

# The Nordic Liver Transplant Registry (NLTR)

## Annual report 2023

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## **1. Source of data**

The numbers and graphs included in the present report are based on data extracted from the Nordic Liver Transplant Registry (NLTR) in March 2024. Prior to the export, data were subjected to extensive integrity and quality control. Entry of missing data and correction of all identified errors were performed at all centers prior to the final data extraction.

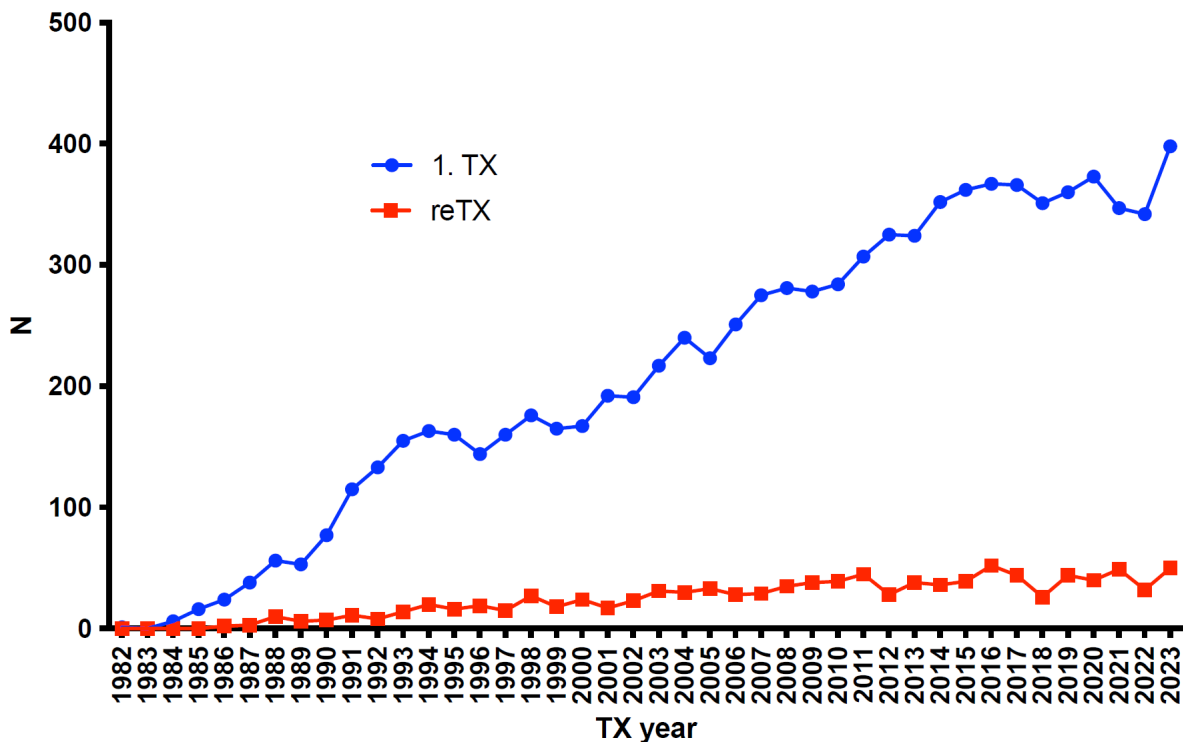
## **2. Data content NLTR 2023**

The registry comprises complete data from the liver transplantation activity at all transplantation centers in Denmark, Sweden, Norway and Finland since 1982. Before 1990, only patients that were transplanted were registered. After 1990, the registry covers all patients entered to the liver transplantation waiting list, regardless of transplantation status. From September 1994, complete waiting list data are available from all patients in addition to the transplantation details. From October 1<sup>st</sup> 2017 data on patients transplanted in Estonia are prospectively included, patients transplanted in Estonia prior to this date have been retrospectively included. All data are stored securely at Scandiatransplant in Århus ([www.scandiatransplant.org](http://www.scandiatransplant.org)).

Up to December 31<sup>st</sup> 2023, data from a total of 10115 patients had been entered into NLTR. Of these, 8884 patients had received a first liver graft, 905 (10.2%) had been transplanted more than once, and 132 (1.5%) had been transplanted more than twice. Of the 905 patients receiving a second liver graft, 8 had received their first graft outside of the Scandiatransplant area. A total of 215 living donor transplantations had been performed. Children below 18 years constituted 933 (10.5%) of the transplanted patients in the registry.

### 3. Transplantation activity 2023

The total number of patients who received a first liver graft in 2023 was 398 (Figure 1). Of these, 17 were combined liver-kidney transplantations and one was a heart-liver transplant performed in Gothenburg. Two were multivisceral and these transplantations were both performed in Gothenburg. Of the first liver transplantations performed in 2023 one was a living donor transplantation and none was a domino transplantation. The living donor transplantation was performed in Oslo. Fourteen patients received a DCD graft. In addition, 50 re-transplantations were performed (Table 2). The total number of liver transplantations was 448, which is a marked increase from the 374 transplants performed in 2022. This represents a new record high for the Nordic program.



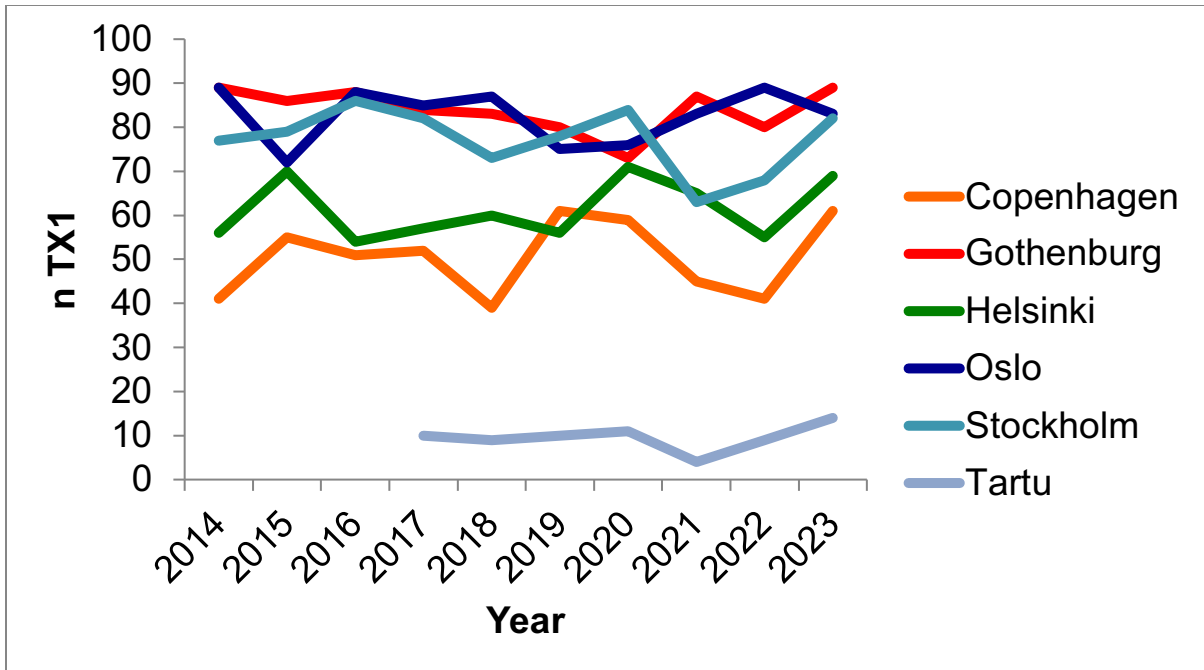
**Figure 1.** Number of patients receiving a liver allograft 1982-2023. The blue line represents the number of patients receiving a first liver graft while the red line represents the total number of re-transplantations.

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
<b>Copenhagen</b>	41	55	51	52	39	61	59	45	41	61
<b>Gothenburg</b>	89	86	88	84	83	80	73	87	80	89
<b>Helsinki</b>	56	70	54	57	60	56	71	65	55	69
<b>Oslo</b>	89	72	88	85	87	75	76	83	89	83
<b>Stockholm</b>	77	79	86	82	73	78	84	63	68	82
<b>Tartu</b>				10	9	10	11	4	9	14

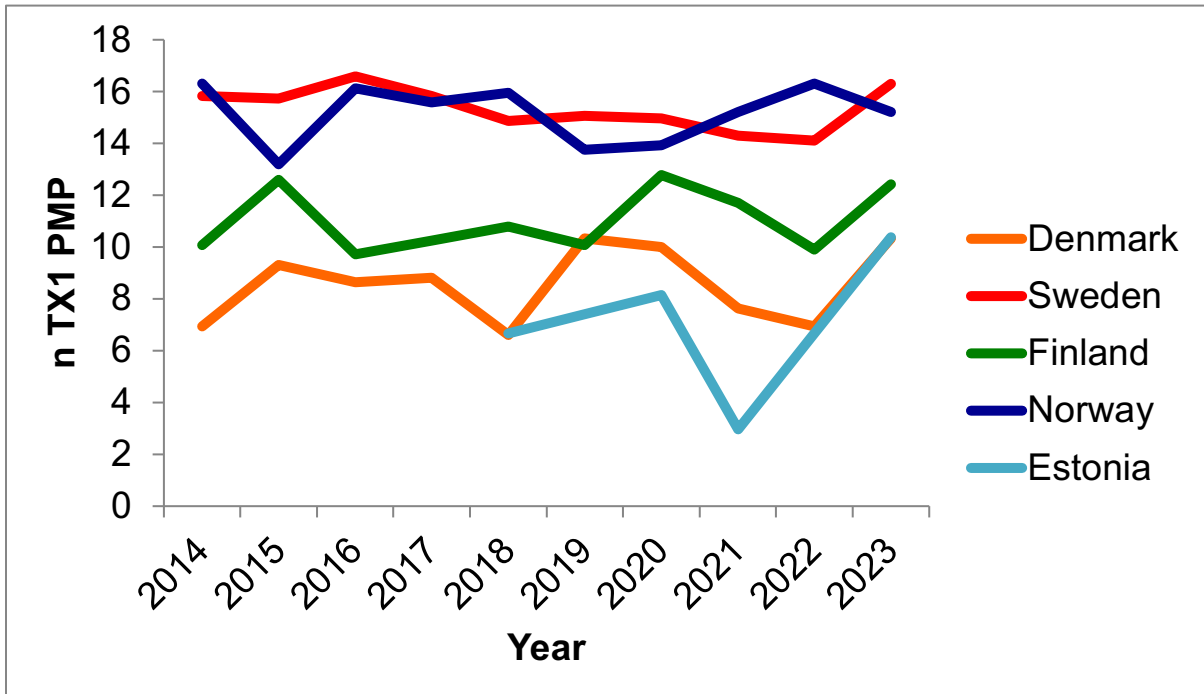
**Table 1.** Number of first liver transplantations performed at the individual centers during the last 10 years. \*Data from Tartu are only included from the time they joined Scandiatransplant

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
<b>Copenhagen</b>	6	3	9	5	4	3	7	5	5	2
<b>Gothenburg</b>	8	8	17	10	3	15	8	11	10	10
<b>Helsinki</b>	3	7	7	6	6	9	4	10	7	9
<b>Oslo</b>	11	14	12	17	8	19	12	15	3	9
<b>Stockholm</b>	8	8	7	5	4	9	8	8	7	17
<b>Tartu</b>				0	1	0	1	0	0	3

**Table 2.** Total number of re-transplantations performed at the individual centers during the last 10 years.



**Figure 2.** Number of first liver transplantations performed at the ScandiTransplant centers that are currently performing liver transplantations.



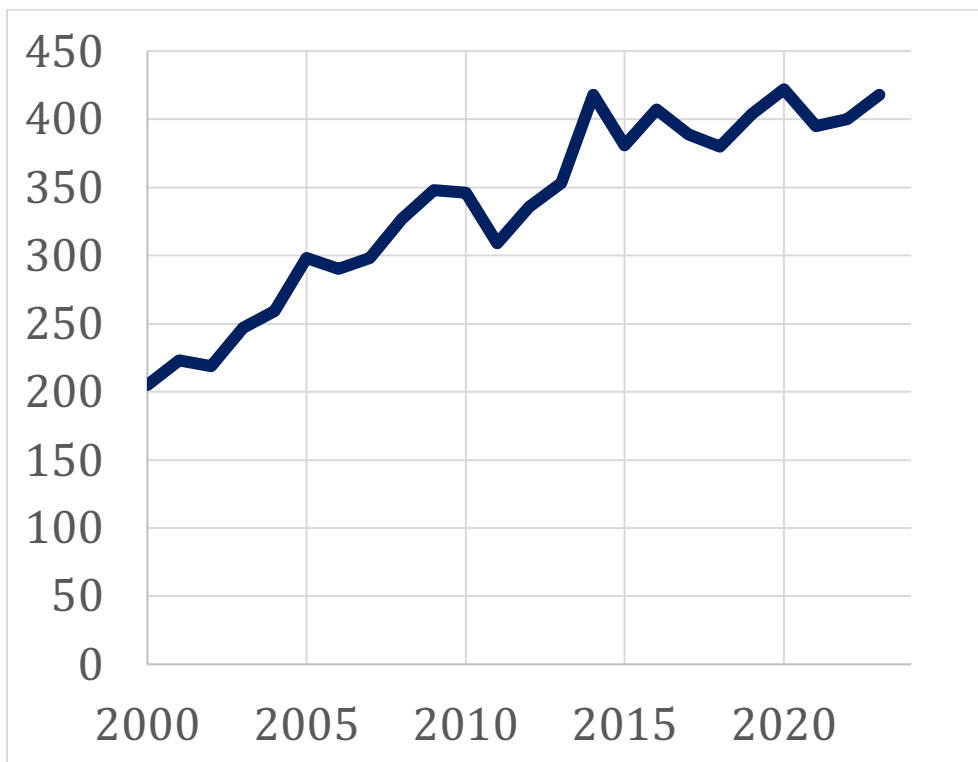
**Figure 3.** Number of first liver transplantations performed in the ScandiTransplant countries according to the country's population. PMP, per million population.

## 4. The waiting list 2023

In 2023, a total of 418 patients were entered on the waiting list for a first liver transplant (Table 3), this is an increase from the 400 entered in 2022 (Figure 4). Nineteen of the patients listed for a first liver transplant in 2023 were listed as highly urgent. This a clear increase from the numbers in 2020, 2021 and 2022 which were markedly decreased compared to previous years.

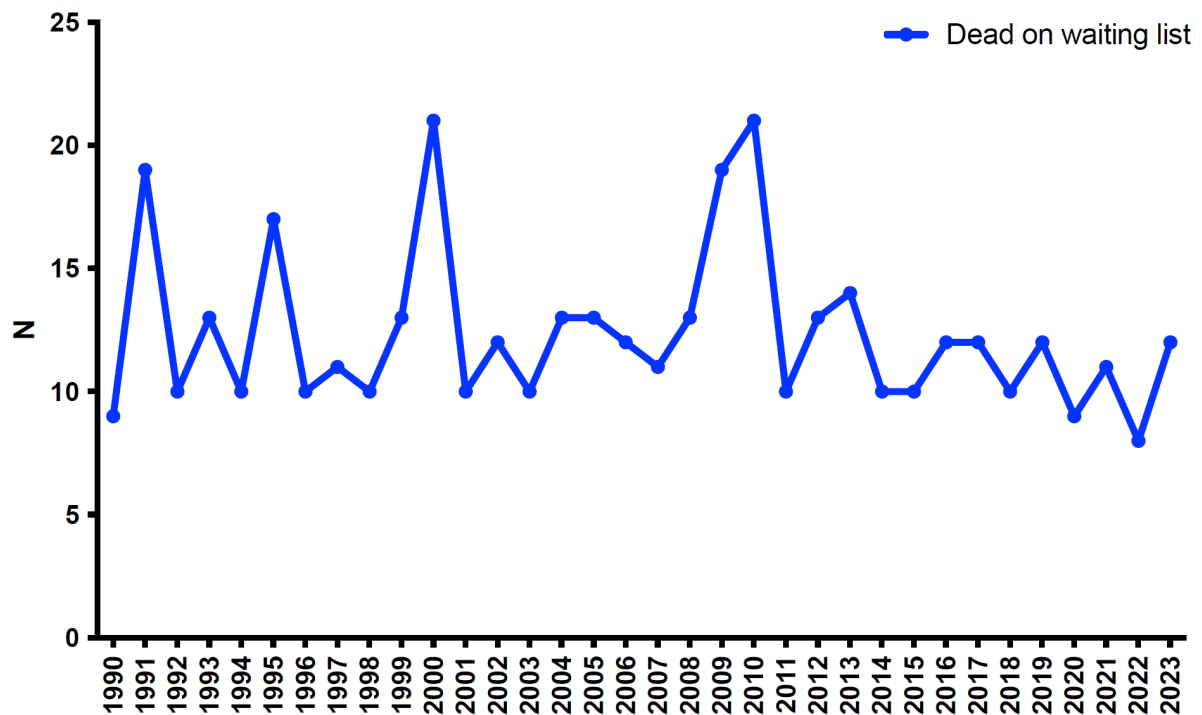
Active on waiting list	Deceased donor	Living donor	Dead	Permanent withdrawal
98	287	1	12	20

**Table 3.** Patients entering the waiting list in 2023 classified by outcome as of December 31<sup>st</sup> 2023.

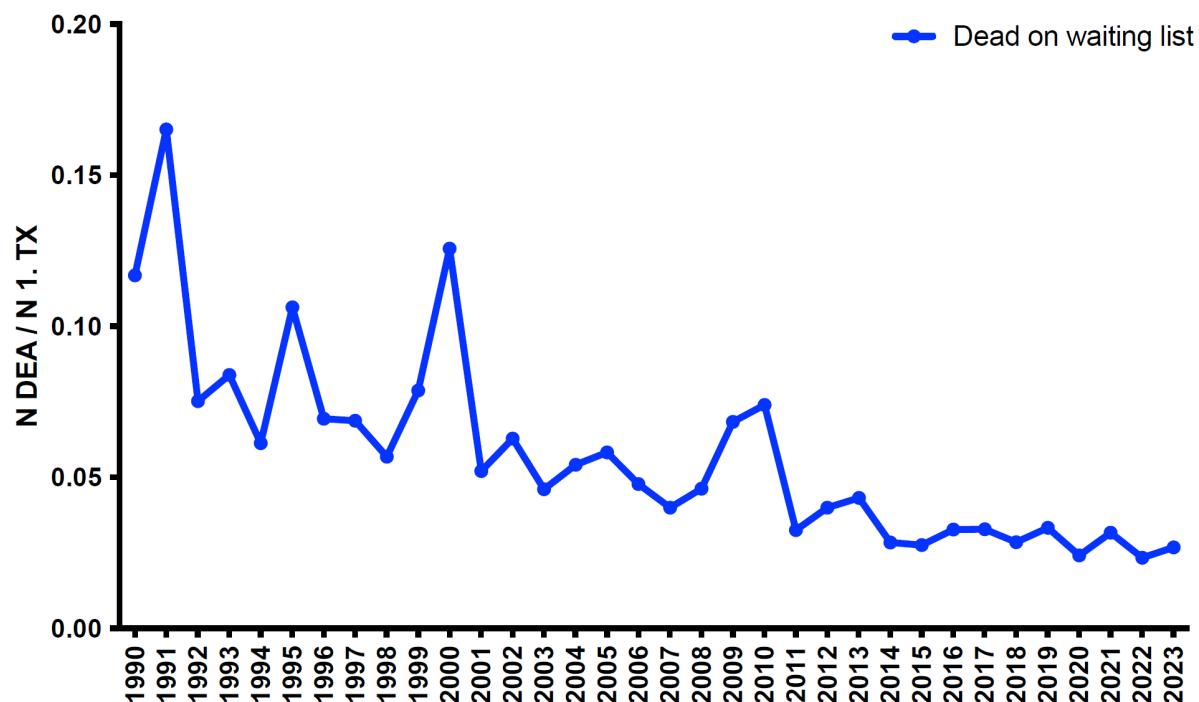


**Figure 4.** Number of patients entering the waiting list from 2000-2023.

The number of deaths among patients listed in 2023 for a first liver transplant was 12 (Denmark 1, Sweden 3, Finland 3, Norway 4, Estonia 1). The absolute number of deaths registered on the waiting list has remained rather stable since 1990 (Figure 5). When the deaths on the waiting list are evaluated in relation to the total liver transplantation activity the relative number of deaths on the waiting list remains low as it has been for many years (Figure 6).



**Figure 5.** Number of patients registered as dead on the waiting list in the period 1990-2023.



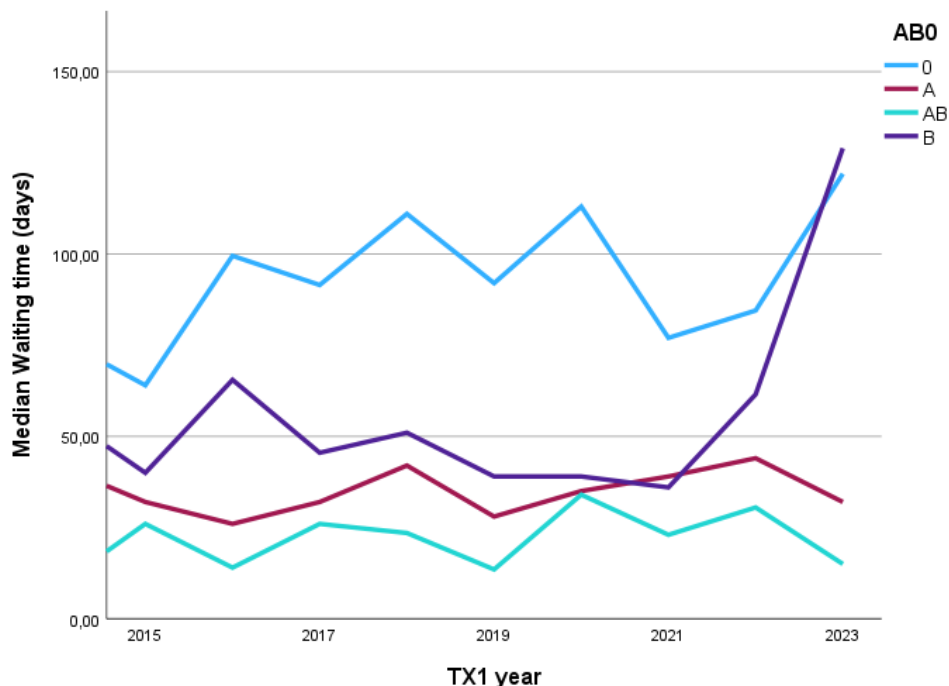
**Figure 6.** Number of patients registered as dead on the waiting list relative to the total transplantation activity in the period 1990-2023.

The median waiting time in 2023 was 60 days when excluding patients listed for a highly urgent liver transplantation. The differences according to different ABO blood types were as expected (Table 4) with largely similar numbers since 2010 (Figure 7).

0	A	AB	B
122 (1231)	32 (695)	15 (161)	129 (940)

**Table 4.** Median time on waiting list (days) for patients receiving a first liver allograft in 2023 according to ABO blood type. The number in parenthesis represents the maximum waiting time for the indicated blood type in 2023. (Patients listed as highly urgent are excluded from the calculations).



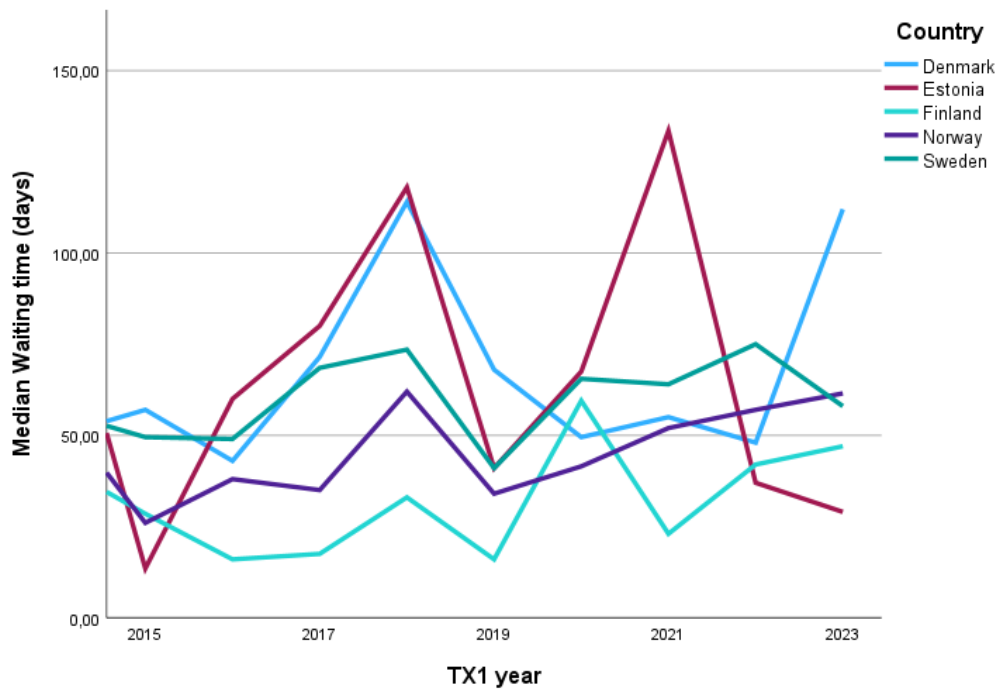


**Figure 7.** Median waiting time for first liver transplantation according to ABO blood type for 2010-2023. (Patients listed as highly urgent are excluded from the calculations).

Tartu had the lowest and Copenhagen the longest waiting time in 2023 (Table 5). The waiting times in 2023 saw a marked increase in Copenhagen, while the waiting time at the other centers were largely stable compare to previous years (Figure 8). Nevertheless, the waiting times are remarkably low compared to other programs.

Copenhagen	Gothenburg	Helsinki	Oslo	Stockholm	Tartu
112 (1096)	71.5 (1155)	47 (283)	61.5 (1231)	32 (709)	29 (216)

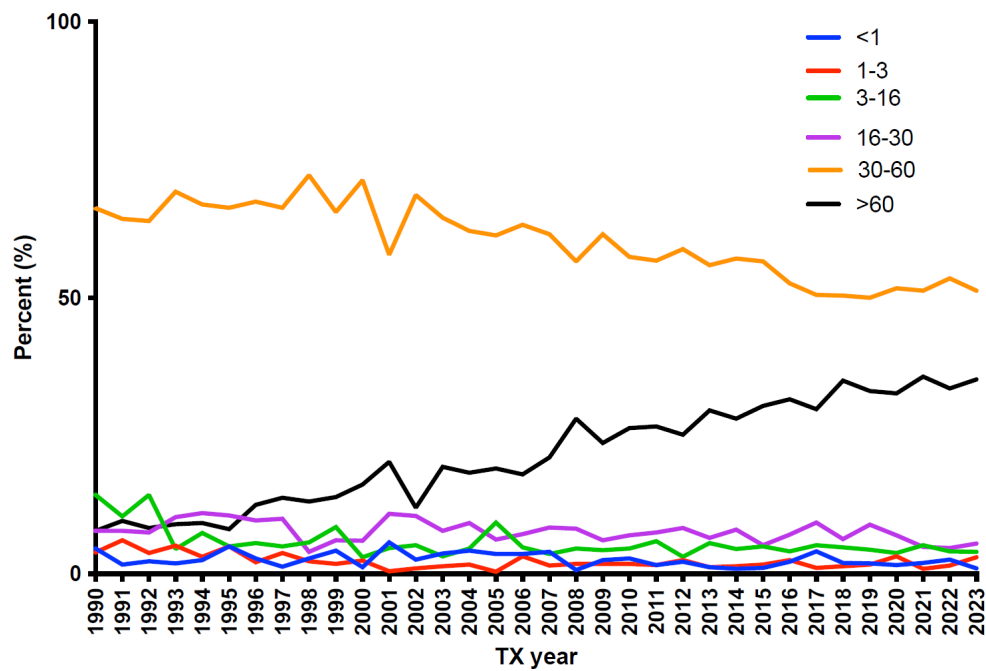
**Table 5.** Median time on waiting list (days) for patients receiving a first liver allograft in 2023 according to transplantation center. The number in parenthesis represents the maximum waiting time for the indicated center in 2023. (Patients listed as highly urgent are excluded from the calculations).



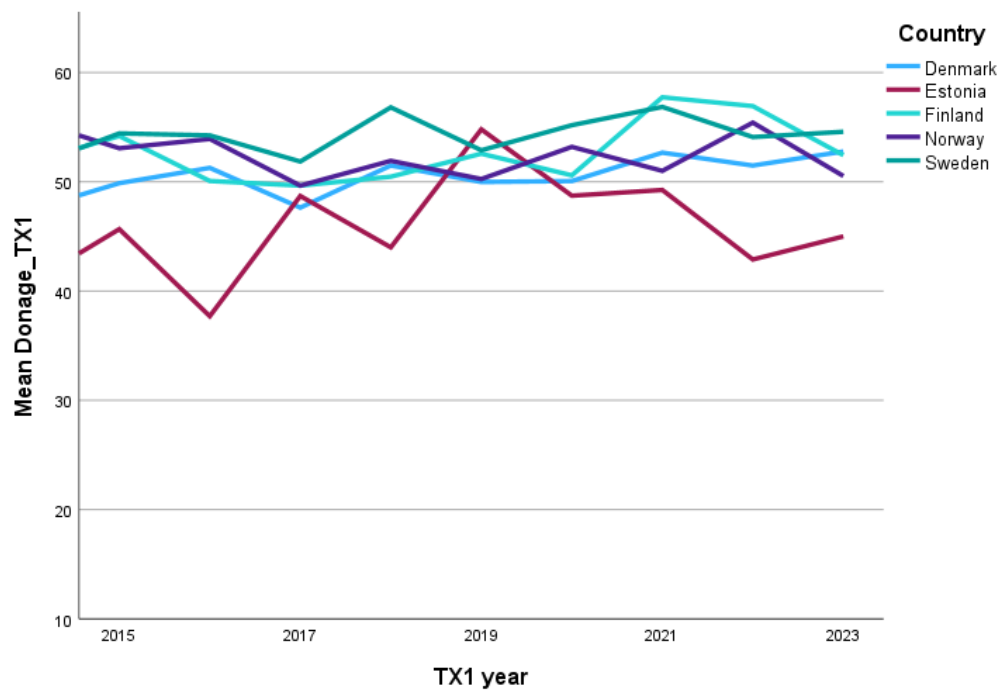
**Figure 8.** Median waiting time for first liver transplantation according to country for 2015-2023. (Patients listed as highly urgent are excluded from the calculations).

## 5. Age of recipients and donors

The mean age of adult liver recipients (>18 years, first liver transplantation) in 2023 was 54.4 years. Mean age of children (<18 years, first liver transplantation) in 2023 was 6.6 years. Since 1990 the proportion of recipients >60 years of age at the first transplantation has gradually increased with 35.2% of the patients transplanted in 2023 being above 60 years of age (Figure 9). The mean age of the donors has remained stable since 2010 with a median age of 58.0 years in 2023 (Figure 10).



**Figure 9.** Proportion of liver transplants in the indicated age groups.



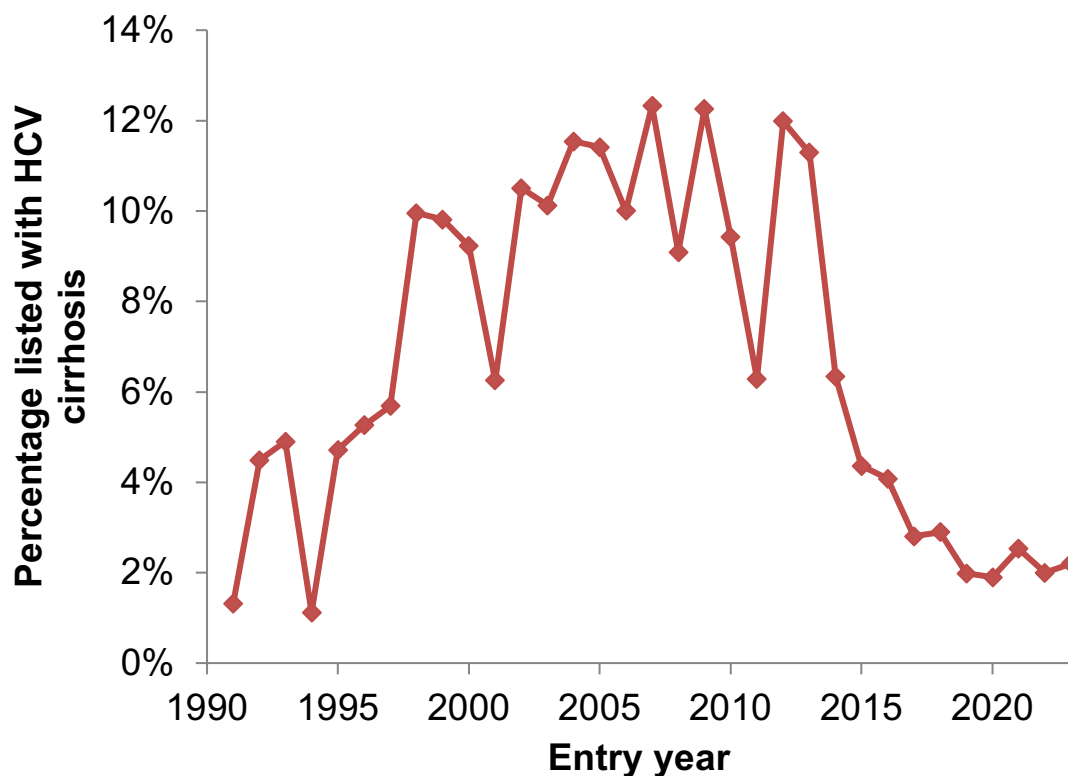
**Figure 10.** Mean age of donors utilized in the indicated years stratified for the different countries.

## 6. Diagnoses

In 2023, hepatocellular carcinoma was the leading indication for liver transplantation in Nordic countries (Table 6). During the last 10 years the percentage of patients listed for transplantation with a diagnosis of HCV cirrhosis has dramatically declined (Figure 11). This decline coincides with the introduction of direct acting antiviral treatment and HCV cirrhosis has moved from being a major indication in our program to a rather rare indication

	1982-90	1991-98	1999-03	2004-08	2009-13	2014-18	2019-23	2023
<b>Hepatocellular carcinoma and cirrhosis</b>	10.8%	5.0%	5.6%	9.0%	14.5%	17.2%	14.8%	17.0%
<b>Alcoholic cirrhosis</b>	1.9%	9.9%	11.7%	11.7%	11.5%	12.5%	16.0%	16.7%
<b>Primary sclerosing cholangitis</b>	11.1%	13.5%	16.1%	15.7%	14.8%	17.8%	15.7%	14.8%
<b>Metabolic disease</b>	9.3%	7.2%	5.6%	5.8%	7.7%	8.4%	9.1%	9.3%
<b>Acute liver failure - other</b>	8.7%	9.6%	6.8%	5.8%	5.0%	5.9%	6.1%	5.0%
<b>Primary biliary cirrhosis</b>	22.6%	12.4%	7.1%	7.4%	5.7%	4.7%	4.2%	4.8%
<b>Cirrhosis unknown</b>	0.6%	3.1%	2.6%	4.5%	6.1%	5.5%	6.7%	4.3%
<b>Polycystic disease</b>	0.3%	1.2%	1.3%	1.6%	1.5%	2.5%	3.1%	4.3%
<b>Autoimmune cirrhosis</b>	2.8%	3.6%	3.8%	4.7%	4.1%	4.6%	4.3%	2.6%
<b>Acute liver failure - toxic</b>	0.6%	2.9%	5.0%	4.1%	3.0%	2.5%	2.5%	2.4%
<b>Extrahepatic biliary atresia</b>	6.8%	5.0%	4.6%	3.7%	2.3%	2.4%	2.6%	2.4%
<b>Cholangiocarcinoma</b>	1.5%	0.8%	1.0%	0.5%	0.4%	0.4%	0.9%	2.2%
<b>Post hepatitis C cirrhosis</b>		4.8%	9.2%	10.5%	10.3%	4.1%	2.1%	2.2%
<b>Biliary tract carcinoma</b>			0.2%	0.2%	0.9%	0.8%	0.7%	1.7%
<b>Secondary liver tumors</b>	0.9%	0.3%	0.5%	1.8%	1.7%	1.9%	2.5%	1.7%
<b>Other</b>	22.0%	20.6%	18.9%	12.9%	10.4%	8.7%	8.8%	8.6%

**Table 6.** Diagnoses of patients listed for a first liver transplantation in 2023 compared with previous time periods.

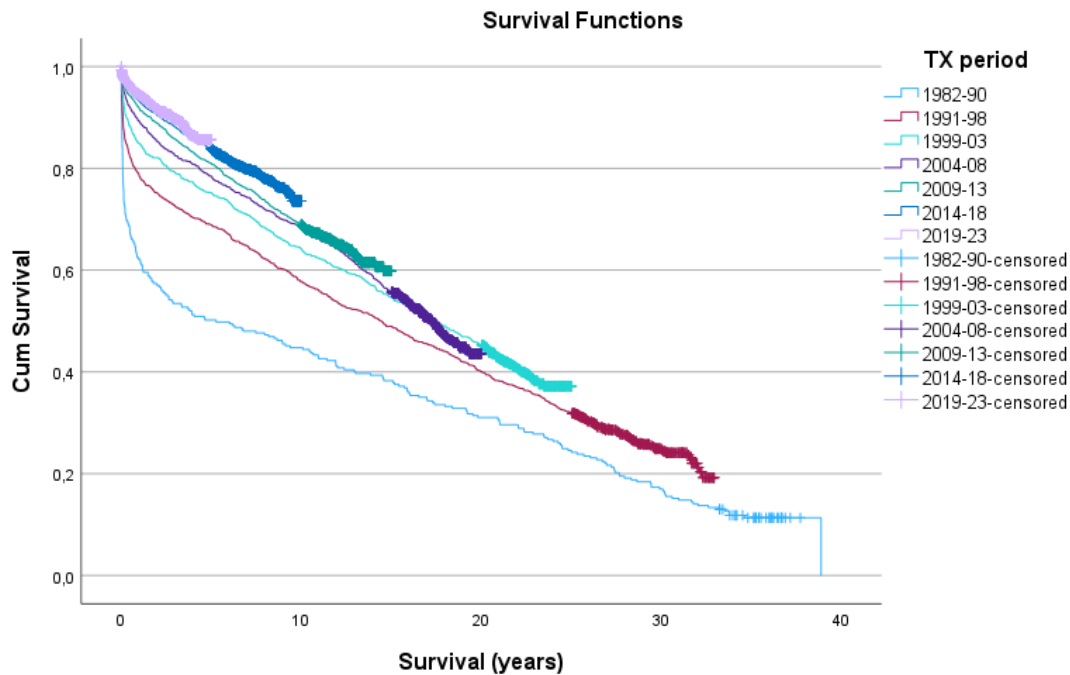


**Figure 11.** Percentage of patients listed with HCV cirrhosis from 1990-2023.

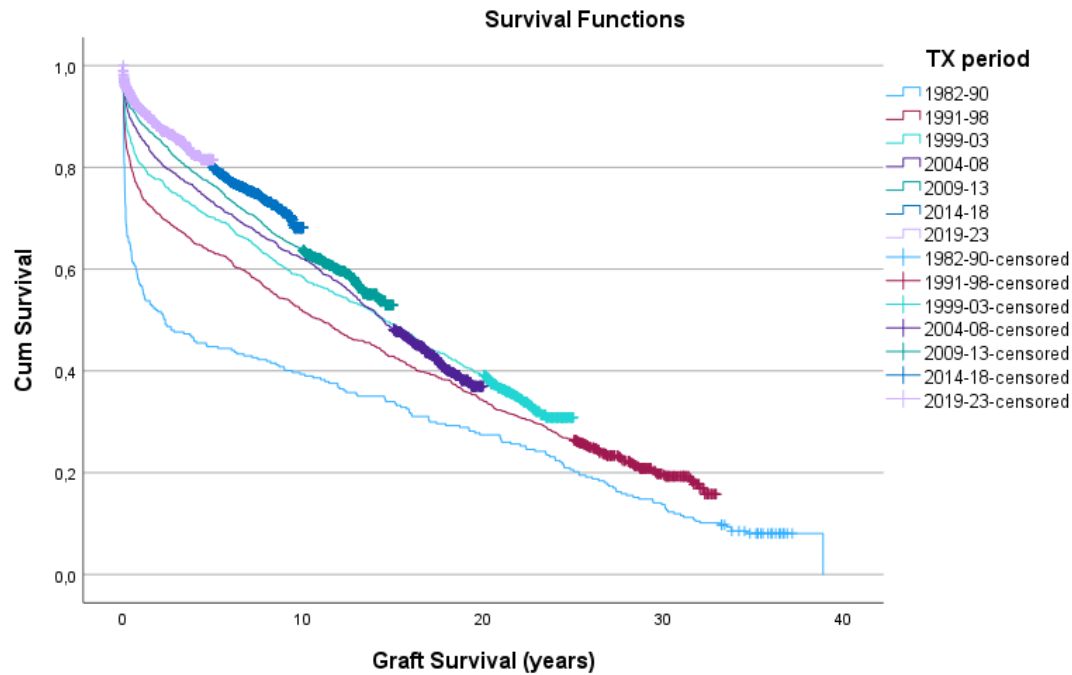
## 7. Patient and liver graft survival

When looking at 5-years intervals, patient survival (defined as time from the first liver transplantation until death) and graft survival (defined as time from the first liver transplantation until death or re-transplantation) were dramatically improving over the first years of the Nordic liver transplantation programs (Figures 12 and 13). For the two last 5-year periods the survival is quite similar. There are notable differences in the long-term patient and graft survival for different indications for transplantation (Figures 14, 15 and Table 7). The survival following retransplantation is reduced compared to the primary transplantation, this is particularly evident during the first months after the transplantation (Figure 16). Similar to the survival following the primary transplantation, the survival following retransplantation is markedly better in the recent time-periods compared to the start of the program. In an intention-to-treat analysis

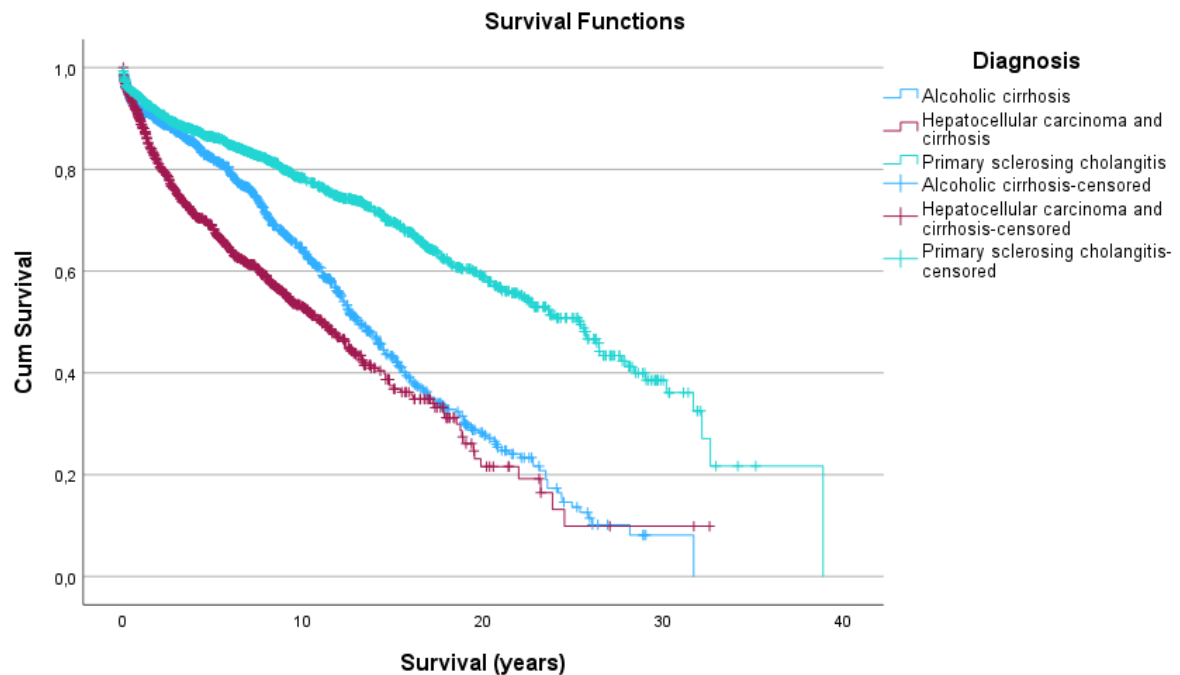
analysing survival from listing for transplantation, the survival is lower but encompasses all events following listing and gives an indication of the performance of the program (Figure 17)



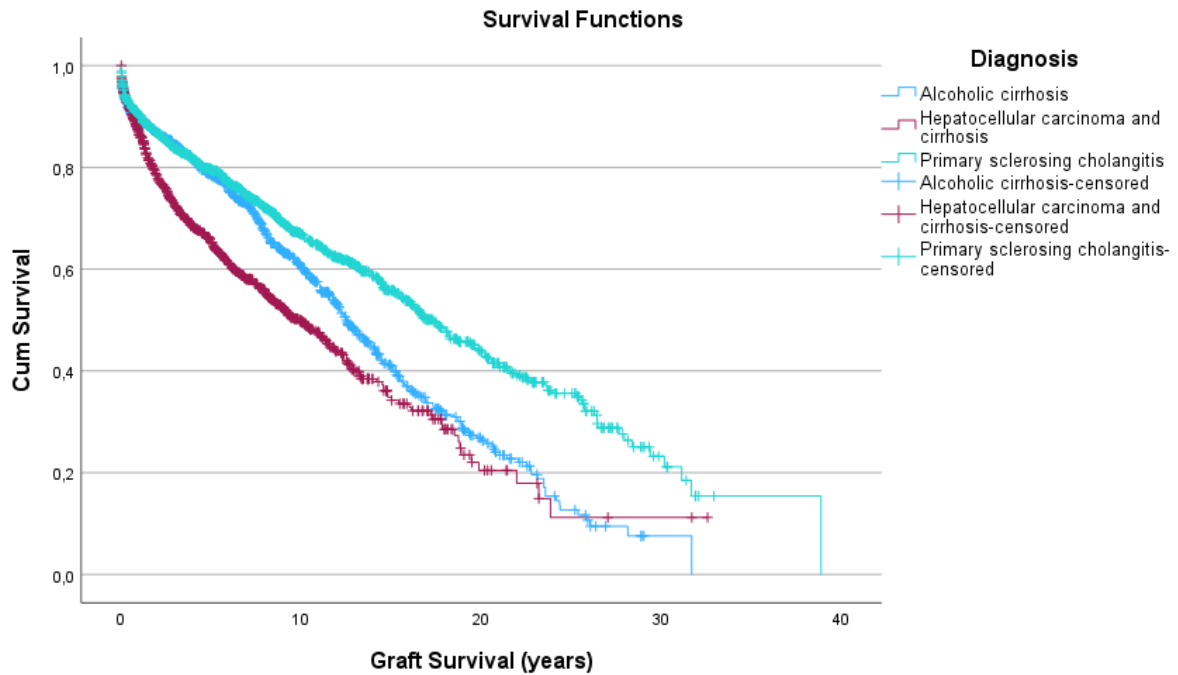
**Figure 12.** Kaplan-Meier patient survival curve for patients receiving a first liver allograft in the indicated time periods.



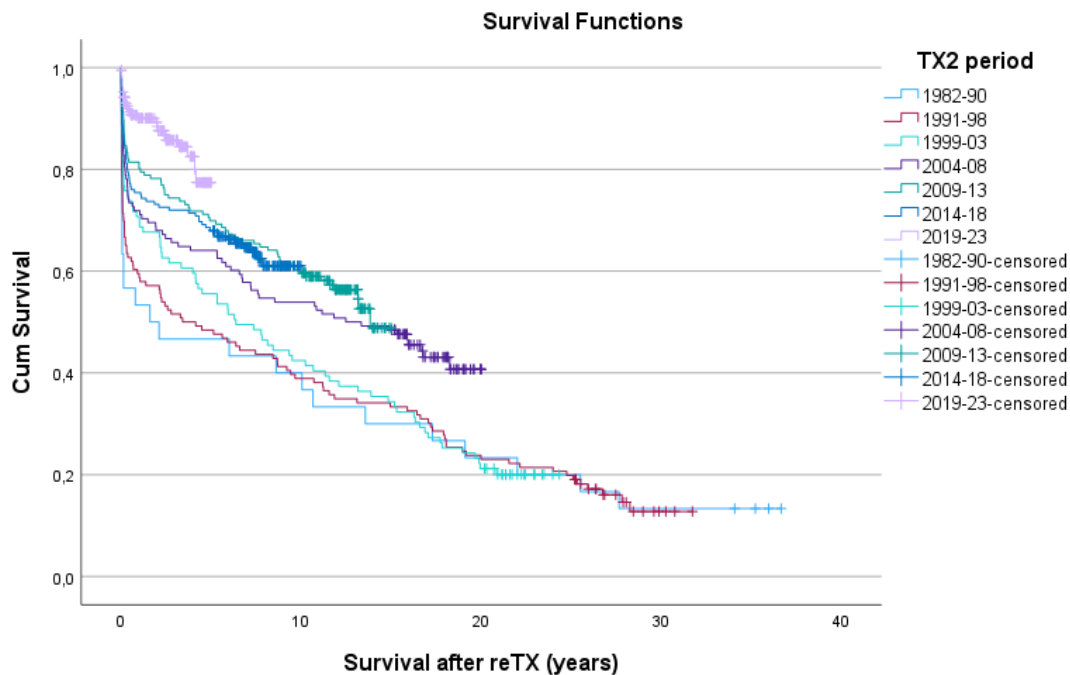
**Figure 13.** Kaplan-Meier graft survival curve for patients receiving a first liver allograft in the indicated time periods.



**Figure 14.** Kaplan-Meier patient survival curve for patients receiving a first liver allograft stratified for the three most common primary diagnoses.

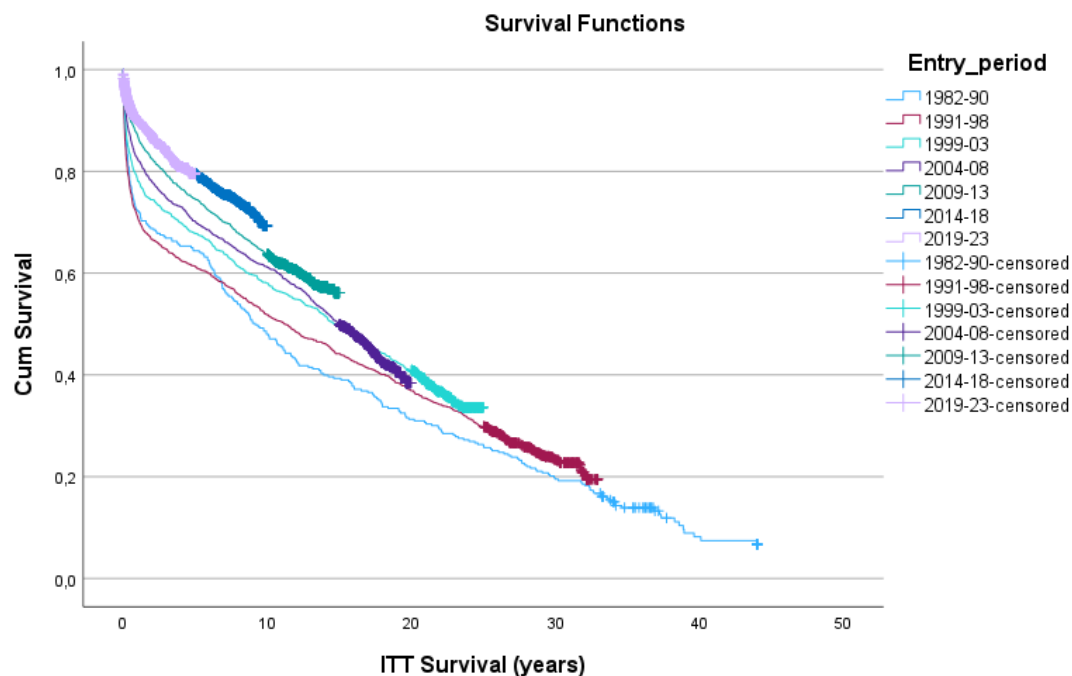


**Figure 15.** Kaplan-Meier graft survival curve for patients receiving a first liver allograft stratified for the three most common primary diagnoses.



**Figure 16.** Kaplan-Meier patient survival curve for patients following retransplantation in the indicated time periods.





**Figure 17.** Kaplan-Meier patient intention-to-treat survival curve following listing for transplantation.

	Median age	1-year survival (%)	5-year survival (%)
Primary sclerosing cholangitis	45.6	98 %	91 %
Hepatocellular carcinoma and cirrhosis	62.3	94 %	77 %
Alcoholic cirrhosis	57.9	96 %	85 %
Metabolic disease	52.3	95 %	88 %
Cirrhosis - unknown	57.3	92 %	88 %
Autoimmune cirrhosis	50.0	96 %	84 %
Primary biliary cholangitis	56.7	92 %	89 %
Extrahepatic biliary atresia	1.3	94 %	94 %
Polycystic disease	55.2	97 %	97 %
Post hepatitis C cirrhosis	55.1	87 %	75 %
Listed as highly urgent	42.6	83 %	78 %

**Table 7.** Age at transplant and survival for the patients listed 2014-2023 for ten selected diagnoses and those listed as highly urgent

## **8. Maintenance of the registry**

There are differences between each center in terms of how extensively data are entered into the NLTR. Diagnosis information, waiting list/transplantation status and survival data for all patients are now complete for 2023. We are extremely grateful for dedicated follow-up provided by the transplant coordinators upon our requests during quality control. In Oslo, we particularly want to thank Monika Olofsson and Hanna Kleven, in Gothenburg Ulrika Samuelsson, in Stockholm Malin Aram and Marie Tranäng, in Copenhagen Mette Gottlieb, in Helsinki Leena Toivonen and in Tartu Virge Pall. During 2023 the role as a scientific coordinator of the registry was transferred from Espen Melum to Lise Katrine Engesæter who from now on will have this responsibility. Quality control of the content of NLTR is a continuous priority, and a particular emphasis is put into ensuring integrity of the survival data, including cause of death. The remainder of the registry must be maintained at a level set at the discretion of each individual center and contact person.

## **9. Acknowledgements - financial support**

The NLTR received no financial support in 2023. The maintenance of the database system has been performed by Scandiatransplant. We are extremely grateful for the help and support from Anne Ørskov Boserup, Ilse Duus Weinreich and the rest of the Scandiatransplant team in Aarhus. Without their assistance, it would very simply not have been possible to maintain the registry and we sincerely hope their efforts are recognized by the NLTG and Scandiatransplant.

## **10. Organization and data ownership**

The registry (software) is the property of Scandiatransplant. The data in the registry are the property of the hospitals represented in the Nordic Liver Transplantation Group. Utilization of data in research

projects should be censored by the latter and need to comply with national guidelines for research ethics and data handling. Co-authorships for publications from research projects should be allocated according to the Vancouver guidelines, this includes presentations of data at conferences. The quality statistics of the transplantation activity presented in this report must not be used in other contexts without permission from the Nordic Liver Transplantation Group.

## **11. Publications based on the NLTR**

### ***Full length articles 1990-2023:***

1. Keiding S, Ericzon BG, Eriksson S, Flatmark A, Hockerstedt K, Isoniemi H, Karlberg I, Keiding N, Olsson R, Samela K, Schrumpf E. Survival after liver transplantation of patients with primary biliary cirrhosis in the Nordic countries. Comparison with expected survival in another series of transplantations and in an international trial of medical treatment. *Scand J Gastroenterol* 1990; 25:11-8
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Gastroenterol 1999;34:714-722

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11. Bjørø K, Ericzon BG, Kirkegaard P, Höckerstedt K, Söderdahl G, Olausson M, Foss A, Schmidt LE, Brandsæter B, Friman S. Liver transplantation for fulminant hepatic failure: impact of donor-recipient ABO-matching on the outcome. *Transplantation* 2003;

12. Brandsæter Bjørn, Broomé Ulrika, Isoniemi Helena, Friman Styrbjörn, Hansen Bent, Schrumpf Erik, Oksanen Antti, Ericzon Bo-Göran, Höckerstedt Krister, Mäkisalo Heikki, Olsson Rolf, Olausson Michael, Kirkegaard Preben, Bjøro Kristian. Liver transplantation for primary sclerosing cholangitis in the Nordic countries: outcome after acceptance to the waiting list. *Liver Transpl.* 2003;9:961-9.

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