DOI: https://doi.org/10.66984/jsmdc.v12.i01.oa.10.

Original Article

# Outcomes of Donors in Living Donor Liver Transplantation: Effect of Strict Donor Selection Criteria

Muhammad Haroon, Muhammad Imran Khan, Raja Saddam Dildar, Muhammad Ijaz Ashraf, Faisal Hanif

**ABSTRACT**

**Objective:** To evaluate the effect of strict institutional donor selection criteria on short term safety outcomes among living liver donors undergoing hepatectomy.

**Methodology:** This retrospective cross-sectional study on 140 living liver donor records was conducted in the Department of Hepatopancreatobiliary (HPB) and Liver Transplant Surgery at Bahria International Hospital, Orchard, Lahore. The study was carried out from January to March 2026 after obtaining institutional ethical approval. Donors were evaluated by a multidisciplinary team and selected through a structured protocol that included clinical, biochemical, radiological, and psychosocial evaluations. Acceptable graft parameters included graft-to-recipient weight ratio (GRWR) ≥0.8 and future liver remnant (FLR) ≥30%. Those with significant comorbidities, fatty liver, abnormal liver function tests, and fibrosis were not selected for donation. Data was analyzed using Statistical Package for the Social Sciences (SPSS) version 29.

**Results:** The mean age of donors was 27.0±4.7 years with a mean body mass index (BMI) of 24.0±2.4 kg/m². The mean length of hospital stay was 5.0±0.7 days. Overall, early postoperative complications occurred in 3(2.1%) donors, including bile leak in 2(1.4%) cases and wound infection in 1(0.7%) case. No donor mortality was observed. Donors who developed early complications had a significantly longer hospital stay compared with those without complications (6.67±0.58 days vs 4.98±0.62 days, p <0.001).

**Conclusion:** The use of a meticulous donor selection protocol, combined with a multidisciplinary assessment, was associated with low complication rates, shorter hospital stays, and no donor mortality.

**Keywords:** *Living donors. Hepatectomy. Postoperative complications. Patient selection. Length of stay.*

## INTRODUCTION

Living donor liver transplantation (LDLT) has become an important strategy for the treatment of end-stage liver disease, particularly in regions where deceased donor transplantation remains limited. In Pakistan and other low- and middle-income areas, LDLT continues to be the principal transplant pathway because of organ scarcity, delayed access to deceased donor transplantation, and a persistent burden of advanced chronic liver disease.[1] Contemporary reviews also show that LDLT offers major recipient advantages, including shorter wait times and timely access to transplantation, but these benefits are acceptable only when donor risk is minimized through rigorous evaluation and careful operative planning.[2] Unlike recipients, living donor are medically healthy individuals and they do not get any direct therapeutic utility from the donation surgery. As a result, every LDLT program should prioritize donor health and safety. The evidence from recent literature shows that donor mortality is infrequent, however, post-operative donor morbidity remains an important clinical concern that requires continuous attention. A recent meta-analysis established that donor complications are uncommon overall but their clinical impact reinforces the need for structured donor evaluation and perioperative safety protocols.[3] Moreover, results from long term follow-up studies have shown that donor outcomes should be judged beyond early postoperative period, and should incorporate long term physical recovery and psychological health & overall life quality after donation.[4]

Current literature advocates a multidisciplinary approach to evaluation of potential living liver donors, comprising a comprehensive history taking, laboratory investigations, cardiopulmonary assessment, psychosocial screening, high resolution cross-sectional imaging, and detailed vascular and biliary mapping with volumetric analysis before donor acceptance.[4] Parameters such as graft-to-recipient weight ratio (GRWR) and future liver remnant (FLR) remain central to decision-making, as they ensure adequate graft function in the recipient while maintaining donor safety. Anatomical variations of the hepatic vasculature and biliary tree are also critically assessed, as they may

*Sharif Medical & Dental College, Sharif Medical City.*
*Sharif Medical City Road, Off Raiwind Road, Jati Umra, Lahore 54000, Pakistan.*

*Correspondence: Dr. Muhammad Haroon*
*Fellow HPB & Liver Transplant Surgery, Department of HPB and Liver Transplant Surgery*
*Bahria International Hospital Orchard, Lahore*
*E-mail: drmhroy@yahoo.com*

---

*Received: April 1, 2026; Accepted: April 23, 2026*

increase operative complexity and influence perioperative donor and recipient outcomes.[5]

Although these core principles are widely applied across transplant centres, variations exist in the strictness of donor selection thresholds, the extent of multidisciplinary consensus, and imaging protocols used for final donor approval. Consequently, differences in institutional selection criteria may contribute to variability in reported donor outcomes across studies.[3] In countries such as Pakistan, where living donation remains the dominant transplant model, locally relevant evidence is needed to determine whether strict institutional screening protocols are associated with safe donor outcomes. The present study was therefore undertaken to evaluate short term outcomes of living liver donors selected through a structured institutional pathway and to assess whether meticulous donor selection and multidisciplinary evaluation were associated with favorable donor safety outcomes in our setting.

## METHODOLOGY

This retrospective cross-sectional study was conducted from January to March 2026 at the Department of Hepatopancreatobiliary (HPB) and Liver Transplant Surgery, Bahria International Hospital, Orchard, Lahore, Pakistan. Ethical approval was obtained from the institutional review board (Letter No. IRB/BIHO/2025/09-OR, 22-12-2025). The records of all 140 eligible donors who met the institutional selection criteria and underwent hepatectomy between July 2019 and December 2025 were included.

Donors were admitted for surgery after informed written consent and completion of all required investigations & workup according to predefined, structured selection criteria (Table 1). The process for selection of donors was conducted in a stepwise way to ascertain cost-effectiveness (Figure 1). Donor assessment encompassed an in-depth clinical evaluation including medical and surgical history, physical examination, BMI computation, Echocardiography (ECG), and general fitness assessment. Baseline laboratory investigations included complete blood count (CBC), liver function tests (LFTs), renal function tests (RFTs), blood grouping & cross-matching, Hemoglobin A1c (HbA1c), coagulation profile, and viral serology for hepatitis A virus (HAV), hepatitis B virus (HBV), hepatitis C virus (HCV), hepatitis D virus (HDV), hepatitis E virus (HEV), and human immunodeficiency virus (HIV). Baseline radiological investigations included Chest X-ray (CXR), ultrasound, and Doppler scan of liver. Liver anatomy and volumetry were determined via radiological assessment. Triphasic computed tomography (CT) facilitated vascular mapping and volumetric analysis, including calculation of the GRWR and analysis of the FLR. Magnetic resonance cholangiopancreatography (MRCP) was done to evaluate biliary anatomy. Transient elastography (Fibro Scan) was used to determine hepatic steatosis and fibrosis. Patients with suspected steatosis or fibrosis underwent liver biopsy.

Key selection criteria included age between 18 and 40 years, normal liver function tests (LFT), absence of hepatic steatosis and fibrosis, negative hepatitis and HIV serology, GRWR $\geq$0.8, and FLR $\geq$30%. Donors with up to two hepatic arteries, two portal veins, and two bile ducts were considered eligible for inclusion. Individuals were excluded from donor selection if they had any significant comorbid conditions (e.g., diabetes mellitus, cardiovascular disease), fatty liver disease, or hepatic fibrosis.

After the completion of clinical, biochemical, and radiological assessment, donors underwent an evaluation by a multidisciplinary team comprising transplant surgeons, hepatologists, anaesthesiologists, psychiatrists, cardiologists, and pulmonologists. Special investigations included metabolic profiling (thyroid and lipid profiles) and autoimmune screening [lupus anticoagulant and antinuclear antibodies (ANA)]. Protein C, Protein S, antithrombin III, D-dimer, and Factor V Leiden levels were performed for thrombophilia screening. A formal psychological evaluation was conducted to confirm voluntary consent & participation while excluding coercion. All donor hepatectomy surgeries were done by experienced transplant surgeons using standard surgical techniques. Postoperative care focused on intensive monitoring, early mobilization, and serial biochemical analysis.

Donors were followed for 30 days after surgery to assess the postoperative outcomes. The primary outcomes included donor mortality and postoperative complications graded using the Clavien-Dindo system, where Grade I illustrates minor deviation without treatment, Grade II requires pharmacological or blood transfusion support, Grade III demands surgical/endoscopic/radiological intervention (Grade IIIa: intervention without general anaesthesia; Grade IIIb: intervention under general anaesthesia), Grade IV depicts life threatening complications requiring ICU care, and Grade V indicates death.[6] The secondary outcome was length of hospital stay.

**Table 1: Institutional Donor Selection Criteria for Living Liver Donors**

| Parameters | Acceptable | Not Acceptable |
|---|---|---|
| **Comorbidities** | None | Hypertension, Ischemic Heart Disease, and Diabetes Mellitus |
| **LFTs** | Normal | Abnormal |
| **Ultrasound Liver** | Normal Liver | Fibrosis<br>Fatty Liver |
| **Liver Attenuation Index (LAI) on CT-scan** | Greater than +5 | <0 |
| **Liver Biopsy [for LAI (0 to +4)]** | No Fibrosis<br>Steatosis <10% | Fibrosis<br>Steatosis >10% |
| **GRWR** | ≥0.8 | <0.8 |
| **FLR** | ≥30 % | <30% |
| **Arterial Anatomy** | Graft with one or up to two Hepatic Arteries | Graft with more than two Hepatic Arteries |
| **Portal Vein Anatomy** | Graft with one or up to two Portal Veins | Graft with more than two Portal Veins |
| **Bile Duct Anatomy** | Graft with one or up to two Bile Ducts | Graft with more than two Bile Ducts/Complex Biliary Anatomy Unsuitable for Reconstruction |

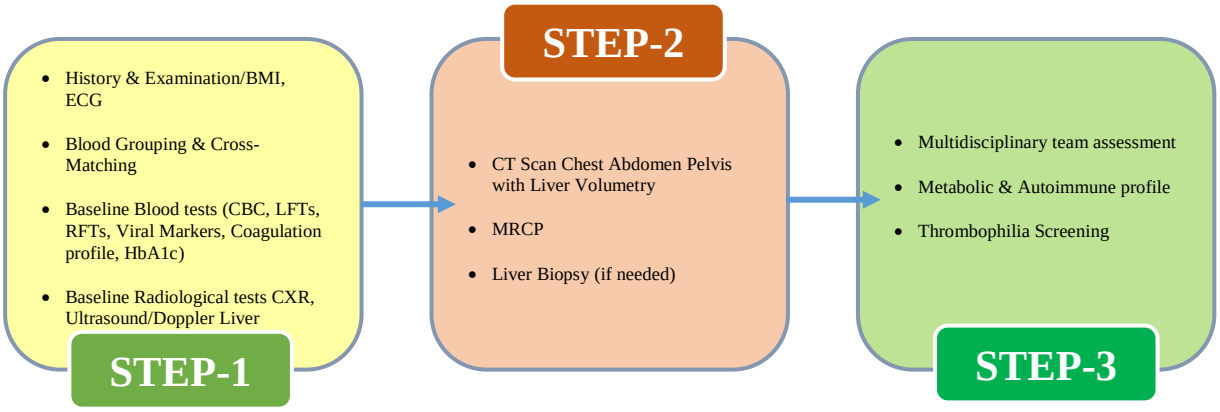


**Figure 1: Stepwise Donor Evaluation Protocol for Living Donor Liver Transplantation**

## STATISTICAL ANALYSIS

Statistical Package for the Social Sciences (SPSS) version 29 was employed for analysis of data. Continuous data were expressed as mean±standard deviation, while qualitative (categorical) variables were reported as frequencies and percentages. Subgroup analysis was performed to compare donors with and without postoperative complications across variables including age, gender, BMI, FLR, GRWR, anatomical variations, and length of hospital stay. The independent t-test was used to compare continuous variables. Fisher's exact test was applied for categorical variables due to small expected cell counts. A p-value of <0.05 was considered statistically significant.

## RESULTS

The mean age of the donors was 27.0±4.7 years with a mean BMI of 24.0±2.4 kg/m², mean FLR of 37.1±3.6%, and mean GRWR of 1.02±0.12. The cohort comprised 80(57.1%) males and 60(42.9%) females. Most donors had conventional vascular and biliary anatomy, including a single hepatic artery in 137(97.9%), a single portal vein in 134(95.7%), and a single bile duct in 101(72.1%) donors.

Overall, 137(97.9%) donors had no early postoperative complications. The mean hospital stay was 5.0±0.7 days, and no (0%) donor mortality was observed. Among donors who developed early postoperative complications, bile leak occurred in 2(1.4%) and wound infection in 1(0.7%). According to the Clavien-Dindo classification, both cases of

bile leak were Grade I. The wound infection was classified as Grade IIIa.

Early postoperative complications were not significantly associated with age, gender, BMI, and anatomical variation (p >0.05). Donors without complications had a mean hospital stay of 4.98±0.62 days, whereas those with complications had a significantly longer stay (6.67±0.58 days, p <0.001). Both groups showed no significant difference in mean FLR and mean GRWR. These findings indicate that although early complications were infrequent, they were associated with a clinically meaningful prolongation of hospital stay (Table 2).

## DISCUSSION

Current donor safety literature continues to place donor protection at the center of LDLT practice.[7] In our study, early postoperative complications occurred in only 3(2.1%) donors, including bile leak in 2(1.4%) cases and wound infection in 1(0.7%) case. No donor mortality was observed. Xiao et al. included outcomes from 60,829 living liver donors in their meta-analysis and reported a pooled overall donor complication rate of 24.7% [95% confidence interval (CI): 21.6-28.1%]. They also reported a substantially lower mortality (0.06%) and wound related complications (0.7%) in their large cohort. These findings confirm that while adverse events in LDLT remain uncommon, they are not negligible.[3] Tuncer et al. also reported a higher overall complication rate of 11.6% (95% CI: 9.0-14.6%) with no mortality among 502 living liver donors.[6]

The present study also demonstrated that donors who developed early complications had a significantly longer hospital stay compared with those without complications (6.67±0.58 days vs 4.98±0.62 days, p <0.001). Early postoperative complications were not significantly associated with age, gender, BMI, or anatomical variation (p >0.05). Both cases of bile leak were classified as Grade I, while only one wound infection was classified as Grade IIIa, compared with 17 major complications (≥Grade IIIa) reported by Tuncer et al. Most of the complications reported in their study were wound infections, followed by bile leakage. Similar to our results, complications were associated with a significantly longer hospital stay, and no significant independent associations were reported between postoperative complication risk and graft type, remnant liver ratio, graft volume, or BMI.[6] Another review reported an overall mortality of 0 to 0.7%, overall complication rate of 7.8-71.2%, while the average length of hospital stay was from 3.9 to 14.5 days among donors.[8]

Rhu et al. reported that the 30 day complication rate of 636 donors undergoing laparoscopic living donor hepatectomy was 16.8%, with Grade IIIa and IIIb complications occurring in 4.4% and 1.9% of cases, respectively. The most frequent complication was bleeding (6.0%), while bile leakage was observed in 3.3% of cases.[9] In another review, 28 studies were compiled, and the rate of major complications (≥Grade IIIa) was 2.1% to 28%. Only one study reported that complications were associated with a significantly increased length of hospital stay, with an incidence rate ratio of 1.36 (95% CI: 1.16-1.58; p <0.001), indicating that even infrequent adverse events can affect recovery and resource use.[10]

**Table 2: Comparison of Donor Characteristics between Patients with and without Early Postoperative Complications**

| Donor Characteristics | | Donors with Complications (n=03) | Donors without Complications (n=137) | p-value |
|---|---|---|---|---|
| **Age (Years)** | **(mean±SD)** | 28.67±2.89 | 26.96±4.75 | 0.538 |
| **Gender (Frequency & Percentage)** | **Female** | 2(66.7) | 58(42.3) | 0.576 |
| | **Male** | 1(33.3) | 79(57.7) | |
| **BMI ($kg/m^2$)** | **(mean±SD)** | 22.47±4.27 | 24.03±2.35 | 0.264 |
| **Anatomical Variation (Frequency & Percentage)** | **Present** | 2(66.7) | 45(32.8) | 0.261 |
| | **Absent** | 1(33.3) | 92(67.2) | |
| **Future Liver Remnant (%)** | **(mean±SD)** | 33.63±3.11 | 37.20±3.56 | 0.087 |
| **Graft-to-Recipient Weight Ratio** | | 1.07±0.21 | 1.02±0.12 | 0.488 |
| **Hospital Stay (Days)** | | 6.67±0.58 | 4.98±0.62 | <0.001* |

**Significant p-value*

In the International LDLT Registry analysis, short term donor complication rates differed substantially ($p < 0.001$) by human development index (HDI), with rates of 9.8% in very high HDI regions versus 21.9% in lower HDI regions, highlighting the sensitivity of outcomes to system level variation in practice and resources.[11] However, the early complication rate of 2.1% in our study appears favorable, likely reflecting conservative donor acceptance and careful perioperative management. Donors in this series were young and had a favorable BMI profile, and our protocol excluded significant comorbidities. This approach was consistent with current donor selection guidance, which emphasizes low risk physiology and adequate hepatic reserve.[5,12] Although broader donor criteria like inclusion of older adults are increasingly discussed, expansion should be approached cautiously. A recent systematic review and meta-analysis found no significant difference in complications and mortality between young and older donors.[13] This finding highlighted that carefully selected older living liver donors may enlarge the donor pool, but such practice still requires careful risk stratification and experienced centers.

Volumetric criteria represented a key strength of the donor selection strategy. All donors met the GRWR ≥0.8 and FLR ≥30%, with a mean GRWR of 1.02±0.12 and a mean FLR of 37.1±3.6%. Kim et al. reported that overall [Odd's ratio (OR) = 1.82; 95% CI: 1.24-2.67; p = 0.002] and minor (OR=1.88; 95% CI: 1.23-2.88; p=0.004) morbidities were significantly lower in donors with a residual liver volume ≥30% compared with those with <30%.[14] Likewise, recipient focused multicenter work has shown that lower GRWR grafts may be feasible in selected circumstances, but that does not eliminate the need for conservative donor protection in routine practice.[8]

Anatomical complexity directly affects surgical planning and reconstruction. Most donors had conventional vascular and biliary anatomy, including a single hepatic artery in 137(97.9%), a single portal vein in 134(95.7%), and a single bile duct in 101(72.1%) donors. Donors with up to two hepatic arteries, bile ducts, and portal vein variations were accepted in this study. The presence of anatomical variations was not significantly associated with postoperative complications. In contrast, Pakistani data from 400 living liver donors reported that vascular and biliary variations were common (34.2%) and therefore must be defined carefully during donor workup.[15] Broader contemporary imaging and donor evaluation reviews also emphasize that anatomical variants are frequent in otherwise healthy donors and that preoperative mapping is indispensable for safe graft procurement.[5,12] Our results suggested that selected minor anatomical variations can be managed safely when operative expertise and preoperative planning are strong.

The long term donor literature showed that donor outcomes should be evaluated not only in terms of mortality, but also through broader measures such as recovery burden, quality of life, psychosocial health, and durable symptoms after donation.[16,17] In the review by Thuluvath et al., 9.1% of donors in studies did not return to baseline physical quality of life scores for at least two years after donation.[16] The absence of donor mortality in our series should be interpreted carefully and should not be presented as evidence that donor risk is absent. A North American data spanning more than three decades and more than 11,000 living donor hepatectomies reinforce that donor death is rare, but not impossible, and that transparent reporting remains essential.[8]

## CONCLUSION

A strict donor selection process combined with multidisciplinary evaluation was associated with low complication rates, shorter hospital stays, and no donor deaths in this cohort. Donors with complications had a significantly longer mean hospital stay compared to those without complications. These findings reinforce the importance of careful donor selection as a central factor in ensuring donor safety in LDLT.

## LIMITATIONS & RECOMMENDATIONS

This was a retrospective, single-centered study with a relatively small number of complication events, which may limit the generalizability of the findings and restrict detailed risk factor analysis. In addition, long term donor outcomes were not assessed. Future research, particularly larger multi-centered prospective studies with extended follow-up, is recommended to confirm these results and help improve donor selection criteria.

**Conflict of interest:** None.

**Source of funding:** None.

**Authors' Contributions:**

Authors approved the draft and are accountable in ensuring that questions related to accuracy or integrity of the work are duly investigated and resolved.

**M.H:** Conceptualization, study design, supervision, manuscript review and final approval.

**M.I.K:** Data collection, donor evaluation, interpretation of results and manuscript drafting.

**R.S.D:** Literature review, statistical analysis and data interpretation.

**M.I.A:** Radiological assessment coordination, data acquisition and critical revision of manuscript.
**F.H:** Surgical supervision, final manuscript editing and overall coordination of the study.

## REFERENCES


1. Syed IA, Khalid A, Khan BA, Aujla UI. The evolution of liver transplant program in Pakistan and the challenges ahead. J Liver Transpl. 2023; 12:100187. doi:10.1016/j.liver.2023.100187.

2. Emond JC, Di Sandro S, Pomfret EA. American perspectives for LDLT in 2024. Updates Surg. 2025; 77(6):1705-12.doi:10.1007/s13304-024-01994-1.

3. Xiao J, Zeng RW, Lim WH, Tan DJH, Yong JN, Fu CE, et al. The incidence of adverse outcome in donors after living donor liver transplantation: a meta-analysis of 60,829 donors. Liver Transpl. 2024; 30(5):493-504. doi:10.1097/LVT.0000000000000303.

4. De Carlis R, Di Lucca G, Lauterio A, Centonze L, De Carlis L. The long-term follow-up of the living liver donors. Updates Surg. 2025; 77(6):1767-75. doi:10.1007/s13304-024-01894-4.

5. Powers C, Gunabushanam V, Centonze L, Humar A. Current perspectives on living donor selection in liver transplantation. Updates Surg. 2025; 77(6):1745-53. doi:10.1007/s13304-025-02131-2.

6. Tuncer A, Sahin E, Unal B, Dirican A. Benchmarking donor safety: postoperative complications and risk stratification in 502 living liver donors. Medicina (Kaunas). 2026; 62(2):358. doi:10.3390/medicina62020358.

7. Liu H, Ashwat E, Humar A. Current status of living donor liver transplantation: impact, advantages, and challenges. Curr Gastroenterol Rep. 2023; 25(10):225-31. doi:10.1007/s11894-023-00882-9.

8. Magyar CTJ, Choi WJ, Li Z, Cattral MS, Selzner N, Ghanekar A, et al. The aim of donor safety: surgical approaches and current results. Updates Surg. 2025; 77(6):1755-66. doi:10.1007/s13304-024-01881-9.

9. Rhu J, Choi GS, Kim JM, Kwon CHD, Joh JW. Risk factors associated with surgical morbidities of laparoscopic living liver donors. Ann Surg. 2023; 278(1):96-102. doi:10.1097/SLA.0000000000005851.

10. Mazzola A, Pittau G, Hong SK, Chinnakotla S, Tautenhahn HM, Maluf DG, et al. When is it safe for the liver donor to be discharged home and prevent unnecessary re-hospitalizations? A systematic review of the literature and expert panel recommendations. Clin Transplant. 2022; 36(10):e14677. doi:10.1111/ctr.14677.

11. Rela M, Pomfret E, Egawa H, Bhangui P, Raptis DA, Berenguer M, et al. Global variation in living donor liver transplantation practices impacts donor and recipient short-term outcomes: initial insights from the international LDLT registry. Am J Transplant. 2025; 25(8):1735-45. doi:10.1016/j.ajt.2025.04.008.

12. Jesse MT, Jackson WE, Liapakis A, Ganesh S, Humar A, Goldaracena N, et al. Living donor liver transplant candidate and donor selection and engagement: Meeting report from the living donor liver transplant consensus conference. Clin Transplant. 2023; 37(7):e14954. doi:10.1111/ctr.14954.

13. Ter Burg HW, Chorley Rn AJ, Polak WG, Kranenburg LW, Boehnert MU, Minnee RC. Older living liver donors can enlarge the donor pool: a systematic review and meta-analysis. Int J Surg. 2024; 110(8):5022-33. doi:10.1097/JS9.0000000000001419.

14. Kim SH, Kim KH, Cho HD. Donor safety of remnant liver volumes of less than 30% in living donor liver transplantation: a systematic review and meta-analysis. Clin Transplant. 2023; 37(9):e15080. doi:10.1111/ctr.15080.

15. Khalid A, Saleem MA, Ihsan-Ul-Haq, Khan Y, Rashid S, Dar FS. Anatomical variations in living donors for liver transplantation-prevalence and relationship. Langenbecks Arch Surg. 2023; 408(1):323. doi:10.1007/s00423-023-03066-1.

16. Thuluvath AJ, Peipert J, Berkowitz R, Siddiqui O, Whitehead B, Thomas A, et al. Donor quality of life after living donor liver transplantation: a review of the literature. Dig Med Res. 2021; 4:49. doi:10.21037/dmr-20-151.

17. Shi Y, Zhang H, Zhu Z. A systematic review of the factors significantly influencing the quality of life of living liver donors. Int J Nurs Sci. 2023; 10(4):579-86. doi:10.1016/j.ijnss.2023.09.012.


***How to cite:*** *Haroon M, Khan MI, Dildar RS, Ashraf MI, Hanif F. Outcomes of donors in living donor liver transplantation: effect of strict donor selection criteria. JSMDC. 2026; 12(01):59-64. doi:https://doi.org/10.66984/jsmdc.v12.i01.oa.10.*