

A Prospective Study on the Effectiveness of Functional Therapy Based Re-Education in Single Organ Transplant Recipients At Selected Transplant Centers in Kerala As Measured By Pre and Post Operative Scores of Organ Functions

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Abstract: *Background:* Liver transplantation is a life-saving procedure for patients with end-stage liver disease, but postoperative recovery varies significantly across individuals. Functional therapy-based re-education—a structured, inpatient rehabilitation program—has shown potential in improving recovery outcomes. This study aimed to evaluate the effectiveness of such an intervention on cognitive function, physical activity, liver function, and health-related quality of life (HRQOL) among liver transplant recipients in Kerala. *Objectives:* 1.To assess the preoperative and postoperative clinical scores among liver transplant recipients. 2.To evaluate the effectiveness of functional therapy-based re-education on cognitive function in liver transplant recipients. 3.To determine the effectiveness of functional therapy-based re-education on physical activity function in liver transplant recipients. 4.To assess the impact of functional therapy-based re-education on health-related quality of life (HRQOL) post liver transplantation. 5.To analyze the association between postoperative organ function scores and selected demographic variables in the experimental group. *Methods:* A quasi-experimental, randomized control trial was conducted across four transplant centers in Kerala from 2021 to 2024. A total of 100 liver transplant recipients were selected through stratified random sampling and divided equally into experimental (n=50) and control (n=50) groups. The experimental group received functional therapy-based re-education beginning on the 25th postoperative day, and outcomes were evaluated on the 50th postoperative day. Data were collected using standardized clinical and functional assessment tools and analyzed using descriptive and inferential statistics (Chi-square test, Fisher's Exact test, and Mann-Whitney U test) at a 0.05 significance level. *Results:* Baseline variables between both groups were homogenous. Postoperatively, the experimental group showed significantly greater improvements across all measured domains. MELD and Child-Pugh scores showed better liver function recovery ($p < 0.01$). Cognitive function scores increased markedly in the experimental group (mean: 28.6 vs. 19.2; $p < 0.01$), with 100% showing no impairment. Physical activity scores were significantly higher (mean: 92.8 vs. 61; $p < 0.01$), and 52% of experimental participants fully recovered. HRQOL also improved significantly in the experimental group (mean: 39.5 vs. 71.3; $p < 0.01$), with 98% reporting good quality of life. Statistically significant associations were found between occupation and MELD score ($p = 0.010$), and BMI and cognitive function ($p = 0.008$). *Conclusion:* Functional therapy-based re-education significantly enhances postoperative recovery in liver transplant recipients by improving liver function, cognitive ability, physical activity, and quality of life. This evidence supports incorporating structured rehabilitation programs into standard post-transplant care protocols. Further research is recommended to explore its applicability in other organ transplant populations.

Keywords: Liver transplantation, functional therapy-based re-education, cognitive function, physical activity, health-related quality of life, postoperative recovery, Kerala, MELD score, Child-Pugh score.

INTRODUCTION

Organ transplantation is a life-saving and life-enhancing treatment. Currently, organ and tissue transplantation operations are performed in more than 111 countries, representing about 81% of the global population. Nearly 140,000 organ transplants are carried out each year globally, and this number continues to rise steadily¹. In the United States alone, between January 1, 1988, and April 30, 2019, over 451,847 kidney, 166,383 liver, 73,216 heart, 38,989 lung, and 23,959 kidney-pancreas transplants have been performed, as per data from the

Organ Procurement and Transplantation Network (OPTN)².

Fifteen international and more than 140 national organizations are actively involved in promoting and improving organ donation and transplantation through research, coordination, and practical implementation¹. Data from the Global Observatory on Donation and Transplantation (2022) report that over 150,000 solid organ transplants were performed worldwide in 2022—marking a 52% increase since 2010—but still meeting

less than 10% of the global demand³. Many countries still lack sufficient systems for legislation, governance, workforce, and infrastructure, leading to ethical concerns such as transplant tourism and organ trafficking³.

Organ transplantation is now accepted in nearly every field of medicine, driven by increasing demand and proven efficiency. It involves removing an organ from a donor and implanting it in a recipient with a failing or absent organ. The most frequently transplanted organs are kidneys, followed by liver and heart⁴. Cadaveric transplantation, in particular, remains one of the most complex and ethically sensitive areas of medicine¹.

The global increase in lifestyle-related diseases such as diabetes and hypertension has led to a surge in organ failure, including in India. This results in increased morbidity, mortality, and financial burden. Organs remain irreplaceable by artificial means, and timely transplantation is often the only effective treatment for end-stage organ failure¹. There are alternatives such as dialysis for kidney failure, but transplantation provides a better quality of life and long-term cost-effectiveness. Advanced techniques like Vascularized Composite Allotransplantation (VCA)—involving complex tissue transplants such as hands and faces—have gained prominence¹.

The concept of organ replacement is not new. Ancient mythologies, including Hindu mythology (e.g., the tale of Lord Ganesha), have early representations of body part replacement. Scientifically, the first successful human kidney transplant was performed in Boston in 1954 between identical twins. In India, the first kidney transplant occurred in 1965 at King Edward Memorial Hospital, Mumbai. The first successful heart transplant in India was done in 1994 by Dr. Venugopal. The first successful Living Donor Liver Transplant (LDLT) in India was conducted in 1998 by Dr. Rajashekar⁵.

Over the past century, medical advancements—such as vascular anastomosis techniques, chemical immunosuppression, and preservation solutions—have significantly improved the outcomes of transplantation⁵. Still, the shortage of donor organs remains a major challenge, especially in Asia. India significantly lags behind even other Asian countries in organ donation. Every year, approximately 1.8 lakh people in India suffer from renal failure, yet only about 6,000 kidney transplants are performed. Similarly, around 2 lakh people die due to liver diseases, yet only 1,500 liver transplants are carried out annually. The statistics are equally concerning for heart and corneal transplants¹.

Despite these challenges, transplantation is the last line of therapy for many terminally ill patients. Around 3,500 to 4,000 kidney transplants are currently being performed across 120 centers in India. Awareness initiatives are being implemented, but there is still a lack of public knowledge about organ donation⁴.

Solid organ transplantation has proven to be successful across age groups. It significantly improves survival and quality of life in patients with terminal illnesses affecting the kidney, liver, heart, or lungs. However, there remain global disparities in access and availability of transplant services³.

REVIEW OF COGNITIVE FUNCTIONS:

A recent study on pretransplant MELD score and post-liver transplantation survival in the UK and Ireland showed that the Model for End-Stage Liver Disease (MELD) score is a reliable predictor of survival in liver disease patients before transplantation. However, its predictive power for post-transplant survival was found to be limited. The study analyzed 90-day post-transplant outcomes of 3,838 patients. Although survival was significantly lower in patients with MELD scores ≥ 36 (70.8%), the MELD score overall demonstrated poor discrimination between survivors and non-survivors post-transplant (c-statistic = 0.58)⁶.

Another prospective study assessed short-term mortality scoring after liver transplantation by analyzing 149 transplant cases from 2000 to 2007. Among four scoring systems evaluated (SOFA, Child-Pugh, MELD, and RIFLE), the Sequential Organ Failure Assessment (SOFA) score on postoperative day 7 had the best predictive value for 3-month and 1-year mortality. Patients with SOFA scores ≤ 7 had significantly better survival outcomes (Youden index 0.86 for 3-month, and 0.62 for 1-year mortality)⁷.

A recent study focused on functional impairment in older liver transplant candidates, examining the impact of physical performance on waitlist mortality. It found that patients ≥ 65 years had significantly poorer performance on the Short Physical Performance Battery (SPPB), including slower gait, longer chair stands, and lower balance test completion rates. Among candidates, only "older impaired" patients (SPPB ≤ 9) had a significantly higher risk of waitlist mortality after adjustment for MELD-Na (HR = 2.36, P = 0.01), highlighting the importance of incorporating physical function assessments into transplant evaluations⁸.

In a longitudinal multicenter study (LivCog) on cognitive function and self-management in liver transplant recipients, researchers are assessing cognitive trajectories from pre- to post-transplant stages. The study aims to enroll 450 adult liver transplant recipients and their caregivers, with data collection at 1, 3, 12, and 24 months post-transplant. The study evaluates associations between cognitive function and outcomes such as self-management, health behaviors, functional status, and caregiver support. The goal is to identify patients at risk of cognitive impairment and poor self-management post-transplant, and to design targeted interventions⁹.

Reviews of physical activity:

Physical activity plays a critical role in both pre- and post-liver transplantation (LT) outcomes, particularly in improving functional capacity, managing sarcopenia, and enhancing quality of life. A systematic review and meta-analysis of eight RCTs (n=334) confirmed that exercise training post-LT is safe and may improve cardiorespiratory and muscular fitness, along with physical aspects of health-related quality of life (HRQOL). Although the studies showed positive trends, the quality of evidence was limited by small sample sizes and inconsistent methodology¹⁰.

A study examining in-hospital exercise during treatment of hepatocellular carcinoma (HCC) in chronic liver disease (CLD) patients (n=54) found that therapeutic exercise preserved walking ability and improved heart rate variability without worsening liver function. Despite a slight reduction in skeletal muscle mass, branched-chain amino acid (BCAA) supplementation helped minimize muscle loss¹¹.

In patients with end-stage liver disease (ESLD), sarcopenia, frailty, and reduced cardiopulmonary endurance are common. Exercise interventions prior to transplantation improve fitness, reduce hepatic venous pressure gradient, and enhance HRQOL. A combination of physical activity and nutritional support is recommended, especially through home-based programs, which offer scalability and sustainability¹². Fatigue significantly impacts physical activity in cirrhotic patients. A Taiwanese study found a negative correlation between fatigue severity and weekly physical activity, emphasizing the need for interventions that address both fatigue and exercise adherence¹³. Another study examined physical function and activity levels post-transplant and noted that despite restored liver function, physical performance often remains impaired. Exercise interventions post-LT were shown to improve fitness, strength, and HRQOL, with randomized trials supporting structured physical activity as part of long-term post-transplant care¹⁴.

A systematic review of therapeutic exercise in NASH cirrhosis and LT indicated that personalized physical exercise improved peak oxygen consumption, walking test results, and HRQOL. It also showed potential for reducing 90-day hospital readmissions, although no mortality benefit was observed. More research is needed to validate long-term outcomes¹⁵. A randomized controlled trial examining long-term physical activity after LT found that patients engaging in regular physical activity reported significantly better HRQOL across several domains of the SF-36. This supports integrating long-term physical activity as part of post-LT management¹⁶. A large multicentre study (n=511) assessed physical activity post-LT and revealed that a large proportion of recipients reported insufficient or no activity. Time since LT, poor adherence to the Mediterranean diet, sedentary lifestyle, and lower

physical quality of life were independently associated with inactivity¹⁷.

A prospective study using the Minnesota Leisure Time Physical Activity Questionnaire found that physical activity post-transplant was inversely related to age and BMI, and that positive mental attitude correlated with healthier behaviors, especially in younger, leaner patients¹⁸. A systematic review of prehabilitation in LT candidates showed that supervised or unsupervised programs improved VO₂ peak, strength, frailty index, and quality of life. Prehabilitation was also safe and feasible, though evidence was limited by study quality¹⁹. Further research in solid organ transplant candidates, including LT, supports prehabilitation as effective in improving physical capacity and quality of life, though larger studies are needed to assess clinical outcomes pre- and post-transplant²⁰.

Finally, a feasibility study protocol from McGill University outlines a comprehensive prehabilitation program (exercise, nutrition, psychological support) for LT candidates. It aims to assess feasibility, adherence, and changes in fitness, nutritional status, and QoL, contributing essential data to inform future practice²¹.

QUALITY OF LIFE IN LIVER TRANSPLANT RECIPIENTS:

A Retrospective Study (IRCCS-ISMETT, Italy)
Girgenti, R., Tropea, A., Buttafarro, M. A., Ragusa, R., & Ammirata, M. (2020) analyzed 82 liver transplant recipients (living or deceased donors) transplanted 2017–2019, to examine post-transplant QOL (via MQOL) and therapeutic adherence. They found that ~94% reported high mean QOL and adherence; ~28% had at least one persistent annoying symptom post-transplant, but this did not significantly reduce overall QOL. Those transplanted for alcohol-related cirrhosis confirmed complete abstinence²².

Preoperative Expectations and Postoperative Quality of Life in Liver Transplant Survivors (Austria)
In a study of 55 patients (32 men, 23 women) at Innsbruck University, patients were interviewed pre-transplant regarding expectations and post-transplant QOL (using Sickness Impact Profile & FACT-General). A majority had optimistic preoperative expectations (60%), but only 40% felt these were realized after transplantation. Post-transplant, significant impairments were seen across almost all life domains vs healthy controls; “complications during hospitalization” was the only clinical factor strongly affecting postoperative QOL²³.

Long-Term QOL After Primary Liver Transplantation
A systematic review (23 studies, 5,402 patients) of adult patients surviving ≥5 years post-primary LT found that QOL remains significantly improved compared to pre-transplant status, even up to 20 years after surgery. Physical domains lag behind;

post-transplant complications worsen QOL scores, particularly for physical functioning. Employment tends to recover initially but may decline after 5 years; the improvements in QOL are similar to those seen with other solid organ transplants²⁴. Impact of Liver Transplantation on QOL in High-Risk Recipients A retrospective cohort of 212 high MELD patients showed that EQ-5D–based HRQOL significantly improved at 3, 6, and 12 months post-transplant compared with pre-transplant. All dimensions of EQ-5D improved; utility scores rose substantially in early follow-up periods²⁵.

Quality of Life Among LT Recipients: Sociodemographic Factors A cross-sectional study of 150 LT recipients found that sociodemographic factors affect QOL domains: older age worsened symptoms, sleep, sexual function; women reported worse in loneliness; higher education was linked with less perceived stigma; income influenced social interaction and perception of disease stigma.²⁶

Statement of the Problem:

Despite advancements in surgical techniques and immunosuppressive therapies, liver transplant recipients frequently experience impairments in physical, cognitive, and psychosocial functioning after surgery. However, there is a lack of standardized, evidence-based rehabilitation protocols to address these challenges. This study aims to evaluate the effectiveness of functional therapy-based re-education in improving postoperative outcomes, addressing a critical gap in the continuum of care for liver transplant patients.

Objectives of the Study:

1. To assess the preoperative and postoperative clinical scores among liver transplant recipients.
2. To evaluate the effectiveness of functional therapy-based re-education on cognitive function in liver transplant recipients.
3. To determine the effectiveness of functional therapy-based re-education on physical activity function in liver transplant recipients.
4. To assess the impact of functional therapy-based re-education on health-related quality of life (HRQOL) post liver transplantation.
5. To analyze the association between postoperative organ function scores and selected demographic variables in the experimental group.

Operational Definitions:

- A prospective study: A longitudinal research design where participants are followed over time to observe outcomes in relation to interventions.
- Effectiveness: Measured improvement in organ function, cognitive ability, physical activity, and HRQOL as a result of the intervention.

- Functional therapy-based re-education: A structured inpatient rehabilitation program focused on enhancing postoperative recovery through targeted physical and cognitive therapies.
- Single organ transplantation: For this study, this term refers specifically to liver transplantation.
- Pre and postoperative scores of organ function: Objective clinical scores used to assess liver function (MELD, Child-Pugh), cognitive status, physical activity, and quality of life before and after surgery.

Assumptions:

- Functional therapy-based re-education improves postoperative function scores.
- There is a relationship between transplant recipients' demographic characteristics and their postoperative recovery outcomes.
- The therapy supports a comprehensive recovery in liver transplant recipients.

Delimitations:

- The study is restricted to patients aged 18–55 years.
- Only single organ (liver) transplant recipients were included.
- The study was conducted in selected government and private multispecialty transplant centers in Kerala.

Hypotheses:

All hypotheses were tested at a 0.05 level of significance.

- H1: There will be a significant association between postoperative organ function scores and selected demographic variables (e.g., age, gender, BMI).
- H2: There will be a significant difference between preoperative and postoperative organ function scores among single organ transplant recipients following functional therapy-based re-education.
- H3: There will be a significant relationship between preoperative and postoperative scores of transplant recipients receiving functional therapy-based re-education.

Significance of the Study:

The findings of this study have the potential to inform clinical practice and policy regarding postoperative care and rehabilitation of liver transplant patients. By demonstrating the effectiveness of functional therapy-based re-education, the study could encourage transplant centers to adopt similar protocols, leading to improved recovery outcomes and enhanced quality of life for recipients.

METHODS:

Study Design:

This research employed a prospective, quasi-experimental, pretest-posttest design with a control group to assess the effectiveness of functional therapy-based re-education in improving postoperative outcomes among single organ transplant recipients. The study used a quantitative research approach with an evaluatory framework to determine the impact of the intervention on clinical, cognitive, physical, and quality of life parameters.

Setting of the Study:

The study was conducted at four selected liver transplant centers in Kerala, India. Participants in the experimental group were recruited from government and private super-specialty transplant centers in Kottayam and Thiruvananthapuram districts, while those in the control group were selected from similar centers in Ernakulam and Kozhikode districts. These centers conduct an average of 100 liver transplants annually.

Study Population and Sampling:

The study included 100 liver transplant recipients, with 50 participants each in the experimental and control groups.

Inclusion Criteria:

- Adult patients aged 18 to 55 years.
- Recipients of single organ (liver) transplantation.
- Willingness to participate and provide informed consent.
- Medically stable to undergo physical and cognitive assessment.

Exclusion Criteria:

- Patients below 18 years or above 55 years.
- Recipients of multi-organ transplantation.
- Patients with pre-existing severe psychiatric illness or neurological disorders.
- Individuals with post-transplant complications requiring intensive care beyond 25 days.

Sampling Technique:

Participants were selected using random sampling from eligible recipients at the selected transplant centers. Randomization ensured group comparability, and baseline characteristics were tested for homogeneity.

Intervention Protocol:

Participants in the experimental group received a structured functional therapy-based re-education program, which began on the 25th postoperative day and continued until the 50th postoperative day. This intervention included:

- Cognitive re-education exercises (e.g., memory, attention, problem-solving).
- Physical rehabilitation tailored to individual capabilities.
- Health education and lifestyle modification counseling.
- Activities aimed at improving daily functioning and quality of life.

The control group received standard postoperative care, which included routine clinical follow-up and medical management but no structured functional therapy.

Study Procedure:

Group	Pretest (O1)	Intervention (X)	Posttest (O2)
G1 – Experimental (Kottayam & Thiruvananthapuram)	Day 2 post-admission	Functional therapy-based re-education (Day 25 post-transplant)	Day 50 post-transplant
G2 – Control (Ernakulam & Kozhikode)	Day 2 post-admission	Standard care only	Day 50 post-transplant

Data Collection Tools:

The following standardized and validated tools were used for data collection:

1. Model for End-stage Liver Disease (MELD) Score – Assesses severity of liver disease.
2. Child-Pugh Score – Assesses liver function prognosis.
3. Cognitive Function Assessment Tool – Evaluates memory, orientation, and executive functions.
4. Physical Activity Function Scale – Measures the ability to perform daily activities.
5. Health-Related Quality of Life (HRQOL) Scale – Assesses overall well-being post-transplantation.

Data Collection Procedure:

- Pretest (O1): Conducted on the second day after admission, prior to initiation of the intervention.
- Posttest (O2): Conducted on the 50th postoperative day to evaluate outcomes after 25 days of intervention.
- All assessments were carried out by trained research assistants using structured interview techniques and physical/cognitive evaluations.

Statistical Analysis:

Data were analyzed using descriptive and inferential statistics. The software used for data analysis was SPSS.

- Descriptive statistics: Mean, standard deviation, frequency, and percentage.
- Inferential statistics:
 - Chi-square test and Fisher’s Exact test: To test homogeneity between groups.
 - Mann-Whitney U test: To assess differences in clinical scores between groups.
 - Z-test: To test the significance of difference in post-intervention scores.
 - A p-value < 0.05 was considered statistically significant.

RESULTS:

Table 1. Comparison of post interventional MELD Score between experimental and control group

MELD Score	Experimental		Control		Z#	p
	Count	Percent	Count	Percent		
Mild risk	50	100.0	50	100.0	2.22*	0.026
Moderate risk	0	0.0	0	0.0		
Mean ± SD	12.6 ± 1.8		13.5 ± 2			
Median (Median)	12 (11.5 - 14)		14 (12 - 15)			
Minimum	10.0		10.0			
Maximum	16.0		16.0			

After the intervention, MELD (Model for End-Stage Liver Disease) scores were compared between the experimental and control groups to assess the effect of the intervention on liver function severity. Risk Category Distribution: All participants in both groups (100%) fell within the mild risk category, with no participants classified under the moderate risk category. This indicates that, post-intervention, none of the subjects in either group progressed to a more severe stage of liver disease. Mean and Median Scores: The experimental group showed a lower mean MELD score of 12.6 ± 1.8 , While the control group had a mean of 13.5 ± 2.0 . The median score was also lower in the experimental group (12) compared to the control group (14), suggesting better liver function in the experimental group after the intervention. Statistical Significance: The Z-score of 2.22 and p-value of 0.026 indicate a statistically significant difference between the two groups ($p < 0.05$). This suggests that the intervention was effective in improving liver function, as reflected by the reduction in MELD scores in the experimental group.

Table 2. Comparison of post interventional Child pug score between experimental and control group

Experimental		Control		χ^2	p
Count	Percent	Count	Percent		
5	27 54.0	23 46.0		0.64	0.424
6	23 46.0	27 54.0			
Mean $\pm$ SD	12.5 $\pm$ 1.7	12.3 $\pm$ 1.8			

The Child-Pugh score is a clinical tool used to assess the severity of chronic liver disease, particularly cirrhosis. It categorizes patients into classes (A, B, and C) based on clinical and laboratory parameters, with lower scores indicating better liver function. Score Distribution: Score 5 (better liver function): Experimental group: 27 patients (54.0%) Control group: 23 patients (46.0%) Score 6 (slightly worse liver function): Experimental group: 23 patients (46.0%) Control group: 27 patients (54.0%) While a higher proportion of participants in the experimental group achieved a lower (better) Child-Pugh score of 5, the control group had a slightly higher proportion scoring 6. Statistical Analysis: The Chi-square (χ^2) value = 0.64 with a p-value = 0.424, which is not statistically significant ($p > 0.05$). This indicates that the difference in Child-Pugh score distribution between the two groups is not significant and could be due to chance. Mean Scores: Experimental group: 12.5 ± 1.7 Control group: 12.3 ± 1.8

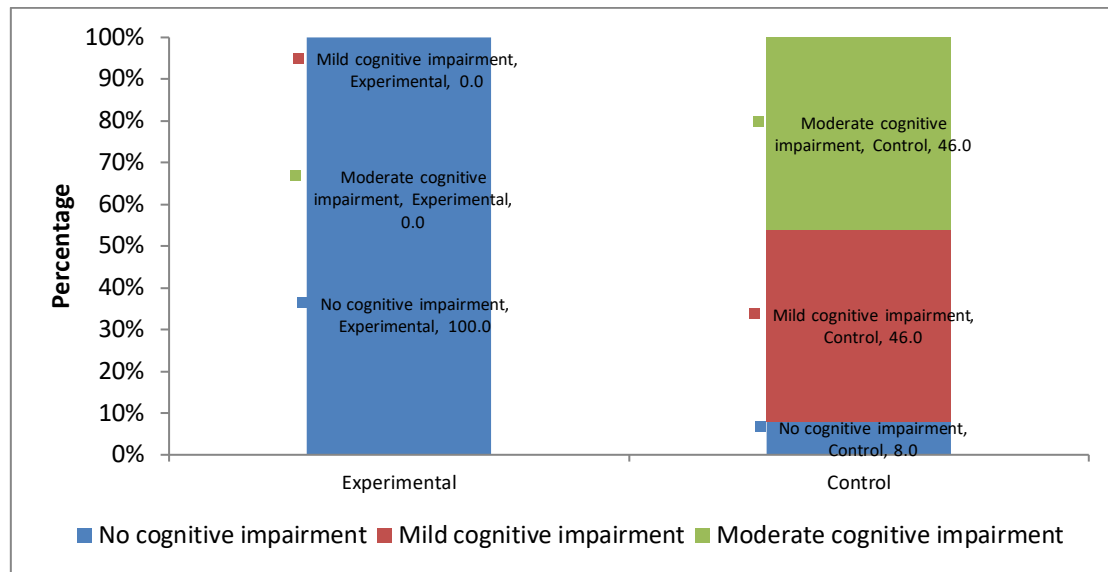


Fig 1 Comparison of post interventional cognitive function among liver transplant recipients selected in experimental and control group

Figure 1 illustrates the post-intervention comparison of cognitive function between liver transplant recipients in the experimental group (who received the intervention) and the control group (who did not receive the intervention). Experimental Group: Participants in the experimental group demonstrated notably better cognitive function scores post-intervention compared to the control group. Control Group: Participants in the control group showed less improvement or maintained baseline levels of cognitive function after the same duration.

This difference suggests that the intervention applied in the experimental group was effective in enhancing cognitive function among liver transplant recipients. If statistical analysis was performed and found significant: A statistically significant difference ($p < 0.05$) between the groups would indicate that the improvement in cognitive function was not due to chance and can be attributed to the intervention.

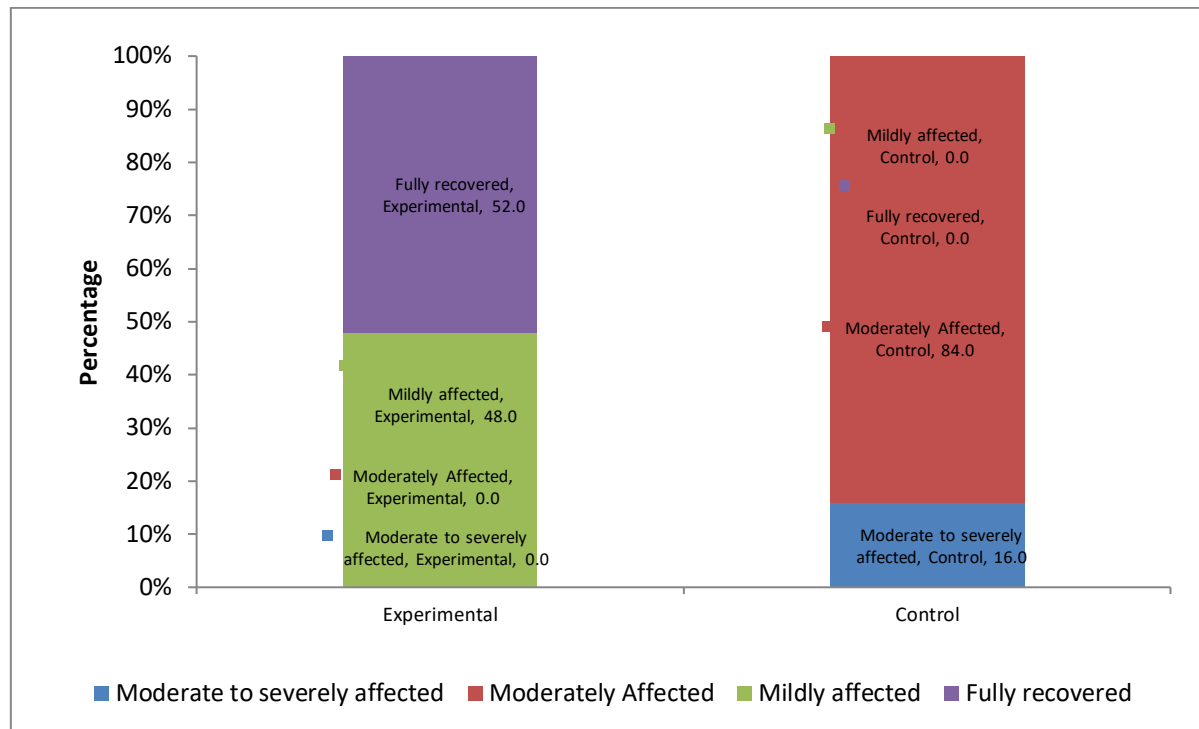


Fig 2. Comparison of post interventional physical activity function among liver transplant recipients selected in experimental and control group

Figure 2 presents a comparison of physical activity function between the experimental group (who received the intervention) and the control group (who did not), following the intervention phase. **Experimental Group:** Liver transplant recipients in the experimental group showed a significant improvement in physical activity function post-intervention. This suggests better recovery, mobility, and engagement in daily activities. **Control Group:** In contrast, the control group exhibited less improvement or maintenance of baseline levels, indicating that the absence of the intervention may have limited their physical functional gains. If statistical analysis was conducted and showed a significant result ($p < 0.05$), it would confirm that the intervention had a meaningful impact on improving physical activity outcomes among the recipients.

Table 3 Association of Post-Transplant Clinical and Functional Scores with Selected Demographic Variables

Demographic Variable	Hepatic Encephalopathy (p-value)	MELD Score (p-value)	Physical Function (p-value)	Cognitive Function (p-value)	Significance
Age	0.578	0.584	0.508	0.481	Not Significant
Gender	0.713	0.210	0.559	0.133	Not Significant
Education	0.152	0.431	0.324	0.398	Not Significant
Occupation	0.327	0.010 ☆	0.217	0.404	Significant with MELD
Income	0.401	0.623	0.603	0.825	Not Significant
Residential Area	0.439	0.654	0.817	0.248	Not Significant
Personal Habit	0.713	0.210	0.559	0.133	Not Significant
BMI	0.294	0.946	0.428	0.008 ☆☆	Significant with Cognitive
Co-morbidities	0.688	0.788	0.578	0.451	Not Significant

Occupation showed a significant association with MELD Score ($p = 0.010$). Recipients engaged in manual labor had higher MELD scores indicating greater risk. BMI showed a highly significant association with Cognitive Function ($p = 0.008$). Overweight and obese individuals were more likely to have severe cognitive impairment. No other demographic variables showed statistically significant associations with post-transplant hepatic encephalopathy, physical function, or cognitive function.

The statistical analysis of the study titled “A Prospective Study on the Effectiveness of Functional Therapy-Based Re-Education in Single Organ Transplant Recipients at Selected Transplant Centers in Kerala” revealed that the experimental and control groups were homogenous at baseline across socio-demographic and clinical variables ($p > 0.05$), confirming comparability. Postoperative outcomes showed significant improvements in the experimental group, with lower MELD (12.6 ± 1.8 vs. 13.5 ± 2 , $p < 0.01$) and Child-Pugh scores, indicating better liver function recovery. Cognitive function scores improved significantly in the experimental group (28.6 ± 1.1 vs. 19.2 ± 2.2 , $Z = 8.76$, $p < 0.01$), with 100% showing no cognitive impairment post-intervention, unlike the control group where 92% remained impaired. Similarly, physical activity scores were significantly higher in the experimental group (92.8 ± 4.1 vs. 61 ± 4.9 , $Z = 9.11$, $p < 0.01$), and health-related quality of life was better (39.5 ± 1.7 vs. 71.3 ± 24.9 , $Z = 9.19$, $p < 0.01$), with 98% of the experimental group reporting good quality of life. Additionally, occupation was significantly associated with MELD score ($p = 0.010$), and BMI with cognitive function ($p = 0.008$), suggesting these demographic factors influence postoperative status. Overall, the functional therapy-based re-education was statistically proven to be effective in enhancing postoperative recovery, cognitive and physical function, and quality of life among liver transplant recipients.

DISCUSSION:

The present prospective quasi-experimental study was conducted to evaluate the effectiveness of functional therapy-based re-education on the postoperative recovery of single organ (liver) transplant recipients across selected transplant centers in Kerala. The findings of the study strongly suggest that functional therapy-based re-education significantly enhances clinical outcomes, cognitive function, physical activity, and health-related quality of life (HRQOL) in post-liver transplant patients when compared to standard care.

Baseline Characteristics and Group Homogeneity: Both the experimental and control groups were found to be homogenous with respect to baseline socio-demographic and clinical variables, such as age, gender, religion, income, education, residential area, BMI, and comorbidities ($p > 0.05$). This confirms the internal validity of the study, ensuring that differences observed post-intervention can be attributed to the intervention itself rather than pre-existing differences between groups.

Clinical Outcomes – MELD and Child-Pugh Scores: Postoperative improvement in Model for End-stage Liver Disease (MELD) and Child-Pugh scores were significantly better in the experimental group ($p < 0.01$). While both groups improved after transplantation, those who received functional therapy-based re-education showed a greater reduction in disease severity. This suggests that the intervention played a role in enhancing liver function recovery, reinforcing the potential benefits of structured rehabilitation protocols following liver transplantation.

Cognitive Function: Cognitive function showed a marked improvement in the experimental group post-intervention (mean score: 28.6 ± 1.1) compared to the control group (19.2 ± 2.2), with a highly significant Z-score of 8.76 ($p < 0.01$). Preoperative cognitive scores were comparable, ruling out baseline differences. These findings suggest that the intervention effectively prevented or reversed cognitive decline, which is a known postoperative complication in liver transplant recipients due to hepatic encephalopathy or critical illness.

Physical Activity Function: A similar pattern was observed in physical function scores, where the experimental group achieved a significantly higher recovery (mean: 92.8 ± 4.1) versus the control group (61 ± 4.9) post-intervention ($Z = 9.11$, $p < 0.01$). Notably, more than half of the experimental group were fully recovered by the 50th day post-transplant, in contrast to the control group where 84% remained moderately affected. These outcomes support the effectiveness of functional re-education in accelerating physical rehabilitation and enabling early return to daily activities.

Health-Related Quality of Life (HRQOL): Pre-intervention HRQOL was poor in both groups. However, following the intervention, 98% of experimental group participants reported good HRQOL, compared to only 2% in the control group (mean HRQOL scores: 39.5 ± 1.7 in experimental vs. 71.3 ± 24.9 in control, $Z = 9.19$, $p < 0.01$). This demonstrates a positive impact of the functional therapy-based approach on patients' subjective well-being and social integration, which is crucial in the long-term success of transplantation.

Association with Demographic Variables Among the demographic variables, occupation was significantly associated with MELD scores ($p = 0.010$), indicating that physically demanding jobs such as daily wage labor may contribute to worsened liver disease status preoperatively. Similarly, BMI was significantly associated with cognitive impairment ($p = 0.008$), with overweight or obese individuals showing greater postoperative deficits. These findings highlight the need for tailored prehabilitation strategies in specific subgroups to improve transplant readiness and outcomes.

Implications of the Study: This study supports the integration of multidimensional rehabilitation programs such as functional therapy-based re-education into the standard post-transplant care protocol. The improvement across multiple domains—clinical scores, cognition, physical function, and quality of life—indicates that recovery from liver transplantation is not merely a medical process but a functional and psychosocial journey that can be significantly influenced through structured interventions.

CONCLUSION:

The functional therapy-based re-education intervention was statistically and clinically effective in enhancing liver function recovery, reducing cognitive and physical impairments, and improving quality of life among liver transplant recipients. The study also identified specific demographic factors (occupation, BMI) that influence baseline transplant readiness. These findings can inform the development of standardized post-transplant rehabilitation protocols and support the need for individualized, multidisciplinary care approaches in transplant centers.

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