MINISTRY OF EDUCATION   MINISTRY OF HEALTH

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TRAN DUC NGHIA

THE STATUS OF MYOPIA IN PRIMARY SCHOOL PUPILS IN DIEN BIEN PHU CITY AND THE EFFECTIVENESS OF SOME INTERVENTION SOLUTIONS

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LIST OF PUBLICATIONS RELATED TO THE THESIS

1. Tran Duc Nghia, Nguyen Thi Thuy Duong, Tran Van An (2017), "Myopia in primary school pupils in Dien Bien Phu city, 2016", Vietnam Journal of Preventive Medicine, vol. 27, No. 9, p. 204-210.

2. Tran Duc Nghia, Tran Van An, Vu Duy Kien, Pham Phuong Lan, Pham Thi Van Anh, Nguyen Thi Thuy Duong (2018), "Effectiveness of some intervention activities to reduce the prevalence of myopia for primary school pupils in Dien Bien Phu city, Dien Bien province (2016-2018)", Vietnam Journal of Preventive Medicine, vol. 28, No. 11, p. 165-172.

INTRODUCTION

Myopia occurs when the eye is too focused as compared to the length of the eyeball. This condition causes the object focus in front of the retina, so the image of the object becomes blurred. It was estimated that in 2016, around 1.4 billion people worldwide had myopia, and it was equivalent to 22.9%, of the world's population. Among people with myopia, about 163 million people (2.7% of the world's population) suffered from severe myopia. In Asia, the prevalence of school myopia has been increasing rapidly every year, and the school myopia tends to spread in many countries.

Vietnam is one of the countries with a high prevalence of myopia, and the prevalence of myopia tends to increase rapidly. In the report of blindness prevention activities in 2006, it was shown that the prevalence of myopia among school-age children in Vietnam ranged from 10% to 12% in rural areas, and from 17% to 25% in urban areas. A recent study showed that the prevalence of myopia reached 40% - 50% among pupils in urban areas.

Dien Bien Phu is a Class II city, which is directly under Dien Bien province with an estimated population of 73,000 people in 2018. One-third of the population in Dien Bien Phu city belongs to ethnic minority groups. Most of Dien Bien Phu citizens live in urban areas (about 97% of the population). The status of school myopia has been mentioned in several health reports of Dien Bien Phu city. However, no study has been conducted to assess the status of school myopia of pupils in Dien Bien Phu city. Furthermore, there is no intervention in Dien Bien Phu city to reduce the prevalence of school myopia, which is increasing in the area.

Providing information about myopia is very important because it will contribute to strengthening health education activities about school myopia for primary school pupils. Therefore, our research question is what the myopia

prevalence of primary school pupils in Dien Bien Phu city, Dien Bien is, and if the status of myopia status is at an alarming level. What are the factors relating to the myopia prevalence of primary school pupils? What intervention solutions for preventing myopia can be effective in reducing the myopia prevalence among primary school pupils.

To deal with our above issues, along with answering the research questions we mentioned above, we conducted the study **"The status of myopia in primary school pupils in Dien Bien Phu city and the effectiveness of some intervention solutions"** with the following objectives:

1. To describe the status of myopia in primary school pupils and the school hygiene status of in primary schools in Dien Bien Phu city in 2016.

2. To identify factors related to myopia in primary school pupils in Dien Bien Phu city in 2016.

3. To evaluate the effectiveness of some myopia preventive solutions for primary school pupils in Dien Bien Phu city, during 2016-2018.

NEW CONTRIBUTIONS AND PRACTICAL SCIENTIFIC MEANINGS OF THE THESIS

This is the first study with the largest scope to learn about the status of myopia in Dien Bien Phu city. Although the study site is a city, it is located in mountainous areas with certain socioeconomic difficulties. The study provided evidence about the prevalence of myopia and the tendency of the prevalence of myopia by pupil grades in Dien Bien Phu city. Some limitations of school hygiene conditions in primary schools in Dien Bien Phu city was found. The study results also provide evidence associated factors with myopia among primary school pupils in Dien Bien Phu city.

Within 18 months of intervention, the study showed the effective impact of communication-based interventions and myopia preventive activities. Based on

the results, it would be the basis for the expansion of the intervention models for all primary schools in Dien Bien Phu city, as well as other areas with the same natural and socioeconomic conditions.

THE LAYOUT OF THE THESIS

The main content of the thesis consists of 103 pages with following sections: Introduction (02 pages); Overview (28 pages); Methods (16 pages); Results (28 pages); Discussion (26 pages); Conclusion (02 pages); Recommendation (01 page). The thesis includes 36 tables, 11 figures (maps, charts, diagrams) and 153 references (30 references in Vietnamese, 123 references in English), of which the number of references published in the last 5 year is 46/153 references, and related annexes.

Chapter 1 OVERVIEW

Myopia is a common refractive error of the eye. The people with myopia has too high optical power as compared to the length of the eyeball axis. In the myopia eye without modification, the light of the object to the eye focuses in front of the retina, rather than directly on its surface. This causes the distant object to be blurred, but nearby objects can be seen as normal. School myopia is a term for children with myopia when they are at school-age. Myopia greatly affects public health and social welfare. Myopia is considered as the leading cause of vision impairment and blindness. People who are blind due to myopia are burdens for families, society, and themselves.

Myopia is a common ophthalmic disease in the world. It is estimated that 1.4 billion people (22.9% of the world's population) had myopia, of which about 163 million people (2.7% of the world population) had severe myopia. The burden of disease relating to myopia is expected to increase to 4.8 billion people (50% of the world population), and an estimated 1 billion people with severe

myopia (about 10% of the world population) by 2050. In high-risk areas, untreatable visual impairment is estimated to increase by 7 to 13 times in 2055.

Vietnam is one of the countries with myopia prevalence tends to grow rapidly. In recent years, the myopia prevalence has increased rapidly not only in urban areas but also in rural and mountainous areas. In 2006, according to research by Thanh et al. in the preventive blindness activities report, the myopia prevalence at school age in Vietnam was from 10% to 12% among pupils in rural areas, and from 17% to 25% among pupils in urban areas. However, in 2014, the study by Hon et al. showed that the myopia prevalence in rural pupils was from 10% to 15%, while it increased from 40 % to 50% among pupils in urban areas.

The factors related to myopia are still being discussed. It is necessary to carry out further studies to find out the risk factors that affect myopia because they would have to deal with the increasing prevalence of myopia. Currently, there are three main causes that associate with myopia, including genetic factors, environmental factors, and other factors. In particular, school hygiene condition is an important issue within the factors of environment because it impacts directly on pupils. In addition, inappropriate living conditions and living habits are also problems of environmental factors related to myopia.

Conducting health communication and education on the prevention of myopia and eye diseases is one of the tasks regulated by the Ministry of Health. The model of school-based health education and communication focuses on several key contents, including the promotion of health education about common diseases among pupils and providing knowledge about school myopia prevention. For pupils, the school plays an important role in regularly integrating health education content into teaching hours. The school also need to organize myopia prevention activities regularly to form appropriate behaviors for pupils. The content of eye disease prevention is also widely disseminated on

learning tools and stationery; thus, it can improve the knowledge of pupils and their parents about myopia.

Chapter 2: STUDY SUBJECTS AND METHODS

2.1. Study subjects

Study subjects for the study to assess the status of myopia were primary school pupils from grade 1 to grade 5. Study subjects for the study to explore the associated factors with myopia were pupils in grade 4 and 5 of Be Van Dan and Him Lam primary schools. Study subjects for the intervention study were pupils in grade 3 and 4 of Him Lam primary school (intervention school) and Be Van Dan (control school).

2.2. Study design

The study applied two main study designs, which were the cross-sectional study design to understand the status of myopia and the associated factors with myopia, and the community-based intervention study design, including before-and-after evaluation and control.

2.3 Time and place

The time of the study was from April 2016 to April 2018. The whole study was conducted in Dien Bien Phu City, Dien Bien Province.

2.4 Sample size

The sample size of the study on myopia status and on the associated factors with myopia was estimated based on the formula of estimating a population proportion with specified relative precision. This formula was recommended by WHO, as follows:

$$n = Z_{1-\alpha/2}^2 \frac{p(1-p)}{(\varepsilon p)^2} \times k \quad (1)$$

where n is the minimum sample size that would be needed, p is the anticipated prevalence, $Z_{1-\alpha/2}$ is a confidence coefficient, ε is relative precision. For the

study to assess the status of myopia, the anticipated myopia prevalence was used as 9.86% based on the result of a previous study, $Z_{1-\alpha/2}$ was selected as 1.96 with 95% confidence level, and the relative precision of 15%. With k equal to 2, applied the formula, the minimum sample size of 3.122 pupils would be needed. In our study, we took the sample size of 4.757 pupils because this study belonged to the provincial project. For the study to identify the associated factors with myopia, the anticipated myopia prevalence of 16% (the myopia prevalence was identified after the pilot study with 100 pupils), $Z_{1-\alpha/2}$ was selected as 1.96 with 95% confidence level, and the relative precision of 25%. Applying the formula 1 without k, the sample size was estimated at 323 pupils. Because the study was implemented by the class, so we collected a total of 402 pupils.

The sample size for the study on intervention is based on the formula of estimating the difference between two population proportions. This formula was recommended by WHO as follows:

$$n = \frac{\left\{Z_{1-\alpha/2}\sqrt{2p(1-p)}+Z_{1-\beta}\sqrt{p_1(1-p_1)+p_2(1-p_2)}\right\}^2}{(p_1-p_2)} \quad (2)$$

Where, n is the minimum sample size for either intervention or control group that would be needed, p_1 is the anticipated myopia prevalence before the intervention (based on the result from a pilot study), p_2 is the anticipated myopia prevalence before the intervention, p is the average change of the myopia prevalence as p= (p1+ p2)/2, $Z_{1-\alpha/2}$ equals to 1.96 (with the confidence level of 95%),$Z_{1-\beta}$= 0,84 (with the sample power of 80%). The sample size estimated for each group was 260 pupils. In our study, 265 pupils from the intervention group and 263 pupils from the control group with adequate information were included in the analysis.

At each participating school, the research team selected one classroom, which represents for each grade from grade 1 to 5. A total of 45 classrooms were selected to our study from nine primary schools.

2.5. Intervention study

2.5.1. Identifying problems that need interventions

- School hygiene according to Vietnamese standards.

- The myopia status of pupils in Dien Bien Phu city.

- The study results about the associated factors with myopia.

- The ability to study population in response to the intervention solutions.

2.5.2 Intervention activities

The time of the study was from September 2016 to April 2018, including two consecutive school-years. Excluding three months of summer vacation, the total time of the intervention conducted at the school was 18 months. The study subjects of the intervention were primary school pupils at grades 3 and 4 of Him Lam primary school. The contents of the intervention include: 1) Changing awareness and behavior by direct communication and distribution of leaflets; 2) Coordinating between the school and parents to control the time of the eye concentration of pupils; 3) Providing guidance on arranging study corners at home to ensure necessary conditions, 4) Implementing the school hygiene measures based on the regulation; 5) Rotating the position of pupils with opposite direction once a month.

2.6 Measurement of the effectiveness of the interventions

Using the Difference-in-Difference method to estimate the effectiveness of the interventions on changing the outcome in the intervention group as compared to that in the control group over a period of time. The intervention effect on the myopia prevalence in this study was estimated based on the difference-in-difference. The formula for estimating the variable different is as follows:

$$DiD = (CT_2 - C_2) - (CT_1 - C_1) \quad (3)$$

DiD is the difference-in-difference of the myopia prevalence (the impact from intervention), CT1 is the myopia prevalence of the intervention group before the intervention, C1 is the myopia prevalence of the control group before

the intervention, CT2 is the myopia prevalence of the intervention group after intervention, C2 is the myopia prevalence of the control group at the time after the intervention. After getting myopia, people cannot recover and often tend to increase the magnitude of myopia. So, when applying formula 3, if the intervention is effective, the value of DiD will be negative, which means that intervention has helped to prevent the increase of the myopia prevalence in the intervention group as compared to the control group.

2.7. Data collection.

Tools and equipment for data collection included: The Landolt broken ring, the glass box with different glass numbers, the form for eyesight examination, the questionnaires for pupils, the meter tape with the accuracy of 1 cm, the Luxmetre machine, the school hygiene checklist. Data collection activities were conducted by the research team included: checking eyesight and collecting relating information, interviewing pupils about knowledge and habits relating to myopia, conducting an assessment on school hygiene conditions and collecting data after the intervention.

2.8. Errors and solutions to control errors

To control the errors of data collection about the diagnosis of myopia, all the doctors who participated in the study agreed on the procedure of examination and final conclusion. The data collectors were selected and trained to understand the questionnaires. The data entry form was designed by Epidata software with appropriate algorithms to avoid errors.

2.9 Data management and analysis

Data were entered and managed by Epidata software version 3.1. Data then were cleaned and analyzed by the STATA software version 14. Descriptive statistics and analysis methods were used. The intervention effect was estimated based on the analysis of difference-in-difference. The statistical significance level used was $p < 0.05$.

2.10 Ethical consideration

The study was approved by the Ethical Committee for Biomedical Research at the National Institute of Hygiene and Epidemiology before conducting research at the document no. CT:IRB - VN 01057-37/ 2016 dated October 6th, 2016.

Chapter 3: RESULTS

3.1. The status of myopia and school hygiene conditions

3.1.1 Characteristics of the study subjects

Table 3.1. Distribution of study subjects by school and sex

Primary school	n	Male		Female	
		N	%	N	Ratio %
Hanoi- Dien Bien Phu	910	467	52.3	443	47.7
Nam Thanh	614	362	58.9	252	41.1
Him Lam	883	492	55.7	391	44.3
Be Van Dan	879	505	57.4	374	42.6
To Vinh Dien	614	337	54.8	277	45.2
Hoang Van No	101	51	50.5	50	49.5
Thanh Minh	114	56	49.1	58	50.9
Thanh Truong	275	131	47.6	144	52.4
Noong Bua	367	183	49.8	184	50.2
Total	4757	2584	54.3	2173	45.7

A total of 4,757 pupils was enrolled in the study, including 2,584 males (54.3%) and 2,173 females (45.7%). Hanoi-Dien Bien Phu primary school had the largest number of pupils (910 pupils), followed by Him Lam Primary School (883 pupils) and Be Van Dan (879 pupils). The lowest number of pupils was at Hoang Van No primary school (101 pupils).
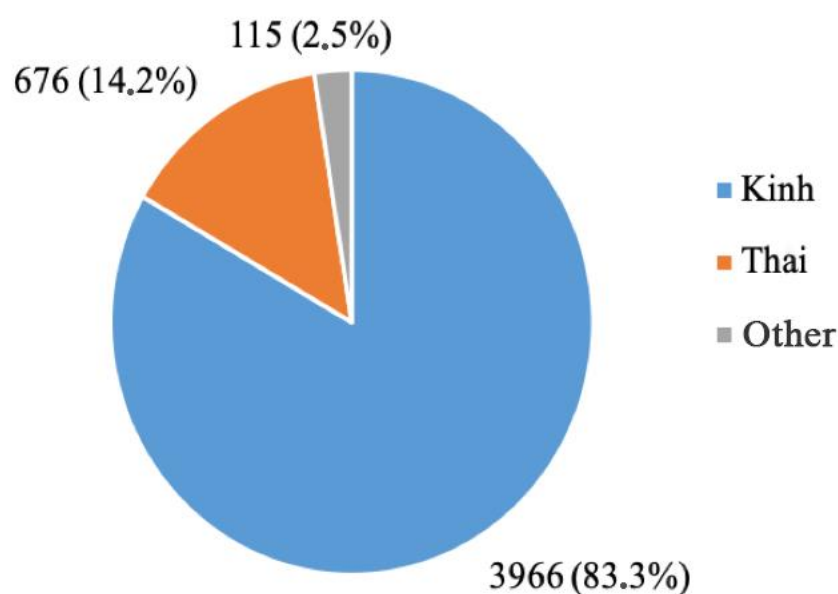
Figure 3.1: Distribution of study subjects by ethnic groups

The majority of pupils in the study were Kinh, accounting for 83.3%. Thai ethnic pupils also account for a significant proportion (14.2%). All pupils from other ethnic groups, including H'mong, Kho Mu, Ha Nhi, etc., accounted for a small percentage (2.5%).

3.1.2. *The status of myopia situation in primary school pupils*

Table 3.2. The percentage of primary school pupils with myopia by school

Primary school	n	Myopia	
		N	%
Hanoi- Dien Bien Phu	910	247	27.1
Nam Thanh	614	106	17.2
Him Lam	883	137	15.5
Be Van Dan	879	140	15.9
To Vinh Dien	614	125	20.3
Hoang Van No	101	0	0
Thanh Minh	114	0	0
Thanh Truong	275	20	7.2
Noong Bua	367	43	11.7
Total	4.757	818	17.2

Out of 4,757 pupils participating in the study, 818 pupils were found with myopia, accounting for 17.2% (Table 3.2). Pupils with myopia in primary schools in Hanoi - Dien Bien Phu (27.1%) accounted for the highest prevalence, followed by pupils of To Vinh Dien primary school (20.3%) and Nam Thanh primary school (17.2%). There were no myopia pupils in Hoang Van No and Thanh Minh primary schools (Table 3.2).

Table 3.3. The myopia prevalence of pupils by grade

Grade	Total	Myopia	
		N	%
Grade 1	955	99	10.3
Grade 2	960	95	9.8
Grade 3	1013	182	17.9
Grade 4	958	209	21.8
Grade 5	871	233	26.7
Total	4,757	818	17.2

The myopia prevalence of pupils by grade is presented in Table 3.3. In general, the myopia prevalence of pupils tends to increase from the low grade to the higher grade, ranging from 9.8% to 26.7%. In the lower grades (grade1 and 2), myopia rate was only about 10%. However, for pupils in grade 5, the myopia prevalence increased to 26.7%.

Table 3.4. The myopia prevalence of pupils by the level of myopia

Level of myopia	N	%
Mild (<3 Diop)	671	82,0
Moderate (3 - 6 Diop)	131	16,0
Severe (> 6 Diop)	16	2,0
Total	818	100

Table 3.4 shows that out of 818 myopia pupils, the myopia pupils with mild degree accounted for 82%, while the moderate level was 16%. The severe myopia accounted for only 2% of the total number of pupils with myopia.

Table 3.5. The myopia prevalence of pupils by myopia features

Myopia features	N	%
Myopia in 1 eye	113	13.8
Myopia in 2 eyes	705	86.2
Total	818	100

Out of 818 cases recorded with myopia, 705 cases got myopia with both eyes, accounting for 86.2%. In addition, there were 113 cases with only myopia in one eye, accounting for 13.8% (Table 3.5).

3.1.3. The status of school hygiene condition of primary schools

In the study, a total of 45 classrooms were enrolled, each representing one grade between grade 1 to grade 5, which were from nine participating schools. For criteria on class size (length ≤8.5m, width≤ 6.5m, height ≤3.5m), 34/45 of classrooms met the standard of class sizes. Only 20/45 of classrooms met the standard of the distance between the first table and the board. Especially, only 1/45 of the classroom met the standard for the last table distance to the board; this distance must be less than or equal to 8m (Table 3.6).

Table 3.6. School hygiene conditions for classrooms

Criteria	Meet the standard (n=45) N (%)
Room size (length≤8.5m, Width≤6.5m,height≤3.6m)	34 (75.6)
Distance between the first table to board (1.7-2m)	20 (44.4)
Distance from the last table to the board (≤8m)	1 (2.2)
Distance between the table and chair (20-25cm)	9 (20.0)
Board - Size: length 1.8-2m, width 1.2-1.5m - Color : Green or Black - Hanging on mid-wall, above floor: 0,8-1m	45 (100)
All criteria	1 (2.2)

Only 9/45 of classrooms met the standard for distance between tables and chairs. For the standard of the board, 100% of the classes met the requirements. For all criteria, only 2.2% (1/45) of the classes met the requirements.

3.2. Myopia and associated factors

3.2.1. Association between myopia and pupil habits

A total of 402 pupils participated in the study to find out the associated factor with myopia. The proportion of male pupils was 42.5%, while the proportion of female pupils was 57.5%. All pupils in the study were in grades 4 and 5, of which the proportion of grade 4 and 5 pupils was 49% and 51%, respectively.

Table 3.7. Factors associated with pupil myopia (multivariable analysis)

Independent variable	Adjusted OR	CI 95%	p value
Parents had myopia			
Yes	**2.67**	**1.45-4.91**	**<0.01**
No	1		
Study extra-classes continuously >1 hour			
Yes	**2.48**	**1.34-4.61**	**<0.01**
No	1		
Use the computer continuously >1 hour			
Yes	**2.25**	**1.13-4.49**	**0.02**
No	1		
Watch TV continuously >1 hour			
Yes	1.38	0.70-2.73	0.35
No	1		
Play computer games continuously >1 hour			
Yes	**2.38**	**1.12-5.03**	**<0.01**
No	1		

The results of multivariable analysis between myopia and some associated factors are presented in Table 3.7. Parents with myopia, studying extra-classes continuously more than 1 hour, using computers continuously for more than 1 hour and playing computer games continuously for more than 1 hour associated with myopia. In detail, pupils who had parents with myopia were 2.67 times more likely to get myopia compared to pupils who had parents without myopia (p<0.01). Pupils who studied in extra-classes continuously for more than 1 hour were 2.48 times more likely to get myopia compared to pupils who did not study in extra-classes continuously more than 1 hour (p <0.01). Pupils who used computers continuously for more than 1 hour were 2.25 times

more likely to get myopia than pupils who did not use computers continuously for more than 1 hour (p = 0.02). Pupils who played video games continuously for more than 1 hour were 2.38 more likely to get myopia than pupils who did not play video games continuously for more than 1 hour (p <0.01). In the multivariate regression model, watching TV continuously for more than 1 hour had no association with myopia (p = 0.35).

3.3. Evaluation of intervention solutions

3.3.1. Intervention activities and results

Table 3.8. Intervention activities at Him Lam primary school

Intervention activities	Target population	Frequency
Workshop: School myopia, preventive measures and treatment	Teacher of Him Lam Primary School	1 session
Communication: Myopia, causes, consequences and prevention of myopia. Guidance on how to arrange the study corner for pupils. Guidance on how to control the time the eye has to work focused	Leaders of the city's education department, parents, teachers and all pupils of Him Lam primary school	1 session
Delivery leaflets: How to detect and prevent some common eye diseases.	Pupils and parents of Him Lam primary school	500 leaflets
Guidance on how to detect abnormalities of eyes: Equipping the vision testing chart and instructing the school health staff on how to test eyesight and detect vision abnormalities for pupils	Medical staff at Him Lam Primary School	01 vision testing chart
Guidance on the frequent changing position of pupils in the classroom: once a month	Homeroom teacher and pupils of Him Lam primary school in grade 3 and 4	1 session
Guidance: ensuring school hygiene conditions	Representatives of the Education Department, school administrators, key staff of Him Lam primary school	1 session

The intervention activities were implemented as planned. Workshops, communication, and distribution of leaflets had direct impact on local pupils, parents, teachers and local education authorities. Moreover, the school's health staff were trained and improved knowledge of early detection of myopia for pupils. The homeroom teachers were instructed on how to change pupils' positions in the classroom and committed to doing so. School administrators and key staff were instructed to ensure that school hygiene conditions are in accordance with regulations (Table 3.8).

3.3.2. General characteristics of study subjects

Table 3.9. Demographic characteristics of study subjects

	Intervention (n=263) N (%)	Control (n=265) N (%)	p value
Sex			
Male	142 (54.0)	148 (55.9)	0.67
Female	121 (46.0)	117 (44.2)	
Grade			
3rd to 4th	131 (49.8)	118 (44.5)	0.22
4th to 5th	132 (50.2)	147 (55.5)	

Table 3.9 shows the demographic characteristics of participants in the intervention study with a total of 263 pupils in the intervention group, and 265 pupils in the control group. Regarding gender, the proportion between male and female pupils did not differ significantly in both the intervention group and the control group (p = 0.67). For the grade level, the percentage of pupils in the grade levels was relatively similar, and there was no significant difference (p = 0.22).

3.3.3 Impact of the interventions

Table 3.10. The myopia prevalence before and after the intervention

Intervention group (n=263) N (%)			Control group (n=265) N (%)		
Before intervention	After intervention	p	Before intervention	After intervention	p

Sex						
Male	27 (19.0)	33 (22.9)	0.42	24 (16.2)	43 (30.7)	<0.01
Female	16 (13.2)	19 (16.0)	0.55	21 (17.9)	38 (30.4)	0.02
Grade						
3rd to 4th	19 (14.5)	21 (16.0)	0.73	15 (12.7)	29 (24.6)	0.02
4th to 5th	24 (18.2)	31 (23.5)	0.29	30 (20.4)	52 (35.4)	<0.01
Total	43 (16.4)	52 (19.8)	0.31	45 (17.0)	81 (30.6)	<0.01

Table 3.10 shows the myopia prevalence of the intervention and control group before and after the intervention. In the intervention group, the myopia prevalence increased after the intervention as compared to before intervention, but the difference was not statistically significant (all values p> 0.05). Meanwhile, in the control group, the myopia prevalence increased significantly between before and after the intervention, the difference was statistically significant (all values p <0.05).

Table 3.11. Intervention impact estimated by difference-in-difference

	Myopia N (%)	p value
Before Intervention		
Control group (n=265)	45 (17.0)	
Intervention group (n=263)	43 (16.4)	
Difference (Intervention - Control) (%)	-0.6	0.86
After Intervention		
Control group (n=265)	52 (30.6)	
Intervention group (n=263)	81 (19.8)	
Difference (Intervention - Control) (%)	-10.8	<0.01
Difference-in-difference (DiD) (%)	-10.2	0.04

Table 3.11 shows the estimation of differences and difference-in-difference between the intervention and control groups before and after the intervention. The myopia prevalence of the intervention group (16.4%) and the

control group (17.0%) at the time before the intervention were relatively similar, and there was no significant difference (p = 0,86). The myopia prevalence in the control group (30.6%) has increased significantly as compared to the intervention group (19.8%), the difference is 10.8%, and it was statistically significant (p <0.01. According to the results, the difference-in-difference of the intervention was estimated to be -10.2%, and it was statistically significant (p = 0.04).

Chapter 4: DISCUSSION

4.1. The status of myopia and school hygiene conditions

Vision examination for 4,757 students of 9 primary schools in Dien Bien Phu city, we found that the number of myopia pupils in primary school students was 818 pupils, accounting for 17.2%. Comparing to previous studies in Vietnam, the school myopia prevalence in primary school pupils in Dien Bien Phu city was higher than that in studies in other provinces or cities. According to study results of Nga et al. in three regions of Hai Phong, Thai Nguyen and Ho Chi Minh city, the myopia prevalence of primary school children was 6.9%. Similarly, the myopia prevalence in our study was higher than that in the study conducted by Dung et al. in Thai Nguyen (16.8%). In our study, although the overall myopia prevalence was 17.2%, the myopia prevalence was different between schools. The high myopia prevalence concentrated in the central primary schools, two surrounding primary schools had no case of myopia, thus, if excluding these two primary schools, the myopia prevalence of pupils in the central areas would be 18%.

The number of myopia pupils in our study was 818 pupils, of which pupils with two-eyed myopia were 705 pupils, accounting for a high proportion of 86.2%. The number of pupils with either right or left eye myopia was 113 pupils, accounting for 13.8%. However, one-eye myopia is much more harmful than myopia in both eyes. For one-eye myopia, the eye with myopia would not involve in the vision process, and the retinal receptor cells become lazy to work,

leading to amblyopia due to refractive errors. If the situation of amblyopia is not detected and treated, the eye will not recover.

When conducting the analysis of myopia by grade level, our study shows that the myopia prevalence of primary school pupils tended to increase gradually from low to high grades. The myopia prevalence of grade 1 and 2 were only 10.3% and 9.8%, but the myopia prevalence reached to 26.7% in the 5th grade pupils. The results of the study showed that the higher the class, the higher the myopia prevalence, or the greater the age of primary school pupils, the higher myopia prevalence (equivalent to the age of pupils from 6 to 10 years old). This result was consistent with some other studies in the world.

School hygiene conditions play an important role in pupils' health and learning ability. In particular, several criteria for school hygiene conditions affect and directly relate to school myopia. All classrooms assessed in our study met the requirements of classrooms area per pupil. However, regarding the size of classes, only 75.6% of the classrooms met criteria. Especially, the criteria for distance from the last table to the board met the requirement by only 1/45 of the classroom, in particular, most of the classes had the distance from the last table to the board larger than 8m. The distance from the last table to the board would make pupils' eyes work harder, affecting their eyesight.

In our study, only 9/24 (20%) of the classrooms qualified for the difference between desks and chairs. Most of the schools invested in their facility, but the synchronization between table and chair in the classroom was not high. Classroom lighting is also an important factor because it affected directly to the eyesight of pupils. If the lighting conditions are good, the ability and efficiency of the eye are higher. Pupils need to regulate their eyes more in case of the lighting of the classroom is inadequate. However, in our study, only 35/45 (77.8%) of the classrooms met the requirements for the lighting of the classroom.

4.2. Factors associated with the myopia of primary pupils

Identifying factors relating to the myopia of pupils plays an important role in providing appropriate interventions for pupils. Different groups of pupils and regions have different characteristics and habits relating to their probability to get myopia. In our study, there was an association between myopia and some habits of pupils, including study in extra-classes continuously more than one hour, use of computers continuously more than one hour, and playing computer game continuously more than one hour. Also, myopia in primary school pupils also associated with the parents' myopia. This is scientific evidence that helps local policymakers to develop appropriate interventions for primary school pupils.

Our research shows that there was a close association between studying in extra-classes and myopia. Accordingly, pupils who took extra-classes were 1.72 times more likely to get myopia than those who did not take extra-classes. Moreover, pupils who studied in extra-classes continuously more than one hour were 2.48 times more likely to get myopia (multivariate regression models) than those who did not. The results of our study were consistent with previous studies when they indicated that myopia pupils often spent more time on learning than those who did not. According to the findings by An et al. at Thang Long University in 2013 - 2014, pupils studied more than 10 hours per week were 1.96 times more likely to get myopia than pupils who did not. In the study by Dung et al., pupils who studied more than five hours per day were 3.2 times more likely to get myopia than those who studied less than two hours per day. In our study, the evaluation of the extra-classes was different from other studies because our study subjects were primary school pupils. Actually, primary school pupils would need to study less than pupils in high school or university. Also, the way that the primary school pupils spending time on studying was different from pupils at more likely education levels.

The work that requires close and continuous working of eyes is considered to be an important risk factor affecting the development of myopia. Using computers, watching television, playing electronic games, and reading storybooks are activities that make the eyes saw close-up continuously. However, different groups of people and different ways of exposure to these risk factors can lead to different myopia prevalence. Some studies found that there was an association between myopia and the use of the computer, watching television, playing electronic games, and reading storybooks. Many authors reported that reading, writing, and using computers regularly for a long-time lead to the more likely myopia prevalence.

In our univariate and multivariate analysis, we found that there was an association between myopia in pupils and the myopia status of their parents. Many studies showed that there was an association between myopia in parents and children. This may be partly due to genetic factors. However, there may also be a combination of bad habits that children learned from their parents. For parents with myopia, more attention should be paid to prevent myopia for their children. In particular, it is necessary to understand the myopia manifestations to detect the abnormalities of the eyes early and take children for examination and getting advice from doctors.

4.3. Effectiveness of interventions for school pupil myopia

During the 18-month intervention period, all intervention activities were completed and ensured according to the plan. Workshop on preventive and treatment measures for school myopia was implemented for all teachers of Him Lam primary school. We also held a communication session on myopia for leaders of the city's education department, parents, teachers, and all pupils of Him Lam primary school. Pupils were given leaflets with basic knowledge about myopia prevention. In particular, we collaborated with teachers to plan and implement the rotation of pupils' sitting positions in the classroom. School health staff were instructed on how to examine and detect suspected cases of

myopia. The key staff of the school was discussed and instructed how to ensure school hygiene conditions at the school.

After the intervention period, we found a significant improvement in the indicators of school hygiene conditions at the intervention schools. Most of the school hygiene indicators met the standards of the Ministry of Health. In particular, all of the classes at the school improved the lighting conditions and the criteria of the difference between desks and chairs. Meanwhile, in the control primary school, the indicators of school hygiene conditions were almost unchanged. This result was also consistent with some other intervention studies. This demonstrates that the intervention solution was feasible and able to be conducted if the schools would pay more attention.

The post-intervention assessment was conducted after the intervention time in both intervention school (Him Lam) and control school (Be Van Dan). The myopia prevalence before and after intervention in both the intervention group and the control group increased at the time of the post-intervention assessment. However, the myopia prevalence in the control group increased more than that in the intervention group. The difference-in-difference was calculated as -10.2% (p = 0.04), meaning that the intervention helped to prevent the increase of the myopia prevalence about 10.2%. The results of this study will be evidence to help policymakers provide appropriate interventions to expand the model of school myopia prevention in Dien Bien Phu city. The difference-in-difference method to evaluate the effectiveness of the interventions was recommended by WHO, and it has been used in many biomedical studies. The difference-in-difference method is recommended because it can help determine the effectiveness of the interventions after a period of interventions.

CONCLUSION

1. The status of myopia and school hygiene conditions

- The myopia prevalence of primary pupils in Dien Bien Phu city was 17.2%. Among the myopia pupils (818 cases), the proportion of pupils had mild, moderate and severe myopia were 82%, 16% and 2%, respectively.

- The myopia prevalence was no difference between male and female pupils.

- The myopia prevalence tended to increase gradually from grade 1 to grade 5, from 10.3% in grade 1 to 26.7% in grade 5.

- Among myopia pupils, 13.8% of pupils had myopia in only one eye, 86.2% had myopia in both eyes.

- The number of classrooms that met the standard of class sizes was 75.6%, but only 44.4% of classrooms met the standard of distance from the first table to the board. Only 2.2% of classroom met the standard of the distance from the last table to the board.

- The proportion of classrooms met the requirements on the difference between desks and chairs was 20%.

- For the standard of the classroom lighting, only 77.8% of the classrooms met the requirement.

2. Factors associated with the myopia of primary pupils

- Pupils whose parents had myopia were 2.67 times more likely to get myopia than those with parents who did not have myopia.

- Pupils who studied in extra-classes continuously more than one hour were 2.48 times more likely to get myopia than those who studied in extra-classes continuously less than one hour.

- Pupils who used computers continuously more than one hour were 2.25 times more likely to get myopia than those who did not use computers continuously for more than one hour.

- Pupils who played computer games continuously more than one hour were 2.38 times more likely to get myopia than those who did not play computer games continuously for more than one hour.

3. Effectiveness of interventions for school pupil myopia

The intervention activities were implemented within 18 months at Him Lam primary school, and the Be Van Dan primary school was a control school. The results are presented, as follows:

- Preventive intervention model included the following main activities:

+ Workshop and communication activities about school myopia

+ Designing and providing leaflets on how to detect and prevent common eye diseases.

+ Training to detect eye signs for school health workers.

+ Instructions to ensure school hygiene conditions.

+ Rotating the sitting position of pupils in the class once a month.

- The myopia prevalence before the intervention was 16.4% in the intervention group and 17% in the control group, the difference was not statistically significant. After the intervention period, the myopia prevalence was 19.8% in the intervention group, and 30.6% in the control group, the difference was statistically significant ($p < 0.01$).

- The estimation of difference in difference after 18 months was -10.2%, which means that the intervention helped to prevent the increase of the myopia prevalence about 10.2%.

STUDY LIMITATIONS

The study was conducted in all primary schools in Dien Bien Phu City to understand the status of myopia, but the study about factors relating to myopia was only conducted for pupils grade 4 and 5. Conducting interviews for pupils in grades 4 and 5 would give more accurate information because, at these

age-groups, pupils had better awareness than pupils in lower grades. However, this result may not reflect all the issues related to primary school pupils. Moreover, this is a cross-sectional study, so the conclusions only showed the association, and it did not allow us to interpret causality. The intervention study was also conducted only with pupils in grades 3 and 4 because at this age-group, the optical status of the eyes was stable. However, the study to follow-up only this target group might not provide the comprehensive effectiveness of the intervention.

RECOMMENDATIONS

Based on the findings from the study about the status of myopia, school hygiene conditions and analysis of associated factors with myopia, through which some interventions with the participation of the community were conducted, we would like to propose some recommendations, as follows:

- The education sector should review and direct schools to pay more attention and ensure the standards of the school hygiene criteria according to the Decision 2112/QD-BYT on school hygiene standards, by which the difference between desks and chairs needs to be improved to fit with the pupils' body.

- The education and health sector should coordinate well in examination, diagnosis, and early detection for pupils with the abnormalities of eyes to get timely intervention measures. At the same time, the school should coordinate with pupils' parents to build appropriate studying and rest time for pupils. This may help to avoid having pupils to study, play games, and use computers continuously for too long. It is recommended not to focus the eyes continuously for more than 1 hour. It is needed that families and schools have coordination and commitment to managing the time and habits of pupils using their eyes.

- When applying new educational models, the education sector should pay attention to ensure the school hygiene regulations following the regulation.

- Through the initial results of the intervention model, it is recommended that policymakers should use this evidence to develop the most appropriate and effective interventions to prevent myopia for pupils in Dien Bien province.

- It is needed to have coordination, cooperation, and engagement from different sectors in prevention of school myopia; thus it would expect to reduce the proportion of pupils wearing glasses and having good human resources for the future.