

Original Article

# Correlation Between Visual Quality and Optical Correction Among Undergraduate Students in Central Taiwan

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**Purpose:** The aim of this study is to investigate visual quality in young adults (college students) and its correlation with current optical correction, to understand the factors that affect visual performance and accuracy of corrective lenses.

**Methods:** There were 191 undergraduate students enrolled (93 males and 98 females). All subjects demonstrated visual acuity greater than 20/20 with/without correction. Questionnaire was administered and refraction-related measurements (e.g., spectacle power, visual acuity with current correction, and subjective refraction) were taken. SPSS 17.0 software was used for descriptive statistics, in addition to Pearson correlation and Spearman's rank correlation.

**Results:** Over-correction and under-correction were common among undergraduate students (24.6 %), making it impossible for them to achieve normal visual quality. Among the study subjects, 37.2% had Snellen visual acuity of less than 20/20. Significant correlations were found not only between comfort ( $r=0.16$ ,  $p=0.028$ ) and visual acuity but also between self-reported clarity of vision ( $r=0.15$ ;  $p=0.041$ ) and visual acuity with corrective lenses, suggesting that accuracy of spectacle prescription greatly impacts visual quality.

**Conclusion:** Whether proper optical correction can be achieved depends on the precision of refraction examination. Improving the accuracy of corrective lens prescriptions and the overall quality of the optometry industry should be emphasized to raise visual quality, achieve higher customer satisfaction, and improve overall vision care services in Taiwan.

**Keywords:** habitual corrected visual acuity, visual quality, visual comfort, and refraction.

## Introduction

Myopia, or short-sightedness, is a refractive error in which parallel rays of light come to a focus in front of the retina when the eye's accommodation is at rest. The result is blurred distance vision without optical correction. In the majority of cases,

myopia is caused by elongation of the vitreous chamber<sup>1,2,3</sup>, such that the eye is too long for its optical power. Myopia is relatively common in developed Western countries. Approximately 25% of adults in Caucasian populations are myopic<sup>4,5</sup>. In South-East Asia, myopia prevalence is nearly three times (~80-90%)<sup>6,7</sup> that in Western countries (~20-30%)<sup>5</sup>. Epidemic levels of myopia (up to 80%) have been reported in Hong Kong<sup>8,9</sup>, Singapore<sup>10,11</sup>, Taiwan<sup>6</sup>, and Japan<sup>12</sup>.

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Both genetic and environmental factors appear to be associated with the development of myopia<sup>13</sup>. Hereditary influences on refractive errors have been shown in subjects with very high myopia and in twins<sup>14,15</sup>. However, the rapid increases in the prevalence of myopia<sup>16</sup> and the association of myopia with demanding educational systems<sup>17</sup> indicates that environmental factors also play an important role. For example, within the Singaporean population, both the prevalence and the degree of myopia correlate with the time spent in full-time education<sup>18</sup>.

High myopia is associated with a variety of ocular pathologies, such as chorioretinal degeneration<sup>19,20</sup>, optical disc abnormalities<sup>21,22</sup>, cataracts<sup>23,24</sup>, and glaucoma<sup>25,26</sup>. Increased risks of retinal detachment, retinal degeneration and posterior staphyloma accompany longer vitreous chamber depth and thinner retina that occurs with increasing myopia<sup>27</sup>. Due to these associated pathologies, myopia has been identified as one of the five major ocular conditions causing blindness in humans (World Health Organisation)<sup>28</sup>. Visual impairment and blindness linked to myopia may lead to major public health problems in South East Asian countries in the years ahead<sup>17</sup>.

Direct costs of myopia include regular eye examinations, spectacles and contact lenses, and refractive surgery. In 1990, the cost of optically correcting refractive errors in the United States was estimated to be \$12.8 billion<sup>29</sup>. This could be considerably higher now, particularly in Asian countries where myopia is exceedingly prevalent<sup>30</sup>. There are also substantial indirect costs related to the treatment of myopia complications, such as retinal detachment and contact lens-related corneal ulcers.

Undoubtedly, the high prevalence of myopia is an important issue in Taiwan. However, it is unclear how this is viewed among young adults. Therefore, habitual visual acuity and best corrected visual acuity (BCVA) were investigated in undergraduate students in central Taiwan. Near work activity and distribution of refractive errors were also studied.

## Methods

Subjects were recruited from the Central Taiwan University of Science and Technology. They included 191 undergraduate students (1<sup>st</sup>~4<sup>th</sup> year of study) aged 18 to 24 years. All participants had visual acuities greater than 20/20 (either before or after applying subjective refraction). Subjects with anisometropia > 2.00 diopters or ocular pathology were excluded. Informed consent form was collected from every participant. The ethical principles of the Declaration of Helsinki were followed.

Visual acuity was measured using a phoropter (Topcon vision tester VT-SE) and a projector (Topcon ACP-8), and recorded as decimal acuity. The visual acuity of each eye was determined by the line of more than 50% of the smallest letters that can be recognized correctly. Subjective refraction was measured in participants with habitual corrected acuity lower than 20/20 and spectacle prescription was measured using an automatic lesometer (Nidek-KM500). Data on visual quality, visual comfort, and near work activity was collected via questionnaire. The refractive errors were analyzed using the average spherical equivalent (spherical power + 1/2 cylindrical power) of both eyes.

Questionnaires and refraction-related measurements (e.g., spectacle power, visual acuity with the current correction, and subjective refraction) were analyzed. The average of the monocular acuities of the right eye and the left eye was used for data analysis. SPSS 17.0 software was used for descriptive statistics, in addition to Pearson correlation and Spearman's rank correlation.

## Results

Regarding the correlations between the self-reported satisfaction scores collected from questionnaires and the visual acuities measured from the subjects' corrective lenses, there was positive correlation between clarity of vision and habitual visual acuity of the subjects ( $r=0.15$ ,

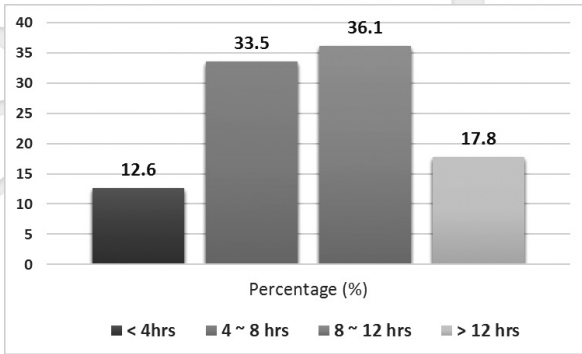


Figure. 1 Near work hours of the recruited college students.

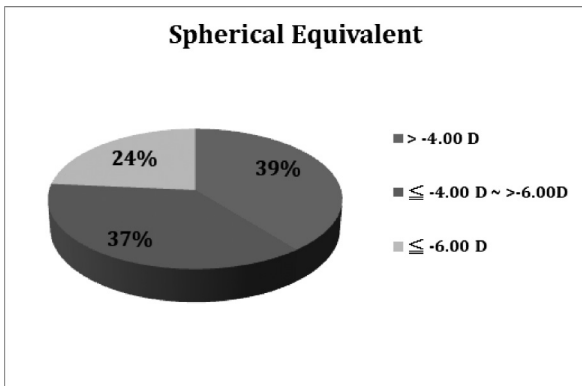


Figure. 2 Distribution of refractive errors (spherical equivalent) among the recruited college students.

$p=0.041$ ). In addition, there was significant correlation between visual comfort and habitual visual acuity ( $r=0.16$ ,  $p=0.028$ ), suggesting that the higher the habitual acuity, the greater the visual comfort and the better the visual clarity. Over half the subjects (54%) spent more than eight hours per day looking near (see Figure. 1).

In terms of the refractive error distribution, 75 subjects had spherical equivalents greater than  $-4.00$  D and 71 had spherical equivalents between  $-4.00$  D and  $-6.00$  D. Moreover, 45 were high myopes ( $\leq -6.00$  D), suggesting that almost one-fourth of all undergraduate students in central Taiwan are highly myopic (Figure. 2).

In this study, the habitual corrected visual acuity of the subjects was examined, and we found that 37.2% of the recruited undergraduate students had corrected visual acuity of less than 20/20 with their own habitual spectacles (see Table. 1). The mean corrected visual acuities of those with

Table 1. Distribution of habitual visual acuities (with current corrections) of the recruited subjects.

Visual acuity	Number (n)	Percentage (%)
$\leq 0.6$	9	4.71 %
0.7	15	7.85 %
0.8	18	9.42 %
0.9	29	15.2 %
1.0	68	35.6 %
1.1	27	14.1 %
1.2	22	11.5 %
> 1.2	3	1.57 %
<b>Total</b>	<b>191</b>	

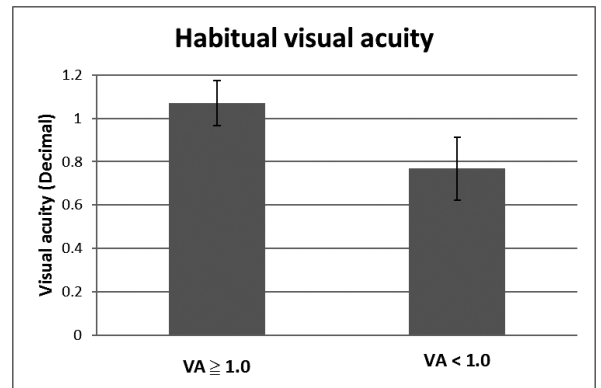


Figure. 3 Visual acuities measured via habitual correction of the two groups (mean $\pm$ SD) of recruited college students.

( $1.07\pm 0.105$ ) and without ( $0.77\pm 0.146$ ) visual acuity greater than 1.0 (Snellen acuity 20/20) are shown in Figure. 3. Moreover, 42 of the 191 subjects were over-corrected (a difference  $> 0.25$  D) and 5 were under-corrected based on comparisons of subjective refraction and habitual prescriptions. This implies that 24.6 % of the recruited college students did not have their vision properly corrected.

## Discussion

Over-correction in young animals is related to an increase in axial lengths, which exacerbates myopia progression<sup>31</sup>. As the subjects recruited in this study were over 18, this should cause only a

very minor effect on axial elongation. However, stress resulting from the over-minus corrections on their accommodation function during near work is still of concern. Accommodative spasm has been reported in young adults and may cause sudden onset of blurred vision, inward deviation of the eyes, and binocular diplopia<sup>32</sup>.

Size, contrast, and color have also been suggested as factors that influence the accommodation response<sup>33</sup>. Majaj et al. (2002) reported that letters of larger size are identified by their edges and those of smaller size by their strokes<sup>34</sup>. A recent study investigated the effect of letter size and contrast on accommodation accuracy. The magnitude and decay of near-work-induced transient myopia have shown that letter size affects accommodation, but contrast has no effect on changing accommodation<sup>35</sup>. Subjects had smaller accommodation lags for smaller letters than for larger letters. However, a longer time was required for them to return to baseline when viewing larger letters. As the majority of the recruited undergraduate students spent long periods of time (up to 8 hours per day) looking near, the accuracy of spectacle prescription should be high enough to prevent adverse effects during near work.

According to an investigation by the Taiwan Health Promotion Administration<sup>36</sup> (published in 2004), the prevalence of high myopia in young adult Taiwanese is 21%. In our study, 23.56% of undergraduate students had myopia greater than 6.00 D. It is surprising that 37.2 % of myopic college students had habitual visual acuity worse than 20/20, suggesting that there is no standard criteria for refraction examination in Taiwan and the young generation does not care about visual quality. Since legislation regarding licensing of optometrists was passed in 2015, there has been the expectation of accurate corrective prescriptions and improved visual health and quality for the public.

## Conclusions

Whether proper optical correction can be achieved depends on the precision of refraction

examination. Improving the accuracy of corrective lens prescriptions and the overall quality of the optometry-related industry should be emphasized to raise visual quality, achieve better customer satisfaction, and improve overall vision care in Taiwan.

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