and submitted ethical approval, drafted primary manuscript. RN performed statistical analysis and prepared all figures and tables, amended and reviewed manuscript. AG amended and reviewed manuscript. JZ amended and reviewed manuscript. NB amended and reviewed manuscript. JR provided ODNZ database and amended and reviewed manuscript. CNJM supervised project and idea conception, amended and reviewed manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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