A Comprehensive Meta-analysis on Intra Ocular Pressure and Central Corneal Thickness in Healthy Children

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Abstract
Background: Glaucoma is the major ophthalmic public health issue and a leading basis of blindness. Elevated intraocular pressure (IOP) is still a foremost risk factor in development and progression of glaucoma. Central corneal thickness (CCT) may play as the risk factor for the progression of glaucoma, closely associated with IOP especially in pediatric age group. This study performed a pioneering investigation combining the outcomes of multiple studies using a meta-analytic approach.

Methods: Nineteen published articles between 1980 and 2015 were designated by searching Scopus, PubMed, and Google Scholar and analyzed with random effects model while I² statistics employed to find out heterogeneity. Subsequently, the information statistically analyzed by Stata software ver. 11.20.

Results: The mean IOP has been documented to 16.22 mmHg (95% CI: 15.48-16.97) in all races subgroups. Analyzing the data by race-based subgroups revealed the lowest IOP of 12.02 mmHg (95% CI: 11.40-12.64) in Indian children while IOP of 17.38 mmHg (95% CI: 15.77-18.98) documented in black children as the highest measurement. The mean CCT was 553.69 micrometer (95% CI: 551.60-555.78) among all races. Lowest CCT of 536.60 mm (95% CI: 531.82-541.38) has been documented in mixed Malay-Indian children whereas Chinese children ought to the highest CCT value of 557.68 mm (95% CI: 553.10-562.25).

Conclusion: Findings of published studies were inconsistent when considered independently; however, meta-analysis of these results showed a significant correlation between CCT and IOP. Owing to non-uniform methods used to measure IOP and CCT in studies, data were stratified into various subgroups according to the instruments used to measure IOP and CCT.

Keywords: Central corneal thickness, Intraocular pressure, Children, Correlation, Meta-analysis

Introduction

Glaucoma is a major ophthalmic public health issue that affects hundreds of millions of patients may consider as one of the prominent causes of blindness (1). Intraocular pressure (IOP) is regularly calculated and documented to monitor the progress of glaucoma while positive linear correlation between central corneal thickness (CCT) and IOP has been described in the literature (2).

Additionally, CCT is a significant value for understanding morphology of the cornea as well as for the development of various ophthalmic diseases including glaucoma. Numerous researches in children and adults revealed that IOP might be affected by the CCT measurement. Normally, a thin cornea underestimates whereas a thick cornea overestimates the IOP (3). CCT is a
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significant factor in the glaucoma diagnosis and treatment since having low CCT value may indicate to under-diagnosis and under-treatment of glaucoma, while a high CCT may cause to over-diagnosis and overtreatment of diseases (3). The results of some studies have indicated a relationship between IOP and ethnicity. Moreover, CCT might differ among subjects from different ethnic groups (3).

The main purpose of the current study was to reveal a meta-analysis to shed light on the relationship between CCT and IOP in children from different ethnic subgroups. To the best of our knowledge such, a meta-analysis has not been formerly performed in this field.

Methods

Databases including PubMed, PubMed Central, SCOPUS, and Google Scholar searched for published studies related to CCT and IOP in children. The search strategy has been limited to English language publications prior to Nov 2015. Subsequently, the publication bias test performed independently. Two authors individually assessed the titles of all publications, eliminating duplicate papers and classifying theoretically applicable researches to be included in analysis. Two authors for additional relevancy appraised abstracts from designated studies whereas full-text publications recovered. In the case of dissimilarity, a third appraiser corresponded to as an authority. Just in case, if the full text of a publication was not found, endeavors were made to contact directly to corresponding author by Email. Nevertheless, if this was ineffective the publication was ignored.

The following information obtained from included researches: first author, year of study, age distribution, CCT, IOP, ethnicity, relationship between CCT and IOP, and instruments used to measure CCT and IOP. The principal outcome measures of interest for this manuscript were the mean CCT and IOP, as well as 95% confidence interval and relationship between CCT and IOP.

By Mantel-Haenszel, random effect modeling data was analyzed and presented in a Forest plot. The standard error of the mean for each paper was designed using the normal distribution. For pooled correlation coefficients, the effect size defined. Following this transformation, by using random effects model effect size pooled. Heterogeneity determined by the chi-square test with a P-value less than 0.1 at significant level combined with an I² statistic for approximations of inconsistency within the analyses. The I² statistic estimated the percent of observed between study variability because of heterogeneity rather than because of chance and ranged from 0 which defined as no heterogeneity to 100% as described to noteworthy heterogeneity. Statistically, I² values exceeding 75% were revealing of significant heterogeneity warranting investigation with a random effect model as opposed to the fixed effect model to adjust for the observed variability. Heterogeneity was explored through subgroup meta-regression. Univariate and multivariate approaches employed to consider the reasons for heterogeneity among the selected included publications, and subsequently the Egger test performed to inspect bias. Statistical analyses performed using Stata software ver. 11.20.

Results

Our searching yielded 53 articles. Following exclusion of duplicates, 19 publications selected for final analysis. Totally, 47266 individuals aged less than 17 yr old participated. The descriptions of included studies are presented in Table 1 and 2. The outcomes demonstrated a significant correlation between CCT and IOP (r=0.0, P=00) (Fig. 1). With transformation of z to r that we were able to compute, r, 95% CI for r is 0.36 (0.30–0.43). This indicates a meaningful relationship between IOP and CCT. The mean IOP from included studies was 16.22 mmHg (95% CI: 15.48-16.97) in all races (Fig. 2). Race-based subgroups analysis revealed that Indian children with the lowest IOP of 12.02 mmHg (95% CI: 11.40-12.64), whereas black children with the highest IOP level of 17.38 mmHg (95% CI: 15.77-18.98).
### Table 1: Study characteristics of intraocular pressure (IOP) in children

| Author          | Year | Country     | Race      | Number | Measurement of IOP                                      | Mean IOP (mmHg) |
|-----------------|------|-------------|-----------|--------|--------------------------------------------------------|-----------------|
| Heidary F⁴      | 2010 | Malaysia    | Malay     | 54     | Air_puff noncontact tonometer                          | 15.65           |
| Haider MK⁵      | 2007 | USA         | Black     | 60     | Tono_pen                                               | 16              |
|                 | 2007 | USA         | White     | 76     | Tono_pen                                               | 15              |
| Muir KW ⁶       | 1997 | USA         | Black     | 27     | Goldmann applanation tonometer (GAT)_Tono_Pen          | 19.3            |
|                 |      |             | White     | 29     | Goldmann applanation tonometer (GAT)_Tono_Pen          | 17.7            |
| Muir KW ⁷       | 2004 | USA         | Black     | 35     | Goldmann applanation tonometer(GAT)_Tono_Pen           | 19.3            |
|                 |      |             | White     | 52     | Goldmann applanation tonometer(GAT)_Tono_Pen           | 17.7            |
| Doughty MJ⁸     | 2001 | New Zealand | White     | 104    | Non-contact tonometer(Handheld air_puff)               | 16.7            |
| Hikoya A⁹      | 2005 | Japan       | Japanese  | 169    | Tono_Pen                                               | 13.9            |
| Lim L.⁹⁰       | 2007 | Singapore   | Chinese   | 186    | Non-contact tonometer(ORA)                             |                |
|                 |      |             | Malay     | 50     | Non-contact tonometer(ORA)                             |                |
|                 |      |             | Indian    | 33     | Non-contact tonometer(ORA)                             |                |
| Tong L.¹¹      | 1999 | Singapore   | Chinese   | 485    | Air_puff noncontact tonometer                          |                |
|                 |      |             | Malay &  | 167    | Air_puff noncontact tonometer                          |                |
|                 |      |             | Indian    |        |                                                        |                |
| Sahin A¹²      | 2007 | Turkey      | White     | 165    | Tono_Pen                                               | 17.47           |
|                 |      |             | White     | 165    | Rebound_Tonometer                                      | 16.81           |
| Krzyza. B.¹³   | 2012 | Poland      | White     | 75     | Non-contact tonometer NCT) (Air_puff)                  | 15.9            |
|                 |      |             | White     | 75     | Icare tonometer(Rebound_Tonometer)                     | 16.9            |
| Song Y.⁴⁶      | 2002 | China       | Chinese   | 1153   | Non-contact tonometer (ORA)                            | 17              |
| Sakalar YB¹⁵   | 2008 | Turkey      | White     | 15160  | Air_puff noncontact tonometer                          | 14.15           |
| Huang Y¹⁶      | 2013 | China       | Chinese   | 571    | Non-contact tonometer (ORA)                            | 17.36           |
| Bueno-G I.¹⁷   | 2014 | Spain       | White     | 99     | Non-contact tonometer (ORA)-iopg                       | 16.75           |
|                 |      |             | White     | 99     | Non-contact tonometer (ORA)-iopec                      | 14.71           |
| Yildirim N.¹⁸  | 2006 | Turkey      | White     | 602    | Tono_Pen                                               | 17.9            |
|                 |      |             | White     | 602    | Air_puff noncontact tonometer                          | 16.75           |
| PEDIG.¹⁹       | 2011 | USA         | White     | 807    | Tono_Pen                                               |                |
|                 |      |             | Black     | 474    | Tono_Pen                                               |                |
|                 |      |             | Hispanic  | 494    | Tono_Pen                                               |                |
|                 |      |             | Indian    | 405    | Perkins applanation tonometer                           | 12.02           |
| Ramanjit S.²⁰  | 2004 | India       | Indian    | 405    | Perkins applanation tonometer                           |                |
| Wei W.²¹       | 2013 | China       | Chinese   | 514    | Air_puff noncontact tonometer                          | 15.31           |
| Huang Y²²      | 2013 | China       | Chinese   | 571    | Goldmann applanation tonometer(GAT)                    | 17.36           |

The mean IOP from included studies was 16.22 mmHg (95% CI: 15.48-16.97) in all races (Fig. 2). Instrument-based subgroups analysis for measurement of IOP, revealed that Rebound tonometer had highest IOP measurements with mean IOP of 16.83 mmHg and Goldmann applanation tonometer(GAT) had lowest IOP measurements with mean IOP of 13.36 mmHg (Fig. 3).

The mean CCT from all articles was 553.69 micrometer (95% CI: 551.60-555.78) (Fig. 4). Race-based subgroup analysis revealed that mixed Malay-Indian children revealed the lowest CCT of 536.60 mm (95% CI: 531.82-541.38), whereas Chinese children had the highest CCT of 557.68 mm (95% CI: 553.10-562.25).

We presented the subgroups based on instruments used for measurement of CCT and IOP in Fig. 3 and 5.

The statistical evaluation for publication bias comprising Begg and Egger tests did not meaningful approving absence of publication bias in our manuscript (P=0.05).
Table 2: Study characteristics of central corneal thickness (CCT) in children

| Author            | Year | Country | Race          | Number | Measurement of CCT                  | Mean CCT (micrometer) |
|-------------------|------|---------|---------------|--------|-------------------------------------|-----------------------|
| Farvardin et al.  | 2010 | Malaysia| Malay         | 54     | Specular Microscope                 | 530.87                |
| Haidary F         | 2009 | Malaysia| Malay         | 32     | Specular Microscope                 | 535                   |
| Muir KW           | 2004 | USA     | White         | 35     | Ultrasonic pachymeter               | 543                   |
| Muir KW           | 2004 | USA     | White         | 52     | Ultrasonic pachymeter               | 562                   |
| Dougherty MJ      | 2001 | New Zealand| White      | 104    | Ultrasonic pachymeter & Specular Microscope | 529                   |
| Hikoya A          | 2005 | Japan   | Japanese      | 169    | Ultrasound pachymeter               | 544.3                 |
| Lim L             | 2007 | Singapore| Malay        | 50     | Ultrasonic pachymeter               | 573.4                 |
| Muir KW           | 1997 | USA     | Black         | 27     | Ultrasonic pachymeter               | 537                   |
| Muir KW           | 1997 | USA     | White         | 29     | Ultrasonic pachymeter               | 564                   |
| Doughtery M       | 2001 | New Zealand| White      | 104    | Ultrasonic pachymeter & Specular Microscope | 529                   |
| Hikoya A          | 2005 | Japan   | Japanese      | 169    | Ultrasound pachymeter               | 544.3                 |
| Lim L             | 2007 | Singapore| Malay        | 50     | Ultrasonic pachymeter               | 573.4                 |
| Tong L            | 1999 | Singapore| Indian       | 33     | Ultrasound pachymeter               | 557.5                 |
| Sahin A           | 2007 | Turkey  | White         | 165    | Ultrasonic pachymeter               | 561.37                |
| Krzyza. B         | 2012 | Poland  | White         | 75     | Ultrasonic pachymeter               | 563                   |
| Song Y           | 2002 | China   | Chinese       | 1153   | Ultrasonic pachymeter               | 553                   |
| Sakalar YB        | 2011 | China   | Chinese       | 571    | Ultrasonic pachymeter               | 557.91                |
| Huang Y           | 2013 | China   | Chinese       | 571    | Ultrasonic pachymeter               | 556.01                |
| Bueno-G L        | 1972 | Spain   | White         | 33     | Ultrasonic pachymeter               | 556.01                |
| Yildirim N        | 2006 | Turkey  | White         | 600    | Ultrasonic pachymeter               | 564.92                |
| PEDIG.            | 2013 | China   | Chinese       | 514    | Non-Contact Tono / Pachymeter       | 554.19                |
| Ramanjit S        | 2004 | India   | Indian        | 405    | Ultrasonic pachymeter               | 541                   |
| Wei W            | 2013 | China   | Chinese       | 571    | Ultrasonic pachymeter               | 556.01                |

Discussion

Our results revealed that the mean IOP and CCT documented to 16.22 mmHg and 553.69 mm, respectively. The final analysis disclosed ethnicity-based differences in IOP and CCT measurement. Analyzing race-based subgroups showed Indian children with lowest IOP of 12.02 mmHg whereas black children with the highest IOP of 17.38 mmHg. Mixed Malay-Indian children presented with the lowest CCT of 536.60 mm whereas Chinese children with the highest CCT of 557.68 mm. Our research is the meta-analysis approach of CCT and IOP in children; however, since CCT and IOP measurements performed with different instruments, we were unable to compare outcomes across studies. Such differences in mean CCT and IOP among sub-groups may offer the hypothesis of the presence of morphological and anatomical disparities among ethnicities. Goldmann applanation tonometers are thought the gold standard for measurement of IOP (5), as well as ultrasound pachymeters, reflected the gold standards in measurement of CCT. However, since children are usually uncooperative, most studies used mixed contact and non-contact methods; therefore, we were unable to compare results homogenously.
The outcomes show a significant confidence interval. Publications that do not locate to the included publications. Squares corresponded to effect estimate of outcomes with 95% confidence intervals as the size of the squares proportional to the weight allocated to the included publications. Diamonds reveal the overall outcomes and 95% confidence interval of the random effect. Lines reveal the confidence interval. Publications that do not cross the zero line show a meaningful correlation between CCT and IOP. The outcomes show a significant correlation between CCT and IOP (r=0.0, P=0.00

### Study ID

| Study ID | Weight | Mean IOP (95% CI) | % |
|----------|--------|-------------------|---|
| Malay    |       |                   |   |
| Heidary P (2010) | 0.46 (0.33, 0.64) | 0.48 (0.33, 0.64) | 3.82 |
| Subtotal (I-squared = 99.4%, p = 0.000) | 0.21 (0.06, 0.37) | 11.2 |
| Black    |       |                   |   |
| Kabryn M (2007) | 0.18 (0.05, 0.41) | 0.36 (0.05, 0.41) | 1.1 |
| Subtotal (I-squared = 0%, p = 1.000) | 0.24 (0.01, 0.50) | 1.1 |
| White    |       |                   |   |
| Kabryn M (2007) | 0.18 (0.05, 0.41) | 0.36 (0.05, 0.41) | 1.1 |
| Subtotal (I-squared = 80.1%, p = 0.025) | 0.21 (0.02, 0.65) | 7.17 |
| Indian   |       |                   |   |
| Lim L (2007) | 0.48 (0.33, 0.64) | 0.48 (0.33, 0.64) | 6.40 |
| Subtotal (I-squared = 80.0%, p = 0.000) | 0.48 (0.33, 0.64) | 6.40 |
| Malay & Indian | 0.38 (0.31, 0.45) | 100.0 |
| Tong L (1999) | 0.48 (0.33, 0.64) | 0.48 (0.33, 0.64) | 6.40 |
| Subtotal (I-squared = 80.0%, p = 0.000) | 0.38 (0.31, 0.45) | 100.0 |

NOTE: Weights are from random effects analysis
**Table 3: Mean IOP based on the instrument that used. Squares correspond to effect estimate of outcomes with 95% confidence intervals with the size of the squares proportional to the weight allocated to the included publications. Diamonds reveal the overall outcomes and 95% confidence interval of the random effect.**

| Study ID | Mean IOP (95% CI) | Weight |
|----------|-------------------|--------|
| Air-puff noncontact tonometer | 15.65 (15.44, 15.86) | 3.36 |
| Dalgleish M. (2001) | 16.70 (16.14, 17.26) | 3.36 |
| Krzyza. B. (2012) | 15.90 (15.11, 16.69) | 3.25 |
| Y B Saklar (2008) | 14.15 (13.40, 14.90) | 4.05 |
| Nilgun Y. (2006) | 15.31 (15.07, 15.55) | 4.03 |
| Subtotal (I-squared = 99.3%, p = 0.000) | 15.74 (15.06, 16.41) | 32.82 |
| Goldmann applanation tonometer(GAT) | 16.00 (14.98, 17.01) | 3.77 |
| Tong L (1999) | 19.30 (17.64, 21.55) | 2.95 |
| Krzyza. B. (2012) | 17.70 (16.17, 19.23) | 3.46 |
| Krzyza. B. (2012) | 19.30 (17.31, 21.29) | 3.14 |
| Hikoya A. (2005) | 17.70 (16.58, 18.84) | 3.70 |
| Sahin A (2007) | 13.90 (13.54, 14.25) | 4.63 |
| Nilgun Y. (2006) | 17.47 (17.08, 17.88) | 4.00 |
| Tong L (2007) | 17.90 (17.75, 18.10) | 4.00 |
| Subtotal (I-squared = 97.0%, p = 0.000) | 18.00 (14.98, 21.01) | 3.77 |
| Non-contact tonometer(ORTA) | 17.00 (15.81, 18.19) | 4.04 |
| Tong L (2007) | 17.36 (17.11, 17.61) | 4.03 |
| Krzyza. B. (2012) | 16.75 (15.68, 17.82) | 3.92 |
| Basset G. (2014) | 14.71 (14.05, 15.34) | 3.94 |
| Subtotal (I-squared = 94.9%, p = 0.000) | 18.51 (17.58, 19.40) | 15.93 |
| Rebound.Tonometer | 18.81 (18.34, 19.28) | 3.90 |
| Kamay A. (2007) | 18.90 (18.13, 19.67) | 3.86 |
| Sahin A (2007) | 16.83 (16.42, 17.24) | 7.67 |
| Subtotal (I-squared = 99.3%, p = 0.000) | 17.00 (16.14, 17.86) | 4.00 |
| Goldmann applanation tonometer(GAT) | 14.70 (14.04, 15.36) | 3.93 |
| Krzyza. B. (2012) | 13.00 (11.46, 14.54) | 3.94 |
| Sahin A (2007) | 13.36 (12.53, 14.19) | 7.87 |
| Subtotal (I-squared = 97.0%, p = 0.000) | 13.36 (12.20, 14.52) | 7.87 |
| Overall (I-squared = 99.4%, p = 0.000) | 16.22 (15.46, 16.97) | 100.00 |

**NOTE:** Weights are from random effects analysis.

**Fig. 3:** Mean IOP based on the instrument that used. Squares correspond to effect estimate of outcomes with 95% confidence intervals with the size of the squares proportional to the weight allocated to the included publications. Diamonds reveal the overall outcomes and 95% confidence interval of the random effect.

**Fig. 4:** Mean CCT based on ethnicity subgroups. Squares corresponded to effect estimate of outcomes with 95% confidence intervals with the size of the squares proportional to the weight allocated to the included publications. Diamonds reveal the overall outcomes and 95% confidence interval of the random effect.
Fig. 5: Mean CCT based on instrument that used. Squares corresponded to effect estimate of outcomes with 95% confidence intervals with the size of the squares proportional to the weight allocated to the included publications. Diamonds reveal the overall outcomes and 95% confidence interval of the random effect.

Former studies showed influence of socioeconomic status on CCT and IOP (4). The socioeconomic backgrounds or effects of environmental factors, as well as levels of malnutrition, were not documented in extracted studies, therefore, we were unable to analyze. This may merit further investigation in future studies as well as longitudinal approach in order to categorize subjects based on their level of socioeconomic status and may measure effect of environmental factors on biophysics of ocular structure.

Different instruments may yield different documentation in measurement of CCT in the same case, for instance, a measurement by specular microscopy may result meaningfully lower values than ultrasound pachymeter measurement (23). In another study, CCT measurements of different instruments were compared while finding out contact specular microscopy was substantially documented lower than measured using other instruments (24).

There is controversial issue in relationship between age and CCT. CCT gradually increases by 5 yr of age, upon which it may reach steady prior beginning to decrease at 10–14 yr of old (6). Relationship between CCT and IOP among children less than 10 yr of age was struggled, did not realize any difference in CCT among the dif-

### Table: Mean CCT (95% CI)

| Study ID | Mean CCT (95% CI) | % Weight |
|----------|------------------|----------|
| Ultrasonic Pachymeter or Specular Microscope | | |
| Hayley F. (2015) | 530.67 (522.66, 539.08) | 2.68 |
| Dougherty MJ (2001) | 529.60 (522.47, 535.53) | 3.15 |
| Subtotal (I-squared = 80.0%, p = 0.727) | 529.72 (524.81, 534.84) | 5.85 |
| Ultrasonic Pachymeter | | |
| Kalbryan M. (2007) | 535.00 (526.14, 543.86) | 2.51 |
| Kalbryan M. (2007) | 559.00 (540.46, 576.54) | 2.99 |
| Mue KW (1997) | 537.00 (520.42, 550.58) | 1.56 |
| Mue KW (2004) | 564.00 (552.81, 574.19) | 2.19 |
| Mue KW (2004) | 543.00 (530.74, 555.26) | 1.77 |
| Hikoya A (2005) | 582.00 (552.49, 571.51) | 2.34 |
| Lim L (2007) | 544.30 (538.74, 549.86) | 3.45 |
| Lim L (2007) | 564.10 (579.31, 588.89) | 3.68 |
| Lim L (2007) | 573.40 (564.36, 582.44) | 2.46 |
| Sahin A (2007) | 557.50 (547.09, 567.91) | 2.14 |
| Sahin A (2007) | 561.37 (555.72, 567.02) | 3.42 |
| Korga B. (2012) | 563.00 (556.21, 569.79) | 3.08 |
| Korga B. (2012) | 563.00 (556.21, 569.79) | 3.08 |
| Korga B. (2012) | 563.00 (556.21, 569.79) | 3.08 |
| Yue Song (2002) | 553.00 (551.11, 554.89) | 4.40 |
| YB Sakar (2008) | 557.90 (557.36, 558.46) | 4.56 |
| Huang Y (2013) | 559.01 (553.63, 558.38) | 4.31 |
| Nilgun Y (2006) | 564.92 (562.76, 567.48) | 4.28 |
| Nilgun Y (2006) | 564.92 (562.76, 567.48) | 4.28 |
| Kalbryan M. (2007) | 550.00 (536.14, 545.86) | 2.51 |
| Kalbryan M. (2007) | 559.00 (550.46, 557.54) | 2.99 |
| Remanj B. (2004) | 541.00 (536.20, 545.40) | 3.68 |
| Huang Y (2013) | 556.01 (553.66, 558.36) | 4.32 |
| Subtotal (I-squared = 93.7%, p = 0.000) | 557.33 (554.44, 560.23) | 75.68 |
| Automated noncontact optical low-coherence reflectometry (OCT) pachymeter | | |
| Tong L (1999) | 546.00 (540.17, 548.83) | 4.22 |
| Tong L (1999) | 536.60 (531.82, 541.38) | 3.69 |
| Subtotal (I-squared = 90.0%, p = 0.001) | 541.51 (532.30, 550.71) | 7.90 |
| Anterior segment OCT | | |
| Bueno G. (2014) | 543.85 (536.83, 550.87) | 3.01 |
| Bueno G. (2014) | 543.85 (536.83, 550.87) | 3.01 |
| Subtotal (I-squared = 0.0%, p = 1.000) | 543.85 (538.86, 548.82) | 6.02 |
| Non-Contact Tonometer / Pachymeter | | |
| Wu W. (2013) | 554.19 (550.89, 555.49) | 4.57 |
| Subtotal (I-squared = %, p = .) | 554.19 (550.89, 555.49) | 4.57 |
| Overall (I-squared = 96.0%, p = 0.000) | 553.69 (551.60, 555.78) | 100.00 |

NOTE: Weights are from random effects analysis
ferent age subgroups (4). In our meta-analysis, most of included publications did not classify their participants into subgroups; therefore, we were unable to formulate age-based comparisons. A modification factor of 2.5 mmHg was recommended for each 50-micrometer difference in CCT (25). Actually, evidence regarding the link between CCT and IOP are controversial. Although a few studies observed no meaningful relationship between mean IOP and CCT among either African American ($R=0.24$) or White ($R=0.18$) children (5) others demonstrated the positive relationship like our analysis revealed a very significant relationship between IOP and CCT ($P=0.00$), as conclusion.

The limitation of the current study was largely associated with the methodology approach of the reviewed publications, individually. Lack of a uniform method of the measurements were the primary limitation; however, such a meta-analysis has not been formerly performed in this field considered as the strength of this research in order to summarize the findings of all related studies and reach the final conclusion regarding the mean CCT and IOP and their relationship. Discovering of racial differences in normal ocular structures may establish invaluable reference value and may promote further understanding of various ocular disorders (26), therefore, future meta-analysis on normal ocular structure are also required.

**Conclusion**

Findings of published studies were inconsistent when considered independently; however, meta-analysis of these results showed a significant correlation between CCT and IOP. Owing to non-uniform methods used to measure IOP and CCT in studies, data were stratified into various subgroups according to the instruments used to measure IOP and CCT.

**Ethical considerations**

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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**Conflict of Interests**

The authors declare that there is no conflict of interest.

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