Title: Donor's long-term quality of life following living-donor lobar lung transplantation

Short running title: Living lung donor's quality of life

Key Words: health-related quality of life, living lung donor, long-term postoperative outcome, lung transplantation, Short Form 36

Authors: Kento Fujii, (ORCID: https://orcid.org/0000-0003-3703-846X)[1, 2], Shin Tanaka, (ORCID: https://orcid.org/0000-0002-0014-9230)[1, 2], Megumi Ishihara[1], Kei Matsubara[1], Kohei Hashimoto[1], Shuji Okahara, (ORCID: https://orcid.org/0000-0003-1188-158X)[3], Kazuhiko Shien, (ORCID: https://orcid.org/0000-0002-4959-4220)[1], Ken Suzawa (ORCID: https://orcid.org/0000-0003-2463-9696)[1], Kentaroh Miyoshi, (ORCID: https://orcid.org/0000-0001-9598-840X)[1], Shinji Otani, (ORCID: https://orcid.org/0000-0002-5462-2919)[4], Hiromasa Yamamoto, (ORCID: https://orcid.org/0000-0002-5330-5460)[1], Mikio Okazaki, (ORCID: https://orcid.org/0000-0002-7202-244X)[1], Seiichiro Sugimoto, (ORCID: https://orcid.org/0000-0001-6649-4777)[1, 2], Masaomi Yamane (ORCID:

https://orcid.org/0000-0002-7649-5738)[5], Shinichi Toyooka (ORCID:

https://orcid.org/0000-0002-7588-6745)[1, 2]

Affiliations:

[1]Department of General Thoracic Surgery and Organ Transplant Center, Okayama University Hospital, Okayama, Japan

[2]Department of General Thoracic Surgery and Breast and Endocrinological Surgery, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama, Japan

[3]Department of Anesthesiology and Resuscitology, Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences, Okayama University, Okayama, Japan

[4]Department of Cardiovascular and Thoracic Surgery, Ehime University Hospital, Ehime, Japan

[5]Thoracic Surgery, Shimane University Hospital, Shimane, Japan

Correspondence: Shin Tanaka, MD

Department of General Thoracic Surgery and Organ Transplant Center, Okayama University Hospital

2-5-1 Shikatacho, Kita-ku, Okayama, 700-8558, Japan

TEL: +81-86-235-7265, FAX: +81-86-235-7269

E-mail: shin-tnk-5@s.okayama-u.ac.jp

Authors' surnames and initials: Fujii K, Tanaka S, Ishihara M, Matsubara K, Hashimoto K, Okahara S, Shien K, Suzawa K, Miyoshi K, Otani S, Yamamoto H, Okazaki M, Sugimoto S, Yamane M, Toyooka S

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List of abbreviations for the article

BMI, body mass index; BP, bodily pain; GH, general health; HRQOL, health-related quality of life; LAS, lung allocation score; LDLLT, living-donor lobar lung transplantation; MCS, mental component summary; MH, mental health; mMRC, modified Medical Research Council; NRS, numerical rating scale; OR, odds ratio; PCS, physical component summary; PF, physical functioning; RCS, role/social component summary; RE, role-emotional; RP, role-physical; SF, social functioning; SF-36, 36-Item Short Form Health Survey; VT, vitality

ABSTRACT

Introduction: Living-donor lobar lung transplantation is an alternative procedure to deceased donation lung transplantation. It involves graft donation from healthy donors;

however, only a few reports have discussed its long-term prognosis in living lung donors and their associated health-related quality of life. This study aimed to examine living lung donors' health-related quality of life.

Methods: In our cross-sectional survey of living lung donors, we assessed health-related quality of life based on three key aspects (physical, mental, and social health) using the 36-Item Short Form Health Survey. We also evaluated chronic postoperative pain and postoperative breathlessness using the numeric rating scale and the modified Medical Research Council Dyspnea scale, respectively.

Results: We obtained consent from 117 of 174 living lung donors. The average scores of the living lung donors on the 36-Item Short Form Health Survey were higher than the national average. However, some donors had poorer physical, mental, and social health, with lower summary scores than the national averages. Low mental component summary predictors included donor age (<40 years; odds ratio=10.2; p<.001) and recipient age (<18 years; odds ratio=2.73; p<.032). Low role-social component summary predictors included high lung allocation score (≥50; odds ratio=3.94, p<.002) and recipient death (odds ratio=3.64; p=.005). There were no predictors for physical component summary. Additionally, many donors did not complain of pain or dyspnea.

Conclusions: Living lung donors maintained acceptable long-term health-related quality of life after surgery. Potential donors should be informed of relevant risk factors, and high-risk donors should receive appropriate support.

Keywords: donor selection, Japan, living donors, lung transplantation, personal satisfaction, postoperative complications, quality of life, risk factors

Author to whom requests for offprints should be sent:

Kento Fujii

Department of General Thoracic Surgery and Organ Transplant Center, Okayama University Hospital

2-5-1 Shikatacho, Kita-ku, Okayama, 700-8558, Japan

TEL: +81-86-235-7265, FAX: +81-86-235-7269

Social Media: Living lung donors in Japan maintained good long-term HRQOL after transplantation. However, some had risks of poor HRQOL, such as recipient death, lung allocation score, and donor and recipient age.

1. INTRODUCTION

Living-donor lobar lung transplantation (LDLLT) is a procedure of organ donation from a healthy donor to a recipient with advanced lung disease or emergent respiratory disease.[1,2] LDLLT was first developed and performed in the United States of America (USA) approximately 30 years ago.[3] However, because of the expanded utilization of the lung allocation scoring system and expanded donation after circulatory death,[4,5] LDLLT is currently rarely performed in the USA and is only performed in a few other countries.[6,7] However, in Japan, LDLLT remains a practical option and has been performed in one-third of lung transplantation procedures since the 1990s instead of deceased donor lung transplantation.[8,9] This finding is partly because deceased lung donors are scarce, resulting in high waiting list-related mortality.[10,11]

A standard LDLLT requires the right lower and left lower lobes from two healthy donors; both grafts are then implanted as the new recipient's right and left lungs.[12,13] This procedure has a good indication for children and female patients with relatively small stature. Compared with deceased donor lung transplantation, LDLLT provides similar rates of survival for the recipient.[14,15] However, donor surgery gives living lung donors the risk of morbidity and mortality, without any medical benefits. Regarding the

safety of living lung donors, previous studies have reported low morbidity without mortality.[16,17]

Although potential LDLLT donors are informed about the short- and long-term donor prognosis, such as low morbidity and mortality risks, they can only avail of evidence regarding short-term health-related quality of life (HRQOL) from postoperative donors.[18-20]

HRQOL refers to more than the absence of illness; it includes multidimensional elements of well-being such as the psychological state, social relationships, and life satisfaction. Previous reports have demonstrated that the average HRQOL of donors after LDLLT was better than the national standard and identified that recipient death and donor-recipient relationships were risk factors for the donor's mental state.[19] Another effect of living-donor lobectomy was worsening dyspnea. Although postoperative pulmonary function, such as forced vital capacity and forced expiratory volume in one second, recovered to more than 80% of those preoperatively, some donors had worsening dyspnea.[20,21]

Nevertheless, these studies included a small sample size and short follow-up periods. Potential donors should be given more detailed information about postoperative HRQOL based on statistical data from larger samples with longer survey periods. We

expected that the long-term postoperative HRQOL of most donors that were healthy before the surgery would remain good, but also that donor surgery may have some long-term postoperative risks of poor HRQOL, and that other recipient and donor factors may also be correlated with the living lung donors' HRQOL. Therefore, we aimed to examine living lung donor HRQOL following a long-term follow-up period of up to 20 years, and to identify risk factors for poor HRQOL. We also expected that outcomes related to HRQOL would include chronic pain from the surgical wound and dyspnea related to activities of daily living. Thus, we investigated the degree of respiratory distress and chronic postoperative pain as secondary long-term outcomes in postoperative living lung donors.

2. MATERIALS & METHODS

We conducted a cross-sectional survey. Our participants were living lung lobar donors at the Okayama University Hospital. Overall, 96 LDLLTs were performed between October 1998 and December 2019, including 78 bilateral, 14 unilateral, 2 bilateral segmental (the donor's lower lobe was separated into two segments and transplanted to the left and right sides of the recipient),[22] and 2 hybrid lung transplants (one side was implanted with a living donor's lung lobe and the other side with a deceased donor's lung lobe).[23]

We surveyed and invited the 174 donors who donated living lobar lungs to participate in this study. The donor selection procedure followed conventional criteria (Table 1). In principle, living donors were limited to adults aged 18 to 60 years and members of the recipients' family: relatives within the third degree of kinship and spouses. Living donors had to be healthy; for instance, they should have no systemic infection, no malignancy, and no comorbidities that may increase mortality associated with donor surgery. Donor surgical management has been described previously.[24] We obtained the characteristics and outcome data of both the donor and recipient from our prospectively maintained database and clinical records. The questionnaire survey was conducted from August to December 2021.

We used the short form 36 (SF-36) health survey questionnaire to estimate the donors' HRQOL. The SF-36 is a general and straightforward questionnaire for measuring HRQOL.[25,26]

The SF-36 has been used in the HRQOL survey for living organ donors, including living lung, living liver, and living kidney donors.[27-30] The SF-36 has 36 questions. The questions are subdivided into the following eight subscales: physical functioning (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (VT), social

functioning (SF), role-emotional (RE), and mental health (MH).[25,31] Based on these subscales, HRQOL can be evaluated using three summary component scores.

Unlike previous studies, we used a three-component model instead of the two-component model that is conventionally used, with its validity confirmed in Western countries.[32] This is because in Asian countries, including Japan, the factor structure of the SF-36 differs from other countries.[30] Therefore, the three components were reconstituted by adjusting the composition and weighting of subscales based on the national norm in Japan. The three-component model has been proven to have a higher validity for Japanese populations than the two-component model.[25]

The physical component summary (PCS) is one of the summary components primarily contributed by the PF subscale with other constituents from the RP, BP, GH, VT, and SF subscales. The second score is a mental component summary (MCS) based primarily on the MH subscale, as well as on the BP, GH, VT, and RE subscales. The third score is a newly created role/social component summary (RCS), which includes the RP, SF, and RE subscales, as well as the GH one.[26] The scores of the PCS and MCS components were used in a previous study; herein, we evaluated HRQOL by using three components, with the addition of the RCS.[19, 20] Higher component scores indicate better HRQOL in each category. The data values were converted into norm-

based scoring data. The mean of the national population score was expressed as 50 points, with one standard deviation being a difference of 10 points from the mean. Many donors had a good HRQOL, higher than the national average. Contrarily, some donors reported poor HRQOL, which was the most notable finding of this study. We defined poor HRQOL as low PCS, MCS, or RCS scores below the national population average of 50, and aimed at identifying the risk factors associated with poor HRQOL.

In addition, in cases for which both the left and right donors participated in this study, we investigated whether there were any notable differences in HRQOL between donors to the same recipient.

Moreover, we simultaneously investigated other scales for pain and dyspnea. Thus, we evaluated the intensity of chronic postoperative pain using the numeric rating scale (NRS). The donors selected a whole number from 0, representing no pain, to 10, representing the worst possible pain.[33] We quantified the donor's postoperative breathlessness in daily life using the modified Medical Research Council (mMRC) Dyspnea Scale. This is an evaluation scale from grade 0 to 4 reflecting the disability of daily life attributable to dyspnea (with higher values corresponding to more severe dyspnea).[34]

All living-donor selections adhered to the International Society for Heart and Lung Transplantation ethics statement. The Okayama University Hospital Ethics Committee approved this research on June 25, 2021 (approval number 1905-022). We obtained informed consent from all participants, as required by the study-authorizing entity.

2.1. Statistical analysis

We used the Mann–Whitney U test to compare each summary score by donor or recipient factors mentioned in previous studies (donor's age, sex, donor body, adverse postoperative events, years after surgery, donor-recipient relationship, and recipient death).[19,20] In this study, we also analyzed other factors likely to affect the physical score, such as BMI and smoking history, and hypothesized that not only the recipient's postoperative outcome but also their preoperative characteristics, such as the recipient's age and lung allocation score (LAS), would be relevant. Moreover, we focused on those with poor HRQOL, defined as a summary score of less than 50, as a high-risk group and performed a univariate analysis using Fisher's exact tests to determine the relationship of each low component summary score with donor and recipient characteristics. Logistic regression analysis was subsequently performed considering possible interrelationships between variables, including the factors for which the univariate

analysis suggested a relative association even though this might not be statistically significant ($p<.20$). Statistical significance was set at $p<.05$.

We also performed the Mann–Whitney U test to investigate whether attributes between donors affect the difference in scores between left and right donors. Finally, we compared the averages of NRS and mMRC scores for each categorical variable using the Mann–Whitney U test. The JMP® 16 (SAS Institute Inc., Cary, NC, USA) software was used for all statistical analyses in this study.

3. RESULTS

The preoperative characteristics of the donors and recipients are summarized in Table 2. Consent was obtained from 117 out of 174 donors. Three donors were dead at the time of the survey. Response rate was higher for donors of living recipients compared to donors of deceased recipients (73.2% vs 56.4%, OR: 2.10, $p=.028$). The donors who participated in the survey were involved in 72 LDLLTs (59 double, 10 single, 1 bilateral segmental, and 2 hybrid lung transplants). There were 63 right donors and 54 left donors, and one of the right donors donated his right middle lobe. For 45 LDLLTs, both the left and right donors participated in this study. The median postoperative follow-up period was 12 years (interquartile range, 7 to 17). No donor had life-threatening postoperative complications; however, 36 (30.8%) experienced adverse postoperative

events. Of these, nine donors had major complications according to the Clavien–Dindo classification grades II and IIIa (three wound complications: separation, infection, and contact dermatitis; one pneumonia; one bronchitis; two pulmonary fistulae; one delayed pneumothorax; and one empyema). The donor-recipient relationship consisted of parents (51 cases), children (17 cases), siblings (33 cases), spouses (13 cases), and others (3 cases).

The donors of 48 female and 24 male recipients participated in this study. The median donor and recipient ages at the time of transplantation were 38 (interquartile range, 31 to 46) and 29 (interquartile range, 13 to 40) years, respectively. Thirty-five donors donated to minor recipients under the age of 18 years. The median LAS of the recipients was 45.7 (interquartile range, 38.3 to 56.3), and 28 (38.9%) of them had a high LAS (≥50). Of the 72 recipients 20 (28%) died after LDLLT, and 35 donors experienced the death of their recipient. The 3-year and 5-year survival rates of the recipients involved in this study were 96.8% and 86.9%, respectively, and their median survival time was 14.6 years. Contrarily, the recipient's survival was 54.2% in the cases for which neither the left- nor the right-side donors participated in this study.

The majority of donors scored above the national standard values on each SF-36 subscale and component summary score, and the averages of the donor scores were

higher than the national average. The summary scores for each postoperative year are shown in Figures 1A, B, and C. PCS ranged from 29.7 to 75.5, and the average PCS value for each postoperative time was around the national average (Figure 1A). The mean PCS score of all donors was 52.6 points, which was higher than the national average. Thirty-eight (32.4%) donors had poor PCS scores. Regarding MCS, the donors scored from 29.0 to 72.5, with an average of 55.0.

Most groups by postoperative years showed a good average, higher than the national standard (Figure 1B). The overall average value was 55.0 points, ranging from 29.0 to 72.5. The number of donors with poor MCS scores was 31 (26.4%).

The mean value of RCS also exceeded the population average at each measured time point (Figure 1C). The overall mean value of RCS was 51.7, with a minimum of 12.8, and a maximum of 68.8. The number of donors with low RCS scores was 29 (24.8%).

Table 3 shows comparisons of the mean HRQOL scores for each characteristic, analyzed using the Mann–Whitney U test. Donors aged over 40 years had better MCS scores (p=.036). Although not significant, donors for recipients aged under 18 years tended to have worse MCS scores (p=.084). Donors of high LAS (≥50) recipients had

significantly higher MCS scores (p=.026). In contrast, a high LAS was significantly associated with a lower RCS score (p<.001).

The significant predictors of poor summary scores for the three components are reported in Table 4. The univariate analysis revealed no predictor associated with low PCS. The donor's age (<40 years) and recipient's age (<18 years) were risk factors for low MCS (odds ratio [OR]=10.24, p<.001 and OR=2.73, p=.032, respectively). Donors of high LAS (≥50) recipients tended to have lower risk of low MCS (OR=0.46, p=.12) than donors of low LAS recipients. In contrast, a high LAS was a risk factor for low RCS (OR=3.94, p=.002). Another factor associated with poor RCS was recipient death (OR=3.64, p=.004).

In multivariate analysis, younger donor age was significantly associated with the risk of low MCS (OR=9.78, p<.001). Risk factors for low RCS were a high LAS (OR=2.72, p=.038) and recipient death (OR=2.79, p=.036). Furthermore, MCS was significantly poorer in donors evaluated less than 1 year after the recipient's death compared with other donors (OR=21.24, p=.017); however, there was no significant difference in MCS scores between donors when divided into two groups by other years after the recipient's death (5 years: OR=0.73, p=.76; and 10 years: OR=1.15, p=.81).

Donors who experienced recipient death reported poor RCS, regardless of the number of years since the recipient's death (1 year, OR=6.44, p=.15; 2 years, OR=22.70, p<.001; 5 years, OR=5.21, p=.006; and 10 years, OR=2.55, p=.048).

For 45 LDLLT cases, both left and right donors participated in this study. In each summary score, some differences between left and right donors were observed. The average of score differences between left and right donors was 7.85±7.83 in PCS, 8.11±6.57 in MCS, and 6.74±8.69 in RCS. Table 5 shows the differences in each summary score due to differences in attributes between left and right donors.

The mean of differences in MCS was significantly greater in the group with more than 10-year age difference between left and right donors (p=.034). Moreover, MCS differences tended to be low when both donors were first-degree relatives(p=.038). Contrarily, differences in the donor's characteristics were not significantly associated with differences in PCS and RCS.

The intensity of postoperative pain was assessed using NRS, and 58% of donors reported no pain. Another 5% of patients presented with a moderate degree of pain (NRS scores, 4–6), and 37% had a mild degree of pain (NRS scores, 1–3). Although postoperative years did not significantly affect the physical score, NRS scores ≥10 years after surgery (n=72) were significantly lower than those within 10 years (n=45; p=.005).

None of the donors had clinically significant dyspnea on exertion (mMRC score, ≥3). Overall, 38% of donors had mild dyspnea (mMRC score, 1–2), whereas the others had no dyspnea. The mMRC score in female donors was slightly worse than that in male donors (0.53 vs. 0.24, p=.002).

4. DISCUSSION

This study showed that many living lung donors had higher HRQOL than the national population in the short-term to long-term after surgery, providing more evidence regarding the acceptability of this life-saving technique for those with severe respiratory conditions who would otherwise die waiting for a deceased lung donation. The findings of this study suggest that living lung donor lobectomy and lung donation may not adversely affect long-term HRQOL in many donors. Moreover, this study surveyed a larger sample size and included more extended postoperative periods (up to 20 years) than previous studies. In addition to the variables investigated in previous studies, we analyzed other recipient factors and clarified the risk factors for poor HRQOL, including LAS, recipient death, and recipient age. Prager et al. reported that 15 donors, assessed 5–10 years after LDLLT, scored well above the national average on the eight scales of the SF-36.[18] Nishioka et al. demonstrated that the average HRQOL of 42 donors up to 6 years after lobectomy exceeded the Japanese standard values and that

recipient death was significantly associated with the donors' poor mental health.[19] More recently, Chen et al. reported that 33 donors showed good SF-36 subscale values 1 year after donation, and the donors who experienced recipient death reported lower SF-36 scores. To our knowledge, there are no long-term follow-up studies on postoperative HRQOL in living lung donors.[20]

The most important contribution of this research is the revelation of predictors for poor HRQOL in the long term after living lobar lung donation. Although the overall scores of SF-36 were above the national average, donors with certain predictive factors had MCS or RCS scores below the general average.

Previous studies have elucidated that the recipient's death impacts the donor's HRQOL. In the univariate and multivariate analyses of this long-term study, recipient death was significantly associated with poor RCS, regardless of the number of years since death. The fatal outcome for recipients may adversely affect the donor's long-term HRQOL. However, there was no significant difference in the average score of donors of living recipients and deceased recipients. This may be due to underestimation owing to the lower survey response rate among donors of deceased recipients. On the other hand, recipient death was not associated with long-term MCS outcome but with short-term

outcome after the recipient's death. This result is in line with that reported by Nishioka et al.[19]

Donors of high LAS recipients represented another interesting group in this study. This group showed significant differences in all statistical tests in this study. Notably, a high preoperative recipient LAS was a risk factor for poor donor RCS. Although recipients with a higher LAS tend to have worse outcomes, including death, the multivariate analysis in this study suggested that a high LAS itself may be a risk factor for low RCS, independent of recipient death. LAS represents the clinical acuity and severity of lung disease.[35,36] In addition to the donor's surgery, this may lead to extra burdens, including daily nursing or care of the recipient, resulting in a decline of the donor's social well-being. Additionally, donors typically have to decide to donate their lung lobar within a limited time, because LDLLTs are often performed as an emergency life-saving procedure for recipients with a high LAS. This may result in some regret in the long term after surgery, even if the donors are not directly involved in the recipients' daily care. Contrarily, the high LAS group had a significantly better average MCS score. Donating to a critically ill recipient, indicated by a high LAS, may contribute to donor satisfaction.

Other predictive factors for a poor MCS were donor and recipient ages. Younger donor or recipient age may cause a poor mental state in the donor. The donor group aged under 40 years had a significantly lower mean MCS value and was significantly associated with poor MCS scores. MCS scores, even for Japanese national standards, tended to be lower in younger age groups. The age of donors appeared to contribute to their mental stability. Furthermore, the greater the age difference between the left and right donors donating to the same recipient, the greater the difference in mental score. This result also seemed to suggest that a better MCS score was attributed to older age. If several relatives match donor selection criteria, the recipient and their relatives may need to consider the donor's age. Regarding recipient age, a preoperative age of under 18 years was significantly associated with poor MCS, although only in Fisher's exact test. In Japanese pediatric recipients, LDLLT has been the main alternative procedure to pediatric deceased donor lung transplantation because deceased pediatric donors are still fewer than deceased adult donors.[22] Donors for pediatric recipients may experience psychological, ethical, and time pressures and anxiety about recipient future. Although this result suggests that donating to a child poses a greater psychological risk than donating to an adult, another study found that the lifetime prevalence of mental disorders is lower in donors to pediatric recipients than in the general population. Thus,

donating to pediatric patients may not be a negative factor for LDLLT.[37] Therefore, the age of the recipient may not be as important for the donor's mental state as the age of the donor.

Regarding donor-recipient relationships, we were unable to show that the type of relationship predicted poor HRQOL significantly. Contrarily, the score difference between left and right donors for the same recipients was greater, except when both donors were first-degree relatives. Even for the same recipient, the two donors may have gotten different satisfaction or gratitude for the donation from the recipient and other family members, depending on differences in their relationship with the recipient.

We could not identify any PCS-related risk factors. Postoperative complications were not a significant risk factor for poor HRQOL. Even when donating organs to the same recipient, there was no significant difference between donors who experienced complications and those who did not. The mean NRS score was not high and improved over time; therefore, postoperative pain was not a significant disadvantage of donor surgery. Although respiratory distress was significantly different between men and women, it hardly interfered with their daily lives. The results showed almost no deterioration when compared with those of a short-term follow-up study.[20]

This study had few limitations. First, the cross-sectional nature of this study prevented us from investigating HRQOL changes over time in the same donor. Moreover, when the preoperative HRQOL was very good, it is possible that it remained above average after surgery despite worsening post donation. Therefore, we should be cautious in drawing the conclusion that donor surgery did not adversely affect donor HRQOL. In that regard, further investigation over time since pre-transplantation is needed. However, as far as we are aware, this study is the first to evaluate long-term postoperative HRQOL in living lung donors.

Second, this study had some selection biases. When the donor's telephone number or address changed from that at the time of surgery, we contacted them through a living recipient. Therefore, we could not contact donors whose recipients had died. Moreover, some donors who experienced their recipient's death refused to participate in the study, replying that they did not want to be involved anymore. These selection biases may lead to an underestimation of the adverse effects of recipient death on poor HRQOL.

5. CONCLUSIONS

Our study suggests that the donor's HRQOL after living lung donation remains good, even in the long term. Most donors maintained their well-being above that of the

normative population at any time in the postoperative period. We identified new risk factors for donor HRQOL. In addition to the recipient's fatal outcome, preoperative recipient factors, including LAS and recipient age, may affect donor HRQOL. This information may help donor selection and donor candidate considerations ahead of providing informed consent. Furthermore, better-powered and longer-term studies should be conducted across different cultural groups to understand the factors contributing to donor well-being and improve HRQOL in LDLLT donors.

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AUTHOR CONTRIBUTIONS

KF, ST, SO, SS, and MY designed this study. KF, ST, MI, KM, KH, and SS participated in the data collection. KF, ST, and SO conducted data analysis and interpretation. KF, ST, and SS participated in writing the paper. KS, KM, SO, HY, MO, SS, MY, and ST confirmed the content and structure of the manuscript. All authors contributed to the writing of the manuscript and approved the final version.

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FIGURE LEGEND

FIGURE 1 Box plots representing each summary score (PCS, MCS, and RCS), as well as the corresponding tables showing percentages of low scores by postoperative years. Center lines show the medians; box limits indicate the 25th and 75th percentiles. Dot plots represent all the data on the timeline, and red lines indicate the national average. Whiskers extend from each quartile to the minimum or maximum value. Red lines show the national average. MCS, mental component summary; PCS, physical component summary; RCS, role/social component summary

TABLES

TABLE 1 Selection criteria for living lobar lung donation

- Relatives within the third degree or a spouse
- Age, 18–60 years
- ABO identical or compatible
- No significant medical history or active medical problems
- No recent viral infection
- No abnormalities on electrocardiogram and echocardiogram
- No significant pulmonary pathology on computed tomography on the donor side
- Arterial oxygen tension ≥80 mmHg
- Forced vital capacity, forced expiratory volume in 1 second ≥85% of predicted
- No previous thoracic operation on the side to be donated
- Non-smokers (if current smokers, cessation of smoking is required at the time of the offer for donation and continuous cessation is required after donor lobectomy)
- Absence of coercion
- Satisfactory psychosocial evaluation

TABLE 2 Donors' characteristics

Donor characteristics	Values
Sex	
Male	59 (50.4)
Female	58 (49.6)
Donor age (years)	38.7 ± 10.1
Body mass index (kg/m^2)	
<25	92 (78.6)
≥25	25 (21.4)
Smoking history	53 (45.9)
Adverse postoperative event	36 (30.8)
Postoperative years	12.1 ± 5.7
Recipient age (years)	29.0 ± 15.8
Lung allocation score	51.4 ± 16.2
Donor-recipient relationship	
Parent	51.4 (16.2)
Child	17 (14.5)
Spouse	13 (11.1)
Siblings	33 (28.2)
Other relatives	3 (2.6)

All values are reported as n (%) or mean ± standard deviation.

TABLE 3 Comparison of HRQOL scores for each characteristic

Variable		N	Mean	p-value
PCS: Physical Component Summary				
Donor age (years)	<40	69	62.5	.17
	≥40	48	53.9	
Sex	Male	59	63.4	.15
	Female	58	54.4	
BMI (kg/m^2)	<25	92	60.8	.25
	≥25	25	52.1	
Smoking history	Yes	53	61.0	.45
	No	63	56.3	
Adverse postoperative event	Yes	36	67.7	.063
	No	81	55.1	
Years after surgery (years)	<10	45	58.7	.94
	≥10	72	59.1	
Donor-recipient relationship	First degree	68	62.6	.17
	Other	49	53.9	
Recipient age (years)	<18	31	53.4	.28
	≥18	86	61.0	
LAS	<50	68	54.5	.18
	≥50	47	62.9	
Recipient death	Yes	35	57.5	.48
	No	82	62.3	
MCS: Mental Component Summary				
Donor age (years)	<40	69	53.5	.036

	≥40	48	66.8	
Sex	Male	59	62.3	.28
	Female	58	55.6	
BMI (kg/m^2)	<25	92	57.6	.40
	≥25	25	64.0	
Smoking history	Yes	53	60.3	.59
	No	63	56.9	
Adverse postoperative event	Yes	36	63.1	.38
	No	81	57.1	
Years after surgery (years)	<10	45	54.8	.30
	≥10	72	61.5	
Donor-recipient relationship	First degree	68	59.7	.76
	Other	49	57.8	
Recipient age (years)	<18	31	49.9	.084
	≥18	86	62.2	
LAS	<50	68	52.2	.026
	≥50	47	66.2	
Recipient death	Yes	35	59.2	.96
	No	82	58.9	
RCS: Role/Social Component Summary				
Donor age (years)	<40	69	58.3	.81
	≥40	48	59.8	
Sex	Male	59	59	.61
	Female	58	58	
BMI (kg/m^2)	<25	92	57.4	.33

	≥25	25	64.8	
Smoking history	Yes	53	60.3	.58
	No	63	56.9	
Adverse postoperative event	Yes	36	58.5	.92
	No	81	59.2	
Years after surgery (years)	<10	45	58.8	.96
	≥10	72	59.1	
Donor-recipient relationship	First degree	68	54.7	.11
	Other	49	64.8	
Recipient age (years)	<18	31	61.0	.69
	≥18	86	58.2	
LAS	<50	68	67.1	<.001
	≥50	47	44.7	
Recipient death	Yes	35	52.0	.14
	No	82	61.9	

HRQOL, health-related quality of life; BMI, body mass index; LAS, lung allocation score.

TABLE 4 Univariate and multivariate regression analyses of the component summary scores

Variable	Univariate OR (95% CI)	p-value	Multivariate OR (95% CI)	p-value
PCS: Physical Component Summary				
Donor age (<40 years)	0.68 (0.31–1.49)	.42	--	--
Sex (male)	0.71 (0.33–1.55)	.43	--	--
BMI (≥25 kg/m^2)	1.52 (0.61–3.81)	.47	--	--
Smoking history	0.94 (0.43–2.06)	>.99	--	--
Adverse postoperative event	0.39 (0.15–1.00)	.055	--	--
Years after surgery (<10 years)	1.07 (0.48–2.36)	>.99	--	--
Donor-recipient relationship (child or parent)	0.61 (0.28–1.34)	.23	--	--
Recipient age (<18 years)	1.46 (0.62–3.43)	.50	--	--
LAS ≥50	0.66 (0.29–1.47)	.32	--	--
Recipient death	0.93 (0.40–2.18)	>.99	--	--
MCS: Mental Component Summary				
Donor age (<40 years)	10.2 (2.90–36.2)	<.001	9.78 (2.66–35.9)	<.001
Sex (male)	0.90 (0.39–2.04)	.83	--	--
BMI (≥25 kg/m^2)	1.10 (0.41–2.96)	.80	--	--
Smoking history	1.05 (0.46–2.43)	>.99	--	--
Adverse postoperative event	1.34 (0.56–3.21)	.50	--	--
Years after surgery (<10 years)	1.75 (0.76–4.02)	.20	--	--
Donor-recipient relationship (child or parent)	1.20 (0.52–2.77)	.83	--	--
Recipient age (<18 years)	2.73 (1.13–6.60)	.032	2.65 (0.98–7.22)	.056

LAS ≥50	0.46 (0.18–1.15)	.12	0.42 (0.15–1.16)	.093
Recipient death	0.94 (0.38–2.33)	>.99	--	--
RCS: Role/Social Component Summary				
Donor age (<40 years)	1.77 (0.72–4.32)	.27	--	--
Sex (male)	1.55 (0.66–3.63)	.39	--	--
BMI (≥25 kg/m^2)	0.95 (0.34–2.66)	>.99	--	--
Smoking history	1.04 (0.44–2.44)	>.99	--	--
Adverse postoperative event	0.82 (0.32–2.07)	.81	--	--
Years after surgery (<10 years)	0.65 (0.27–1.59)	.38	--	--
Donor-recipient relationship (child or parent)	1.85 (0.76–4.52)	.19	1.86 (0.71–4.92)	.20
Recipient age (<18 years)	0.66 (0.24–1.81)	.47	--	--
LAS ≥50	3.94 (1.62–9.57)	.002	2.72 (1.05–7.02)	.038
Recipient death	3.64 (1.51–8.81)	.004	2.79 (1.07–7.29)	.036

BMI, body mass index; CI, confidence interval; LAS, lung allocation score; OR, odds ratio.

TABLE 5 Comparison of HRQOL score difference between two donors for the same recipient

Differences between left and right donors	Comparison of score difference	p-value
PCS: Physical Component Summary		
Age difference		
≥10 vs. <10 years	8.34 vs. 7.61	.30
Difference in sex		
Same vs. opposite	7.27 vs. 8.24	.69
Complications		
Either vs. neither	7.31 vs. 8.47	.91
Relationship		
First-degree relatives vs. others	6.27 vs. 9.01	.15
MCS: Mental Component Summary		
Age difference		
≥10 vs. <10 years	12.0 vs. 6.15	.034
Difference in sex		
Same vs. opposite	10.5 vs. 6.50	.179
Complications		
Either vs. neither	9.35 vs. 6.70	.47
Relationship		
First-degree relatives vs. others	5.55 vs. 9.98	.038
RCS: Role/Social Component Summary		
Age difference		
≥10 vs. <10 years	7.17 vs. 6.53	.26
Difference in sex		
Same vs. opposite	5.35 vs. 7.67	.23
Complications		
Either vs. neither	6.22 vs. 7.35	.79
Relationship		
First-degree relatives vs. others	5.40 vs. 7.73	.37

HRQOL, health-related quality of life.