

Cornea Donation in Denmark

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ABSTRACT

Purpose: Shortage of donor corneal tissue exists in Denmark. The Danish Donor Register founded in 1990, contains individuals' consents to donation of a variety of tissues and organs including the cornea. This study describes the registered donors.

Methods: Data from the Donor Register was analyzed.

Results: Since the beginning of the register, the number of registered citizens has increased and now represents 18% of the total adult population. In addition, the diversity of consents has also evolved. Citizens in the larger cities consent more often than citizens living outside the cities. Females consent more often than men. Of those consenting to donation in the Donor Register, almost 85% of them have agreed to cornea donation. The Danish Cornea Bank however only record less than half of the expected donors among the deceased in hospitals due to the discrepancy in the age among the registered and the age at death.

Conclusion: The number of corneas donated and procured is increasing. Corneal transplantation is the most common tissue/organ transplant procedure in Denmark.

KEYWORDS

Corneal transplantation. Donor register. Eye bank. Keratoplasty. Tissue donation.

INTRODUCTION

Organ donation is life-saving whereas tissue donation can improve the quality of life. Visual impairment and blindness are strong predictors for reduced quality of life due to difficulties in e.g. reading, car driving, and computer use as well as in connection with participating in social and cultural activities. A corneal transplantation may change this.

Tissue and organ donation are administered individually in Denmark. Historically, tissue establishments have been managed locally e.g. cornea banks by their own ophthalmological department. Tissue can be stored awaiting its recipient in contrast to organs that require transplantation soon after recovery. The tissue law¹ from 2006 that set standards for tissue establishments, based on the European tissue directives from 2004 and 2006,²⁻⁴ was implemented years before the organ law⁵ was passed in 2012. The Danish Center for Organ Donation was established in 2007 with the purpose of coordinating organ donation and was governmentally financed with 1 million Euros in 2012.⁶ Tissue banks in contrast are self-financed and receive no public funding for public relation. Considerable variation thus exists between the work with tissues and organs.

In Denmark, approximately 600 donor corneas are needed annually for cornea transplantation in patients with corneal disease but only half of these corneas are recovered. This study will describe the cornea donation procedures in Denmark. As the donation system varies greatly between countries, the history of the Danish Donor Register is briefly reviewed including the development in diversity of consents.

The Donor Register

Organ donation in Denmark was facilitated by the law on brain death criterion in 1990.⁷ The law highlighted the need for a public registry where citizens in a simple and a non- bureaucratic way could express their personal stand on donation. This resulted in the formation of the Donor Register in 1990 by the Danish Health and Medicines Authority.

With the law defining brain death,⁷ consent prior to removal of tissue for other patient treatment was also introduced. Prior to this such consent was not needed. Three ways to consent to being a donor became available: *i*) registering directly with the Donor Register, *ii*) filling in a donor card, and *iii*) informing ones next of kin; this can be done orally or in writing.⁸ A donor card is sent by mail on request. When it is filled out it can either be returned to the Donor Register or carried by the person at all times. In 2005, it became possible to register online using a personal digital signature.⁹ In 2008/2009, in an attempt to increase donation, municipalities began to send out donor cards together with the Social Security Card.¹⁰

The guideline describe three levels of consent to donation: *i*) "Full consent" (cornea, heart, kidney, liver, lung and pancreas), *ii*) "Partial consent" to the aforementioned six organs/tissue, and *iii*) "Prohibition" to donation.⁸ Skin and small intestine were later added to the donation list in 1995. The consent was originally a decision to be taken by the individual donor but in 2005 the level of consent was extended with the choice of "Consent that requires the acceptance of my next of kin". Previously, the family could not legally object to donation. In 2008/2009, the consent was further extended with the statement "Do not know".¹⁰ Even though donors can change or withdraw the consent at any time, it is usually a life-long

decision as it does not automatically require renewal or expiration after a predefined time frame, as known in other countries e.g. the United States and Canada.

An opting-out system (automatic presumed consent) for donation used in Austria,¹¹ Belgium¹² and Spain¹³ and recently passed in Wales has been discussed for several years in Denmark. At present the opting-in system is maintained where citizens actively have to take and register their decision in the Donor Register. These data are explored in the present study with special focus on cornea donation.

MATERIALS & METHODS

Danish citizens are at birth given a unique identification number (CPR number) which is used to store information about age, sex, location etc. in the Civil Registration System. Donors in the Donor Register and in the Danish Cornea Bank are registered with their CPR number, thus making it possible to extract detailed information for the study.

Data (type of consent, age, sex, postal code) were extracted from the Donor Register (Danish Health and Medicines Authority) and the Danish Cornea Bank (Aarhus University Hospital).

RESULTS

FIGURE 1

A total of 791,242 citizens have registered as donors in the Donor Register since its establishment in 1990; excluding those registered that are now deceased (Fig. 1). This corresponds to 13.9% of the total population and 17.9% of the adult population (18 years of

age and older). Since 2008, there has been an annual increase in the number of those newly registered.

FIGURE 2 & 3

The annual number of new registrations in the Donor Register is shown in Figures 2 and 3. Most registrations consent to full donation (81%) while the categories partial consent (13%), prohibition (6.0%) and "Do not know" (0.43%) comprise the remaining part (Figure 2). The relative distribution of new registrations between the categories has been almost constant over time.

Registrations that include or exclude cornea in their consent are shown in Figure 3. The proportion that consent to cornea donation is much higher than those who do not. The positive consent rate varies between 78% and 90% each year (average of 84.6%). With 791,242 registrations in the Donor Register and an adult population of 4,412,327 (age 18 or more), this corresponds to 15.2% of the adult Danish population having agreed to cornea donation.

FIGURE 4

Figure 4 examines the group of "Partial consents" from Figure 2. It shows what organs/tissues that are specifically selected. In a decreasing order: kidney, liver, lung, pancreas, small intestine, heart, cornea and skin are donated. The tissues that are most often not selected for donation are thus corneas (66.7%) and skin (74.2%).

FIGURE 5

The consent status of all deceased patients (3,124 deaths) reported to the Danish Cornea Bank has been examined over a two-year period.¹⁴ Only 5.67% of these potential donors were registered with a positive consent in the Donor Register for cornea donation, compared to the calculated ratio of 15.2%. Figure 5 shows the age of those registered in the Donor Register and the age of death in Denmark.¹⁵ The majority in the first group are 20-69 years old of which the age span 30-49 years accounts for 47% and the majority in the second group are 70 years or older. Only a minor fraction of the citizens above 79.9 years are registered in the Donor Register (4.5%). This difference may explain why fewer cornea donors are observed than expected; the average age of cornea donors in the cornea bank is 69.9 years.

When comparing the gender distribution of registered citizens in the Donor Register it shows that more females than males are registered for all the age groups; 57% and 43%, respectively.

TABLE 1

Denmark consists of five regions. Thirty-four per cent of those in the Donor Register live in the Capital Region, 14% in the Zealand Region, 23% in the Central Denmark Region, 19% in the Region of Southern Denmark and 9% in the North Denmark Region. When adjusting for population size in each region, the percentage is 15%, 13%, 14%, 12% and 12%, respectively, showing an equal interest to register across the entire country. Although Copenhagen, the capital, has the highest number of registered citizens in the Donor Register in absolute

numbers, it has the lowest proportion of registered citizens (16.0%) when compared with the ten largest cities in Denmark (Table 1). The highest number (27.2%) is found in Aalborg, the fourth largest city in Denmark, and the smaller cities Vejle and Roskilde with only fifty thousand citizens. No correlation is observed between these city sizes and the ratio of registered citizens. Only 11.7% of those citizens living outside the ten largest cities are registered in the Donor Register.

TABLE 2

The number of organ and tissue transplantations is shown in Table 2. A total of 202 cornea donors were received (corresponding to 404 corneas) while 356 donor corneas were distributed from the Danish Cornea Bank in 2012, the only cornea bank in Denmark.¹⁶ Additionally 12 corneas were imported from Europe and 72 from the United States in an attempt to meet the national demand. Cornea transplantation is thus the most frequently performed transplantation with twice as many procedures as the second highest; kidney transplantation.

DISCUSSION

There is a general shortage of donor corneas for transplantation in Europe, including Denmark. Approximately 600 donor corneas are needed annually for cornea transplantation but only half of these are recovered. This study describes the donor system.

The number of registered citizens in the Donor Register has increased to 17.9% of the adult population since the register was established in 1990. The peaks in 2002 and 2008 coincide with two public campaigns to encourage registration as a donor. Similar campaigns have been successful in Sweden.¹⁷ In the last five years, an increasing number of citizens has been

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registered, possibly because of the easy access for registration on the internet and the automatic distribution of donor cards with the social security card.⁹⁻¹⁰

The proportion of those registered in the Donor Register that consents to cornea donation is 84.6%. It corresponds to 15.2% of the adult population have actively expressed a wish to donate, indicating a rather positive attitude towards cornea donation. Reasons to omit cornea donation are e.g. sparse knowledge of corneal donation or awareness of one's own corneal disease (or laser treatment).¹⁸⁻¹⁹

Corneal tissue can be removed either by excision of the corneoscleral button or by enucleation (removal of the entire bulbus). Eleven of the cornea banks in the European Eye Bank Association use excision, 31 banks use enucleation and an additional 20 use both techniques.²⁰ In Denmark, enucleation is the preferred method as it has the lowest contamination rate with microorganisms²¹ and a steep learning curve. After surgery, the orbit is reconstructed and the eye lids are closed, leaving the physical appearance of the donor unchanged so that viewing of the deceased can take place by the next of kin even after the procedure.

The Danish Cornea Bank has investigated the donor status among deceased hospitalized patients. Of more than three thousand registered deaths, only 5.67% were registered as corneal donors in the Donor Register in contrast to the expected percentage of 15.2%. While the average life expectancy of Danes is 79.9 years, the average age of those registered in the Donor Register is much younger. Hence most registered donors have not reached the relevant age for potential donation.

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The gender and regional distribution of donors was also examined. More women than men are registered in the Donor Register. The proportion of registered in the larger cities is much higher (16 to 27.2%) than outside these cities (11.7%).

In accordance with the health law,²² it is possible to recover tissue during autopsy to use for patient treatment if there is consent from the deceased or if a next of kin gives consent. Presumed consent is used for autopsy in circumstances where the next of kin has been offered the possibility but does not respond within six hours. In case of donation explicit consent is required. If there is no next of kin, tissue cannot be donated.²³ Traditionally, donor corneas for the Danish Cornea Bank have been recovered from autopsies but today only 8.4% of the recovered cornea donors had given consent via autopsy in 2012.¹⁶

Body donation of the entire corpse for medical science has been expanded at the Institute of Biomedicine, Aarhus University to include consent to donate corneas for treatment of eye patients. It is however, a major challenge in these cases to draw blood for testing for transmissible diseases within the defined time frames when donors have died in their private or nursing homes and subsequently being transported to the institute.

The Danish Cornea Bank is the only tissue establishment in Denmark recovering, storing and distributing human donor corneas. In contrast to organ donation, recovering of donor corneas takes place from non-heart-beating donors. The Danish Cornea Bank collaborates with 12 pathological departments and morgues all over Denmark. With 356 donor corneas distributed from the Danish Cornea Bank and 84 other corneas being imported,¹⁶ cornea transplantation is the most frequently performed type of transplantation of tissues/organs from the Donor

Register list.

According to corneal surgeons, the national need for cornea transplantations is estimated to be 600 per year, corresponding to approximately 350 cornea donors. This is a modest number compared to the high numbers filed in the Donor Register. The major obstacles for recovering an adequate number of corneas are of a practical nature within the hospitals: performing inquest soon after death, transport of the deceased from the wards/departments to the morgue within defined time limits, and for doctors to discuss donation with the next of kin; this is known to increase the donation rate.²⁴ A legal obligation for hospitals to facilitate donation, e.g. known from the United States²⁵ may improve donor recovery numbers. As a comparison, more than 59,000 cornea donations were recovered in the US in 2012 that theoretically would equal 1,000-1,100 cornea donations in Denmark, which would more than satisfy the national demand.²⁶

The EU tissue directive³ set a requirement that blood samples testing for transmissible diseases from deceased donors be drawn within 24 hours of death, satisfying the test kit instructions for serology testing. In Denmark, however, an additional requirement of NAT (nucleic acid amplification test) exists. In order to comply with these test kit instructions, the donors need to arrive in the morgue within 12 hours of the time of death. As stated above, this is a practical challenge for cornea donation.

This study has described the principles of cornea donation in Denmark. Despite a general shortage of organs and tissues, including corneas, the numbers of cornea donations are increasing.

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REFERENCES

1. The tissue law (Vævsloven). Law 273 of the 1st April 2006.
2. EU directive 2004/23/EC of the 31st March 2004.
3. EU directive 2006/17/EC of the 8th February 2006.
4. EU directive 2006/86/EC of the 24th October 2006.
5. Law for quality and safety in the handling of human organs for transplantation (Lov om kvalitets- og sikkerhedskrav ved håndtering af menneskelige organer til transplantation). Law 151 of the 28th February 2012.
6. State budget 2012. Paragraph 16.51.52.
7. Law for death certification, autopsy and transplantation (Lov om ligsyn, obduktion og transplantation m.v.). Law 402 of the 13th June 1990.
8. Guidelines for consent for transplantation from deceased persons (Vejledning om samtykke til transplantation fra afdøde personer). Guidance 101 of the 8th December 2006.
9. Notification of amendment for signing up to the Donor Register (Orientering om ændring af tilmelding til Donorregistret på www.sundhed.dk). Ministry of Health 2012 Marts 6.
<http://www.ft.dk/samling/20111/almDEL/suu/bilag/235/1089259/index.htm>. Accessed August 10, 2014.

10. Proposal for the parliament resolution on registration of 18-year old stand to donation of their own organs (Forslag til folketingsbeslutning om registrering af 18-åriges standpunkt til donation af egne organer). Proposal 2007/2BSF100 of the 8th April 2008.
11. Gnant MFX, Wamser P, Goetzinger P, et al. The impact of the presumed consent law and a decentralized organ procurement system on organ donation: quadruplication in the number of organ donors. *Transplant Proc* 1991;23(5):2685-6. PMID: 1926537.
12. Roels L, Vanrenterghem Y, Waer M, et al. Three years of experience with a 'presumed consent' legislation in Belgium: its impact on multi-organ donation in comparison with other European countries. *Transplant Proc* 1991;23(1):903-4. PMID: 1989341.
13. Matesanz R, Domínguez-Gil B, Coll E, et al. Spanish experience as a leading country: what kind of measures were taken? *Transplant International* 2011;24(4):333-43. PMID: 21210863.
14. Annual Report 2011. Danish Cornea Bank. Aarhus, Denmark. June 2012.
15. Statistics Denmark. <http://www.dst.dk>. Accessed August 10, 2014.
16. Annual Report 2012. Danish Cornea Bank. Aarhus, Denmark. September 2013.
17. Krekula LG, Malenicke S, Linder M, et al. From words to action – influence of two organ donation campaigns on knowledge and formal decision making. *Clin Transplant* 2009;23(3):343-50. PMID: 19191814.
18. Krieglstein TR, Welge-Lüssen UC, Priglinger S, et al. Consenting to cornea donation: influencing factors. *Graefe's Arch Clin Exp Ophthalmol* 2002;240(10):816-21. PMID: 12397429.

19. Lawlor M, Kerridge I, Ankeny R, et al. Specific unwillingness to donate eye: The impact of disfigurement, knowledge and procurement on corneal donation. *Am J Transplant* 2010;10(3):657-63. PMID: 20121739.
20. Directory 2013. European Eye Bank Association. 21st edition. January 2013.
21. Linke SJ, Eddy MT, Bednarz J, et al. Thirty years of cornea cultivation: long-term experience in a single eye bank. *Acta Ophthalmol* 2013;91(6):571-8. PMID: 22863151.
22. The health law (Sundhedsloven). Paragraph 53 in law 913 of the 13th July 2010.
23. Guidelines for consent to medical autopsies (Vejledning om samtykke til lægevidenskabelige obduktioner m.m.)". Guidance 100 of the 7th December 2006.
24. Muraine M, Menguy E, Martin J, et al. The interview with the donor's family before postmortem cornea procurement. *Cornea* 2000;19(1):12-6. PMID: 10632001.
25. Uniform anatomical gift act. Revised code of Washington. Chapter 68.64.
26. Restoring sight worldwide. 2013 EBAA year in review. Eye Bank Association of America. http://issuu.com/moiremarketing/docs/ebaa_2013_year_in_review. Accessed August 10, 2014.

FIGURE LEGENDS

Figure 1. Cumulative number of citizens registered in the Donor Register since 1990.

Figure 2. Annual number of new registrations in the Donor Register divided into "Full consent" (dark grey), "Partial consent" (light grey) and jointly "Prohibition" and "Do not know" (black).

Figure 3. Annual number of new registrations in the Donor Register divided into consents that include cornea donation (dark grey) and exclude cornea donation (light grey).

Figure 4. "Partial consents" in the Donor Register divided into eight categories of tissues/organs. For comparison the total number is adjusted to hundred percent.

Figure 5. Age distribution in the Donor Register (light grey) and age of death among the general population in 2012 (dark grey).

Figure 1

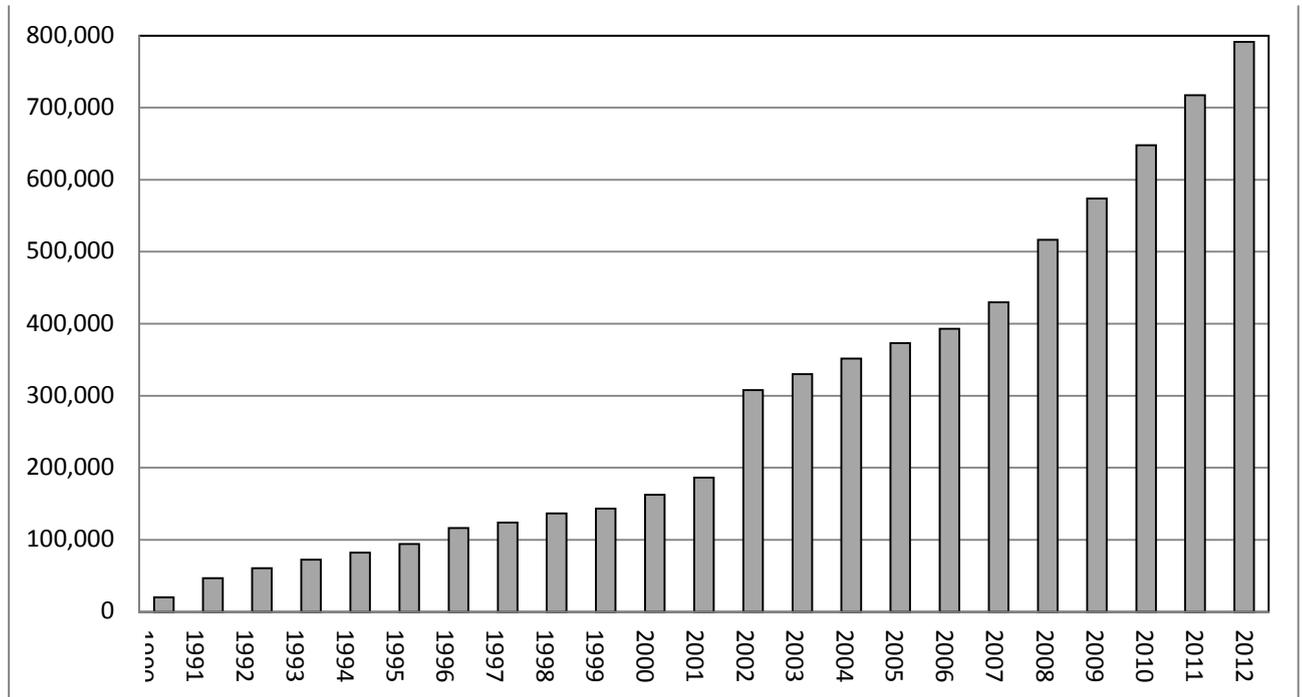


Figure 2

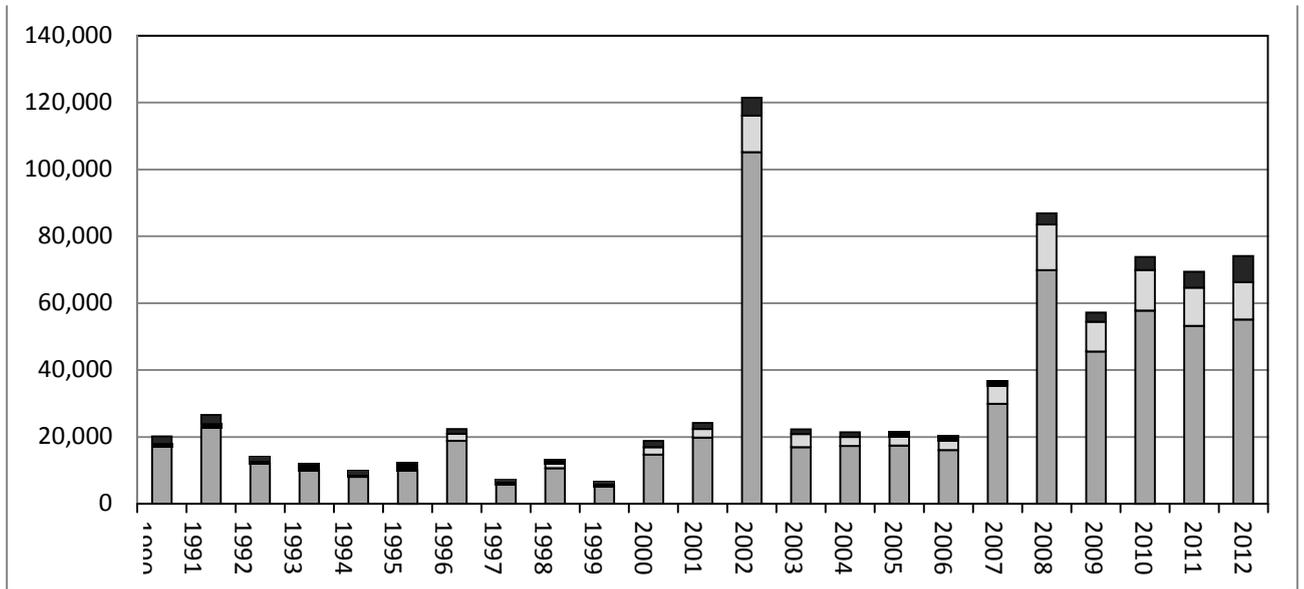


Figure 3

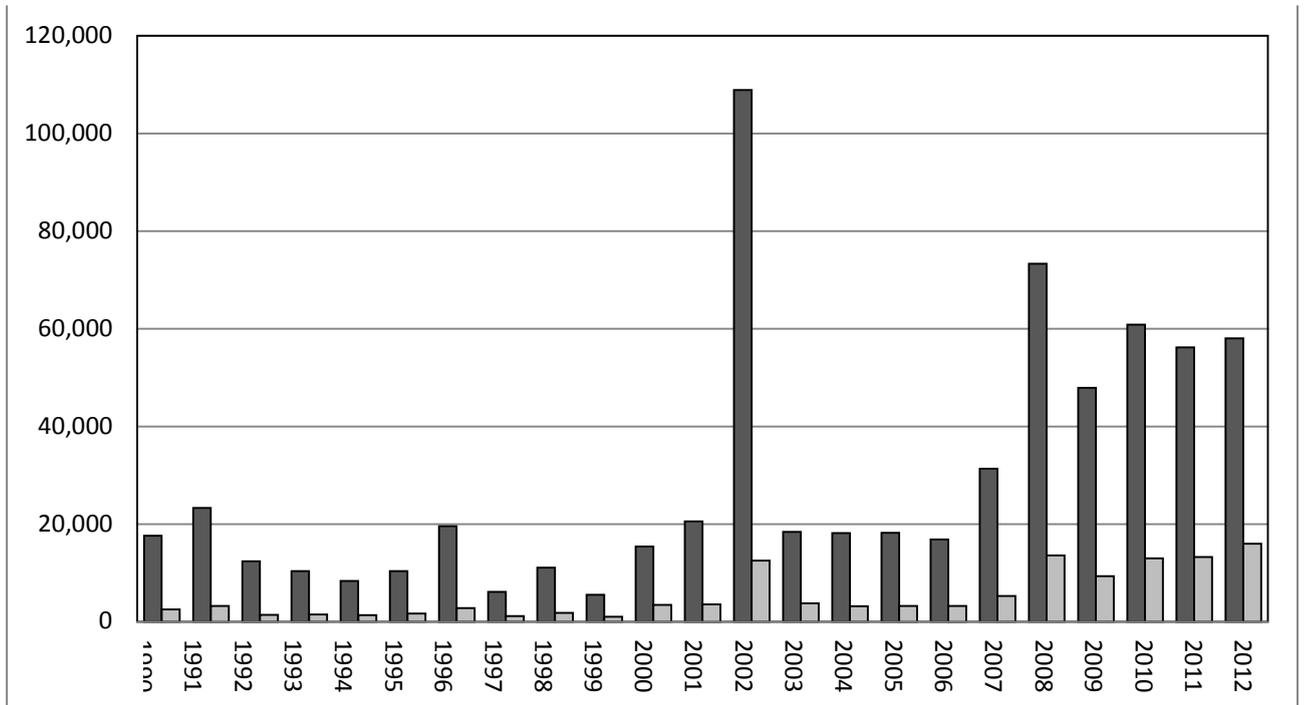


Figure 4

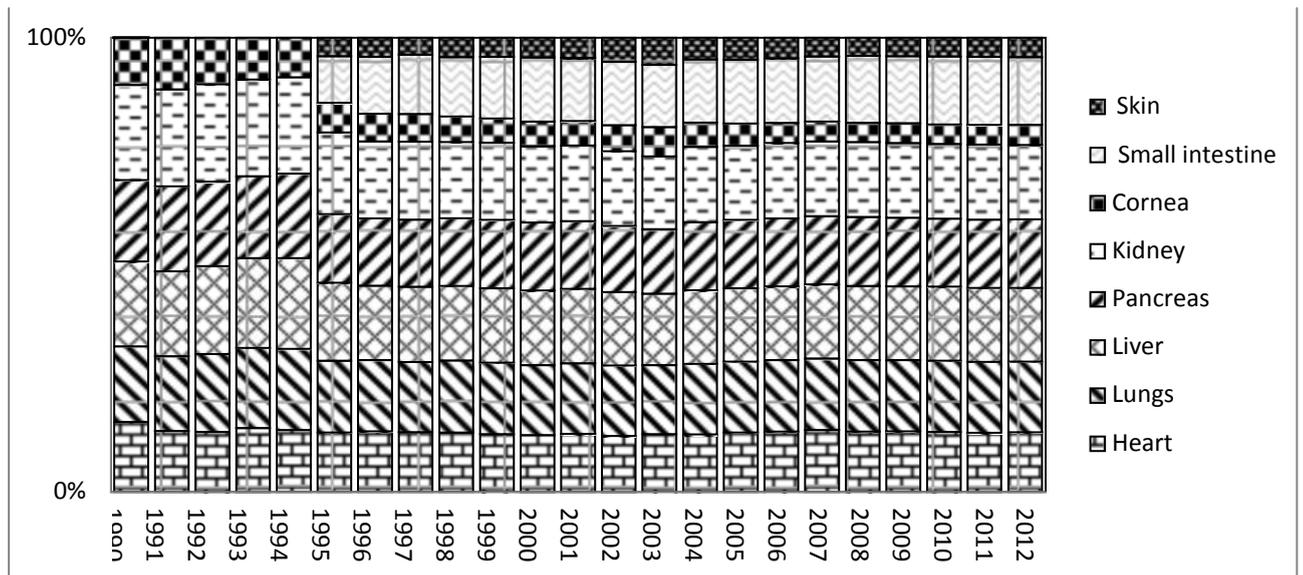
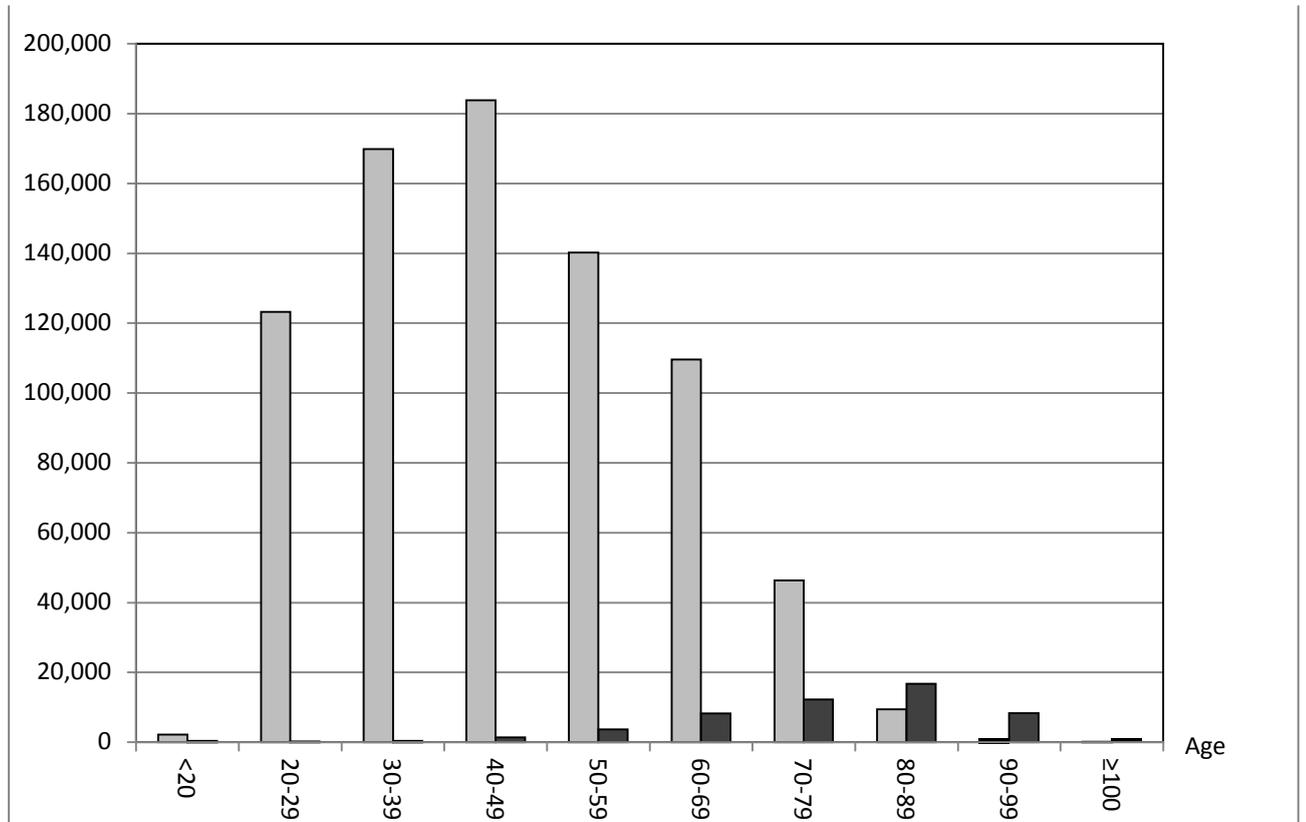


Figure 5



	Number of citizens	Percent of registered citizens
Copenhagen	1,230,728	16.0
Aarhus	256,018	21.3
Odense	170,327	16.3
Aalborg	106,916	27.2
Esbjerg	71,491	19.2
Randers	60,895	21.2
Kolding	57,583	20.5
Horsens	55,253	20.3
Vejle	52,449	26.5
Roskilde	48,186	25.9

Table 1. Registered citizens in the Donor Register in the ten largest cities in Denmark in 2012.

Transplantations

Cornea	440 ^a
Kidney	214 ^b
Liver	48
Lung	30
Heart	26
Skin	ND
Pancreas	0
Small intestine	0

Table 2. Number of transplanted patients in 2012 with organs/tissues from the Donor Register list. ^{a)} 356 donor corneas were recovered in Denmark and 84 were imported. ^{b)} Kidneys were recovered from 137 brain-death donors and 77 from living donors. ND; not determined.