

# The safety and Efficacy of Phacoemulsification in Diabetic Versus Non-Diabetic Patients: A Systematic Review and Meta-Analysis



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## ABSTRACT

This review aims to compare the safety and efficacy of phacoemulsification cataract surgery between diabetic and non-diabetic patients, focusing on the differences in postoperative outcomes. Rev Man 5.4 was used for data analysis. Eighteen studies were included consisting of 2233 cases. We found better best corrected visual acuity (BCVA) at first post-operative day in non-diabetic patients and a lower endothelial cell density (ECD) in diabetic patients at 1<sup>st</sup> week and 3<sup>rd</sup> month. The central corneal thickness (CCT) was significantly thicker in diabetic group at 1<sup>st</sup> week and 1<sup>st</sup> month postoperatively. The coefficient of variations (CV) was significantly higher and hexagonal cell percentage (HCP) was significantly lower in the diabetic group at 1<sup>st</sup> week. HCP was significantly lower in at 1<sup>st</sup> and 3<sup>rd</sup> month postoperatively in diabetic group. No significant difference of central macular thickness (CMT) was found. Phacoemulsification has a greater impact on corneal endothelial damage and visual acuity in patients with diabetes mellitus (DM).

**Keywords:** Phacoemulsification, Diabetes, Endothelial cell count, Visual Acuity, Meta-analysis.

**How to Cite this Article:** Putri MCDM, Wahyuni I, Utami DM, Farid ZM, Klopung NA. The safety and Efficacy of Phacoemulsification in Diabetic Versus Non-Diabetic Patients: A Systematic Review and Meta-Analysis. 2025;41(2):197-208. **Doi: 10.36351/pjo.v41i2.1958**

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*Received: October 06, 2024  
Revised: December 25, 2024  
Accepted: February 23, 2025*

## INTRODUCTION

Cataract has been a huge problem around the world resulting in reversible blindness. The global prevalence of blindness and severe vision impairment caused by cataract reach 45.4% in adults more than 50 years. Among cataract patients, diabetes is considered as a major cause of ocular complication. Diabetes mellitus increases the incidence of cataract with 20.4 incidence risk per 1000 diabetic persons and 10.8 among 1000 person-years of population without diabetes.<sup>1</sup>

Cataract surgery has been evolving through decades from couching, extracapsular cataract extraction, intracapsular cataract extraction, and now the modern phacoemulsification. Phaco or phacoemulsification was first performed in 1967 and now it is one of the safest and preferred surgeries for cataract and is considered a gold standard.<sup>2</sup> The process requires small incision, quicker procedure, quick mobilization and visual rehabilitation.<sup>2</sup>

Vision improvement in diabetic patients after phacoemulsification surgery depends on the patient's previous eye condition but may also be related to subclinical changes in the cornea and retina.<sup>3</sup> Several studies have published the impact of cataract surgery including the result and complications in diabetic patients compared to non-diabetic patients. This study compares the effectiveness and safety of phacoemulsification in diabetic and non-diabetic patients.

## METHODS

This systematic review's protocol has been registered with the **ID number: CRD42023451257** in PROSPERO and conducted based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines.

Authors collected the relevant studies through PubMed, Scopus, Web of Science, Cumulative Index to Nursing and Allied Health Literature via EBSCO, and Science Direct up to July 2023. The search terms used in this study were: (phacoemulsification) and (diabetes or non-diabetes or diabetic patient") and (endothelial cell or visual outcome or visual acuity| or complication). The authors did not restrict the publication date. The authors removed the duplicates, and reviewed the articles, screened abstracts for relevance, and evaluated the chosen articles for full text availability based on eligibility criteria. This study used the following PICO model to set the eligibility criteria. Population: diabetic patients with cataract; Intervention: phacoemulsification; Comparison: non diabetic patients; and Outcomes: the main outcomes were visual acuity, endothelial cell density (ECD), central corneal thickness (CCT), and retinal change. Secondary outcomes included the patient's diabetic condition. Exclusion criteria involved irrelevant title or abstract, unretrievable full text, reviews, case series, case reports, letter to the editors, conference abstracts or studies used other than English.

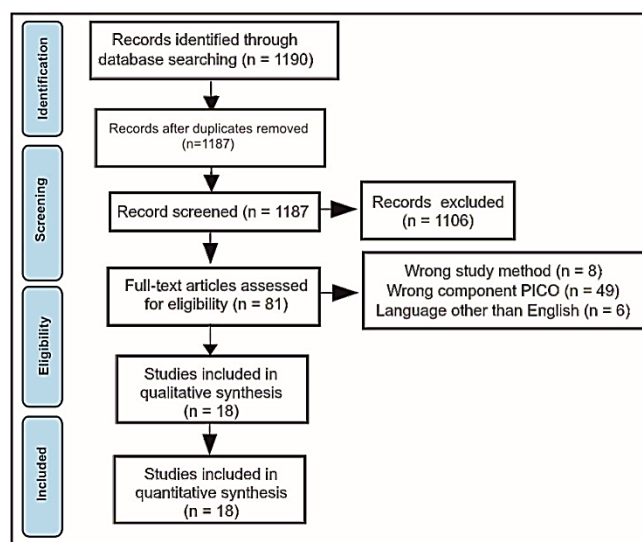
The next step was collecting relevant data for each included study including the first author, year when the studies were published, studies' location and design, sample size in each group, percentage of women, population age, values for each outcome (visual acuity, endothelial cell density, central corneal thickness, coefficient of variation, hexagonal cell percentage, and complications), diabetic condition, duration of diabetes mellitus, number of diabetic retinopathy, and grade of cataract. Methodological quality of each study was assessed with the original Newcastle-Ottawa Scale (NOS) for case control and cohort studies, while for cross sectional studies used the adapted NOS.<sup>4</sup>

Review Manager version 5.4 was used for performing all analyses. Standard mean difference (SMD) and 95% confidence interval (CI) were calculated based on the selected outcomes. A statistically significant difference was considered if  $P < 0.05$ . Heterogeneity was tested using  $I^2$  test and Cochran's Q test which  $I^2 < 50\%$  and  $P > 0.1$  indicated

no heterogeneity. To calculate the pooled effect, the fixed-effect model was used. A random effect model was used in the condition where a significant heterogeneity was found.

## RESULTS

To select the eligible studies, 5 reviewers searched and selected studies independently. Initially, 1190 studies were extracted. The duplicates were removed, the articles were reviewed, the abstracts were screened for relevance, and the chosen articles were evaluated for full-text availability based on eligibility criteria. Three duplicates were removed by using Mendeley. The inappropriate title, topics, and abstracts (1106 records, followed by browsing 81 full text studies) were excluded. Eighteen eligible studies were chosen after excluding the wrong study method ( $n = 8$ ), wrong component PICO ( $n = 49$ ), and language other than English ( $n = 6$ ). Finally, 18 studies were used in analysis as shown in figure 1.



**Figure 1:** Study Selection Flow Diagram.

Figures of A Systematic Review and Meta-analysis on Phacoemulsification: The Safety and Efficacy for Cataract in Diabetic Vs Non-Diabetic Patients were described in 9 studies where 5 of them showed more male patients.<sup>5,6,7,8,9</sup> Two studies recorded that the mean age of patients was under 60, while the rest were above 60.<sup>4,8</sup> The duration of diabetes was variable. In a study by Mehra et al, most of the patients werewith diabetes mellitus (DM) and 969 eyes without DM. The analysis consisted of 16

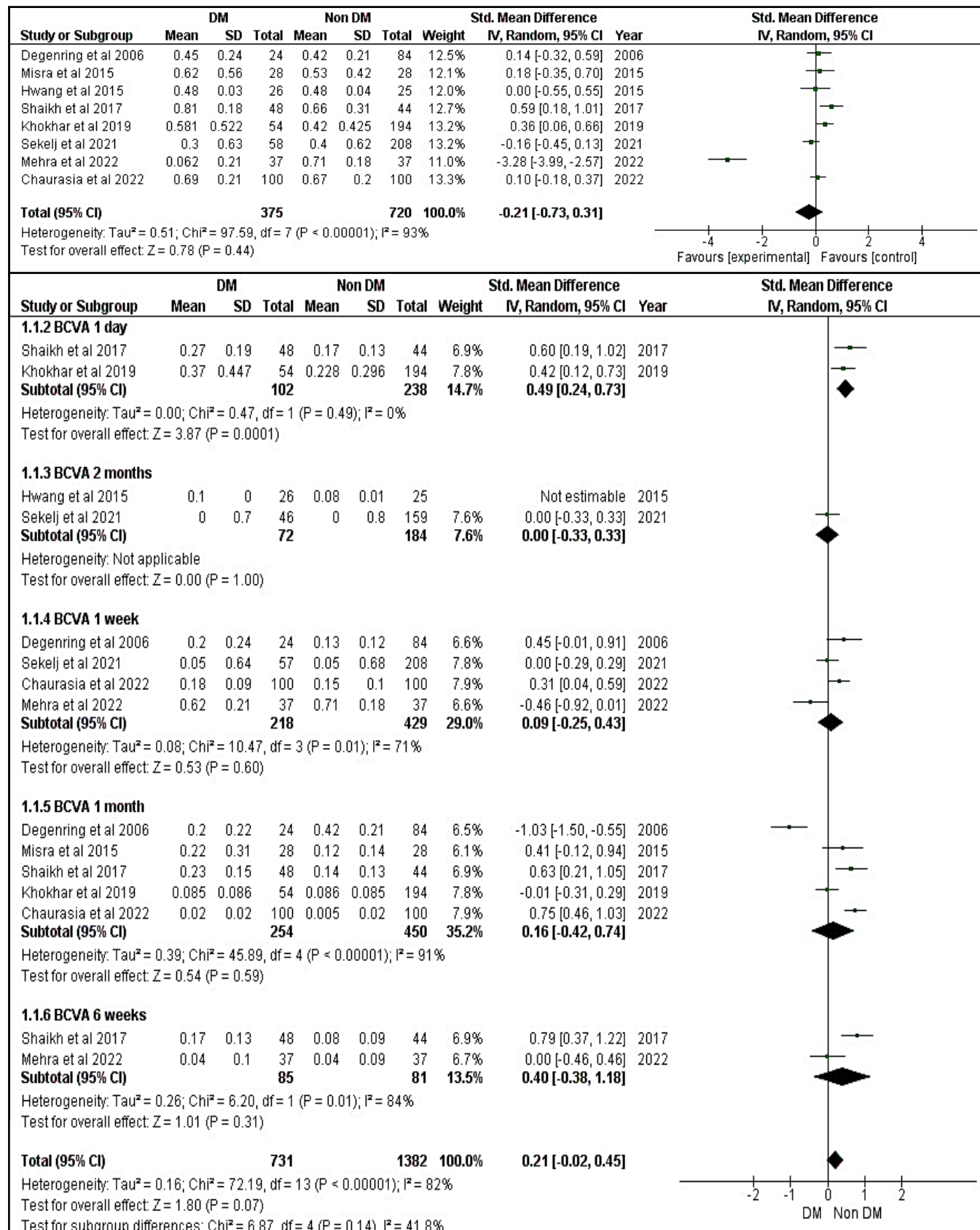


Figure 2: Forest Plot showing pre-operative and post-operative BCVA.

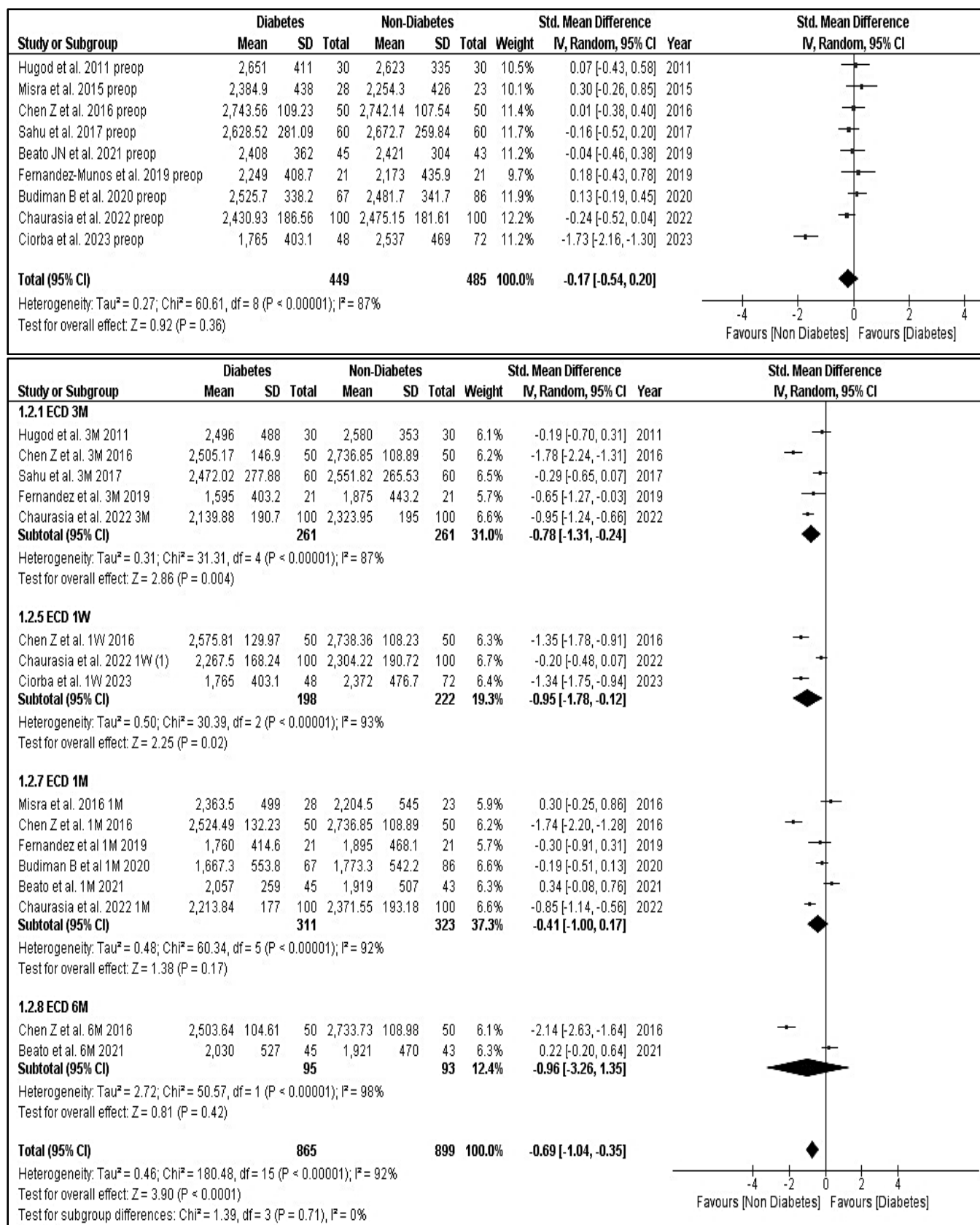


Figure 3: Forest Plot of ECD Results Pre-op and post-operative.

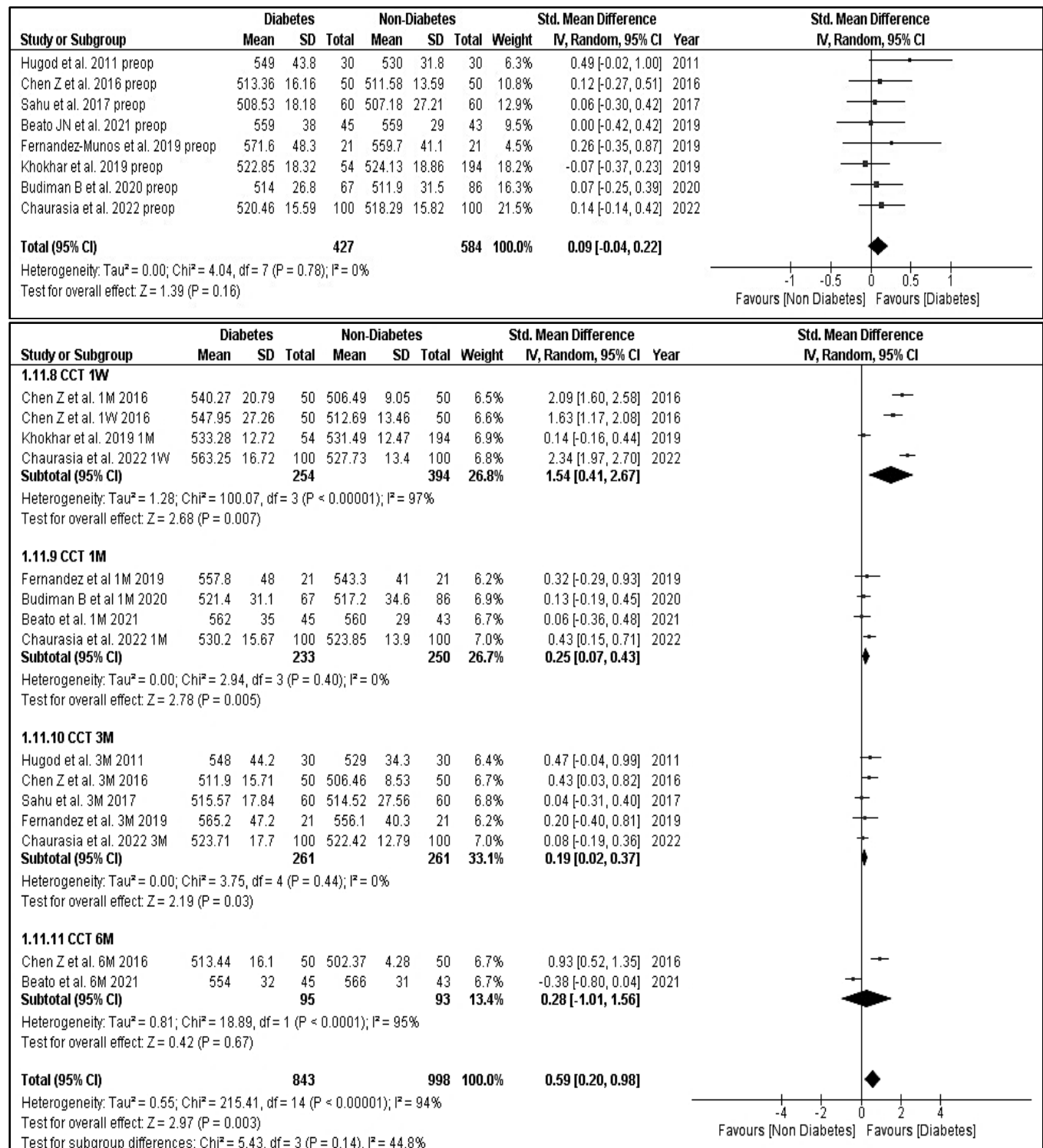


Figure 4: Forest Plot of CCT Results Pre-op and post-op

prospective studies We collected 18 observational studies published between 2006 and 2023, including a total of 1,264 eyes and 2 cross sectional studies. Female and male ratio diagnosed with diabetes within

5-10 years.<sup>9</sup> Other studies provided mean duration of 20.08, 10, 5, 9.1, 4.4, 3.06, and 11.54 years.<sup>5,6,9-13</sup>

There were 8 studies that reported patients with

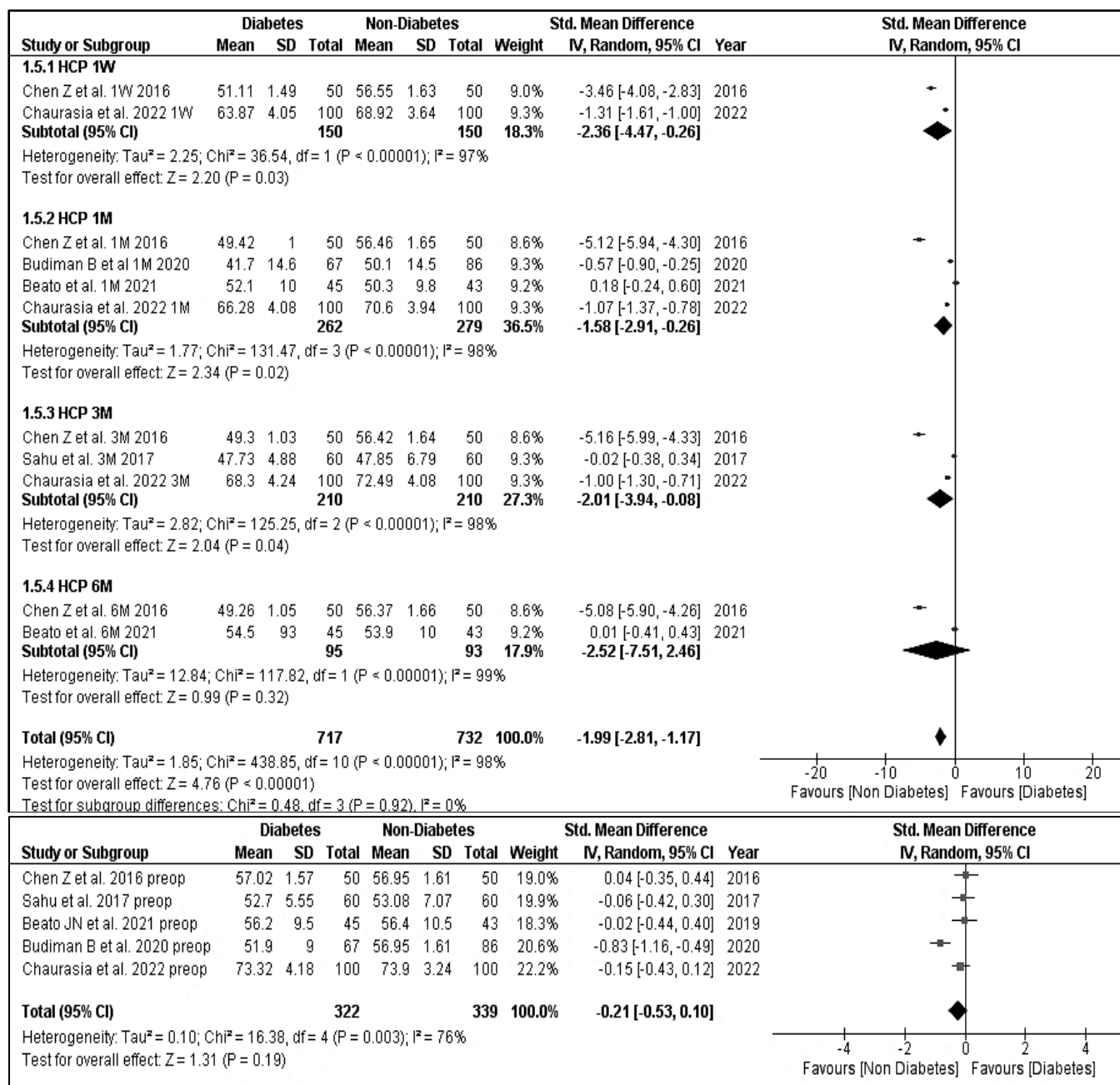


Figure 5: Forest Plot of HCP Results Pre-op and post-op.

mild to moderate non proliferative diabetic retinopathy.<sup>5,9-11,14-17</sup> While the rest had either no retinopathy patients or did not present the data. Cataract grades were categorized using LOCS II and LOCS III as follows: grade II (LOCS II)<sup>7</sup>, less than grade IV (LOCS III),<sup>18</sup> moderate cataracts,<sup>19</sup> primarily grade II<sup>3</sup> and nuclear sclerosis (ranging from grade II to III,<sup>13</sup> with most cases in grade III<sup>12</sup> or grade II<sup>7</sup>).

The assessment of NOS is based on the selection

valued by 4 stars, comparability valued by 2 stars and outcome valued by 3 stars. A study is mentioned to have a considerable risk of bias if there is 0 star in any categories of questions. Moderate risk if scoring 1-star and low risk of bias if scoring 2 star or above in all categories. Only 1 study in this analysis scored moderate risk of bias.<sup>7</sup> The rest of the studies had 2 stars or above in all categories and were marked as low risk of bias.<sup>5,6,8,9,10,12,13,14,21-22</sup>

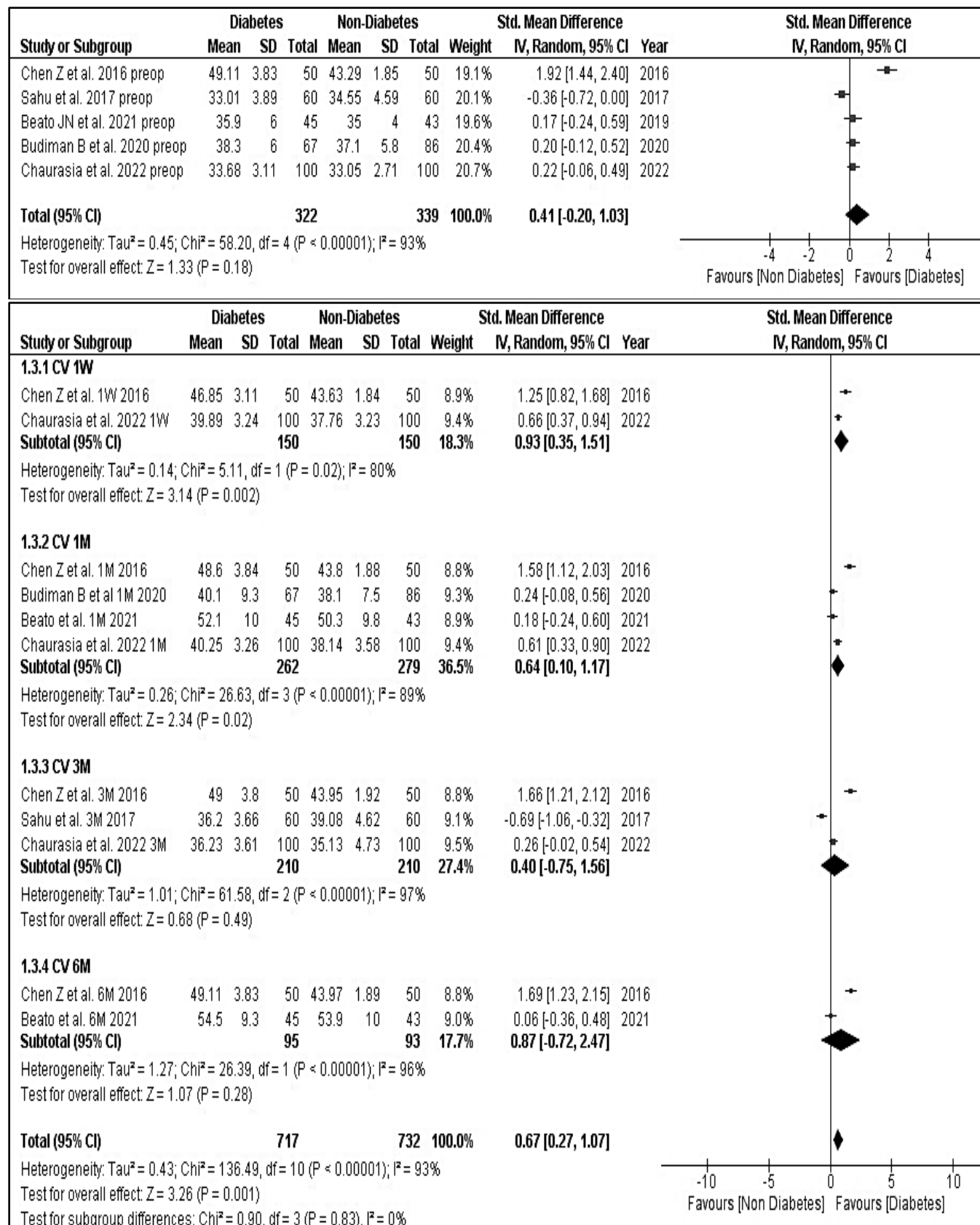


Figure 6: Forest Plot of CV Results Pre-op and post-op.

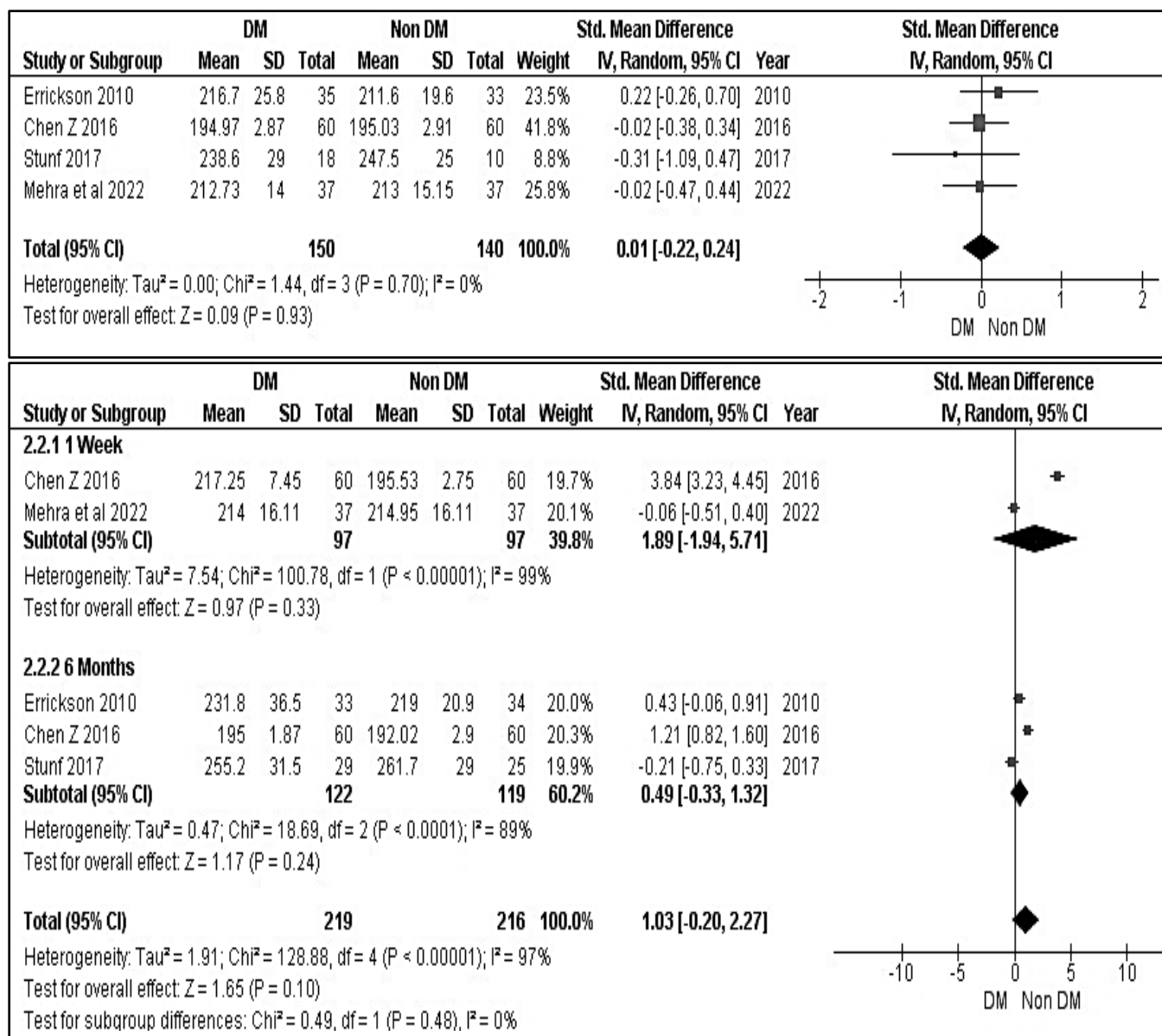


Figure 7: Forest Plot Pre-op and Post-op CMT.

The BCVA values at one week, one month, two months, and six weeks of assessments did not differ statistically (Fig. 2; 1 week: WMD= 0.09, 95% CI: -0.25-0.43, P= 0.60; 1 month: WMD= 0.18, 95% CI: 0.33-0.70, P= 0.18; 2 months: WMD= 0.96, 95% CI: -0.97-2.89, P= 0.33; 6 weeks: WMD= 0.40, 95% CI: -0.38-1.18) However, the result is significant in 1 day postoperatively favoured the non-DM group (WMD= 0.49, 95% CI: 0.24-0.73, p= 0.0001).

There were 10 studies that calculated the parameters of endothelial change after phacoemulsification. These studies measured the ECD,

CCT, CV and HCP in pre-operative and the post-operative evaluation on the first week, first month, third months and six months post-operative. Significant difference of ECD was not found between the two groups pre-op, 1 month and 6 months post-op (pre-op: WMD= -0.17, 95% CI: -0.54-0.20, p= 0.36; 1 month: WMD= -0.41, 95% CI: -1.00-0.17, p= 0.17; 6 months: WMD= -0.96, 95% CI: -3.25-1.35, p= 0.42).

However, the significant result was seen in ECD measurement in 1 week and 3 months follow up which favoured to non-DM group as shown in figure 3. (1 week: WMD= -0.95, 95% CI, -1.78 to -0.12,



$p=0.02$ ; 3 months: WMD= -0.78, 95% CI: -1.31 to -0.24,  $p= 0.004$ ).

Meanwhile for CCT (figure 4), the differences in preoperative, 3 months and 6 months of follow up showed no significant result. (pre-op: WMD= 0.09, 95% CI: -0.040.22,  $p= 0.16$ ; 3 months: WMD= 0.19, 95% CI: 0.02-0.37,  $p= 0.03$ ; 6 months: WMD= 0.28, 95% CI: -1.01-1.56,  $p= 0.67$ ) However, DM group had significantly thicker CCT in 1 week and 1 month follow ups (1 week: WMD= 1.54, 95% CI: 0.41-2.67,  $p= 0.007$ ; 1 month: WMD= 0.25, 95% CI: 0.07-0.43,  $p= 0.005$ ).

Authors found a significantly lower result of HCP (figure 5) in 1<sup>st</sup> week, 1<sup>st</sup> month, and 3<sup>rd</sup> months after surgery in the DM group (1 week: WMD= -2.36, 95% CI: -4.47 to -0.26,  $p= 0.03$ , 1 month: WMD= -1.58, 95% CI: 2.91 - -0.26,  $p= 0.02$ , 3 months: WMD= -2.01, 95% CI: -3.94 - -0.08,  $p= 0.04$ ) but also found that the result measured preoperatively and 6 months post op was not significant (pre-op: WMD= -0.21, 95% CI: -0.53-0.10,  $p= 0.19$ ; 6 months: WMD= -2.52, 95% CI: -7.51-2.46,  $p= 0.32$ ).

In figure 6, DM patients have significantly higher CV in 1 week and 1-month follow up (1 week: WMD= 0.93, 95% CI: 0.35-1.51,  $p= 0.002$ ; 1 month: WMD= 0.64, 95% CI: 0.10-1.17,  $p= 0.02$ ). However, the result showed no significant difference in preoperative, 3 months and 6 months postoperative, respectively (pre-op: WMD= 0.41, 95% CI: -0.20-1.03,  $p= 0.18$ , 3 months: WMD= 0.40, 95% CI: -0.75-1.56,  $p= 0.49$ ; 6 months: WMD= 0.87, 95% CI: -0.72-2.47,  $p= 0.28$ ).

Four studies that measured CMT and included in this review are shown in Figure 7 (preoperative: WMD= 0.01, 95% CI: -0.22-0.24,  $p= 0.93$ ; 1 week: WMD= 1.89, 95% CI: -1.94-5.71,  $p= 0.33$ ; 6 months: WMD= 0.49, 95% CI: -0.33-1.32,  $p= 0.24$ ).

## DISCUSSION

In patients with diabetes especially uncontrolled ones will bring complications whether its pre-intra-post-surgery. Nevertheless, there is no notable difference in the outcome. This study was conducted to discuss latest analysis regarding the outcomes seen after phacoemulsification in diabetes compared with non-diabetic patients.

The meta-analysis revealed that non-diabetic (non-DM) patients achieved significantly better best-corrected visual acuity (BCVA) results one day postoperatively. This outcome may be attributed to

severe postoperative inflammation in the diabetic group, which reduces retinal sensitivity. Cataract surgery contributes significantly to macular thickening and the development of macular edema, leading to vision deterioration through the release of prostaglandins and increased oxidative stress.

Patients with diabetes who already have high levels of oxidative stress because of their underlying disease, the impact of cataract surgery may result in more frequent and pronounced macular thickening.<sup>12</sup> The visual outcomes for diabetic individuals after phacoemulsification with intraocular lens implantation were nearly equivalent to those in non-diabetic patients, especially when diabetics maintained good glycaemic control and had no diabetic retinopathy or were in the early stages of diabetic retinopathy. Previous studies have also supported these findings, emphasizing the pre-operative diabetic retinopathy status as a crucial prognostic factor after cataract surgery in diabetics. Other factors linked to a good visual outcome included the highest level of education, clinical centre network, preoperative visual acuity, and undergoing bilateral cataract surgery.<sup>11</sup> Hence, our results suggest that enhanced visual outcomes can be expected post-surgery by phacoemulsification for both DM and non-DM patients.

High blood glucose influences the corneal biochemical and ultrastructural abnormalities. Therefore, the corneas of diabetics with cataract surgery are believed to be more susceptible to stress and trauma caused by the surgery.<sup>11</sup> This research shows higher ECD in 1 week and 3 months follow up in non-diabetic patients. Yang et al, reported that endothelial cell density (ECD) was significantly lower in the diabetic (DM) group, while endothelial cell loss increased significantly in non-diabetic patients from 1 month to 6 months postoperatively.<sup>23</sup> This suggests that endothelial cell loss continues to accelerate and does not stabilize within 6 months after surgery, indicating delayed postoperative corneal recovery in DM patients. This condition may be attributed to factors such as advanced patient age, increased vulnerability of endothelial cells in diabetic patients, higher cataract density, and greater cataract grade.

CCT measurements can be used to determine endothelial damage due to surgery. In this study, the results showed that surgery influences corneal condition of diabetic patients which was proved by higher CCT results of diabetic compared to the non-diabetic patients after surgery. Similarly, Chaurasia

et al, found significant differences in CCT at 1-week and 1 month follow-up which was higher in DM group.<sup>7</sup> In normal conditions, the corneal endothelial cell pump regulate hydration balance. If the corneal endothelial cell pump does not function, water will accumulate in the corneal stroma which can cause swelling and characterized by the increasing of corneal thickness.<sup>3</sup>

HCP and CV describe the repair process and morphology of endothelial cells of the cornea after injury. Increased CV indicates large variability in cell size, whereas decreased HCP indicates increased pleomorphism.<sup>23</sup> In this study, authors found that HCP in 1 week, 1 month, and 3 months post-op were significantly lower in the DM patients. In line with previous study, a significant decrease in HCP at 3 months after surgery was seen in the diabetic group.<sup>17</sup> Contrary to these findings Beato et al, showed no differences in HCP between two groups six months after surgery.<sup>11</sup> It is thought that these variations are caused by endothelial cell rearrangements and cellular oedema that occur early after surgery but progressively recover to preoperative status. The higher CV in DM patient in 1 week and 1 month follow up was also explained by Chaurasia's study which showed higher CV in diabetic patients compared to non-diabetic patients at the follow-up stage.

This analysis recorded that patient with diabetes often had higher CMT levels than patients without the disease. Even though the difference of each group was not significant statistically. The same result was also recorded from a previous study by Ikegami et al.<sup>24</sup> Furthermore, the lack of significant variations in CMT between the two groups may be attributed by the diabetic conditions that revealed some mild and moderate diabetic retinopathy with variable mean duration of diabetes and glycaemic management. However, a wider range of time of follow up done by Katsimpris et al, shows significantly different CMT on 1, 3, 6, and 12 months postoperatively.<sup>25</sup>

## CONCLUSION

This study demonstrated significant effects of phacoemulsification surgery on diabetic patients, particularly in endothelial changes and visual outcomes. While the outcomes appeared worse in the diabetic group, gradual improvement was observed over time. These findings highlight the importance of adopting a comprehensive approach in managing

diabetic patients, rather than focusing solely on cataract. Future research should consider stratifying patients based on the presence or absence of retinopathy and distinguishing between controlled and uncontrolled diabetes for more comprehensive insights.

**Funding:** None.

**Patient's Consent:** Researchers followed the guide lines set forth in the Declaration of Helsinki.

**Conflict of Interest:** Authors declared no conflict of interest.

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### Authors Designation and Contribution

Made Chindy Dwiyantri Marheni Putri; *Medical Doctor: Concepts, Design, Literature search, Data acquisition, Data analysis, Statistical analysis, Manuscript preparation, Manuscript editing, Manuscript review.*

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Nabila Ananda Kloping; **Designation:** *Manuscript preparation, Manuscript editing, Manuscript review.*

