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POST-TRAUMATIC GROWTH FOLLOWING LIVER TRANSPLANTATION: A SYSTEMATIC REVIEW AND META-ANALYSIS OF PSYCHOLOGICAL RESILIENCE IN TRANSPLANT SURVIVORS

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ABSTRACT

Liver transplantation is a life-saving procedure for patients with end-stage liver disease and hepatocellular carcinoma. Although survival outcomes have improved substantially, many patients experience long-term psychological and emotional challenges after transplantation. One emerging concept is post-traumatic growth (PTG), which refers to positive psychological changes that may occur after experiencing a major life-threatening event, such as organ transplantation. PTG does not imply absence of distress, but rather the development of new perspectives, personal strength, and appreciation of life. This meta-analysis aims to evaluate the prevalence of post-traumatic growth among liver transplant recipients, identify key factors associated with its development, and assess its impact on psychological well-being, resilience, and quality of life. A systematic search of PubMed, Web of Science, Scopus, ScienceDirect, and Google Scholar identified studies assessing post-traumatic growth in adult liver transplant recipients. PTG was measured using the Post-Traumatic Growth Inventory (PTGI), which evaluates five domains: appreciation of life, personal strength, relating to others, new possibilities, and spiritual change. Random-effects meta-analysis was performed using Comprehensive Meta-Analysis software. Out of 611 identified articles, six studies met the inclusion criteria, representing 1,135 liver transplant recipients. The pooled prevalence of high PTG was 41.6% (95% CI: 32.4–50.7%) and the pooled mean PTG score was 63.7 (95% CI: 61.7–65.7). Subscale analysis showed pooled mean scores of 2.97 (95% CI: 2.87–3.08) for New Possibilities, 3.13 (95% CI: 3.02–3.24) for Personal Strength, 3.03 (95% CI: 2.92–3.14) for Relations to Others, 2.53 (95% CI: 2.38–2.67) for Spiritual Changes, and 3.72 (95% CI: 3.62–3.82) for Appreciation of Life. Overall heterogeneity across PTG subscales was high ($I^2 = 95.02\%$, $p < 0.001$, $\tau^2 = 0.166$). This meta-analysis shows that many liver transplant recipients experience positive psychological growth, especially in appreciating life, gaining personal strength, and seeing new possibilities. However, differences across studies suggest that this growth is influenced by various personal and cultural factors. Customized psychosocial support can help enhance these positive outcomes.

KEYWORDS: "Post-traumatic growth," "Liver transplantation," "Psychological resilience," "Quality of life," "Patient adaptation," "Mental health," "Emotional well-being," "Transplant survivorship," "Coping strategies," and "Positive psychology."

1 INTRODUCTION

Liver transplantation offers a potential cure for individuals with decompensated cirrhosis or early-stage hepatocellular carcinoma, with five-year survival rates exceeding 70% (Durand et al., 2017). Despite these favorable outcomes, recovery following liver transplantation is often demanding and involves substantial physical, emotional, and psychological challenges. Recipients must adapt to a new lifestyle that requires strict adherence to immunosuppressive therapy, frequent medical follow-up, and the management of potential complications. Understanding patients' perspectives on recovery is therefore essential for improving post-transplant care.

Liver transplantation survivorship extends beyond patient and graft survival to encompass the lived experiences, symptoms, and psychosocial adjustments that influence overall well-being. However, the long-term adaptation of liver transplant recipients remains incompletely understood. Patient-reported outcome measures and surveys provide valuable insights into post-transplant survivorship that are not fully captured by traditional clinical indicators.

Despite successful transplantation, many recipients report a reduced quality of life compared with the general population. This decline is often attributed to stress related to acute and chronic graft rejection, disease recurrence, and the adverse effects of long-term immunosuppressive therapy. These ongoing challenges may also increase vulnerability to psychological distress and mental health disorders. In this context, the concept of **post-traumatic growth (PTG)** is particularly relevant. PTG refers to positive psychological changes that can emerge following exposure to traumatic or highly stressful life events. Unlike resilience, which involves returning to a prior level of functioning, PTG reflects a transformative process in which individuals experience growth beyond their pre-trauma baseline. Tedeschi and Calhoun first introduced this concept, defining PTG as "the experience of positive change that occurs as a result of the struggle with highly challenging life crises" (Durand et al., 2017).

Post-traumatic growth is closely aligned with the principles of positive psychology, which emphasize human strengths, well-being, and personal development. PTG encompasses positive changes across multiple life domains, including a greater appreciation for life, improved interpersonal relationships, enhanced personal strength, recognition of new possibilities, and spiritual or existential development (Lieber et al., 2021). These

domains are commonly assessed using instruments such as the Post-Traumatic Growth Inventory, developed by Tedeschi and Calhoun.

Importantly, PTG does not imply the absence of psychological distress. Rather, growth often coexists with emotional suffering, and the process may be facilitated by actively confronting and making sense of trauma (Lieber et al., 2021). Factors influencing PTG include individual coping strategies, personality traits, perceived social support, and broader cultural and contextual influences (Institute of Medicine & National Research Council, 2006).

In health-related contexts such as organ transplantation, PTG may be particularly salient. Liver transplant recipients face complex physical and emotional adjustments, including lifestyle changes, fear of graft rejection, lifelong medication use, and existential concerns. These challenges may act as catalysts for PTG, encouraging individuals to reassess priorities, develop new perspectives, and cultivate psychological resilience (Masala et al., 2012).

Despite the substantial psychosocial burden associated with liver transplantation, PTG in this population remains underexplored. Existing research has largely focused on survival outcomes, medical complications, and quality of life, with comparatively limited attention given to positive psychological adaptation and growth. Examining PTG in liver transplant recipients is therefore essential for advancing a more comprehensive understanding of post-transplant recovery.

Accordingly, this study aims to systematically review and synthesize the existing literature on post-traumatic growth following liver transplantation. Through a systematic review and meta-analysis, this research examines the prevalence of PTG, associated psychosocial factors, and related psychological outcomes in liver transplant recipients. Identifying factors that promote psychological resilience may inform the development of targeted interventions to support emotional well-being and enhance long-term post-transplant care. Recognizing PTG as a key component of post-transplant adaptation shifts the focus from survival alone toward a more holistic model of recovery that integrates mental health and quality of life.

3 MATERIALS AND METHODS

Study design and duration

The preferred reporting items for systematic reviews and meta-analyses, or PRISMA standards, were followed in this meta-analysis (Page et al., 2021). This analysis was conducted in March of 2025.

Literature search

Searches for relevant literature were conducted thoroughly and systematically using PubMed, Web of Science, Scopus, ScienceDirect, and Google Scholar. The search was limited to English and tailored to meet the specific requirements of each database. To identify relevant research articles, the selected search phrases were adapted into topic terms in Scopus or MeSH terms in PubMed: "Post-traumatic growth," "Liver transplantation," "Psychological resilience," "Quality of life," "Patient adaptation," "Mental health," "Emotional well-being," "Transplant survivorship," "Coping strategies," and "Positive psychology." Boolean operators like "OR," "AND," and "NOT," were paired with the relevant keywords.

Study selection and Data extraction

The output of the search method was double-checked using Rayyan (QCRI) software (Ouzzani *et al.*, 2016). By applying inclusion and exclusion criteria to the combined search results, the researchers evaluated the titles and abstracts for relevance. Every paper that meets the inclusion criteria was thoroughly reviewed by the researchers. The authors discussed methods for resolving any disputes. The approved studies were uploaded using a pre-designed data extraction form. The authors extracted data, including study titles, authors, publication year, country, sample size, mean age, post-traumatic growth, psychosocial adaptation, mental health outcomes, and resilience following transplantation. A separate sheet was created for the risk of bias assessment.

High PTG definition

The original included studies' criteria were used to define high post-traumatic growth. The majority of studies classified high PTG using study-specific thresholds, typically based on upper-tertile or percentile distributions or predetermined score ranges. Before pooling, PTGI scores were harmonized to guarantee comparability across studies. The total PTGI scores (range: 0–105) reported in the studies were analyzed for pooled mean estimation. The mean item or subscale scores (range: 0–5) reported in the studies were pooled independently within their respective domains. Beyond standardizing the original PTGI scoring framework, no score transformations were used (Tedeschi *et al.*, 2017).

Selection criteria

In this meta-analysis, the PICO question focused on understanding post-traumatic growth in liver

transplant recipients. The population (P) included adult patients who have undergone liver transplantation. The intervention (I) was the experience of liver transplantation as a significant life event that may lead to psychological adaptation and growth. The comparison (C) involved either liver transplant recipients with lower or no post-traumatic growth or those experiencing psychological distress post-transplantation. The outcome (O) assessed the extent of post-traumatic growth, including improvements in psychological resilience, emotional well-being, and overall quality of life. This study systematically evaluated the existing literature to determine the factors contributing to post-traumatic growth and its impact on post-transplant adaptation. Only studies published in the last 20 years and in English language were included.

Risk of bias assessment

Systematic reviews of cross-sectional research were conducted using the Joanna Briggs Institute Critical Appraisal tools (JBI) (Moola *et al.*, 2020). Positive responses below 49% indicated a high risk of prejudice, those between 50% and 69% indicated a moderate risk of bias, and those over 70% indicated a low risk of bias.

Statistical analysis

The statistical program Comprehensive Meta-Analysis was used to analyze the data (Borenstein, 2022). A report on the fixed effects were provided. Standardized mean differences were calculated to assess the magnitude of post-traumatic growth effects across studies. Additionally, pooled prevalence estimates were computed to determine the overall occurrence of post-traumatic growth among liver transplant recipients. The results were presented as OR (95% CI) and standardized mean difference, with statistical significance determined by two-tailed p-values less than 0.05. Moreover, p-values less than 0.1 and $I^2 > 50\%$ were considered indicators of substantial heterogeneity. Funnel plots were employed as a critical tool for assessing publication bias.

3 RESULTS

Search results

Following an extensive search, 611 articles were initially identified. After removing 342 duplicates, 269 studies remained for title and abstract screening, of which 203 were excluded. Of the 66 full-text reports requested, 2 were unavailable. After full-text screening of 64 articles, 41 were excluded due to irrelevant outcomes, 15 due to unsuitable population,

1 was only an abstract, and 1 was an editor's letter. Ultimately, six studies met the inclusion criteria for

this analysis. The study selection process is illustrated in **Figure 1**.

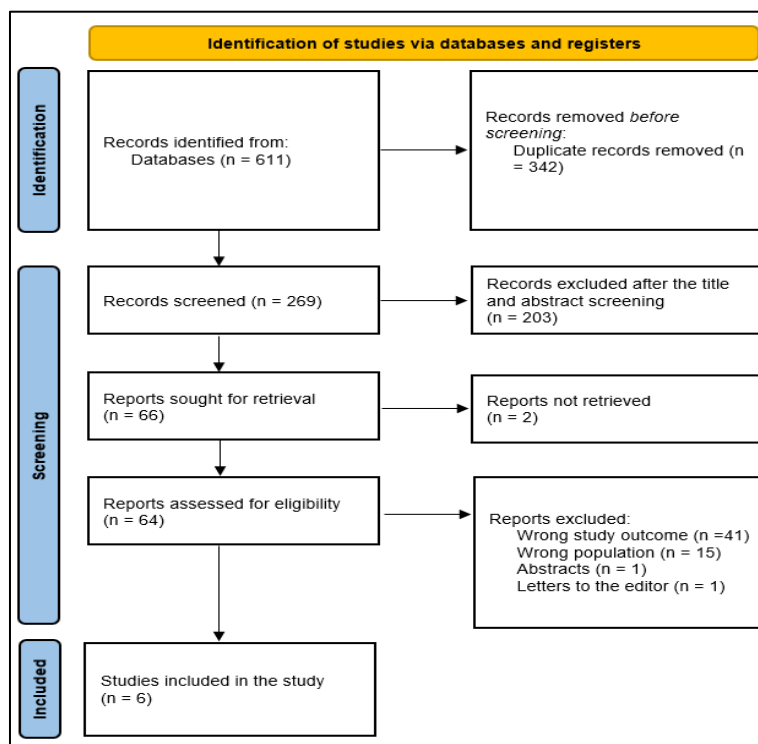


Figure (1): Study selection is summed up in a PRISMA flowchart.

Study characteristics

Table 1 shows the sociodemographic features of the study articles that were considered. Our results included six studies with a total of 1135 participants who underwent liver transplantation and 871 (76.7%). All of the included studies were cross-sectional studies. Three studies were conducted in

Spain (Pérez-San-Gregorio *et al.*, 2017; Pérez-San-Gregorio *et al.*, 2018; Fernández-Alonso *et al.*, 2024), one in Turkey (Harmanci & Bulbuloglu, 2023), one in the USA (Kruckenberg *et al.*, 2021), and one in Italy (Gangeri *et al.*, 2018). All of the included studies used PTGI to assess the prevalence and domains of PTG.

Table (1): Sociodemographic characteristics of the included participants.

Study	Study design	Country	Sample size	Mean age	Males (%)	PTG assessment tool
Harmanci & Bulbuloglu, 2023	Coss-sectional	Turkey	218	64.68±20.09	161 (73.9%)	PTGI
Kruckenberg et al., 2021	Cross-sectional	USA	118	57±9	84 (43%)	PTGI
Pérez-San-Gregorio et al., 2017	Cross-sectional	Spain	214	60.41±9.36	165 (77.1%)	PTGI
Pérez-San-Gregorio et al., 2018	Cross-sectional	Spain	240	60.21±9.30	185 (77.1%)	PTGI
Gangeri et al., 2018	Cross-sectional	Italy	171	61	144 (84%)	PTGI
Fernández-Alonso et al., 2024	Cross-sectional	Spain	174	53	132 (75.9%)	PTGI

Meta-analysis of pooled fixed effects

The forest plot shows a pooled prevalence of high PTG of 41.6% (95% CI: 32.4–50.7%). There was little heterogeneity between studies ($\tau^2 = 0.0073$). The 95% prediction interval showed significant variation in prevalence estimates across subsequent studies, ranging from 22.4% to 60.7% **Figure (2)**.

The vertical reference line in Figure 2 represents the overall mean prevalence across studies, not a null-effect line. Because prevalence meta-analyses do not test deviation from a null value (unlike standardized

mean differences), the reference line does not necessarily intersect the center of the pooled estimate diamond. This differs from forest plots of continuous outcomes, where the vertical line typically represents the pooled mean or null value and therefore intersects the rhomboid.

The pooled mean PTG was 63.7 (95% CI: 61.7–65.7). There was moderate between-study heterogeneity ($\tau^2 = 1.12$, $I^2 = 50.4\%$, $Q = 4.03$, $p = 0.13$). The true mean PTG in a similar study in the future is likely to fall within the 95% prediction interval, which ranged

from roughly 60.8 to 66.6 **Figure (3)**.

For new possibilities, the pooled mean was 2.97 (95% CI: 2.87–3.08). There was little to moderate between-study heterogeneity ($\tau^2 \approx 0.02$). The true mean in a similar study in the future is to fall within the 95% prediction interval, which ranged from roughly 2.65 to 3.30 **Figure (4)**.

The pooled mean personal strength score, was 3.13 (95% CI: 3.02–3.24). There was little to moderate between-study heterogeneity ($\tau^2 \approx 0.01$ –0.02). The true mean personal strength score in a similar study in the future is likely to fall within the 95% prediction interval, which ranged from roughly 2.85 to 3.40 **Figure (5)**.

Relations to others had a pooled mean score of 3.03 (95% CI: 2.92–3.14). There was little heterogeneity

between studies ($\tau^2 \approx 0.01$). The 95% prediction interval showed little variation in this domain across subsequent comparable studies, ranging from roughly 2.80 to 3.25 **Figure (6)**.

Spiritual changes had a pooled mean score of 2.53 (95% CI: 2.38–2.67). Between-study heterogeneity was low ($\tau^2 \approx 0.01$). The range of the 95% prediction interval was roughly 2.20 to 2.85, suggesting that spiritual change scores will vary slightly between similar studies in the future **Figure (7)**.

Appreciation of life had a pooled mean score of 3.72 (95% CI: 3.62–3.82). There was little heterogeneity between studies ($\tau^2 \approx 0.01$). The 95% prediction interval showed little variation in appreciation-of-life scores across similar studies in the future, ranging from roughly 3.40 to 4.00 **Figure (8)**.

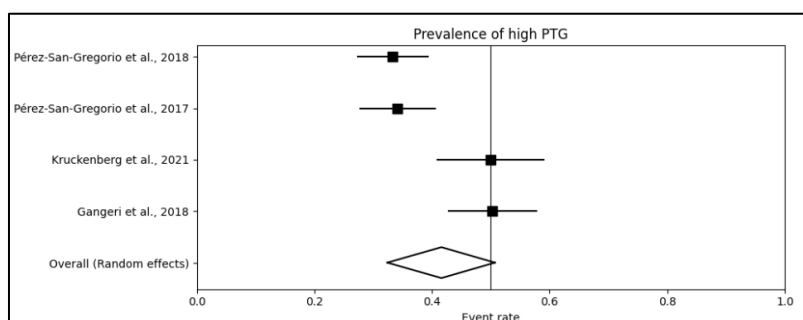


Figure (2): Forest plot of overall prevalence of high PTG.

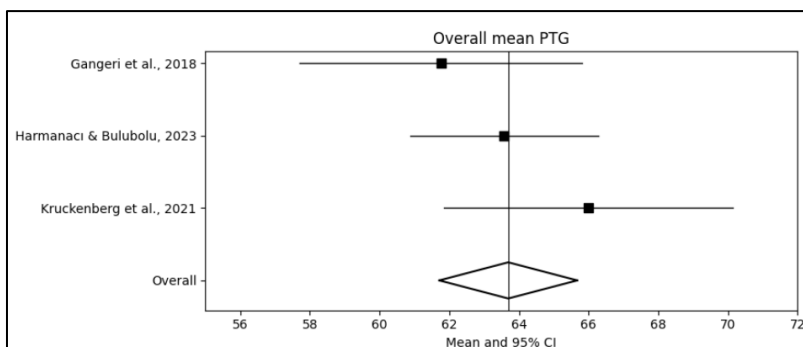


Figure (3): Forest plot of the PTG. The random-effects model was used to pool the overall mean and study weights.

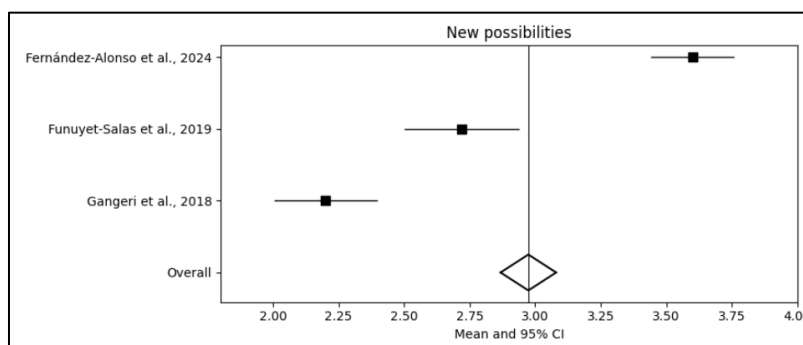


Figure (4): Forest plot of the new possibilities. The random-effects model was used to pool the overall mean and study weights.

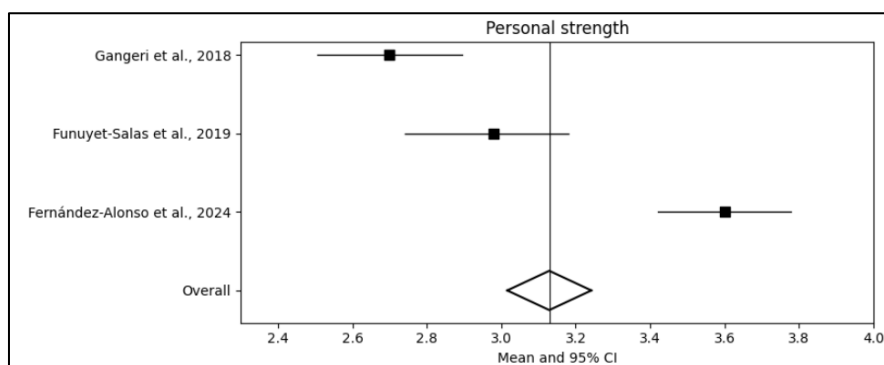


Figure (5): Forest plot of the “personal strength”. The random-effects model was used to pool the overall mean and study weights.

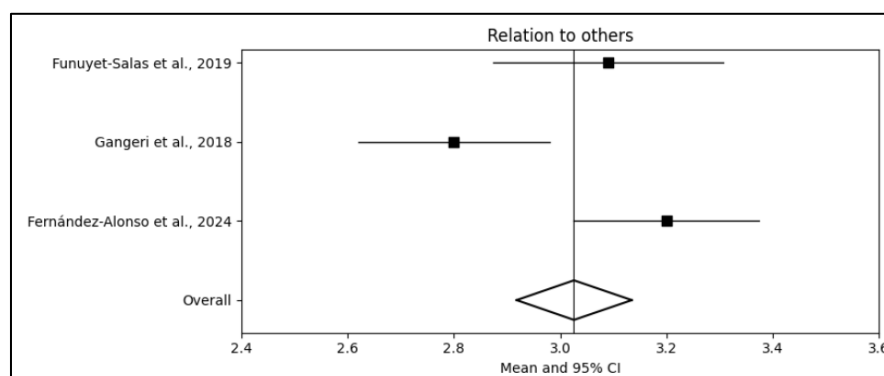


Figure (6): Forest plot of the “relation to others”. The random-effects model was used to pool the overall mean and study weights.

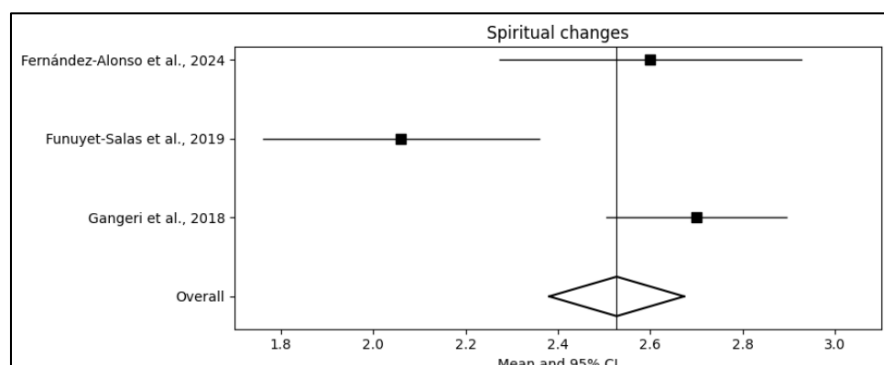


Figure (7): Forest plot of the “spiritual changes”. The random-effects model was used to pool the overall mean and study weights.

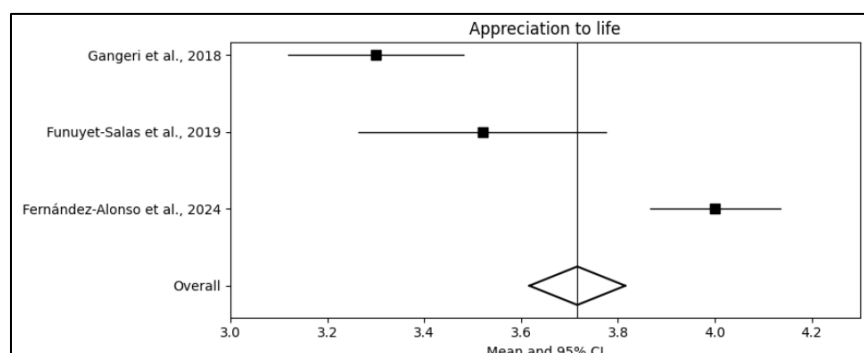


Figure (8): Forest plot of the “appreciation to life”. The random-effects model was used to pool the overall mean and study weights.

Table (2): Risk of bias assessment.

Authors	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	% Yes	Risk
Harmanci & Bulubolu, 2023	✓	✓	✓	✓	✓	✓	✓	✓	100	Low
Kruckenberget al., 2021	✓	✓	✓	✓	✓	✓	✓	✓	100	Low
Pérez-San-Gregorio et al., 2017	✓	✓	✓	✓	X	✓	✓	✓	87.5	Low
Pérez-San-Gregorio et al., 2018	✓	✓	✓	✓	✓	✓	✓	✓	100	Low
Gangeri et al., 2018	✓	✓	✓	✓	✓	✓	✓	✓	100	Low
Fernández-Alonso et al., 2024	✓	✓	✓	✓	✓	✓	✓	✓	100	Low

Q1. Were the criteria for inclusion in the sample clearly defined? Q2. Were the study subjects and the setting described in detail? Q3. Was the exposure measured in a valid and reliable way? Q4. Were objective, standard criteria used for measurement of the condition? Q5. Were confounding factors identified? Q6. Were strategies to deal with confounding factors stated? Q7. Were the outcomes measured in a valid and reliable way? Q8. Was appropriate statistical analysis used? ✓ = Yes; X = No; U = Unclear; N/A = Not applicable

4 DISCUSSION

PTG of **41.6%**, indicating that approximately four out of every ten liver transplant recipients experience significant psychological growth following transplantation (Látos et al., 2015). Despite the substantial variability observed across studies (range: 33.3%–50.3%), the pooled estimate provides a robust indicator of psychological resilience and adaptive growth in this population. Nevertheless, these findings underscore the importance of addressing not only physical but also psychological outcomes in post-transplant care (Lefebvre et al., 1973).

The pooled mean PTG score of 63.7 (95% CI: 61.7–65.7) reflects a moderate to high level of post-traumatic growth among liver transplant recipients. The statistical significance across the included studies supports the reliability of this pooled estimate. Notably, Harmanci and Bulubolu (2023) contributed the greatest relative weight (53.27%), which may have influenced the overall pooled mean. These findings are consistent with previous evidence showing that higher PTG is associated with improved quality of life and psychological well-being following transplantation (Hwang et al., 2021). With respect to PTG subdomains, the pooled mean score for New Possibilities was 2.97 (95% CI: 2.87–3.08), indicating that many transplant recipients perceive new opportunities or life paths following their experience. In contrast, previous investigations conducted in New York reported higher scores, whereas studies from Italy and Germany yielded comparatively lower values (Cormio et al., 2017; Jansen et al., 2015).

The pooled mean score for Personal Strength was 3.13 (95% CI: 3.02–3.24), suggesting that many liver transplant recipients experience increased inner strength following transplantation. This moderate to high level of perceived personal growth is consistent with findings reported by Cormio et al. (2015) and Tomich and Helgeson (2012), who similarly observed enhanced resilience among individuals facing major health-related trauma.

Subscale analysis further demonstrated that Relations to Others had a pooled mean score of 3.03 (95% CI: 2.92–3.14), reflecting strong interpersonal growth and improved relational depth following transplantation. In contrast, Spiritual Changes exhibited a lower pooled mean score of 2.53 (95% CI: 2.38–2.67).

The highest pooled mean score was observed for Appreciation of Life, with a value of 3.72 (95% CI: 3.62–3.82). This finding reflects a heightened sense of gratitude and re-evaluation of life priorities following transplantation. The limited heterogeneity and narrow prediction interval (3.40–4.00) suggest that appreciation of life represents one of the most consistent dimensions of post-traumatic growth across studies.

Rajkumar et al. reported that post-traumatic growth observed in individuals grieving the loss of a loved one to cancer reflects a profound psychological shift, allowing individuals to reconstruct meaning from trauma and experience personal transformation (Rajkumar et al., 2024). This aligns with the current findings, which highlight the multifaceted nature of post-traumatic growth and emphasize the role of contextual and individual factors in shaping growth trajectories. Quality of life after liver transplantation is influenced not only by graft function and survival but also by long-term physical, emotional, and psychosocial factors. Although most recipients experience marked improvement in physical health and functional status compared with the pre-transplant period, many continue to report persistent symptoms such as fatigue, pain, sleep disturbances, and reduced exercise tolerance. In parallel, psychological challenges are common and include anxiety related to graft rejection, fear of disease recurrence, medication dependence, PTG and

uncertainty about the future. Depression and emotional distress may persist even in the absence of medical complications and can negatively affect treatment adherence, social reintegration, and overall well-being. Consequently, health-related quality of life in liver transplant recipients often remains lower than that of the general population despite successful transplantation. These findings highlight the importance of addressing psychological health as an integral component of post-transplant care, alongside routine medical follow-up, to optimize long-term outcomes and patient-centered recovery. Regarding all our findings we assumed a low quality of life to high proportion of liver transplantation patients as a result of relatively high PTG ratio and all other psychological challenges.

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5 CONCLUSION

This meta-analysis confirms that a significant proportion of liver transplant recipients experience meaningful post-traumatic growth, particularly in areas of life appreciation, personal strength, and new possibilities. However, the considerable heterogeneity across studies suggests that post-traumatic growth is shaped by a complex interplay of personal, cultural, and contextual factors. Tailored psychosocial support and follow-up interventions could help maximize the positive psychological outcomes of transplantation.

Conflict of Interest: The authors declare no conflict of interest.

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