

## ORIGINAL ARTICLE

# Degree of Myopia was Associated with Central Corneal Thickness in 18-40 Years Old


## Derajat Miopia Berhubungan dengan Ketebalan Kornea Sentral pada Usia 18-40 Tahun

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### ABSTRACT

#### Background

The central corneal thickness (CCT) is important in assessing the cornea's condition and correlates with refractive errors in which myopic eyes have the thinnest central cornea. Based on the 2018 Riskesdas, 2,133,017 people suffer from severe low vision, of which 42% were connected to refractive errors. One of the treatments for myopia is to perform LASIK surgery, but complications may occur during its process. One of the risk factors for post-LASIK complications is a CCT of less than 500 microns. This study aimed to assess the association between the degree of myopia and CCT at 18-40 years old.

#### Methods

This study was a cross-sectional design with data taken from 124 medical records from the Gading Laser Eye Center with subjects aged 18-40 years consisting of 88 males and 36 females. Variables collected were initials, age, gender, CCT, and degree of myopia. Data analysis was carried out using the Chi-Square test with a significance level of  $p < 0.05$ .

#### Results

The age category was 18-28 (87.9%), dominated by males (71.0%). Most degrees of myopia were mild (48.4%), and CCT was dominated by thinning corneas (63.7%). Data analysis based on the Chi-Square test regarding the degree of myopia and CCT showed a significant association ( $p = 0.001$ ).

#### Conclusions

This study showed an association between the degree of myopia and CCT at the age of 18-40 years.

**Keywords:** central corneal thickness; degree of miopia; refractive errors

## ABSTRAK

### Latar Belakang

Ketebalan kornea sentral merupakan parameter penting dalam menilai keadaan kornea dan memiliki korelasi dengan kelainan refraksi di mana mata miopia memiliki ketebalan kornea sentral yang paling tipis. Menurut Riskesdas tahun 2018, terdapat 2.133.017 orang yang mengalami penurunan penglihatan dan 42% disebabkan oleh gangguan refraksi. Salah satu penanganan miopia adalah dengan melakukan tindakan bedah LASIK namun dalam prosesnya dapat terjadi komplikasi. Salah satu faktor risiko terjadinya komplikasi pasca LASIK adalah ketebalan kornea sentral yang kurang dari 500 mikron. Tujuan penelitian adalah menilai hubungan derajat miopia dan ketebalan kornea sentral pada usia 18-40 tahun.

### Metode

Desain studi adalah potong lintang yang datanya diambil dari 124 rekam medis dari Gading Laser Eye Center dengan subjek berusia 18-40 tahun, terdiri dari 88 laki-laki dan 36 perempuan. Variabel yang dikumpulkan adalah inisial nama, usia, jenis kelamin, ketebalan kornea sentral, dan derajat miopia. Analisis data dilakukan menggunakan uji *Chi-Square* dengan tingkat kemaknaan  $p < 0.05$ .

### Hasil

Karakteristik responden terbanyak berusia 18-28 tahun (87.9%), didominasi oleh laki-laki (71.0%). Untuk derajat miopia paling banyak adalah derajat ringan (48.4%) dan ketebalan kornea sentral didominasi oleh menipis (63.7%).

Hasil analisis data berdasarkan uji *Chi-square* mengenai derajat miopia dengan ketebalan kornea sentral pada usia 18-40 tahun menunjukkan terdapat hubungan yang bermakna ( $p = 0.001$ ).

### Kesimpulan

Terdapat hubungan antara derajat miopia dengan ketebalan kornea sentral pada usia 18-40 tahun.

**Kata Kunci:** derajat miopia, kelainan refraksi, ketebalan kornea sentral

## INTRODUCTION

Myopia is one of the most common eyes refractive errors. Myopia occurs because parallel light rays from far shadows are focused on a point in front of the retina, and this condition is a burden to public health worldwide.<sup>1</sup> The World Health Organization (WHO) stated in 2015 that untreated refractive errors rank first as a cause of visual impairment in the world; it is estimated that more than 285 million people in the world have a visual impairment, and 42% of them are caused by refractive errors that are not corrected.<sup>2</sup> The latest data for 2020 states that around 28.3% of the global population suffers from myopia and 4 % have a high degree of myopia. If this condition is not handled correctly, myopia cases are expected to increase in 2050 to 49.8% of the global population and those with high-degree myopia are estimated to be around 9.8%.<sup>3</sup>

In Indonesia, the prevalence of refractive errors is relatively high, 24.7% and ranks first for eye diseases.<sup>4,5</sup> As many as 48.1% of young adults over 21 years have myopia with a lens power of more than -0.5 Diopters.<sup>5</sup> Myopia can also affect children; around 10% of 66 million Indonesian children suffer from refractive errors.<sup>4</sup> Myopia has become a public health and socio-economic problem globally.<sup>3</sup> This visual disorder can hinder a person from carrying out daily activities.<sup>4</sup>

Myopia that occurs in adults is very likely to experience pathological changes which can cause blindness because it is accompanied by degenerative changes in the posterior segment of the eyeball associated with elongation of the anteroposterior diameter of the eyeball.<sup>6,7</sup> Patients with high degrees of myopia are at high risk of developing cataracts posterior subcapsular, glaucoma, and chorioretinal abnormalities.<sup>8</sup> In cases of high myopia, a decrease in corneal thickness is generally found.

The cornea is a transparent structure in the anterior one-sixth of the eyeball, is avascular and is composed of 5 layers, namely: the corneal epithelium, Bowman's membrane, stroma, Descemet's membrane, and endothelium.<sup>9-11</sup> The cornea is a barrier and protects other structures within the ball. Eye in fighting infection as well as with the tear curtain layer contributing to two-thirds of the eye's refractive power.<sup>10</sup> The cornea's refractive power ranges from 40-44 Diopters or about 70% of the total refraction with a refractive index of 1,376.<sup>10</sup> From the central part of the cornea occurs gradually increasing in thickness to the periphery. Under normal circumstances, the central part of the cornea has an average thickness of 540.4  $\mu\text{m}$  (ranging from 520  $\mu\text{m}$  to 565  $\mu\text{m}$ ), while in the peripheral parts, the thickness ranges from 612-670  $\mu\text{m}$ .<sup>7,11,12</sup> Corneal thickness will decrease with age.<sup>10</sup> In myopic eyes, there is an eyeball enlargement associated with the cornea's thinning, in which the myopic eye thins approximately 0.018 mm compared to a normal eye.<sup>7</sup> The horizontal diameter of the cornea is 11-12 mm and 9-11 mm vertically with an average corneal diameter of  $11.77 \pm 0.42$  mm, slightly different between males and females (male  $11.77 \pm 0.37$  mm; female  $11.64 \pm 0.47$  mm).<sup>10</sup>

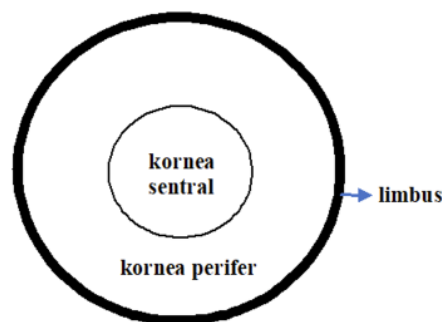


Figure 1. Central and peripheral corneal regions

The management of myopia cases includes the use of glasses and contact lenses, and in the last decade, the technique of refractive surgery has been increasingly developed.<sup>13</sup> One of the most frequently performed refractive surgery techniques is LASIK (Laser-Assisted In Situ Keratomileusis). Corneal thickness is important for diagnostic purposes (for example, tonometry) and therapy in refractive surgery to determine whether a patient with refractive errors can undergo LASIK surgery.<sup>9</sup> In the procedure, corneal thickness is an important factor because to correct the disorder, The refractive procedure is to reduce the thickness of the central cornea with a laser. The LASIK surgical technique provides satisfactory results, but the procedure can cause some complications. The most feared complication by refractive surgeons is corneal ectasia<sup>15</sup> which is the progressive thinning of the cornea and is associated with a decrease in visual acuity that cannot be corrected.<sup>12,16</sup> Therefore, central corneal thickness is an important determinant for preventing

corneal ectasia after LASIK. Besides being a risk factor for post-LASIK ectasia, central corneal thickness is also associated with an increased risk factor for glaucoma, which is visual impairment due to damage to the optic nerve and can lead to blindness.<sup>17</sup> Cornea thickness that is less or more than normal can lead to errors in assessing intraocular pressure, which results in delays in diagnosing and treating glaucoma.<sup>9</sup>

Pachymetry is a procedure for measuring central corneal thickness that can be performed through contact (e.g. ultrasound) and non-contact (optical biometry) methods.<sup>9</sup> The acceptable limit value for corneal thickness for safe refractive surgery is 500 µm. Corneas thinner than this size are at risk of corneal ectasia in the LASIK procedure.<sup>11</sup> Mohammed et al. state that central corneal thickness correlates with refractive errors, in which myopic eyes have the thinnest central corneal thickness, followed by emmetropia and hypermetropia.<sup>9</sup> Research by Das et al. concluded that there is a significant correlation between central corneal thickness and the incidence of myopia where there is a decrease in central corneal thickness in cases of myopia.<sup>7</sup> Another study by Chen et al. concluded that there was no correlation between central corneal thickness and the incidence of myopia in adult subjects in Taiwan. According to this study, it is possible that in cases of myopia, the cornea does not thin in the same way as the sclera.<sup>18</sup> The study of Kobayashi et al. concluded that the corneal thickness had no significant difference between low, moderate and severe myopia on each axis. Still, the pachymetry map (a simple test to assess corneal thickness) showed a thinner cornea in the inferior meridians than in the superior meridians in mild and moderate myopia.<sup>19</sup>

The effect of myopia on central corneal thickness has been widely reported, but the results are conflicting. Several studies have found myopic subjects with thicker central corneas, but others have found otherwise.<sup>7</sup> This study assessed the relationship between demographic characteristics (age, sex) and degree of myopia with central corneal thickness in adults aged 18-40 years.

## METHODS

This study is an observational analytic study with a cross-sectional approach to assessing the relationship between myopia degree and central corneal thickness at 18-40 years old. The data was taken from the medical records of patients treated in the June-December 2020 period at the Gading Laser Eye Center Clinic, North Jakarta. The data collection period is September – October 2021. One hundred twenty-four respondents aged 18-40 comprised 88 men and 38 women. The inclusion criteria for this study were patients with mild, moderate, or severe degrees of myopia. They had complete medical record data, especially the results of an examination of central corneal thickness and degree of myopia. The exclusion criteria for this study were having a history of glaucoma, corneal disease, and a history of eye surgery or trauma to the eye. The sampling technique was a non-random consecutive sampling technique from the medical records of patients who met the inclusion and exclusion criteria. Central corneal thickness at the clinic was measured using a pachymetry measuring instrument, and myopia refractive errors were measured using a Snellen chart measuring instrument with negative spheres by optical refractionist and An ophthalmologist analyzed the examination results.

Statistical analysis used the IBM SPSS (Statistical product and service solution) program version 24 with the Chi-Square test, and the significance value was  $p < 0.05$ . This research has obtained an ethical permit from the Research Ethics Commission of the Faculty of Medicine,

University of Trisakti number 98//KER-FK/IX/2021 and received a research permit from the local clinic.

## RESULTS

From the research results, it was found that 109 subjects (87.9%) were in the age range of 18-28 years, with the median (maximum-minimum) age being 19 (18-40) years. The results of the Kolmogorov-Smirnov normality test showed that the data distribution was not normal ( $p=0.000$ ). The majority of subjects were male, namely 88 subjects (71.0%).

Research on myopia is divided into 3 degrees, namely mild degrees ( $<3$  Diopters/D), moderate degrees (3-6 Diopters), and severe degrees ( $> 6$  Diopters). As many as 60 subjects (48.4%) suffered from mild degrees of myopia. Variable central corneal thickness is classified into thin ( $< 540 \mu\text{m}$ ) and normal (540-550  $\mu\text{m}$ ). The study found that as many as 79 subjects (63.7%) had thin central corneal thickness. (Table 1)

Table 1. Distribution of subject characteristics

Variable	Frequency (n)	Percentage (%)
<b>Age</b>		
18-28 years old	109	87.9
29-40 years old	15	12.1
<b>Gender</b>		
Male	88	71.0
Female	36	29.0
<b>Degree of myopia</b>		
Mild	60	48.4
Moderate	48	38.7
Severe	16	12.9
<b>Central corneal thickness</b>		
Thinning	79	63.7
Normal	45	36.3

Based on the bivariate analysis results, it was found that 68 (62.4%) of 109 subjects aged 18-28 years had thinning central corneal thickness, and for subjects aged 29-40 years, there were 11 people (73.3%). However, the Chi-square statistical test results between age and central corneal thickness did not show a significant relationship ( $p=0.408$ ).

Based on gender, the results showed that more female subjects had thinner central corneal thickness than male subjects (75.0% vs 59.1%). The results of the Chi-square statistical test between gender and central corneal thickness in subjects aged 18-40 also found no significant relationship ( $p=0.094$ ). (see table 2)

Table 2. Relationship between sociodemographic characteristics, degree of myopia, and central corneal thickness

Variable	Central corneal thickness		p*
	Thinning	Normal	
<b>Age</b>			
18-28 years old	68 (62.4%)	41 (37.6%)	0.408
29-40 years old	11 (73.3%)	4 (26.7%)	
<b>Gender</b>			
Male	52 (59.1%)	36 (40.9%)	0.094
Female	27 (75.0%)	9 (25.0%)	
<b>Degree of myopia</b>			
Mild	21 (35.0%)	39 (65.0%)	0.001
Moderate	42 (87.5%)	6 (12.5%)	
Severe	16 (100.0%)	0 (0.0%)	

\* Analysis used the Chi-Square test, ( $p < 0.05$ ) = statistically significant

There were as many as 21 (35%) subjects who had mild degrees of myopia had a thinning central corneal thickness; subjects with moderate degrees of myopia, as many as 42 subjects (87.5%) had thinning central corneal thickness; and all subjects with severe myopia had a thinning central corneal thickness. The results of the Chi-square statistical test between the myopia degree variable and central corneal thickness showed a significant relationship ( $p = 0.001$ ).

## DISCUSSION

This study found that the age of people living with myopia was 18-28 years, dominated by men, the severity of myopia was mild, and the majority of subjects had a thinning central cornea. Research by Wang et al. with adult subjects (aged 18-44 years), people with myopia in China who underwent laser refractive surgery were also dominated by the male sex (63.4%).<sup>20</sup> The same thing was also found in a study by Verkicharia et al. with people with myopia in various age groups, and as many as 53% were male; most subjects suffered from mild degrees of myopia (65%).<sup>21</sup>

This study found that the percentage of subjects aged 29-40 who experienced central corneal thinning was higher than those aged 18-28 (73.3% vs 62.4%). Wang et al.'s study<sup>17</sup> concluded that central corneal thinning increased with age. Sridhar also stated that the thickness of the cornea would decrease with age.<sup>10</sup> Furthermore, this study also found that the percentage of female subjects with thinning central corneal thickness was higher than that of males (75% vs 59.1%). Wang S et al.'s study<sup>17</sup> found that the average central corneal thickness in women was thinner than that of men ( $553.0 \pm 40.0 \mu\text{m}$  vs  $554.6 \pm 41.0 \mu\text{m}$ ). The same thing was also expressed by Wang Q et al.<sup>20</sup>, who stated that men have a thicker central cornea than women ( $p < 0.001$ ).

This study's results indicate a significant relationship between the degree of myopia and central corneal thickness. This is in line with the research by Das et al. with a subject of 100 myopia patients with lens power between -1.00 D to -17.00 D (mean  $-4.41 \pm 3.23$  D) concluded that there is a significant correlation between the degree of myopia and central corneal thickness. According to this study, the higher a person's degree of myopia, the thinner the central corneal thickness. The average central corneal thickness is thinner in high-degree myopia than in moderate and low-

degree myopia. Statistical analysis found a significant difference in mean thickness central cornea between low and high degrees of myopia and moderate and high degrees of myopia, but not significant between low and moderate myopia.<sup>7</sup>

A retrospective study by Mimouni et al. with a subject of 30,245 patients (myopia up to -12.0 D and cylinders up to 6.0 D) who underwent refractive surgery from January 2000 to December 2014 at Care-Vision Laser Centers, Tel-Aviv, Israel, also obtained the same result, namely a significant correlation between degrees of myopia and central corneal thickness. The mean central corneal thickness for various myopia ranges ranged between 528 and 538  $\mu\text{m}$ . This may be related to the axial elongation of the eyeball that occurs in cases of myopia.<sup>22</sup>

Research by Mohammed et al. found that the cornea of the central part of the myopic eye is the thinnest ( $449.65 \pm 39.27 \mu\text{m}$ ) compared to emmetropia ( $542.66 \pm 46.35 \mu\text{m}$ ) and hypermetropia ( $557.67 \pm 41.83 \mu\text{m}$ ). The study concluded that there is a correlation between central corneal thickness and refractive errors. Another study by Nemesure et al. also stated that central corneal thickness is associated with refractive errors. Price et al. stated that a thin central cornea is associated with myopic eyes, and this may be an explanation for the tendency to develop glaucoma in myopic cases.<sup>9</sup>

Research by Wang X et al.<sup>8</sup>, who compared 97 subjects with normal eyes and 48 subjects with high degrees of myopia, concluded that there were significant differences in the cornea's thickness and the eyeball's axial length between the two groups but not in the thickness of the corneal epithelium. The study found a group of patients with degrees of myopia significantly increased the axial length of the eyeball (by 16%) compared to the normal group.<sup>8</sup> What's interesting about this study is that the corneal thickness increased (thicker) in myopic eyes. Differences in corneal thickness may be related to the stages of changes in corneal thickness in myopic eyes (whether it occurs at an early/middle/advanced stage). Still, there needs to be more research on this. In addition, the thickness of the cornea also fluctuates within 24 hours, so differences in measurement times may affect the results. From the results of this study, it was found that the cornea of the high-degree myopia group was thicker than the normal eye group. Still, from measurements of the thickness of the corneal epithelium (the outermost layer of the cornea), it was not different between the two groups. This indicates that changes in the thickness of the cornea mainly occur in the stroma. Another thing that might affect the results of the study is the difference in the technique of measuring the thickness of the cornea.<sup>8</sup>

Research by Krishnan et al. concluded that an increase in the cornea's refractive power is associated with an increase in myopic refraction. The increased curvature (curvature) of the cornea is related to the axial length of the eyeball and the thinning of the cornea. The mean central corneal thickness was 533.87  $\mu\text{m}$ , with a standard deviation of 40.02. According to this study, axial myopia is associated with increased corneal thickness. This ocular biometric finding has important implications in refractive surgery.<sup>23</sup>

Different results were obtained in the study of Solu et al. with a subject of 150 patients consisting of 66 myopia patients, 33 hypermetropic patients, and 51 emmetropic patients, which concluded that central corneal thickness did not have a significant relationship with the degree of myopia, possibly because each individual's central corneal thickness was influenced by genetics so that the results could be in contrast to other research results.<sup>24</sup> Research by Chen et al. with a



subject of 528 patients who underwent laser refractive surgery for myopia correction from January 2004 to December 2006 found that myopia with an average lens power of  $-7.27 \pm 2.96$  D and a mean central corneal thickness of  $560 \pm 35$   $\mu\text{m}$ , based on the statistical analysis found no relationship between refractive error with central corneal thickness. The different results may be due to differences in age, sex, genetics, ethnicity, diurnal variations in measuring central corneal thickness and the tools used in measuring.<sup>18</sup> Several studies have reported a reduction in central corneal thickness as a person ages due to a decrease in keratinocyte density.<sup>9</sup> In addition, the onset of a person with myopia also affects the progression of the disease; the younger the onset of myopia, the more likely it is to experience myopia development to a more severe level.<sup>25</sup>

Wolffsohn et al. stated that the condition of refractive error is an inherited disorder. This was proven by identifying 150 gene loci related to myopia. However, the development of myopia is inseparable from the interaction of genetics and environmental factors. Research on students in China concluded that students with a history of reading at close range and both parents have myopia have a 26x higher risk of suffering from myopia than students who habitually read at a distance of more than 20 cm and do not have parents with myopia. This inherited myopia disorder may be related to certain ocular components, such as the axial length of the eyeball.<sup>25</sup> The study of Wang S et al. found that female gender, advancing age and race were associated with thinning of the cornea. The Negroid race has a thinner cornea ( $537.3 \pm 39.9$   $\mu\text{m}$ ) than the Caucasian race ( $558.5 \pm 40.3$   $\mu\text{m}$ ), while the Asian and Hispanic races have a cornea in between thicknesses.<sup>17</sup>

This study also assessed the relationship between age and central corneal thickness in 124 myopia patients aged 18-40 (divided into two age groups) who underwent central corneal thickness examination. The results showed that there was no significant relationship between the two variables. These results are in accordance with the research of Ismail et al. in 60 hyperopic eyes at Al-Azhar University Hospital, Cairo, Egypt, which were divided into two age groups (20-37 and 42-56 years). This study found no significant relationship between age and central corneal thickness in the two age groups.<sup>26</sup> A study by Ismaili et al., which was carried out on 80 patients with refractive eye errors at the Kosovo University Clinic with an age range of 19-38 years, also obtained the same result, namely that there was no significant relationship between age and central corneal thickness.<sup>27</sup> Meanwhile, Mashige stated that with age, there is a reduction in central corneal thickness due to decreased keratocyte density.<sup>9</sup> This difference in results may occur because the central corneal thickness is said to be related to genetics, so because there are differences in the study population, the results obtained may also be different.

An analysis to assess the relationship between gender and central corneal thickness was also carried out with 124 myopia patients consisting of 88 men and 36 women who examined central corneal thickness. The findings showed no significant relationship between the two variables. The same was also found in research by Iyamu et al. in 2012 in Nigeria with 130 subjects consisting of 77 men and 53 women, who said there was no significant relationship between gender and central corneal thickness.<sup>28</sup> The results obtained were also in accordance with research conducted by Hahn et al., who found that the difference in central corneal thickness between men and women was very small, only 4.6  $\mu\text{m}$ . This size is smaller than the mean difference in interocular central corneal thickness (7.7  $\mu\text{m}$ ) in normal subjects, so it is concluded that the difference in male and female central corneal thickness values is statistically significant but not clinically significant.<sup>9</sup>



Research Chen et al. with the mean age of the subjects being  $34.8 \pm 7.3$  years and the majority of women (79.9%) concluded that central corneal thickness was not related to age, and central corneal thickness was significantly thinner in women than in men.<sup>18</sup> Study of Chang et al. stated that the cornea of myopic eyes tends to be thinner in eyes with increased axial length, but statistically no relationship was found. Central corneal thickness may decrease with age and female sex is associated with a thin cornea. According to Chang, different central corneal thickness measurement techniques might have influenced the results of the study.<sup>18</sup> The study of Wang X et al. compared corneal biometric parameters between groups of normal eyes and high-degree myopia and assessed factors influencing these parameters such as age and gender. The study found that age did not correlate with central corneal thickness, axial length of the eyeball or corneal epithelial thickness in the high-degree myopia group, while gender correlated with axial length of the eyeball and central corneal thickness, but not with corneal epithelial thickness.<sup>8</sup> The effect of gender on central corneal thickness and axial length of the eyeball may be related to hormonal differences between males and females because gonadal hormones affect ocular tissue growth.<sup>8</sup>

Based on this study that the degree of myopia affects the thickness of the central cornea, so one of the expected practical implications is to open people's minds to pay more attention to eye health, it is important to identify and treat myopia as early as possible to prevent worsening of eye refraction, especially for those who are interested in doing LASIK surgery to avoid complications of corneal ectasia. Further research regarding central corneal thickness may be carried out by paying attention to the axial length of the eyeball, the time of measurement to minimize diurnal variations, the stages of myopia development and the length of time suffering from myopia, as well as the measuring instrument used. With the development of science and technology, it may also be possible to measure certain layers of the cornea so that the thinning layer can be assessed.

## CONCLUSION

Of people with myopia aged 18-40 years who were treated at the Gading Laser Eye Center Clinic, North Jakarta, in June-December 2020, 63.7% experienced central corneal thinning and 48.4% suffered from mild degrees of myopia. There is a significant relationship between the degree of myopia and central corneal thickness at 18-40 years old. However, there is no significant relationship between age and sex with central corneal thickness at 18-40 years.

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## AUTHORS CONTRIBUTION

ERR plays a role in preparing research designs, data collection, data analysis, and data interpretation and is responsible for data collection in the field and preparing manuscripts. K plays a role in drafting concepts, data analysis, data interpretation, preparing and revising final manuscripts for publication.

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## CONFLICT OF INTEREST

There is no conflict of interest between the authors

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