



# Identifying inequities in lung transplantation: a call for strategies and future research

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Innovations in organ preservation, surgical technique, and postoperative care have transformed solid organ transplantation. As organ transplantation becomes more common, potential racial, ethnic, and socioeconomic inequities in the referral and selection process are also emerging. Research studies highlight that patients from minoritized and low socioeconomic groups experience lower rates of referrals, reduced access to the transplant waitlist, higher rates of postoperative complications, and higher mortality rates for cardiothoracic (lung/heart) and abdominal (liver/kidney/pancreas) transplants. Yet, the drivers of these inequities are understudied and thus poorly understood. Strategies that address the root causes and mitigate these inequities are urgently needed. The purpose of this manuscript is not to be a systematic review, partially because there is limited research in this area, but to lay a roadmap toward equity in lung transplant. We highlight the available literature on lung transplantation inequities, identify critical needs, and propose strategies for the next steps. Our goal is to urge a call to action for the research community to systematically address the research in lung transplant disparities, and for health systems, organizations, and policymakers to implement the organizational and health system changes to meaningfully reduce these disparities.

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Organ transplantation has become a viable option for many advanced diseases. The global increases in organ transplantation are likely due to improved donor availability, transplant surgical technique, postsurgical care, and outcomes. Despite this progress, contemporary research

across the field of organ transplantation highlights the reduced access, longer wait to transplant, increased postoperative complications, and higher mortality rates in patients from minority and low socioeconomic groups, and women.<sup>1-3</sup> Disparities research in organ transplantation is critical for advancing care, as highlighted by several clinical trials in abdominal transplantation.<sup>4-7</sup> The lung transplantation field is notably smaller in relation to the heart or abdominal organs, but there are even fewer studies published focusing on this area, which impedes progress.<sup>2</sup> The

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limited research on disparities in lung transplantation stands in contrast to the comparatively larger research on disparities of pulmonary disease burden, access to treatment, and patient outcomes.<sup>8-14</sup>

Previous attempts have been made to reduce inequities in access to donor lungs in the United States (US). These include the implementation of the lung allocation score (LAS) in 2005 prioritizing access for sicker and older patients, the adjustment of the LAS in waitlist patients with idiopathic pulmonary artery hypertension,<sup>15</sup> and expanding the primary allocation unit for donor lungs from the local donation service area to a 250-nautical mile radius around the donor hospital.<sup>16</sup> However, these well-intended efforts may have led to untended consequences such as increasing costs, reduced efficiencies, and worsening access to short-stature individuals, and patients in need of multiorgan transplants.<sup>15,17</sup> Very recently, the Organ Procurement and Transplantation Network (OPTN) implemented a continuous allocation score (CAS) that takes donor and recipient factors into consideration, with the candidate's score changing with each donor-recipient match run.<sup>18</sup> In simulation models, CAS reduced geographic disparities, increased equity in organ allocation, and reduced waitlist mortality.<sup>19</sup> In contrast to these efforts, very few steps have been taken to improve access to the transplant waitlist. There is a critical need for systematic evaluation of patient-level and process-driven inequities across the continuum of lung transplant care—from waitlist access to postoperative health, ultimately to inform the development of strategic solutions.

In this perspective, we aim to highlight what is known about lung transplant inequities, identify the critical gaps in understanding, and propose strategies for the next steps toward mitigation. We outline this for 3 phases of lung transplant care: (1) the referral process, (2) the transplantation process (evaluation, listing, and allocation), and (3) post-transplant care. Our goal is to urge a systematic approach to lung transplant inequities research that facilitates individual, societal, and health system changes to meaningfully reduce disparities. We review the extent of this problem within the US with a brief global overview, highlighting common themes and issues unique to other countries.

## Road to referral: upstream factors that influence transplant care

It is important to recognize that health care disparities can impact patients before they ever enter transplant care. Disparities in other health care domains can have significant consequences that carry forward through the transplant care continuum. Any process that contributes to inequities in access to clean air, environmental exposures, diagnosis, and management of disease can drive inequities in access to lung transplant referrals. Populations with limited resources across the globe are disproportionately burdened with

chronic lung conditions resulting from early childhood disadvantages and exposure to environmental toxins, such as outdoor and indoor pollutants, pesticides, and smoking.<sup>13,20</sup> Additionally, patients from minoritized and low socioeconomic groups are known to experience delays in the diagnosis of chronic lung conditions, such as chronic obstructive pulmonary disease and sarcoidosis,<sup>21-23</sup> and reduced access to effective treatments, such as pulmonary rehabilitation.<sup>24</sup> These populations can also experience limited access to preventative strategies such as smoking cessation interventions<sup>25</sup> and poor treatment adherence<sup>26</sup> that can further contribute to higher morbidity and mortality rates.<sup>26</sup> Inequities in access to health care,<sup>27</sup> secondary to income and racial segregation in neighborhoods,<sup>28,29</sup> can adversely impact access to lung transplantation. A recent study in the US population demonstrates that median zip code income and geographic proximity of a lung transplant center were associated with a lower likelihood of receiving lung transplantation among patients with idiopathic pulmonary fibrosis (IPF).<sup>30</sup>

To help inform and standardize the referral process, the International Society for Heart and Lung Transplantation provides comprehensive, disease-specific lung transplant referral guidelines.<sup>31</sup> However, the processes of a referral including patient selection, initiation of the transplant referral, and following the center-specific guidelines fall solely on the local pulmonary providers, can be burdensome and resource-consuming. This point in care is likely one of the important drivers of inequities in access to lung transplantation, but data evaluating these referral processes systematically are sparse. Providers affiliated with a lung transplant center are more likely to refer due to familiarity with the referral process, as suggested in the above study of IPF patients.<sup>30</sup> For those who receive these referrals, further challenges exist for resource-limited populations such as unequal geographic access to transplantation programs, insurance coverage, limitations associated with Medicaid, relocation requirements, logistics, and financial costs for the patients and their caregivers. We argue that disparities in lung transplant reflect and are affected by health disparities more broadly. We call to the attention of lung transplant clinicians these parallels to encourage greater efforts by this community to ensure lung transplant research and care organizations treat equitable access as a priority shared by primary care physicians, pulmonologists, and transplant clinicians alike.

In [Table 1](#), we summarize current gaps in the referral process and recommend strategies for the next steps. Analysis of referral patterns, assessment of pulmonologists' experience in accessing transplant evaluations, their resource needs, and education needs could be crucial in improving access to lung transplant referrals for eligible candidates. A key limitation for the referral analyses is the lack of national or international lung transplant referral datasets. Establishing national lung transplant referral registries, compilation of all chronic lung disease registries, and potential linkage of these to the transplant registries could help mitigate this critical gap. Once these referral

**Table 1** Inequities in Lung Transplant Care Continuum

Inequities in lung transplantation	Knowledge gap	Proposed focus for future research
<i>Referral process</i>		
Referrals to lung transplantation do not reflect the demographic characteristics of advanced lung disease patients	<ul style="list-style-type: none"> <li>• National referral patterns are unknown</li> <li>• Rationale for provider referral, or lack thereof is unknown</li> <li>• Patient preferences for transplant are unknown</li> <li>• Transplant referral education and experience is unknown</li> </ul>	<ul style="list-style-type: none"> <li>• Building national lung transplantation referral datasets</li> <li>• Compilation and assessment of all chronic lung disease registries</li> <li>• Linking chronic lung disease registries to transplantation registries such as OPTN</li> <li>• Transplant organizations develop focused working groups to analyze referrals across lung transplant programs</li> <li>• Foster cross-collaboration among programs to address the geographic gap points</li> <li>• Develop robust referral pathways at the health systems level to assist referring providers in discussion of transplant as a treatment strategy</li> <li>• Pulmonary societies and organizations assess educational needs and review current guidelines for pulmonary care to include transplant as a potential treatment strategy</li> </ul>
<i>Transplantation process</i>		
Access to a transplant program and access to the transplant waitlist varies from center to center Lung transplant evaluations include social and economic reviews that could introduce bias and drive inequities Geographic variations in lung transplant evaluations can introduce unintended inequities	<ul style="list-style-type: none"> <li>• Lack of objective data or registry data to assess the extent of inequity in the lung transplant evaluation process</li> <li>• Many of the current assessments do not have validation studies on outcomes</li> <li>• Crucial data on access to a transplant program and waitlist is currently not captured by national registries</li> </ul>	<ul style="list-style-type: none"> <li>• Mandated reporting of waitlist denials for all programs</li> <li>• Minimizing variations and standardizing processes across the programs</li> <li>• Conduct validation research of current standardized assessments with a focus on outcomes</li> <li>• Linking unique patient identifiers to registries while ensuring data protection</li> </ul>
Racial, socioeconomic, and gender differences in waitlist mortality and access to organs	<ul style="list-style-type: none"> <li>• Unclear etiology of mortality differences</li> <li>• Unclear impact of donor allocation system changes</li> <li>• Causes for variability in donor acceptance are unknown</li> </ul>	<ul style="list-style-type: none"> <li>• Center-specific and national registry analysis to identify areas of opportunity</li> <li>• Focused efforts to follow recommendations of the “Realizing the Promise of Equity in the Organ Transplantation System”</li> </ul>
<i>Post-transplantation process</i>		
Racial, socioeconomic, and gender differences in outcomes after lung transplant Reported worst outcomes in recipients of donor lungs from minorities and women	<ul style="list-style-type: none"> <li>• Etiology and factors driving post-transplant mortality differences are unknown</li> <li>• Factors leading to worse outcomes associated with Black race and female gender are unknown</li> </ul>	<ul style="list-style-type: none"> <li>• Expansion of national registry data to include biological markers</li> <li>• Expanded collection of social determinants of health (SDOH) from national and international registries</li> <li>• Multilevel advocacy in addressing disparities in lung health before the transplant</li> <li>• Research studies focused on donor lung exposure to SDOH and associated outcomes</li> </ul>

Abbreviation: OPTN, Organ Procurement and Transplantation Network.

data are available, the health systems, transplant societies, and organizations, such as OPTN, could collaborate to analyze the datasets. Pulmonary societies could address the observed geographic gaps in lung transplant referrals through need-based interventions and advocacy. Pulmonary care guidelines may be opportune for informing educational needs at the health system, provider, and patient levels.

### Transplantation process: Evaluation, listing, and allocation

Race, ethnicity, and socioeconomic status can negatively impact the lung transplant evaluation process. An observational study of patients with cystic fibrosis and Medicaid insurance recipients demonstrated 1.56-fold

higher odds of not being accepted for lung transplant than patients without Medicaid.<sup>32</sup> Patients who did not complete high school and who reside in the lowest ZIP code median household income category experienced 2.37-fold and 1.39-fold higher odds respectively of not being accepted for a lung transplant. Additionally, race and ethnicity can negatively impact the psychosocial evaluation,<sup>32</sup> posing further barriers to being listed. Thus access to the waitlist after a referral is another understudied area. Practices vary from center to center and this crucial data are not captured by any national registries. This is a hidden driver of inequities in the field of lung transplantation and we propose mandated reporting of evaluation and listing data for all programs. This reported data, in turn, can improve transparency, provide a unique insight for health-system based research, and identify areas of opportunity to ensure equal access to lung transplant waitlists.

Once listed for transplant, disparities in access to lung allografts<sup>33,34</sup> as well as delisting or death after listing<sup>35</sup> have been observed among racial groups and women. These disparities are likely driven by differences in disease management, timing of referral, and transplant center evaluation and waitlist management practices.<sup>33</sup> A retrospective analysis of patients listed for lung transplant in the OPTN database from 1984 until 2019 reported that 51.7% of those listed were men. The median waitlist time for transplanted males was 43 days while for transplanted females it was 80 days. White patients accounted for 82.6% and 84.3% of listed and transplanted patients, respectively.<sup>36</sup> These findings persisted despite changes in donor allocation with the LAS<sup>33-35</sup> and were thought to be due to differences in disease severity at the time of listing. The LAS surprisingly did not account for sex-differences in allocation priority, in spite of documented differences in waitlist mortality.<sup>34</sup> Expansion of the primary allocation unit in 2017 from a donor service area to a 250-mile radius resulted in moderate improvements in waitlist outcomes, but significant geographic disparities persist.<sup>16</sup> The most recent adoption of the CAS promises to improve waitlist mortality, more equitable organ allocation, and reduction in geographic boundaries in simulation models,<sup>19</sup> but it is too early to assess its real impact on these inequities.

A recent report from the National Academies of Sciences, Engineering, and Medicine outlines wide and persistent disparities in access to the transplant waitlist, allocation, and transplantation of donor organs.<sup>37</sup> Their recommendations, although based on research in the field of abdominal transplant, are widely applicable to lung transplant. We believe the specific recommendations to expand data collection to include center-based evaluation processes, to improve equity in organ allocation algorithms, and to increase accountability declines for organ are important next steps toward equity in the field of lung transplantation. Efforts to increase transparency and accountability for organ offers and to establish informatics to track performance within and across centers would provide much needed data for mitigation strategies.<sup>37</sup>

## Life after transplant: Post-transplant care

Race and socioeconomic status can negatively impact post-transplant morbidity and mortality. A recent study evaluating 19,504 lung transplant donor and recipient pairs found that post-transplant mortality rates for non-Hispanic Black recipients are 18% higher than those for Hispanic recipients and 11% higher than those for non-Hispanic White recipients. As the authors point out, this disproportionately high mortality in non-Hispanic Black recipients may reflect the biological embodiment of social adversity across the life course.<sup>38</sup> Previous research also attributes low socioeconomic status or certain residential areas to high post-transplant mortality,<sup>39</sup> and higher need for aggressive postoperative interventions, such as dialysis in racial and ethnic minorities.<sup>40</sup>

Another area of potential inequity arises from intense post-transplant care. Lung transplant recipients experience shorter survival, frequent rejections, and infectious complications in comparison to abdominal organ transplantation.<sup>41</sup> This requires care at lung transplant centers indefinitely, as opposed to delegation to local providers. This system of centralized care can expose resource-limited lung transplant recipients to unintended and unrecognized inequities related to the cost of travel and caregiver lost wages. These can be mitigated with adequate preparation and planning for resources during the waitlisting process and harnessing the power of advanced technology such as virtual visits and remote digital monitoring.

## Global challenges

The 2021 Global Observatory on Donation and Transplantation data report an 8.9% increase in lung transplants globally. Austria, Belgium, and Canada report a higher number of lung transplants per million population in comparison to the US.<sup>42</sup> This data suggests better access across the continuum of care in these countries. A 2020 study evaluating the longitudinal data from the Canadian and US Cystic Fibrosis (CF) Foundation Registries reported lower 1-, 3-, and 5-year survival rates of 88.3%, 71.8%, and 60.3% in the US population, respectively, in comparison to 90.5%, 79.9%, and 69.7% rates in Canadians. Additionally, CF patients from the US experienced higher waitlist mortality, with an estimated 7.5 years of survival benefit to Canadian CF patients.<sup>43</sup> Another prospective cohort study evaluating fibrotic interstitial lung disease (FILD) outcomes reported that FILD in the US from areas with greater neighborhood-level disadvantage experience higher mortality and lower odds of lung transplantation. These disparities were not observed in Canadian FLID patients.<sup>44</sup> Further research addressing these adverse outcomes in the US population is warranted to close these gaps. European Society of Transplantation (ESOT) also brings to light the widespread inequities among European countries stemming

from varied awareness and education of health care professionals about lung transplantation and treatment, although further work is still needed to understand the factors that drive them. To address these inequities, ESOT plans to launch international data-driven registries, work with patient associations to establish a multilingual and culturally competent transplant information portal for patients, and develop an health care professional communication guide.<sup>45</sup> These international collaborations and registries can be crucial in advancing transplant research, clinical care, and the quick sharing of best practices globally.

Data in this area from Australia and New Zealand are sparse. However based on reports of poorer lung health in Indigenous populations than their non-Indigenous counterparts<sup>46</sup> and poor access to kidney transplantation,<sup>47</sup> it is possible that the Indigenous population may be experiencing disparities currently unrecognized. Thoracic transplant activities are rapidly growing in developing economies such as Brazil and India.<sup>42</sup> For these programs it will be particularly important to monitor new policies for emerging disparities or unintended consequences. African nations experience worse geographic disparities in access to solid organ transplants due to a lack of skilled workforce, infrastructure, and institutional support in program development.<sup>48,49</sup> Thus inequalities in access to lung transplantation exist globally in various forms and shapes and require an in-depth evaluation. The WHO task force plans to address these global challenges by developing a framework for the exchange of best practices and technical expertise to ensure proper care is delivered globally.<sup>50</sup> The international guidelines will be especially important for many countries with emerging transplant programs or without established programs but development plans in the future.

## Call for action

We ultimately believe that the medical and surgical scientific advancements in the field of lung transplantation would be futile if not accessible to those who need it the most. The time has come to apply the same scientific rigor and dollars to these inequities that we apply to medical risk factors and surgical techniques. With the recent Health Resources and Service Administration proposal of doubling the funding for organ procurement and transplantation to 67 million dollars and to modernize the OTPN, we should seize the opportunity to organize and focus research efforts related to access to lung transplantation.<sup>51</sup> The 2022 report from the National Academies is an excellent first step framework to address health inequities. In Table 1, we propose focused quality improvement and research efforts across the lung transplantation care continuum. These are built upon health equity research principles of a multilevel approach and intentional engagement with regulatory bodies, health systems, professional societies, and community-based organizations. With effective implementation, these interventions could be longitudinally sustainable and highly impactful in mitigating inequities among patients who would need a referral, and those who are actually referred to, evaluated for, waitlisted

for, or undergoing lung transplantation care (Table 1). A key component will be an investment in improved informatics systems at individual centers as well as national and international registries.

These US-based strategies, in collaboration with the action plan from ESOT, and the WHO framework of sharing best practices and technical experiences, can be instrumental in improving cross-collaboration among international programs, mitigating lung transplant inequities, and advancing care forward globally.

## Disclosure statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

During the preparation of this work, the author(s) used Grammarly free version and Microsoft Word for spelling, grammar, and punctuation corrections. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

## References

- Higgins R, Fishman J. Disparities in solid organ transplantation for ethnic minorities: facts and solutions. *Am J Transplant* 2006;6:2556-62.
- Park C, Jones MM, Kaplan S, et al. A scoping review of inequities in access to organ transplant in the United States. *Int J Equity Health* 2022;21:22. <https://doi.org/10.1186/s12939-021-01616-x>.
- Sawinski D, Lai JC, Pinney S, et al. Addressing sex-based disparities in solid organ transplantation in the United States - a conference report. *Am J Transplant* 2023;23:316-25. <https://doi.org/10.1016/j.ajt.2022.11.008>.
- Rodrigue JR, Pavlakis M, Egbuna O, Paek M, Waterman AD, Mandelbrot DA. The "House Calls" trial: a randomized controlled trial to reduce racial disparities in live donor kidney transplantation: rationale and design. *Contemp Clin Trials* 2012;33:811-8. <https://doi.org/10.1016/j.cct.2012.03.015>.
- Bornemann K, Croswell E, Abaye M, et al. Protocol of the KTFT-TALK study to reduce racial disparities in kidney transplant evaluation and living donor kidney transplantation. *Contemp Clin Trials* 2017;53:52-9. <https://doi.org/10.1016/j.cct.2016.11.011>.
- Gordon EJ, Uriarte JJ, Lee J, et al. Effectiveness of a culturally competent care intervention in reducing disparities in Hispanic live donor kidney transplantation: a hybrid trial. *Am J Transplant* 2022;22:474-88. <https://doi.org/10.1111/ajt.16857>.
- Gentry SE, Massie AB, Cheek SW, et al. Addressing geographic disparities in liver transplantation through redistricting. *Am J Transplant* 2013;13:2052-8. <https://doi.org/10.1111/ajt.12301>.
- Espinosa J, Raja S. Social disparities in benign lung diseases. *Thorac Surg Clin* 2022;32:43-9. <https://doi.org/10.1016/j.thorsurg.2021.09.006>.
- Brigham E, Allbright K, Harris D. Health disparities in environmental and occupational lung disease. *Clin Chest Med* 2020;41:623-39. <https://doi.org/10.1016/j.ccm.2020.08.009>.
- Gaffney AW, Hawks L, White AC, et al. Health care disparities across the urban-rural divide: a national study of individuals with COPD. *J Rural Health* 2022;38:207-16. <https://doi.org/10.1111/jrh.12525>.
- Lee YC, Chang KY, Mirsaeidi M. State-level health disparity is associated with sarcoidosis mortality. *J Clin Med* 2021;10:2366. <https://doi.org/10.3390/jcm10112366>.
- Sharp M, Eakin MN, Drent M. Socioeconomic determinants and disparities in sarcoidosis. *Curr Opin Pulm Med* 2020;26:568-73. <https://doi.org/10.1097/mcp.0000000000000704>.



13. Brakema EA, Tabyshova A, van der Kleij RMJJ, et al. The socioeconomic burden of chronic lung disease in low-resource settings across the globe – an observational FRESH AIR study. *Respir Res* 2019;20:291. <https://doi.org/10.1186/s12931-019-1255-z>.
14. Gaffney AW, Himmelstein DU, Christiani DC, Woolhandler S. Socioeconomic Inequality in Respiratory Health in the US From 1959 to 2018. *JAMA Intern Med* 2021;181:968-76. <https://doi.org/10.1001/jamainternmed.2021.2441>.
15. Weill D. Access to lung transplantation. the long and short of it. *Am J Respir Crit Care Med* 2016;193:605-6. <https://doi.org/10.1164/rccm.201511-2257ED>.
16. Benvenuto LJ, Anderson MR, Aversa M, et al. Geographic disparities in lung transplantation in the United States before and after the November 2017 allocation change. *J Heart Lung Transplant* 2022;41:382-90. <https://doi.org/10.1016/j.healun.2021.11.002>.
17. MacMurdo MG, Sweet SC. Impact and implications following the November 2017 Emergency Change to the United States Lung Allocation Policy. *Ann Am Thorac Soc* 2020;17:795-9. <https://doi.org/10.1513/AnnalsATS.201911-818PS>.
18. Organ Procurement & Transplant network (OPTN). Lung continuous distribution policy. <https://optn.transplant.hrsa.gov/professionals-by-organ/heart-lung/lung-continuous-distribution-policy/>.
19. Valapour M, Lehr CJ, Wey A, Skeans MA, Miller J, Lease ED. Expected effect of the lung Composite Allocation Score system on US lung transplantation. *Am J Transplant* 2022;22:2971-80. <https://doi.org/10.1111/ajt.17160>.
20. Levy JJ, Quirós-Alcalá L, Fabian MP, Basra K, Hansel NN. Established and emerging environmental contributors to disparities in asthma and chronic obstructive pulmonary disease. *Curr Epidemiol Rep* 2018;5:114-24. <https://doi.org/10.1007/s40471-018-0149-9>.
21. Vyas-Read S, Jensen EA, Bamat N, Lagatta JM, Murthy K, Patel RM. Chronic lung disease-related mortality in the US from 1999-2017: trends and racial disparities. *J Perinatol* 2022;42:1244-5. <https://doi.org/10.1038/s41372-022-01468-5>.
22. Hena KM. Sarcoidosis epidemiology: race matters. *Front Immunol* 2020;11:537382. <https://doi.org/10.3389/fimmu.2020.537382>.
23. Mamary AJ, Stewart JJ, Kinney GL, et al. Race and gender disparities are evident in COPD underdiagnoses across all severities of measured airflow obstruction. *Chronic Obstr Pulm Dis* 2018;5:177-84. <https://doi.org/10.15326/jcopdf.5.3.2017.0145>.
24. Oates GR, Hamby BW, Stepanikova I, et al. Social determinants of adherence to pulmonary rehabilitation for chronic obstructive pulmonary disease. *Copd* 2017;14:610-7. <https://doi.org/10.1080/15412555.2017.1379070>.
25. Browning KK, Ferketich AK, Salsberry PJ, Wewers ME. Socioeconomic disparity in provider-delivered assistance to quit smoking. *Nicotine Tob Res* 2008;10:55-61. <https://doi.org/10.1080/14622200701704905>.
26. Dransfield MT, Bailey WC. COPD: racial disparities in susceptibility, treatment, and outcomes. *Clin Chest Med* 2006;27:463-71. <https://doi.org/10.1016/j.ccm.2006.04.005>.
27. Gaskin DJ, Dinwiddie GY, Chan KS, McCleary RR. Residential segregation and the availability of primary care physicians. *Health Serv Res* 2012;47:2353-76. <https://doi.org/10.1111/j.1475-6773.2012.01417.x>.
28. Anderson KF. Racial residential segregation and the distribution of health-related organizations in urban neighborhoods. *Soc Prob* 2017;2017:256-76.
29. Watson T. Inequality and the measurement of residential segregation by income in American neighborhoods. *Rev Income Wealth* 2009;55:820-44.
30. Swaminathan AC, Hellkamp AS, Neely ML, et al. Disparities in lung transplant among patients with idiopathic pulmonary fibrosis: an analysis of the IPF-PRO Registry. *Ann Am Thorac Soc* 2022;19:981-90. <https://doi.org/10.1513/AnnalsATS.202105-589OC>.
31. Orens JB, Estenne M, Arcasoy S, et al. International guidelines for the selection of lung transplant candidates: 2006 update—a consensus report from the Pulmonary Scientific Council of the International Society for Heart and Lung Transplantation. *J Heart Lung Transplant* 2006;25:745-55. <https://doi.org/10.1016/j.healun.2006.03.011>.
32. Quon BS, Psoter K, Mayer-Hamblett N, Aitken ML, Li CI, Goss CH. Disparities in access to lung transplantation for patients with cystic fibrosis by socioeconomic status. *Am J Respir Crit Care Med* 2012;186:1008-13. <https://doi.org/10.1164/rccm.201205-0949OC>.
33. Mooney JJ, Hedlin H, Mohabir P, Bhattacharya J, Dhillon GS. Racial and ethnic disparities in lung transplant listing and waitlist outcomes. *J Heart Lung Transplant* 2018;37:394-400. <https://doi.org/10.1016/j.healun.2017.09.017>.
34. Riley LE, Lascano J. Gender and racial disparities in lung transplantation in the United States. *J Heart Lung Transplant* 2021;40:963-9. <https://doi.org/10.1016/j.healun.2021.06.004>.
35. Lederer DJ, Caplan-Shaw CE, O'Shea MK, et al. Racial and ethnic disparities in survival in lung transplant candidates with idiopathic pulmonary fibrosis. *Am J Transplant* 2006;6:398-403. <https://doi.org/10.1111/j.1600-6143.2005.01205.x>.
36. Riley LE, Lascano J. Gender and racial disparities in lung transplantation in the United States. *J Heart Lung Transplant* 2021;40:963-9. <https://doi.org/10.1016/j.healun.2021.06.004>.
37. National Academies of Sciences, Engineering, and Medicine. A Fairer and More Equitable, Cost-Effective, and Transparent System of Donor Organ Procurement, Allocation, and Distribution. 2022.
38. Lehr CJ, Valapour M, Gonsalus PR, et al. Association of socioeconomic position with racial and ethnic disparities in survival after lung transplant. *JAMA Netw Open* 2023;6:e238306. <https://doi.org/10.1001/jamanetworkopen.2023.8306>.
39. Allen JG, Weiss ES, Merlo CA, Baumgartner WA, Conte JV, Shah AS. Impact of donor-recipient race matching on survival after lung transplantation: analysis of over 11,000 patients. *J Heart Lung Transplant* 2009;28:1063-71. <https://doi.org/10.1016/j.healun.2009.06.012>.
40. Banga A, Mohanka M, Mullins J, et al. Characteristics and outcomes among patients with need for early dialysis after lung transplantation surgery. *Clin Transplant* 2017;31. <https://doi.org/10.1111/ctr.13106>.
41. Erasmus ME, van der Bij W. Death after lung transplantation: improving long term survival despite perilous early postoperative years. *Transpl Int* 2020;33:128-9. <https://doi.org/10.1111/tri.13553>.
42. Transplantation WcCoDa. Global Observatory on Donation and Transplantation (GODT). Available at: <https://www.transplant-observatory.org/2021-global-report-5/>, accessed September 25, 2023.
43. Stephenson AL, Ramos KJ, Sykes J, et al. Bridging the survival gap in cystic fibrosis: an investigation of lung transplant outcomes in Canada and the United States. *J Heart Lung Transplant* 2021;40:201-9. <https://doi.org/10.1016/j.healun.2020.12.001>.
44. Goobie GC, Ryerson CJ, Johansson KA, et al. Neighborhood-level disadvantage impacts on patients with fibrotic interstitial lung disease. *Am J Respir Crit Care Med* 2021;205:459-67. <https://doi.org/10.1164/rccm.202109-2065OC>.
45. The European Society for Organ Transplantation. New ESOT manifesto – tackling inequalities in organ transplantation: a pathway forward. Available at: <https://esot.org/esot-manifesto/>, accessed August 22, 2023.
46. Chang AB, Marsh RL, Upham JW, et al. Toward making inroads in reducing the disparity of lung health in Australian Indigenous and New Zealand Māori children. *Front Pediatr* 2015;3:9. <https://doi.org/10.3389/fped.2015.00009>.
47. Khanal N, Lawton PD, Cass A, McDonald SP. Disparity of access to kidney transplantation by Indigenous and non-Indigenous Australians. *Med J Aust* 2018;209:261-6. <https://doi.org/10.5694/mja18.00304>.
48. Awuah WA, Ng JC, Bulut HI, et al. The unmet need of organ transplantation in Africa. *Int J Surg* 2023;109:519-20. <https://doi.org/10.1097/js9.0000000000000025>.
49. Chan-on C, Sarwal MM. A comprehensive analysis of the current status and unmet needs in kidney transplantation in Southeast Asia. *Front Med* 2017;4:84. <https://doi.org/10.3389/fmed.2017.00084>. 2017-June-23, Published 2017 Jun 23.
50. World Health Organization. Human organ and tissue transplantation Report by the Director-General. Available at: [https://apps.who.int/gb/ebwha/pdf\\_files/WHA75/A75\\_41-en.pdf](https://apps.who.int/gb/ebwha/pdf_files/WHA75/A75_41-en.pdf), accessed August 22, 2023.
51. Services USDoHaH. HRSA Announces Organ Procurement and Transplantation Network Modernization Initiative. Available at: <https://www.hhs.gov/about/news/2023/03/22/hrsa-announces-organ-procurement-transplantation-network-modernization-initiative.html>, accessed September 26, 2023.