Chapter 5
Discussion

5.1 Sensitivity and specificity of the screening tests

Since the vision screening of the SFK program used newly developed screening tests, the author decided to study the sensitivity and specificity of the tests. The results of the sensitivity and specificity study are as followings.

Table 5.1 Sensitivity and specificity of the screening tests

Test	Sensitivity (95% CI)	Specificity (95% CI)
VA + stereopsis	75.0% (65.0-85.0)	95.8% (93.3-98.3)
VA test	68.1% (57.3-78.9)	96.6% (94.3-98.9)

In the reported studies, the sensitivity of the screening tests ranged from 65% to 95%; the specificity ranged from 82% to 97%. The sensitivity and the specificity of the screening tests used in the SFK program are in lines with the results of other studies (as shown in table 5.2).

Table 5.2 Sensitivity and specificity of screening tests in other studies

Authors (Year)	Tests	Sensitivity	Specificity
Konig (2002) (Tong et al., 2002a)	VA	86.4% - 90.9% 72% (68-76)	91.9%-94.8% 97% (95-98)
Konig (2002)	VA + cover test + motility examination	90.9% - 95.5%	90.9%- 92.4%
(Tong et al., 2000) (Enzenauer, Freeman, Larson, & Williams, 2000)	MTI photoscreener	65% 74%	87% 82%
(Schmidt, 1994)	Stereopsis test	76.9%	88.2%

5.2 Referral compliance and explanatory socioeconomic variables

To study the referral compliance, the questionnaires were distributed to 311 parents of the screen positive students in randomized 8 schools. The response rate of 72.7% was adequate for further analysis.

The average monthly family income was 9,892.16 Baht. The data were not symmetrically distributed so the median of 8,000 Baht may be better representative of the central tendency. About one-third of the families had income of 6,000 Baht or less, and another one-third had income of 6,001-9,000 Baht. This information showed that the families in this study were poor compare to the average households. The data from the 2002 Household Socio-Economic Survey (Ministry of Information and Communication Technology) showed that the average household income from the whole kingdom was 13,736 Baht. Since this study was performed in Bangkok, the better index of comparison is the average household income of the Greater Bangkok which is 28,239 Baht. (*Pocket Thailand in figures, 2004*, 2004)

For the alternatives that provide diagnostic eye care by refer the screen positive students to the existing health care facilities, the outcome of the screening program depends much on the referral compliance. The questionnaires sending to the parents of screen positive students in the SFK program show that the referral compliance rate is 82.3%. Readers should bear in mind that the study is performed in Bangkok. The average traveling time to health care facilities is 46 minutes. If the program is expanded into other provinces, the referral compliance may change. In the study, 15.9% of the parents answer that they probably take their child to health care facility and 1.8% answer that they certainly not comply. The author includes both probably group and certainly not comply group into "not comply" category. The majority in the "not comply" group who explained the reasons of not comply said because of lack of time.

The factors associated with the non-compliance are income, level of mother's education, and the ratio of referral cost to income. The final logit model is as following.

$$\log_e\left\{\frac{p_i}{(1-p_i)}\right\} = 0.129 + 0.076INC + 0.760MEDU1 + 1.570MEDU2 + 0.296COST$$

(p-value) (0.7903) (0.0914) (0.0791) (0.0416) (0.0816)

p = referral compliance

INC = monthly family income (unit of measurement 1,000 Baht)

MEDU1 = Mother's education1 (secondary level = 1; else = 0)

MEEU2 = Mother's education2 (certificate level or bachelor degree or post-graduation = 1; else = 0)

COST = the total referral cost to the parent (unit of measurement 100 Baht)

Some of the explanatory variables in the study are correlated. The multicollinearity of the independent variables is an important cause of the non-significance of several variables. The Pearson correlation coefficient of the family income and the proportion of referral cost to monthly family income is -0.298 (p = 0.000). This means when the family income is increased the proportion of the referral cost to family income decreased. The relationships of the other variables are shown in the following table. Fortunately, the main objective of this study is not to proof explanatory factors related to the compliance.

Table 5.3 Relationship of the father's education, mother's education and average family income

	Father's education of primary school	Father's education of secondary school	Father's education of higher level	Statistical test (p)
Mother's education of primary school	57	30	15	Chi-square (0.000)
Mother's education of secondary school	28	33	10	
Mother's education of higher level	5	10	24	
Average family income, Baht (mean, SD)	8,837.44 (5,896.95)	9,876.67 (4,716.22)	12,244.29 (6,714.77)	ANOVA (0.004)

Table 5.4 The results of the final logit model

Variable	β Coefficient	Std. Error	Z-statistic	Prob.	Exp. (β)
β_0	0.129287	0.486222	0.265900	0.7903	1.1380
INC	0.076010	0.045030	1.687696	0.0914	1.0790
MEDU1	0.759998	0.432763	1.756152	0.0791	2.1383
MEDU2	1.570037	0.770653	2.037282	0.0416	4.8068
COST	0.295929	0.169948	1.741285	0.0816	1.3444

Method: Binary Logit

Included observation: 217 Convergence achieved after 6 iterations

Log likelihood -87.18143 Restr. Log likelihood -95.87133

Probability (LR Stat) 0.001631

Logits are the natural logs of odds ratios. The odds is the ratio of the probability something is true divided by the probability that it is not. For example when we consider the parents' referral compliance in the group that mothers' education is primary school level (comply 78, non-comply 24). Then the odds of compliance in this group is equal to 78/24 = 3.25. The referral compliance in the group that mothers' education is secondary school level is 68 comply, and 9 non-comply. The odds of compliance in this group is 68/9 = 7.56. The odds ratio is the ratio of tow odds. The odds ratio of compliance in the group that mothers' education level of secondary school to that of primary school is 7.56/3.25 = 2.33. This means that the mothers whose education level is secondary school are 2.33 times more likely to comply.

The β coefficients of the logit model could not be interpreted directly as those of the linear regression model. A positive β coefficient means that, when the independent variable increases the odds of dependent variable increases. A

negative β coefficient means that, when the independent variable increases the odds of dependent variable decreases. Transformation the β coefficients of the logit model into odds ratio is simply by using the exponential function (raising the natural log e to the β power). For instance, if the logit β equals 0.759998 then the odds ratio equal 2.1383. From the model, the significant independent variable is the level of mother's education. When compare to mothers whose education is primary level, mothers with secondary level of education have the odds ratio of compliance of 2.14. For the mothers whose education level is higher, the odds ratio is even higher (4.81).

The available data in this study shows that mothers' education level is stronger related to referral compliance than the fathers' education. This is understandable as mothers involve more in taking care of the children. The family income also related to the compliance. The higher the family income is, the compliance rate increases. The result from the logit model shows that when the total referral cost to the parents increases the compliance rate increases. This is contradicted with the assumption. The possible explanation for this is that the referral cost is related to the family income, and the overall effect is because of the effect of the family income. If we consider other variable that relates to referral cost without relationship to income, that variable should be traveling time to the health care facility. The logit coefficient shows that when the traveling time increases the referral compliance decrease (though the p-level is not as good).

The logit model gives the idea of which factors are related to the compliance rate. It also has benefits in estimating the referral compliance in the community which referral compliance rate is unknown. This is useful when the program is expanded into other provinces.

Strickland & Strickland studied barriers to preventive health services, and found that the barriers composed of socio-economic factors such as health values, behavior, places of residence, race and socio-economic status. (Strickland & Strickland, 1996) They found that the primary barriers included ability to pay,

perception of need, service availability, accessibility of services and perception of discrimination. Yawn et al, studied the barriers to seeking care following school vision screening in Minnesota, USA, and found the major barriers to be community awareness of the importance of eye diseases, communication between schools and parents, high cost, and convenience to access to eye care.

The questionnaires in this study provide some information. Majority of the parents (73.45%) would take their child to public hospital. The average traveling time to health care facility is 45.5 minutes. The average traveling cost and income foregone for the parents is 159 Baht. When asking how much could the family spend in a year for the eye care of the child without difficulties (have to borrow money or to sell one's property), the answers averaged to 931.64 Baht. The 95% confidence interval is from 0 to 4,335.34 Baht. About one-fifth of the families could not spend extra money without difficulties, and another one-fifth of the families could spend 300 Baht or less without difficulties. From this information, there is still economic barrier for some families to access to eye health facilities.

5.3 Cost-effectiveness of school vision screening program

The results from this study show that the cost-effectiveness of the alternatives to be used in the school vision screening program range from 1,877.37 Baht per case in alternative 1 (use VA test plus stereopsis as screening test and provide mobile team) to 1,788.11 for alternative 4 (use VA test alone and refer the screen positive students to health care facilities). The difference from the alternative with lowest cost per effectiveness (alternative 4) to the highest alternative (alternative 1) is 5 per cent.

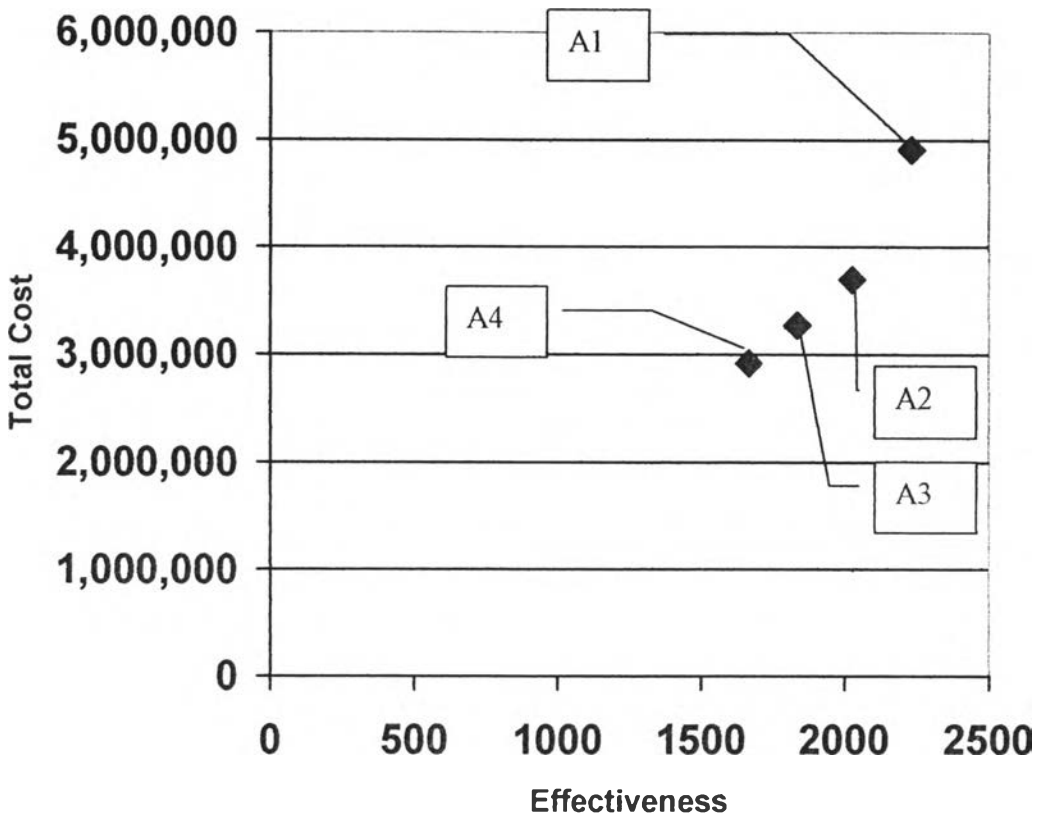

Figure 5.1 Shows the effectiveness (Y axis) and total cost of the 4 alternatives of school vision screening program.

5.3.1 Incremental cost-effectiveness

The overall results are shown in the figure 5.1. The results do not contrary to the expectation that alternative 1 (which uses combined screening tests, VA plus stereopsis, and provides mobile team) consumes the highest resource but gives the highest number of effectiveness.

To compute the incremental cost-effectiveness between alternatives, we could compare between the alternatives with similar basic processes and one alternative has additional component. The calculation of incremental cost-effectiveness will show the additional (incremental) cost per additional (incremental) effectiveness. If we look at the alternatives studied in this study

(table 5.5), we can clearly see that we are able to compare the incremental cost-effectiveness between any 2 adjacent cells vertically.

Table 5.5 Shows the screening tests and diagnostic eye care delivery methods used in each alternative

	Eye care service	
	Mobile team	**Refer to hospital**
VA + stereopsis test	Alternative 1	Alternative 3
VA test	Alternative 2	Alternative 4

First the author compares the incremental cost-effectiveness between the vertically adjacent cells. That is the incremental effect when adding the stereopsis as additional screening test. Alternative 2 (which uses VA test alone and provides mobile team) consume less resource but gives less effectiveness. Comparing alternatives 1 and alternative 2, the author calculates the incremental cost effectiveness (if stereopsis test is added to alternative 2) to be 5,923.85 Baht per additional case of effectiveness. When compare alternative 3 and alternative 4, the difference between the two alternatives is combined screening tests vs. VA test alone, the similarity of the two alternatives is that these two alternatives refer the screen positive students to health care facilities. The incremental cost-effectiveness between alternative 4 to alternative 3 is 2,093.89 Baht per additional case of effectiveness. The author proposes that when providing the mobile team which can examine all the screen positive students, adding the screening test (stereopsis test) results in higher cost per additional effectiveness. But for the referral groups (alternative 3 and alternative 4), which compliance is not 100%;

adding the stereopsis provide better sensitivity and specificity, and results in lower incremental cost per additional effectiveness.

5.3.2 Comparing the eye care delivery between mobile team vs. referral

Looking at the figure 5.1, alternative 1 (combined screening tests and mobile team) provides the highest effectiveness and also use the highest resource. Comparing alternative 1 (combined screening test and mobile team) and alternative 3 (combined screening tests and refer), and comparing alternative 2 (VA test and mobile team) and alternative 4 (VA tests and refer); Alternatives 3 and 4 that refer the screen positive students use lower results and provide less effectiveness.

5.3.3 Comparison with other studies

The author performed electronic literature search (Pubmed), and found only one study on the economic evaluation of the screening method. (Koenig & Barry, 2002) Koenig & Barry, performed the cost-effectiveness analysis of different screening tests (VA tests with different cut-off points, VA test plus cover test and motility examination, autorefraction) with different options of refer or re-screen for inconclusive results. They performed the study in Germany. They found that the cost-effectiveness ratios (CER) of the VA test are from 886-948 Euros per case. The CER of VA test plus cover test and motility examination are from 908-982 Euros per case. The CER of autorefraction test are 1471-1514 Euros per case. Since the CER of the autorefraction method is much higher than those of the VA tests and those of the VA test plus cover test and motility examination. They concluded that the autorefraction method is unfavorable, but the comparison between VA test alone or VA test plus cover test and motility test are inconclusive.

Comparing to the author's study, it is clearly that the CER of the vision screening in Thailand (1788-1877 Baht per case or about 44.7-46.9 Euros per

case) is much lower than that in Germany. The cost of the Koenig's study was derived from another field study on 1180 children in 121 Kindergartens. (Konig, Barry, Leidl, & Zrenner, 2002) Most of the cost in Germany is from the labor cost. For example, an orthoptic screening examination was 12.58 Euros, with the labor cost of 10.99 Euros (87.4%). If we correct the labor cost, which is extraordinarily high in Germany compared to Thailand, the results seem to go along very well with the author's finding.

5.4 The importance of false negative

When introducing a screening program, one aspect that should be considered is the false negative cases. False negative is the proportion of individuals who test negative even though they have the diseases. False negative results from imperfection of the screening test. Number of false negative cases can be calculated by one minus the sensitivity, then multiplied by the prevalence and multiply by the number of total population. False negative is important because it can induce a false sense of security to the false negative cases. That is, the patients with eye diseases who are screened and the results are negative may think they are normal and not to seek treatment.

The false negative rate in vision screening program for children ranges from 4% to 43%. (Hatch, 1998) The data in this study show that the false negative rate ranges from 0.85% to 1.08% which is quite acceptable. The problem of the false negative could be managed by either increase the sensitivity of the screening test or increase the frequency of the screening. Both methods come with increasing in cost for the program.

The results from this study show that the CER in alternatives which refer the screen positive students to the available health care facilities (alternative 3 and alternative 4) are lower than the alternatives which provide mobile team (alternative 1 and alternative 2). When we consider only the CER, the alternative 4 (VA test + refer) has CER of 1,788.11 which is 2% lower than the CER of

alternative 3. Since the false negative is important, the false negative rate should be taken into consideration. The use of combined VA and stereopsis tests results in reduction of the false negative rate (compare to the use of VA test alone) by about 20%. Because of the importance of the false negative, the alternative using combined screening test should be considered seriously. Thus, alternative 3 which use combine VA test plus stereopsis test and refer the screen positive students to the health care facilities should be the alternative of choice.

Fortunately, most of the eye diseases in children are slowly progressive. Konig & Barry studied and compared the models that sent all questionable cases to the ophthalmologists (increase sensitivity) to re-screen in one year (increase frequency of screening) and found both methods resulted in comparable effectiveness but the cost of increase sensitivity method was about 7% higher.

The false negative cases may be quantified as number of cases or in monetary term. Since this study is performed in children, there is no accurate way to transform the false negative cases into monetary term. Thus, the author decides to present the false negative as number of cases.

5.5 Results from the sensitivity analysis

The sensitivity analysis shows that different in discount rates seem not to affect the overall results much. The main factors that influence the results are the prevalence rate of eye diseases and the referral compliance rate.

If the prevalence of eye diseases increases, the CER will decrease. This shows that if the vision screening program is administered in a region with high prevalence of eye diseases, the cost per detected case will be lower.

The compliance rate also affects the CER of the program. If the compliance rate decreases, the cost per detected case will increase. If the compliance rate increases, the cost per detected cases will decrease. From the graph, if the compliance rate is increased, the CER of the alternatives which refer the screen positive students will be lower than the cost of alternatives which provide mobile

team by 7.7-8.3%. When expanding the program into different population, if the policy makers decide to use referral model, care must be taken to boost up the compliance rate to keep CER low. The compliance rate could be boosted up easily and not induced so much cost by asking the teachers to monitor referral compliance of the screen positive students.

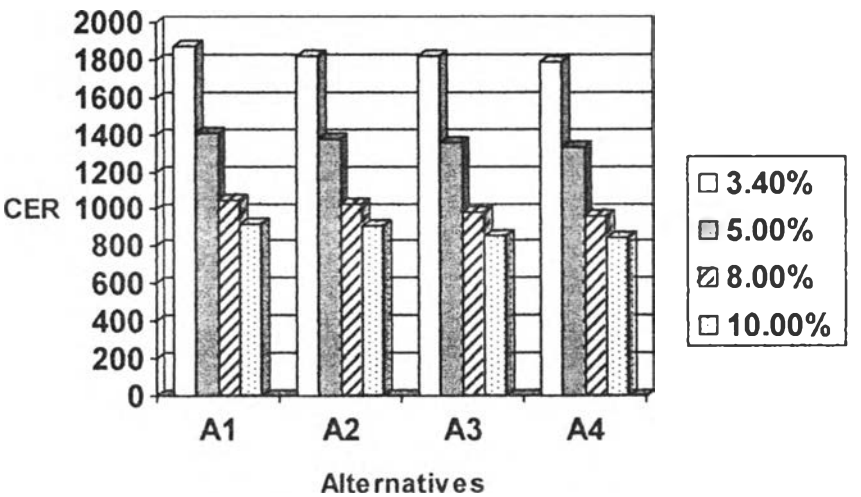

Figure 5.2 Sensitivity analysis of CER in different prevalence eye diseases

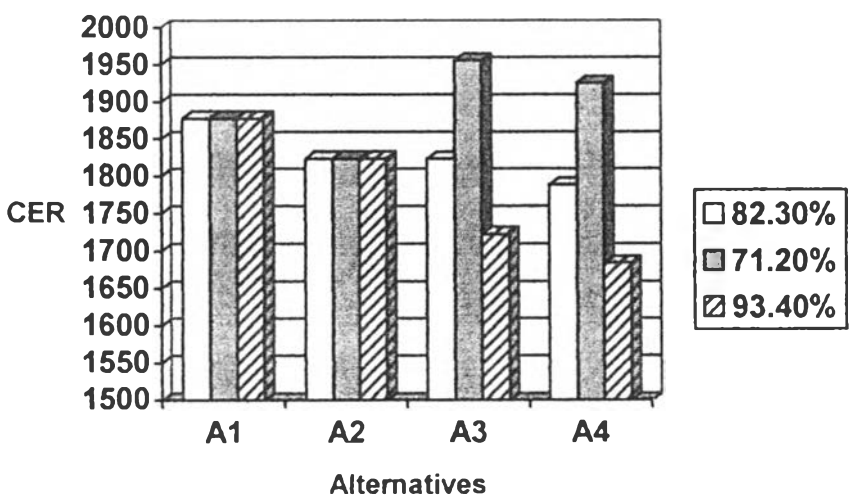

Figure 5.3 Sensitivity analysis of CER in different referral compliance rate