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Rerearch paper

The assessment of visual acuity for low socioeconomic status kids by their environmental factors

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Abstract: Although many studies have discussed visual acuity (VA), the childhood myopia epidemic has not been alleviated and requires further investigation. In this study, investigations were carried out on the difference in kids' VA by their environmental factors, such as various family structures, the effect of visual health attitudes (VHA) and visual health behaviours (VHB) on VA. The research subjects are selected for kids in low socioeconomic status (SES) families in Changhua County, Taiwan. This study conducted purposive sampling based on a questionnaire survey and combining a VA examination. There were 260 questionnaires collected, and significantly over 60% of the samples of low SES elementary school kids were not living with their both parents. Of these kids, the highest proportion (33.5%) lived with their mothers, sequentially, 32.7% with their grandparents and 30.0% with their fathers. In fact, 48.8% of these low SES kids' visions were below 0.9, which is 2.7% higher than the defective vision rate in Taiwan. These kids with poor VA mostly in worse VHA can lead to unhealthy VHB and ultimately to myopia. Some parents at low SES families were busy at making money rather than taking care of kids. Thus, kids addicted to playing 3C products at home without participating in leisure sports result in the rapid increase of myopia. According to the results of the study, "correct" VHA can lead to "correct" VHB; nevertheless, leisure sports participation (LSP) can lead to "correct" VHB for ensuring good VA for kids.

Keywords: Visual acuity (VA); Visual health attitudes (VHA); Visual health behaviours (VHB); Low socioeconomic status (SES).

1. Introduction

1.1. Prelude of study for visual acuity

The World Health Organization (WHO) estimates that there are 246 million visually impaired people worldwide and, in which, 90% of these people are of low socioeconomic status (SES) [1]. According to the WHO, 43% of moderate to severe visual impairment is caused by uncorrected refractive errors, such as myopia, hyperopia, astigmatism and presbyopia. Although, the WHO reports that worldwide socioeconomic development and concerted public health action have brought about a general decrease in visual impairment worldwide, there is a scholarly consensus that myopia is increasing worldwide and is approaching epidemic proportions in the industrialized nations of East Asia [2-5]. A strong negative association between prevalence rates of moderate-to-severe visual impairment

(MSVI) and blindness and socioeconomic level of development was observed [6]. Also, one recent study reports a prevalence of myopia as high as 86.1% among young Taiwanese men aged 18 to 24 years [7], and their visual impairment may happen early in kid age. Although myopia and other refractive error can be corrected with the aid of glasses, contact lenses and refractive surgeries, myopes will likely suffer to some degree from lost educational and employment opportunities, lost economic gain, and impaired quality of life [8–9]. Moreover, myopes are at a higher risk of blindness in old age. The increased prevalence of myopia is likely to lead to increases in the numbers of blind people, whose health care poses a serious socioeconomic burden to families and societies.

An observation was commonly found in children with visual impairment who resort to repetitive behaviour when the environment becomes too visually complex for them to cope with. Therefore, theory of Planned Behaviour (TPB) [10] can be applied to suggest that low-SES kids' behaviour can be predicted based on their attitudes under different environmental factors. The Theory of Planned Behavior (TPB) was developed by social psychologists and has been widely employed as a tool to aid our understanding of a variety of behaviors including health behaviors [11–12].

In this study, investigations were carried out on the difference in kids' VA by their environmental factors, such as various family structures, the effect of visual health attitudes (VHA) and visual health behaviours (VHB) on visual acuity (VA). Here, a model of TPB was formed to analyze VA for 260 kids in low SES families in Changhua County, Taiwan. VA is controlled by VHB which guided by attitude to the VHA and perceived behavioural control with leisure sports participation (LSP), too. The designed questionnaire was conducted on students counselled by social welfare organizations. A purposive sampling study and an examination of VA were also conducted as part of the preliminary study.

1.2. Environmental factors affecting visual acuity

More researches are needed to investigate whether unhealthy visual behaviours such as not doing sufficient daytime outdoor activity and obsessively watching electronic devices (e.g. smartphones, computer monitors or TV screens) are environmental factors in the development of myopia.

1.2.1. Myopia and outdoor activities

Myopia has traditionally been considered a hereditary condition, and many previous studies indicate that kids with myopia are more likely to have a family history of myopia [13–14]. However, there is a growing scholarly consensus that both environmental and hereditary factors play a role in the development of myopia. [15] reported that, in China, school kids in urban settings exhibit a higher prevalence of myopia than kids in rural settings, suggesting that environmental factors are involved in the kid's myopia development. A research in Japan by [16] mentioned that visual acuity of kids is influenced by hereditary and environmental factors. The lifestyle of kids has changed. Video games have become popular; kids must study hard in order to enter first-rank schools and they often stay up till late at night. Such circumstances might have some influence on their visual acuity. [17] found that a lower prevalence of myopia in Chinese kids raised in Sydney than in Chinese kids living in Singapore was associated with increased hours of outdoor activities.

1.2.2. Recent studies about childhood myopia

Many studies have shown that near work may be a significant factor in the development of childhood myopia. In Singapore, kids who read more than two books per week had a 1.43 and 3.05 higher incidence of low/ moderate myopia and high myopia than kids who read less than two books per week [18]. Besides reading books, the definition of near work might be expanded to include watching TV, playing computer games and using mobile devices, such

as smartphones and tablet computers. Many studies of myopia in industrialized East Asian countries have suggested that the problem is most acute among kids of higher socioeconomic status parents [19]. These studies may suggest that white collar parents pressurize their kids to do more near work at a younger age, putting their kids at greater risk of developing myopia.

2. Materials and methods

2.1. Hypotheses

The hypothesis that white-collar kids spend longer hours doing near work than blue collar kids do, might become somewhat less plausible, because it seems unlikely that white collar parents would put pressure on their kids to use electronic devices. More researches are needed before scholars can hypothesize confidently about the relationship between SES, near work and electronic devices. Based on the widely utilized TPB, which suggests that people's behaviour can be predicted based on their attitudes. The purpose of this study is to investigate the relationship between VHB and VHA. The study's hypotheses follow.

- H1: The low SES elementary school students' VHA will have a positive impact on VHB.
- H2: The low SES kids' LSP will have a positive impact on VHB.
- H3: VHB will have a positive impact on VA.

A TPB model as Figure 1 is created where VHB is guided by VHA and perceived behavioural control LSP. Finally, behaviour (VA) is controlled by VHB.

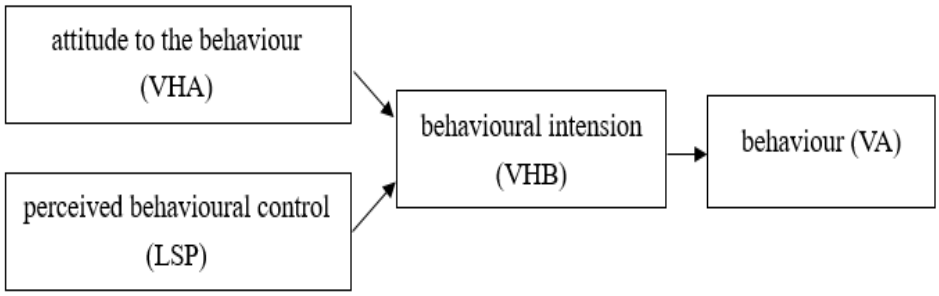

Figure 1. The framework of TPB model about visual acuity with visual health behaviour.

2.2. Research subjects and scope

The kids in low SES families counselled by social welfare organizations (one Taiwanese fund for kids and families and two charity foundations based in Changhua County) are the research subjects. Most of these kids were in low-SES families, single-parent families, foster families, or families in which parental responsibility fell on grandparents, relatives, foreign spouses, and parents with physical or mental disorders.

2.3. Questionnaire collection

To anticipate the reliability of the questionnaire, a preliminary test using the questionnaire was conducted on students counselled by social welfare organizations. A purposive sampling study and an examination of VA were also conducted as part of the preliminary study. There were 50 questionnaires returned in total with test results indicating that Cronbach's on research variables were over 0.8 which show a reliable result and a high interior consistency. Later, there were 330 formal questionnaires distributed and 260 questionnaires returned. The scale reliability of Cronbach's was higher than 0.80, also showing high consistency.

3. Results and discussion

3.1. Samples structural analysis

Structural analysis was carried out by SPSS software package. The demographic statistics in the basic data of the sample are shown by gender. There are 116 (44.6%) males and 144 (55.4%) females. 104 (40.0%) kids live with their both parents and 156 (60.0%) kids do not, among whom, the highest proportion live with the mother (25.4%). Of the low SES students, the highest proportion (33.5%) are raised by their mothers, the second highest proportion (32.7%), by their grandparents, and the third highest (30.0%), by their fathers.

3.2. Visual acuity testing

The study conducted a questionnaire and performed a VA examination on low SES elementary school kids. The VA examination used a standard visual scale to measure uncorrected defective VA. Any uncorrected VA less than 0.9 without other eye diseases was regarded as poor VA. The worst eye would be measured if both eyes exhibited poor VA, and the right eye would be measured if the eyes were of the same VA. The result of the examination is shown in Table 1. Approximately 48.8% of the student's VA is under 1.0.

Table 1. Eyes classified by unaided VA on low SES elementary school kids.

VA	No.	%	Accumulated %
over 1.0 (normal)	133	51.2	51.2
0.8-0.9 (mild vision loss)	28	10.8	62.0
0.4-0.7 (ametropia)	57	22.0	84.0
under 0.3 (severe ametropia)	42	16.0	100.0
Total	**260**	**100.0**	

3.3. Data analysis

For questionnaire a Likert's 4-point scale is applied from most disagree in 1 to most agree in 4. The children whose VA was over 1.0 and between 0.4 to 0.7 had significant differences in 3 questions related to VHB, as shown in table 2. The children with good VA had established the habit of resting the eyes by taking a 10-minute break after 30 minutes reading, but the children whose VA was between 0.4 to 0.7 did not pay attention to resting the eyes. The children with good VA had "correct" VHA and would do outdoor sports everyday. Also, the children with good VA could keep reading distance of over 35 cm while some other whose VA was between 0.4 to 0.7 could not good eye care habits on reading or doing homework. There is a turning point of agree level about the children whose VA was under 0.3. It was assumed that children whose VA under 0.3 might show strong self-examination in mind to change their eye care habits to avoid deterioration of vision. However, this assumption is not significant.

Table 2. ANOVA of the differences environmental factors in VHB for various VA.

VHB	VA	Agree Level	Mean	Standard deviation	PostHoc (Scheffe)
A. I look into the distance and rest for 10 minutes after reading for 30 minutes.	(1) over 1.0	2.625	1.099	2.994*	(1) > (3)
	(2) 0.8-1.0	2.313	1.026		
	(3) 0.4-0.7	2.012	1.006		
	(4) under 0.3	2.236	0.980		
B. I spend at least 120 minutes outdoors every day.	(1) over 1.0	2.968	1.031	4.814*	(1) > (3)
	(2) 0.8-1.0	2.525	1.003		
	(3) 0.4-0.7	2.189	1.013		

VHB	VA	Agree Level	Mean	Standard deviation	PostHoc (Scheffe)
	(4) under 0.3	2.454	0.959		
C. I maintain a reading distance of over 35 cm while reading or doing homework.	(1) over 1.0	2.968	0.999	3.695*	(1) > (3)
	(2) 0.8-1.0	2.606	0.966		
	(3) 0.4-0.7	2.303	1.078		
	(4) under 0.3	2.436	0.976		

*Significant $p < 0.05$

Also, an ANOVA significant difference between the various family structures emerged regarding the questionnaire item "I look into the distance and rest for 10 minutes after reading, watching TV or playing computer for 30 minutes". As shown in Table 3 kids who live with their parents have poorer VHB than those who do not live with their parents in significant difference.

Table 3. ANOVA of the differences between various family structures in questionnaire.

Question	Family Structure	Mean	F-value	PostHoc (Scheffe)
"I look into the distance and rest for 10 minutes after reading, watching TV or playing computer for 30 minutes"	(1) Live with parents	2.278	3.539*	(4) > (1)
	(2) Live with fathers	2.578		
	(3) Live with mothers	2.318		
	(4) others	2.800		

*Significant $p < 0.05$

The overall structure model was evaluated according to comparison with judgment index of multivariate data analysis [20], yielding the following results: AGFI = 0.93, GFI = 0.91, IFI = 0.95, TLI = 0.94, CFI = 0.95, RMSEA = 0.05, RMR = 0.04. All judgment indexes were within standard value. The sample estimation data and the content of the visual health and vision overall model (Structural Equation Model) are shown in Table 4 and Figure 2. According to the results of regression analysis, "correct" VHA, LSP affected VHB, and ultimately affected the test result. Besides, participating in more leisure sports also positively affected VHB and VA.

Table 4. ANOVA of the differences between various family structures in questionnaire.

Variable path relationship	regression coefficient	*p*-value
VHB ← VHA	0.466***	0.000
VHB ← LSP	0.282**	0.003
VA ← VHB	0.200*	0.031

*significant p < 0.05 **high significant p < 0.01 ***very high significant p < 0.001

$$VHB = 0.466\ VHA + 0.282LSP \quad (1)$$

$$VA = 0.200\ VHB \quad (2)$$

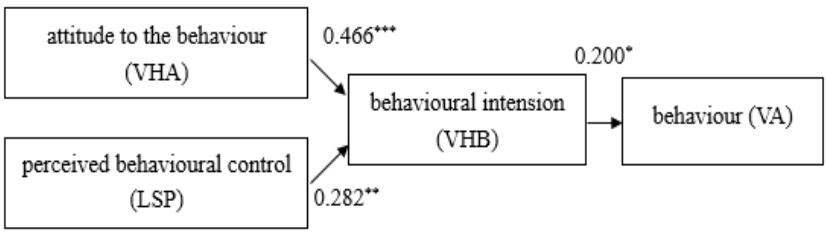

Figure 2. Path analysis of the overall structural relation TPB model.

For more specific questions referring VHA, VHB and LSP in regression analysis Table 5 shows that: the B3 "I don't want to get myopia, so I need to take care of my eyes" was the most effective question regarding VHA (regression coefficient 0.775 in a very high

significance level). The C7 "I read, do my homework, watch TV and play computer with good illumination indoors" was the most effective question regarding VHB (regression coefficient 0.727 in a very high significance level). The A9 "The number of times I participated in leisure sports in a week" was the most effective question regarding LSP (regression coefficient 0.707 in a very high significance level).

Table 5. Regression analysis for overall model regression coefficient.

Variable path relationship	regression coefficient	*p*-value
B1: Although glasses are expensive, I still need to wear glasses if I have myopia. ← VHA	0.660***	0.000
B2: Although wearing glasses looks good, I don't want to get myopia. ← VHA	0.602***	0.000
B3: I don't want to get myopia, so I need to take care of my eyes. ← VHA	0.775***	0.000
B5: I think I need to see an ophthalmologist when I can't see clearly. ← VHA	0.771**	0.006
B7: I think it is necessary to ask my family to take me to have my eyes examined. ← VHA	0.522***	0.000
B9: I want to avoid getting myopia even though my family has myopia. ← VHA	0.710***	0.000
C1: I use television, computer and smartphone for less than 2 hours per day. ← VHB	0.575***	0.000
C2: I look into the distance and rest for 10 minutes after reading, watching TV or playing computer for 30 minutes. ← VHB	0.692***	0.000
C4: I keep a 35 cm reading distance while reading or doing homework. ← VHB	0.679***	0.000
C7: I read, do my homework, watch TV and play computer with good illumination indoors. ← VHB	0.727***	0.000
C8: I have a balanced diet and am not a picky eater. ← VHB	0.542***	0.000
A9: The number of times I participated in leisure sports in a week. ← LSP	0.707***	0.000
A10: The average minutes I participated in leisure sports each time. ← LSP	0.695***	0.000

*significant $p < 0.05$ **highly significant $p < 0.01$ ***very highly significant $p < 0.001$

3.4. Discussions

According the analysis in Table 2 children with good VA had established the habit of resting the eyes by taking a 10-minute break after reading for 30 minutes, but the children whose VA was between 0.4 to 0.7 did not pay attention to resting the eyes. The children with good VA had "correct" VHA and would do outdoor sports more than 2 hours everyday. Due to unhealthy reading distance children whose VA was between 0.4 to 0.7 would squint their eyes to read clearly, making it harder for the ciliary muscles of they eye to adjust.

The results relating hypotheses test are discussed below:

- H1: Kid's VHA will have a positive impact on VHB. As shown in Table 4, the regression coefficient of VHA to VHB was 0.466 which achieved a very high significance level; thus, H1 was feasible.

- H2: kid's LSP will have a positive impact on VHB. As shown in Table 4, the regression coefficient of LSP to VHB was 0.282 which achieved a high significance level; thus, H2 was feasible.

- H3: VHB will have a positive impact on VA. As shown in Table 4, the regression coefficient of VHB to VA was 0.200 which achieved a significance level; thus, H3 was feasible.

For questions referring VHA, VHB and LSP in regression analysis in Table 5 with a very high significance level it could be found that children knew the relationship between myopia and well care of eyes, importance of indoor illumination, and regular leisure sports for strong healthy body and wider field of vision.

3.5. Limitations of study

Because the questionnaire and VA examination needed to have a parent or guardian's agree and signature before filling in and testing, it was not possible to obtain test results from all the low SES elementary school students in whole county. Also, Those VA examination of the low SES children were counseled by social welfare organizations only. Data collection for those who were not counseled by social welfare organizations were not included. Furthermore, it is necessary that a guidance counselor had to read the questions and helped each of the children to complete the questionnaire. It was possible that error crept into the results due to misunderstanding through bad communication.

4. Conclusion

There was 48.8% of the low SES kids' vision below 0.9, which is an increase of 2.7% on the defective vision rate in Taiwan (46.1%) [21]. A failure to maintain a healthy book-to-eye distance when reading seemed to be the main cause of myopia onset. The students with poor VA had worse VHA, leading to unhealthy VHB and ultimately to myopia shown by analysis in Table 2. This study also found that students participated in leisure sports, had positively affected VHB. Participating in leisure sports can reduce the usage time which has great help on the visual health care. Beside questionnaire study interviews with some low SES elementary school kids had been done, too. Facts were found that some parents in low SES families were busy at making money rather than taking care of students. Thus, students addicted to playing 3C (computer, communications, and consumer-electronics) products at home result in the rapid increase of myopia. Most low SES children did not have a dedicated desk lamp and only turned on a lamp to write or read under weak light to save money, forcing them to maintain an unhealthy reading distance. According to the results of the study, "correct" VHA led to "correct" VHB; LSP led to "correct" VHB and "correct" VHB ensured good VA for students. The low SES students need more care and assistance to change the situation of low SES and prevent the deteriorating of VA.

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