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ORIGINAL PAPER

Advancement of Organ and Tissue Transplantation in Maranhão: an Analysis of the 2023-2025 Acceleration Plan

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ABSTRACT

Objectives: To analyze and discuss the progress of organ and tissue transplantation in the state of Maranhão from January 2023 to July 2025. **Methods:** This is a retrospective, descriptive, observational study using a quantitative approach. Data were extracted from the statistical reports of the National Transplant System. Data collection took place in July and August 2025. The collected data were analyzed and tabulated using Microsoft Excel 2019, applying simple descriptive statistics to summarize the data and observations. **Results:** The analyzed data reveal a continuous increase in the number of organ and tissue transplants performed in the state of Maranhão during the specified period. A predominance of male patients and older patients was observed. Furthermore, a high number of patients on the waiting list for solid organ and tissue transplants donations was found. **Conclusion:** The importance of this advance is especially relevant for patients who are still on the transplant waiting list, considering that with the evolution of the state, the implementation of new commissions, the qualification of health professionals, the awareness of the population on the subject, and the support of the state government, these data tend to improve and thus through the "yes" of donor families, continue to increase each year.

Descriptors: Transplantation; Organ Transplantation; Tissue and Organ Procurement; Epidemiology.

Avanço do Transplante de Órgãos e Tecidos no Maranhão: Uma Análise do Plano de Aceleração de 2023 a 2025

RESUMO

Objetivos: Analisar e discutir o avanço no transplante de órgãos e tecidos no estado do Maranhão no período de janeiro de 2023 a julho de 2025. **Métodos:** Estudo observacional retrospectivo e descritivo, empregando uma abordagem quantitativa. Os dados foram extraídos dos relatórios estatísticos do Sistema Nacional de Transplantes. A coleta de dados ocorreu nos meses de julho e agosto de 2025. A análise e a tabulação dos dados coletados foram realizadas utilizando o programa Microsoft Excel 2019, aplicando estatística descritiva simples para sintetizar os dados e as observações. **Resultados:** Os dados analisados revelam um crescimento contínuo no número de transplantes de órgãos e tecidos realizados no estado do Maranhão durante o período em questão. Observa-se a predominância de pacientes do sexo masculino e em faixas etárias mais avançadas. Adicionalmente, constata-se um número elevado de pacientes em lista de espera por doações para transplantes de órgãos sólidos e tecidos. **Conclusão:** A importância desse avanço se dá especialmente em relação aos pacientes que ainda se encontram na fila de espera de transplante, tendo em vista que, com a evolução do estado, a implementação de novas comissões, a qualificação dos profissionais da saúde, a conscientização da população sobre o assunto e o apoio do governo estadual esses dados tendem a melhorar e, assim, por meio do "sim" das famílias doadoras, esses números tendem a crescer a cada ano.

Descritores: Transplante; Transplante de Órgãos; Obtenção de Tecidos e Órgãos; Epidemiologia.

INTRODUCTION

In Brazil, the practice of transplants began in 1964 with kidney transplants, followed by heart, liver, intestinal, and pancreas transplants. However, it was only in 1997 that the National Transplant System (*Sistema Nacional de Transplantes-SNT*) was formally established by Law No. 9,434/1997, which established guidelines for performing transplants in Brazil. The SNT is responsible for coordinating, regulating, and monitoring transplants in the country[1].

Thus, the main objective of this system is to ensure that transplants are carried out in an ethical, safe, and transparent manner, in line with the principles of the Unified Health System (*Sistema Único de Saúde-SUS*). Additionally, it is responsible for regulating and overseeing the process, whether from living or deceased donors, by monitoring the single waiting list. It also works to train healthcare professionals, raise public awareness about the importance of donation, and ensure the quality and safety of transplant procedures[2].

Data indicate that in 2024, Brazil reached a historic record for transplants performed by the Unified Health System (*Sistema Único de Saúde-SUS*), with more than 30,000 procedures, representing an 18% increase compared to 2022. Currently, 78,000 individuals are awaiting organ donations, with the highest demand in 2024 being for kidneys, corneas, and livers, respectively. However, the most transplanted organs were: corneas, with 17,107 donations; kidneys, with 6,320; bone marrow, with 3,743; and liver, with 2,454[3].

Within the SUS (Brazilian Unified Health System), the process of matching organ donors and recipients involves the technique of true crossmatching, which consists of mixing the donor's antigens with the potential recipient's serum. The Ministry of Health (*Ministério da Saúde-MS*) is introducing virtual crossmatching as an innovation to be implemented soon in the SUS. This procedure is based on the analysis of immunological data previously registered in a system, information obtained from recipient samples stored in serum collections distributed throughout the country. If the virtual crossmatching results are negative, the process advances to the real cross-matching phase, thus optimizing organ distribution[2].

Regarding the state of Maranhão, there was a significant increase in the number of transplants performed in the first half of 2024 (from January to June), compared to the same period in 2023. Notably, cornea, kidney, and liver transplants stood out, totaling an increase from 124 to 225 procedures[4]. In this context, the State Transplant Center (Central Estadual de Transplantes-CET) plays a crucial role in organizing, coordinating, and regulating donation and transplant activities, among other duties[5].

Accordingly, to increase the number of donors, Intra-Hospital Commissions for Donation of Organs and Tissues for Transplantation (*Comissões Intra-Hospitalares de Doação de Órgãos e Tecidos para Transplante-CIHDOTT*) and Organ Procurement Organizations (*Organizações de Procura de Órgãos-OPO*) were established, through ordinances. The CIHDOTT organizes the donation assistance protocol within the hospital setting, among other responsibilities. The OPO, in turn, plays a supra-hospital coordination role, organizing and supporting the hospitals under its jurisdiction. Furthermore, it is recommended that there be one OPO for every 2 million inhabitants[6].

It should be noted that in 2022, the state of Maranhão had the lowest indicators in the country regarding cornea and multiple organ transplants. However, the implementation of the Transplant Acceleration Plan (*Plano de Aceleração de Transplantes-PAT*),

started in 2023 by CET, contributed to the increase in the number of donors and procedures performed in the state[7]. This scenario highlights the relevance of the present study, since the analysis of recent advances in Maranhão, notably after the implementation of the PAT, allows us to understand the factors that contributed to the improvement of the indicators.

In light of this, it is also essential to highlight the mobilization of healthcare professionals on transplant committees and their importance, as well as the state government's efforts to improve statistics and reduce the waiting list. Therefore, the objective of this study is to analyze and discuss progress in organ and tissue transplantation in the state of Maranhão from January 2023 to July 2025.

METHODS

This study consists of an observational, retrospective, and descriptive analysis, employing a quantitative approach. The research was conducted using data extracted from the SNT statistical reports, made available electronically by the Ministry of Health, and from the statistical reports of the Brazilian Transplant Registry (*Registro Brasileiro de Transplantes-RBT*), made available electronically by the Brazilian Organ Transplant Association (*Associação Brasileira de Transplante de Órgãos-ABTO*). Data collection took place in July and August 2025. The study population comprised all records related to organ and tissue transplants performed, as well as waiting list data in the state of Maranhão, with a time frame from January 2023 to July 2025. The variables included in the study were: sex, age group, number of solid organs (SO), corneas and bone marrow transplanted, and waiting list for SO and corneas. SO are considered: heart, lung, liver, pancreas, and kidneys.

It is noteworthy that this study was conducted based on an analysis of organ and tissue transplant data, specifically regarding the state of Maranhão. This state, whose capital is São Luís, borders the states of Pará to the west, Tocantins to the southeast and south, and Piauí to the east. According to data from the latest demographic census, conducted in 2022, its population totals 6,776,699 inhabitants, ranking it the 12th most populous state in Brazil[8].

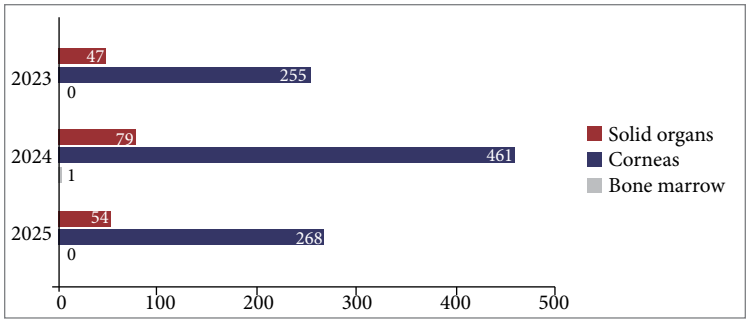
The collected data were analyzed and tabulated using Microsoft Excel 2019, applying simple descriptive statistics to summarize the data and observations. To better understand the results, graphs and tables were created using the quantitative method, presenting absolute and percentage values. These data were correlated with relevant scientific literature.

Since the data are in the public domain and freely accessible, and contain only information of interest to public health, there are no direct implications for human beings. Consequently, the submission of this research to the Research Ethics Committee (*Comitê de Ética e Pesquisa-CEP*) was unnecessary. Therefore, the study complies with Resolutions No. 466/12, No. 510/2016, and No. 738/2024 of the National Health Council (*Conselho Nacional de Saúde-CNS*).

RESULTS

The results of this study include the analysis and interpretation of each variable investigated in the state of Maranhão, from January 2023 to July 2025. The analyzed data demonstrate a consistent increase in the number of organ and tissue transplants performed over the period in question.

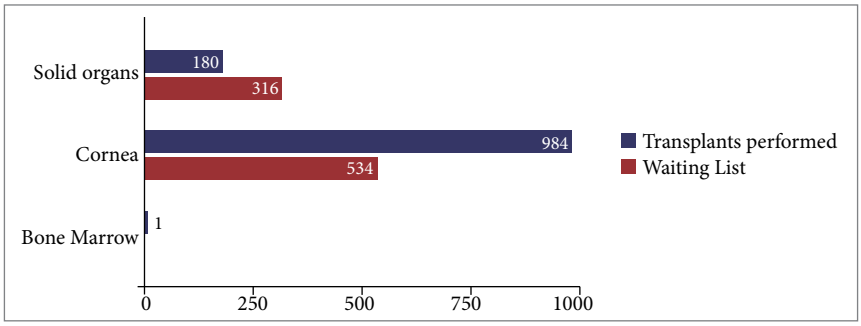
Fig. 1 shows a considerable increase from 2023 to 2024, particularly in cornea donations. Comparing both years with 2025, it is noteworthy that the data obtained for 2025 corresponds to July, already surpassing the number of cornea donations in 2023 and approaching the total number of SO donations for the entire year of 2023, demonstrating an increase in organs and tissues transplanted this year. Additionally, it is worth noting that, in 2024, the state of Maranhão performed its first bone marrow transplant (BMT).



Source: Elaborated by the authors.

Figure 1. Organ, tissue and bone marrow transplants performed per year, São Luís, state of Maranhão, 2025.

Fig. 2 presents the overall numbers for the period 2023 to 2025, totaling 180 transplants for SO, 984 for corneas, and one BMT. Additionally, the figure presents the waiting list for the compared years, showing 316 people on the SO waiting list and 534 on the cornea waiting list. These data correspond to the three years analyzed together. Regarding BMT, a waiting list is not established. Instead, a registry is maintained, in which the search for a compatible donor may vary in speed depending on the patient's genetic profile. This methodology differs from the waiting list observed for SO and cornea transplants.



Source: Elaborated by the authors.

Figure 2. Organ, cornea and bone marrow transplants performed vs. waiting list from 2023 to 2025, São Luís, state of Maranhão, 2025.

Table 1 presents the number of SO transplants performed between 2023 and 2025. It should be noted that, for the year 2025, the data are presented exclusively in absolute values, due to the lack of related information, such as the rate per million inhabitants (pmp), in both the SNT and RBT records.

Table 1. Distribution of SO transplants performed by year, organ type, gender and age group, São Luís, State of Maranhão, 2025.

Organ	Absolute number	Rate pmp	Male	Age group	Female
Organ transplants performed in 2023					
Heart	0	0.0	3	Over 65	3
Lung	0	0.0	5	50-64	4
Liver	3	0.4	9	35-49	4
Pancreas	0	0.0	8	18-34	2
Kidney	44	6.5	3	11-17	2
Pancreas + kidney	0	0.0	2	6-10	1
Multivisceral	0	0.0	1	1-5	0
			0	0	0
Total	47	6.9	31		16
Organ transplants performed in 2024					
Heart	0	0.0	2	Over 65	2
Lung	0	0.0	15	50-64	5
Liver	16	2.3	18	35-49	9
Pancreas	0	0.0	13	18-34	10
Kidney	63	9.0	3	11-17	2
Pancreas + kidney	0	0.0	0	6-10	0
Multivisceral	0	0.0	0	1-5	0
			0	0	0
Total	79	11.3	51		28
Organ transplants performed in 2025					
Heart	1	-	5	Over 65	0
Lung	0	-	11	50-64	4
Liver	14	-	16	35-49	9
Pancreas	0	-	4	18-34	3
Kidney	39	-	1	11-17	1
Pancreas + kidney	0	-	0	6-10	0
Multivisceral	0	-	0	1-5	0
		-	0	0	0
Total	54	-	37		17

Source: Elaborated by the authors.

In 2023, a total of three liver transplants and 44 kidney transplants were performed, with a higher percentage of males, totaling 31 transplants. The age group that stood out most was 35 to 49 years old.

In 2024, there was a significant increase in transplants performed, totaling 16 liver transplants and 63 kidney transplants. As in 2023, male transplants stood out, with a total of 51 transplants performed in this population, predominantly in the 35-49 age group, followed by the 50-64 age group, with 15 transplants in males. It is worth noting that, in 2024, the most significant female population was concentrated in the 18-34 age group, with 10 transplants performed.

Analyzing the year 2025 through July, there was a notable increase in organ transplants, highlighting the first heart transplant performed in the state of Maranhão, compared to 2023 and 2024, which did not record this type of organ transplant. Thus, up to July, there were one heart transplant, 14 liver transplants, and 39 kidney transplants. This data is crucial, considering that 2025 has not yet ended.

Furthermore, in 2025, similar to previous years, the highest incidence of transplants performed on males prevailed, with a total of 37 procedures. Of these, 16 were males aged 35 to 49. Although females have shown a lower rate during the observed years, in 2025, the age group that stood out most in this population was also the 35 to 49-year-old age group.

Table 2 presents the distribution of corneal transplants performed by year, sex, and age group. During the analyzed period, there was a significant increase in corneal transplants performed in the state of Maranhão. In 2023, 255 corneal transplants were recorded, a number that increased to 461 in 2024, representing an increase of approximately 80.78% in corneal transplants from 2023 to 2024. It is noteworthy that, by July 2025, this number had already reached 268 transplants performed, surpassing the total for 2023.

Table 2. Distribution of corneal transplants performed by year, gender and age group, São Luís, State of Maranhão, 2025.

Tissue	Male	Age Group	Female
	Corneal transplants performed in 2023		
Corneas	31	Over 65	40
	35	50-64	26
	34	35-49	20
	34	18-34	16
	5	11-17	6
	2	6-10	1
	1	1-5	3
	1	0	0
Total = 255 Rate pmp = 37.6	143		112
	Corneal transplants performed in 2024		
Corneas	75	Over 65	115
	55	50-64	43
	46	35-49	24
	54	18-34	33
	7	11-17	0
	2	6-10	2
	1	1-5	2
	2	0	0
Total = 461 Rate pmp = 65.0	242		219
	Corneal transplants performed in 2025		
Corneas	38	Over 65	66
	37	50-64	29
	40	35-49	19
	22	18-34	8
	5	11-17	1
	0	6-10	2
	1	1-5	0
	0	0	0
Total = 268	143		125

Source: Elaborated by the authors.

Regarding the patient profile, it was observed that, in all the years analyzed, there was a higher prevalence of donations from males. Regarding age group, it was observed that, in the period studied, the occurrence of transplants performed was higher in older patients.

Table 3, in turn, presents the number of individuals on the waiting list for SO and corneas, segmented by organ type, gender and age group.

Table 3. Waiting list for SO and corneas according to organ type, sex and age group, São Luís, State of Maranhão, 2025.

Organ	Waiting List for SO			
		Male	Age group	Female
Heart	0	22	Over 65	15
Lung	0	73	50-64	31
Liver	20	60	35-49	53
Pancreas	0	33	18-34	26
Kidney	296	2	11-17	0
Pancreas + kidney	0	1	6-10	0
Multivisceral	0	0	1-5	0
		0	0	0
Total	316	191		125
Tissue	**Waiting List for Cornea**			
		Male	**Age group**	**Female**
Cornea		93	Over 65	151
		63	50-64	54
		53	35-49	29
		40	18-34	26
		11	11-17	8
		2	6-10	0
		2	1-5	2
		0	0	0
Total	534	264		270

Source: Elaborated by the authors.

Regarding the SO transplant waiting list, a total of 316 patients are awaiting donation. Of these, 296 are awaiting kidney transplants and 20 are awaiting liver transplants. The profile of these patients is predominantly male, and in terms of age, there was a higher prevalence of individuals in the 35-49 age group, followed by those in the 50-64 age group.

There are a total of 534 patients awaiting corneal transplants, the majority (n = 270) being female. Regarding age, patients aged 65 and over predominate, followed by those aged 50-64. The number of patients increases with age, except for the 1-5 age group, which outnumbered those aged 6-10.

DISCUSSION

The results reveal a growing trend in organ and tissue transplants performed in the state of Maranhão. It is notable that, in just seven months of 2025, the volume of cornea donations has already surpassed the total documented in 2023. Additionally, overall OS donations in 2025 are approaching the overall number of transplants achieved in 2023. The projection of this analysis for 2025 indicates a promising outlook for the continued increase in transplant rates performed in the state.

In 2023, the Maranhão State Transplant Center (CET) implemented the Transplant Acceleration Program (PAT). This phased plan aimed to reorganize the specialized network. The first phase consisted of expanding the CIHDOTTs and OPOs, as well as establishing partnerships to promote awareness and encourage donation[9]. In October of that same year, the first OPO was established in São Luís. Its role is to support the institutions that are part of the organ and tissue donation and transplant network, replacing the regional transplant centers.

In 2025, with the need to expand the cause to other parts of Maranhão, the state government opened the OPO in Imperatriz, the first in the interior and the second in the state[10]. Furthermore, the second phase focused on regionalization, resulting in the creation of 21 new committees, six of which were established in the interior of the state. The final phase, currently underway, aims to eliminate the transplant waiting list and improve processes through auditing and rigorous quality control[9].

The organ donation scenario in Maranhão has shown remarkable progress, with a significant increase in the number of effective donors. According to the most recent data, the state registered a jump from 1.7 pmp in 2022 to 8.0 by March 2025[11,12]. These data reflect a clear and encouraging indication of the substantial increase in the organ and tissue donation process during the period analyzed, demonstrating the success of awareness campaigns and the growing family adherence to the organ donation process by the population.

The progress observed is the result of joint efforts, including the implementation of the PAT, awareness campaigns, improvements to hospital infrastructure, the opening of new transplant centers, the accreditation of these institutions, and the training of healthcare professionals. This progress is crucial for reducing transplant waiting lists, offering a new perspective on life for countless patients.

The results of this study demonstrated a higher prevalence of liver and kidney transplants. These findings corroborate the results of a study that analyzed the number of transplants performed between 2018 and 2022 and revealed a clear trend: the kidney consistently ranks as the most frequently transplanted organ annually, with a considerable volume of procedures. Subsequently, the liver also stands out, reaching a total of 2,135 transplants in 2022[13].

In 2025, the state also witnessed its first heart transplant, rising to third place in the Northeast region. Nationally, Maranhão ranks 10th, tied with states such as Rio Grande do Norte, Bahia, and Paraíba[12]. By demonstrating such growth, the state positions itself more prominently in the national organ donation scenario, contributing to saving lives and strengthening the country's transplant system.

In Brazil, the transplant waiting list has shown a continuous increase over the past three years, indicating a growing demand for organs, notably kidneys, livers, and hearts. In 2023, the number of people awaiting a transplant was 59,958, rising to 67,879 in 2024 and reaching 73,937 in March 2025[12,14,15].

Additionally, the number of family refusals, identified as the main factor responsible for non-donation of organs and tissues, is associated with the increase in the waiting list for an organ or tissue. In conjunction with this fact, although the number of donations is increasing, the current infrastructure may not be adequate to handle all donations and perform the necessary transplants efficiently. This scenario may increase the waiting list, even with the increase in the number of donors[16].

A study sought to analyze the panorama of organ transplants in the Northeast Region. It showed that some states, such as Pernambuco and Ceará, stand out in relation to the others in the number of transplants performed and in the number of teams dedicated to these procedures, which reflects an inequality in infrastructure and distribution of trained professionals[17].

Therefore, the lack of specialized teams to perform transplants, combined with the limited number of effective donors, contributes substantially to high demand and a long waiting list of patients requiring organ and tissue transplants.

Regarding the state of Maranhão, the waiting list for OS transplants registered 207 patients in 2023, 173 in 2024, and 247 in 2025. Regarding the list of active patients waiting for corneal transplants, the number decreased from 677 in 2023 to 501 in 2024, and as of March 2025, there were 408 patients waiting[12,14,15].

To reduce the waiting list for cornea transplants, it is necessary to train professionals, especially nurses and nursing technicians, in eyeball enucleation for transplants, in addition to conducting an effective interview with the donor's family to ensure positive family adherence. Therefore, the State Department of Health (Secretaria de Estado da Saúde-SES), through CET-MA, in partnership with the Eye Bank of the University Hospital of the University of Maranhão, promoted the 1st Course on Collection of Human Ocular Tissues for Transplants, in June 2025[18].

CONCLUSION

This study identified and discussed progress in organ and tissue transplantation in the state of Maranhão from January 2023 to July 2025. It was evident that the state's Transplant Acceleration Plan (PAT) has made a difference in the statistics, reflecting the work and dedication of the healthcare professionals involved in the process. This progress is significant for patients still on the transplant waiting list. With the state's development, the implementation of new committees, the training of healthcare professionals, public awareness, and support from the state government, these data are expected to improve. Thus, with the "yes" of donor families, these figures are expected to grow each year.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR'S CONTRIBUTION

Substantive scientific and intellectual contributions to the study: Lima AMSA, Bastos VS, Aquino ACR, Maramaldo ICR, Soares MS, Oliveira JC, Cerqueira CC, Santos JS, Ramos AA, Silva SP, Leite NA, Araujo MFS, Lucena MR, Barboza JMA, Fraccaroli BI; **Conception and design:** Lima AMSA, Bastos VS; **Data analysis and interpretation:** Lima AMSA, Bastos VS, Aquino ACR; **Article writing:** Lima AMSA, Bastos VS; **Critical revision:** Lima AMSA, Bastos VS, Aquino ACR, Maramaldo ICR, Soares MS, Oliveira JC, Cerqueira CC, Santos JS, Ramos AA, Silva SP, Leite NA, Araujo MFS, Lucena MR, Barboza JMA, Fraccaroli BI; **Final approval:** Lima AMSA.

DATA AVAILABILITY STATEMENT

Data will be availble upon reasonable request.

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