RELATIONSHIP BETWEEN PROTEIN-ENERGY MALNUTRITION, ANEMIA AND ACADEMIC ACHIEVEMENT IN SCHOOL CHILDREN

BY

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ABSTRACT

The specific aims of the research were to study the association between (1) protein-energy status and academic achievement (2) anemia and academic achievement in 546 school children, Angthong province. This study included 8 to 15 years old children from three rural schools and two urban schools. Prior to the first nutrition status measurement, children were examined for academic achievement which included subject areas of mathematic, Thai language, life experience and basic skill with the standardized tests of Departments of Curriculum and Instruction Development, Ministry of Education. Data of the academic achievement in teachers'tests from student record were also collected to compared with the standardized test.

The anthropometric measurement based on Thai and NCHS references were used for assessing protein-energy status while hematocrit and hemoglobin value were used to determine anemia. The data from this study revealed that there was highly

significant association between anemia and academic achievement in all subject areas of both standardized and teachers'tests. There were significant association between mathematic achievement of both tests and height/age based on both Thai and NCHS references. The association seemed to be more significant if NCHS reference was used.

There was also significant association between weight/age, height/age and Thai language achievement, but no significant association between PEM and life experience achievement.

The association between basic skill achievement and protein energy status were highly significant only if NCHS reference was used as criteria of weight/age and height/age. The association was also observed when standardized tests was used and nutrition status was based on height/age of Thai reference.

The results from this study suggested that in order to improve the quality of education and prevent the educational wastage of primary education, it is necessary to improve the nutrition status especially protein energy and iron status of those children.

ชื่อวิทยานิพนธ์	ความสัมพันธ์ระหว่างการขาดโปรตีน-พลังงาน, โรคโลหิตจาง ต่อสัมฤทธิ์ผลทางการเรียนของเด็กวัยเรียน
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บทคัดย่อ

วัตถุประสงค์ในการวิจัยนี้เพื่อจะศึกษาความสัมพันธ์ระหว่าง ๑) การขาดโปรตีน-พลังงาน ต่อสัมฤทธิ์ผลในการเรียน ๒) โรคโลหิตจาง ต่อสัมฤทธิ์ผลทางการเรียนในเด็กนักเรียนประถมศึกษา จังหวัดอ่างทอง อายุระหว่าง ๘ ถึง ๑๕ ปี โรงเรียนในเขตชนบท ๓ โรงเรียน ในเขตเมือง ๒ โรงเรียน ได้ทำการทดสอบสัมฤทธิ์ผลในการเรียนใน ๔ วิชา คือ คณิตศาสตร์, ภาษาไทย, สร้างเสริมประสบการณ์ชีวิต และทักษะพื้นฐาน ด้วยแบบทดสอบมาตรฐานของกรมวิชาการ กระทรวงศึกษาธิการ และได้เก็บข้อมูลสัมฤทธิ์ผลทางการเรียนจากแบบทดสอบของครู จากสมุดรายงานประจำตัวนักเรียนเปรียบเทียบด้วย

ในการศึกษาครั้งนี้ได้ใช้มาตรฐานการวัดความเจริญเติบโตของไทยและขององค์การอนามัยโลก ในการตัดสินภาวะการขาดโปรตีน-พลังงาน และใช้ค่าของจำนวนเม็ดเลือดแดงอัดแน่น (อีมาโตคริต) และค่าฮีโมโกลบินในการตัดสินภาวะโรคโลหิตจาง

จากการศึกษาครั้งนี้พบว่ามีความสัมพันธ์กันอย่างมากระหว่างโรคโลหิตจางต่อสัมฤทธิ์ผลทางการเรียนในทุกกลุ่มวิชา ทั้งมาตรฐานไทยและขององค์การอนามัยโลก สำหรับภาวะโปรตีน-พลังงาน พบความสัมพันธ์ระหว่างวิชาคณิตศาสตร์ต่อส่วนสูง ตามอายุ ตามมาตรฐานทั้งสอง ซึ่งจะสังเกตุได้ว่าตามมาตรฐานขององค์การอนามัยโลกจะมีความสัมพันธ์ต่อวิชาคณิตศาสตร์มากกว่ามาตรฐานไทยด้วย และยังพบความสัมพันธ์ระหว่างน้ำหนักตามอายุ, ส่วนสูง

ตามอายุ ต่อสัมฤทธิ์ผลทางการเรียนวิชาภาษาไทย แต่ไม่พบความสัมพันธ์ระหว่างการขาดโปรตีน-พลังงาน ต่อสัมฤทธิ์ผลทางการเรียนในวิชาสร้างเสริมประสบการณ์ชีวิต

สำหรับสัมฤทธิ์ผลในการเรียนกลุ่มวิชาทักษะต่อภาวะโปรตีน-พลังงาน พบว่ามีความสัมพันธ์กันมาก และถ้าใช้มาตรฐานของอนามัยโลกตัดสินการขาดโปรตีน-พลังงาน จะพบความสัมพันธ์กันมากกว่าใช้มาตรฐานไทยด้วย

จากผลการวิจัยนี้ เพื่อที่จะพัฒนาคุณภาพของการศึกษาและป้องกันความสูญเปล่าทางการศึกษาในระดับประถมศึกษา โดยเฉพาะอย่างยิ่งปรับปรุงภาวะโภชนาการในด้านโปรตีน พลังงาน และธาตุเหล็กในเด็กเหล่านั้นด้วย.

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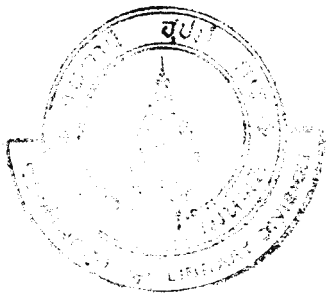

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CHAPTER 1

INTRODUCTION

Through-out the developing world, educational wastage represents one of the largest and most significant educational problem, involving a high human and capital cost. Educational wastage generally refers to the number of children who repeat a grade, or who drop out from school. Repetition is defined as the student who, after studied academic year, remains in the same class. Dropping out is defined as the student leaving before the end of the academic year of the educational course in which he is enrolled. The greastest problem of 'wastage' is found in Africa, where in some countries 30 percent or more of their children (boys and girls) in primary education were found as repeaters.

In 1980 among English-speaking countries in Africa, the average level of repetition was around 6.1 percent, while for French-speaking countries the average was about 22.6 percent. There are also a large number of south and central American countries where 15 percent or more of their primary school students are repeater. (i.e. Honduras, Guatemala, Dominican Republic, Peru, Brazil, Unesco Division of statistics in education, 1984).

The following table presents the coverage and median percentage of repetitions in primary education.

Coverage and median percentage of repetitions in primary education, boys and girls

	Coverage[1] 1980 %	Number of countries	Percentage variation in number of repeaters	Median percentage of repeaters
Total	62.8	121	0.0-46.6	10
Africa	60.1	42	0.0-46.6	16
Latin America and the Caribbean	89.4	24	3.6-25.8	12
Asia and Oceania	46.4	32	0.0-17.8	8
Europe and USSR	86.6	23	0.0-19.0	2

1 Representativeness of the Countries examined with reference to total enrolment in primary education.

In Thailand, there are also a large number of repeaters in primary education shown in the following table.

Grade (Pratom)	Percentage* 1984	Percentage* 1985
Grade 1	8.19	12.11
Grade 2	5.63	5.42
Grade 3	3.65	3.53
Grade 4	3.08	3.04
Grade 5	4.48	4.46
Grade 6	2.05	2.06
Total	4.73	5.17

* Representativeness of the Office of National Primary Education Commission (ONPEC).

Evidently, the human and capital cost of educational wastage varies according to a number of factors. The educational implication of dropping out are significantly different between the children who learn to read before they leave school, from those who are illiterate. Likewise, the occupational future of children who drop out at the beginning or at the end of the primary school period will also be different. In any event, coping with the educational wastage required an in-depth analysis of its roots ,its distant and proximal causal factors-so that relevant policies can remedy it, if not prevent it.

The most direct impact of malnutrition is its effect on the health of individuals. This effect ranges in severity from physical inconvenience, diminution of competence, to more serious forms of illness, to death. Other detrimental effects that follow are increased medical expenditure both at the family and national level, reduced productivity and hence income of the level force, more frequently absence from work because of low resistance to other diseases, and finally in its most severe form, permanent loss of ability to work.

On a more indirect front, there are social and economic effects of malnutrition on education development of children. Probably the most significant period in this aspect is from a conception to a period of pregnancy and in most cases will contribute first year of life through a weaning period. It is likely that malnutrition of the mother during pregnancy and lactation will result in physical deficiency and reduced intellectual potential of the child.

A part from the level of intelligence, children who suffer from malnutrition will lack of enthusiasm, curiousity of incentive performance and thus low ability to learn. This kind of situation can be widely observed in Thai rural areas for school-age children. The educational effects of malnutrition can be viewed in term of the effects on the child's potential performance, duration and continuity of his education.

The long-term effects of malnutrition on education are presented in various sections of the population. In this research presents a substantive effect of nutrition and malnutrition on education achievement.

Serious methodological short coming in many studies in this area of nutrition and education cloud the significance of finding. However, when data is pooled and analysed together certain conclusions are justified.

Inferences are therefore made regarding the significance of nutrition as determinant of school progress and achievement. Some implications for nutrition and educational policies are also made based on the data reviewed. A basic proposition of this research is that nutrition, in particular, and health, in general, need to be considered as key determinants of school progress and achievement, and that they are amenable to changes through relevant social and educational policies.

CHAPTER 2

LITERATURE REVIEW

2.1 Nutrition as a determinant of schooling

In comparison to studies on the social and economic determinants of schooling, there is a scarcity of information on the effects that nutrition and health have on school enrolment and academic progress. Conceivably, this lack of information has contributed to the little attention given by educational policies in most countries in the world to the nutritional and health status of the students.

In developed countries there is generally a low prevalence of undernutrition, of specific nutritional deficiencies, and of disease conditions with place at risk the school progress of children and are major causes of public health concern. In developing countries (Southeast Asian countries like Thailand,Philippines,Burma, Indonesia and in Africa), particularly among the low income segments of population, infections and malnutrition are often endemic. Among them the prevalence of protein-energy malnutrition (PEM), and micronutrient deficiencies including vitamins and minerals are generally extremely high (1). Gastrointestinal and upper respiratory infections have high frequency of occurence, increasing the risk of malnutrition and mortality (2),(3). Accordingly, in these countries malnutrition, as a risk factor for the educational future of infants and children

should be a major concern for health, nutrition and educational policies.

The scientific evidences show that malnutrition in children is a major risk factor in the formal educational system. It is therefore important to include nutrition as a determinant of school performance and achievement. Early malnutrition or poor nutritional status among school children has significantly adverse effects on school progress. There is a direct relationship between the prevalence of malnutrition in a country and the contribution by malnourished children to educational wastage, mastering school mattering. Malnutrition are frequently observed among those with high chances of repeating grades and dropping out early from school (4).

2.2 Nutritional deficiencies

A brief description of protein-energy malnutrition, anemia, mainly from iron deficiency, vitamin deficiencies, and iodine deficiency were presented. Out of this four types of malnutrition the first three are highly prevalent in many developing countries. Iodine deficiency exists throughout many regions of the world, but has more restricted geographical distribution as compared to protein-energy malnutrition, vitamin A and anemia from iron deficiency. These four types of malnutrition can affect the behavioral development and adaptation of children. However,the studies reviewed are restricted to protein-energy malnutrition, hunger and anemia. Studies on vitamin A and iodine deficiency have been excluded because of

lack of substantive information and the nature of their behavio. effects. Severe vitamin A deficiency results in blindness may preclude the child from attending the regular classroom. The concern in this review is more with specific and mild to-moderate effects on cognitive development that affect the child's educational process.

2.3 Protein-energy malnutrition

The nutritional problem with the highest prevalence in developing countries is protein-energy malnutrition. Infants and pre-school children, pregnant and lactating women are particularly at risk. Protein-energy malnutrition is generally caused by a deficient diet within a severely economically impoverished environment. Most children with protein-energy malnutrition are generally born into, and develop in, an unsanitary environment with few early opportunities for learning and psychosocial stimulation, and are constantly exposed to agents that will lead to infectious diseases.

The most severe forms of protein-energy malnutrition are : marasmus, kwashiorkor, and marasmic-kwashiorkor. The first is the result of a deficient diet both in protein and energy as well as of multiple other deprivations. Severe growth retardation is the characteristic of the marasmic child. The etiology of kwashiorkor, on the other hand, is basically due to a deficient protein intake, although it may be precipitated by an infectious episode. Growth retardation is often part of the clinical picture of the kwashiorkor child. Marasmic-kwashiorkor is the most frequent form of severe

malnutrition seen and combines the symptoms of the marasmic and kwashiorkor child.

2.4 Protein-energy malnutrition in school children

Limited data have been availabled on the prevalence of PEM in school children.

Valyasevi and Dhanamitta studied school children in Lampang (north) and Pattani (south). Table 2-1 shows that moderate degree of PEM in school children were about 6-7 percent in rural group and only 3 percent in city group. The total prevalence of various degree of PEM in school children ranged from 24-26 percent in the city to 41-48 percent in rural area.

Nutritional society of Thailand revealed that 640,000 school children in 52 provinces did not have lunch. Some of them did not have breakfast and lunch (5). Hunger leads to weakness, irritability and decreased learning ability, and PEM is unavoided.

Table 2-1 Percent prevalence of PEM in school children* (weight for age-Thai standard)**

Degree of PEM	Lampang		Pattani	
	Rural	City	Rural	City
Mild	42	21	34	23
Moderate	6	3	7	3
Severe	0	0	0	0
Total	48	24	41	26
No of children studied	199		554	439

* Valyasevi A. and Dhanamitta (6)

** reference (7)

2.5 Anemia from iron deficiency

Anemia can occur from deficiency of various nutrients (Wadsworth, 1959). The principle ones are iron, folic acid and vitamin B_{12}.

Iron deficiency may exist in the body as a result of inadequate dietary intake, poor absorption (8) or excessive loss, especially as a result of hook-worm infestation.

This disease was found in 10-30% of the population of all age group (8). Iron deficiency is probably the micronutrient deficiency with the highest prevalence in both developed and developing countries. Moreover, in many parts of the world it generally coexists with protein-energy malnutrition or with other micronutrient (vitamin and minerals) deficits. It is now estimated that there are about 1.3 billion people with iron deficiency anemia. There is also a conclusive evidence that it has a debilitating effect on worker's productivity, and on the attention and learning of children.

Iron deficiency anemia is an extreme form of this micronutrient deficiency; However, there may be depletion in the storage or in the transport of iron before the oxygen carrying capacity of blood is affected. Iron deficiency is generally caused by a deficient intake or absorbtion of iron. Anemia may also be caused by folate deficiency, particularly among pregnant women and children.

2.6 Iron deficiency anemia in school children

Nutrition anemia has been found in all age group. The highest prevalence appeared in pregnant women due to increased requirement for red blood cell synthesis. Higher incidence of complication has been found during delivery if the mothers are severely anemic. Generally, anemia results in weakness, pallor, decreased in learning and working capacity and decreased resistance to infection. Though many nutrient deficiences such as iron, folate, vitamin B_{12} have been reported as the causes of anemia, iron deficiency was reported to be the most prevalent (9).

Reports from Khonkaen (in the northeast) and Bangkok showed the prevalences of anemia in school children to be 61 and 30 percent respectively. Sixty percent of school children in Khonkaen has hook worm as shown by stool examination. The etiology of anemia in school children can be due to both low iron intake and hook worm infestation(10).

In any age group, the prevalence of anemia appeared to be higher in rural than city areas. Anemia is generally related to socioeconomic status as well as physiological and pathological conditions of the host.

2.7 Education system, curricula and administration of education of primary school

There are four levels of education in Thailand :- (1) pre-school education, (2) primary education, (3) secondary education and (4) higher education (11).

Primary school education aims at providing the learners with basic knowledge and skills; children are taught how to read, write and do arithmetic. The main emphasis is to prepare each individual to be a good citizen under democratic constitutional monarchy.

The primary education requires six years to complete. It is compulsory and free of charge. All children at the age of six are required, by law, to attend primary school.

Curricula for primary education has been developed in 1978, accordance with the new school system of 1977. It aims at inculcating the learners basic knowledge and skills as stated in the National Education Scheme.

There are five groups of learning experiences, namely, basic skills (Thai language and arithmetics), life experience (social studies, environmental and health education), character education (ethics, art, and physical education), work experience (pre-vocation orientation) and special group arranged for students at grade five and six (either English for daily life or vocational orientation).

Following the principle of school accountability in the new curricula, evaluation of students' achievement for the purpose of class room and course evaluation has been assigned to teachers with the approval of either principals or school cluster committees.

The course evaluation in primary level includes the marks

from the exams(cognitive and practice) and behavioral objectives. The percentage of passing a number of behavioral objectives is required to allow the students to move up to the next higher level. Classifications of grade test using the criteria of less than 40%, 40%-59%, 60%-69%, 70%-79% and over than 80% are as follow.

<40%	=	grade 0	=	fail
40%-59%	=	grade 1	=	poor
60%-69%	=	grade 2	=	fair
70%-79%	=	grade 3	=	good
>80%	=	grade 4	=	very good

In this study using less than 69% and equal or over 69% of full scores are criteria for evaluation of achievement or quality assessment.

The Office of National Primary Education Commission (ONPEC), Ministry of Education which is responsible for all governmental Education of the primary schools in the Ministry of Education conducts the national assessment programme to look at the quality of Education.

2.8 Nutrition education which concerned to effect of PEM and anemia in school age on school achievement and inlellectual function

Are the cognitive or learning abilities of the undernourished or iron deficient children affected attention, concentration or memory in the classroom setting?. These questions relevant to millions of children in the developing world, and of critical importance for educational policies.

There are many of the studies reviewed relationship between nutrition status(such as PEM,anemia from iron deficiency)with school performance and achievement.

2.8.1 Effect of protein-energy malnutrition or growth retardation on school performance and achievement

A Study conducted in Singapore (12) assessed the relationship between the physique of students and success in passing the Primary VI examination 12 year old children were classified according to body size divided into three groups:tall(90 percentile of Hong Kong growth standard), average (between 10 and 90 percentile of growth standard) and small (below 10 percentile) Findings showed statistically significant association between the number of failures in the examination and the body size group classification, children in the tall group had a 78 percent chance of passing the examination; those in the average group had 50 percent chance and those in the small group had only a 25 percent chance of passing the examination.

Another study (13) on general nutritional status and school achievement among 12-14 year old children conducted in the Philippines addressed two questions. One dealt with the relationship between (a) body size (weight/height) and (b) hemoglobin to detect anemia and performance in man educational acheivement measure.

Low hemoglobin values-which is an indication of anemia-was associated with low scores in a language learning test and in a composite test score. Low hemoglobin values were also related to

high absenteeism. Likewise a small body size (weight-for-hight measure) -which is interpreted as an indication of protein-energy undernutrition-was related to poor scores in tests of mathematics and poor concentration. These associations between nutritional status measures and school performance remained when the effect of the socio-economic status of the children were controlled.

Four studies (14),(15),(16) assessed the relationship between time of hospitalization (or adoption) and severity of the deficit in intellectual performance. A reason for looking at the time of hospitalization is because it is a crude indicator of the onset of the malnutrition. Three of this studies showed that age at hospitalization was independent of the severity of the deficit. The fourth study (15) assessed the impact of time of admission to an adoption agency (before and after 3 years of age) and the performance of the children at a later age in school achievement and intellectual function. This comparative analysis also yield no statistically significant effect of age at admission on school performance or intelligence testing. However, an analysis of the relationship between time of adoption (before or after 4 years of age) by families from the United States and performance yield statistically significant effects.

In contrast to the negative finding on the timing of hospitalization the evidence on the effects of the severity of under nutrition (measured by the degree of stunting) indicate that this is

a critical developmental variable. The children adopted from a Korean agency after their third birthday, (15), were divided into three groups according to their degree of growth retardation at the time of enrolment in the agency. Later in school there was a positive association between school performance and IQ and their initial growth retardation. The study of the children adopted sometime during their first two years of life had a similar finding (17). Likewise, Hoorweg and Co-workers (1979) showed an association between severity of undernutrition (as indicated by varied signs and symetoms)in early life and intellectual performance during school age.

A well-designed study(18) focusing on pre-school, analysed the relationships between the degree of growth retardation, and other clinical signs associated with severe protein deficiency and the severe protein deficiency and the severity of intellectual performance among children recently rehabilitated from severe malnutrition. The strongest predictor of intellectual deficit was the degree of growth retardation.

Conversely, Pichardson (16) failed to find an association between type and severity of malnutrition and degree of cognitive deficit in the school age period. Height and Weight measures at admission to the hospital were used to define the degree of under-nutrition. These two measures, and a social background measured were then correlated with later IQ. An analysis to measure the effect of each variable on the out come variable controlling for the effects of the others, showed that the socio-economic background of the children

was the only variable that made a significant contribution to IQ.

Although the findings from the studies reviewed above are not fully consistent with each other, most of evidence supports the hypothesis that the severity of the nutritional deficit is positively associated with the magnitude of the cognitive deficiency during school age.

Two studies conducted in the Caribbean assessed the school behaviour and performance of children with a history of severe malnutrition One was carried out in the island of Barbados (19) and the other in Jamaica (16). The Barbados study showed that malnourished children in comparison to control children (matched by age, sex and handedness) had more significant problems in at least three academic related area : Cognition, social interaction, and emotion stability (particularly the girls). The Jamaica study also showed that in comparison to control children,the malnourished children had lower IQ scores and lower academic achievement. The other two studies (20),(21) reported no detectable effects of the nutritional history. Both studies found that there were no differences in IQ or in other measures of intellectual function between malnourished and control children. The first study compared malnourished (kwashiorkor or marasmic-kwashiorkor) black children with sibling and cousin close in age who were in good health. The second study compared malnourished children who had been hospitalized for kwashiorkor and marasmus with well-nourished siblings and neighbourhood children. Both studies showed no difference between the malnourished

and control children in any of the intelligence tests used that were administered in childhood or early adolescene.

2.8.2 Effects of anemia and iron deficiency anemia on school performance and achievement

Two studies in the United States of America have assessed the relation of iron deficiency anemia and school performance (22) (23). Both were conducted among 12-14 years old predominately black students attending a secondary school in an economically deprived urban area. The anemic students had hemoglobin which ranged from 10.1 to 11.4 g/dl while that of the controls ranged from 14.0 to 14.9 g/dl. The out come measures used were a composite score of the Iowa Tests of Basic skills and the behavioral adjustment scale with included items on aspects personality disturbances, inadequacy-immaturity, and conduct problems. The composite score in the Iowa test of the anemic students was significantly lower than that of the control students. Moreover, the lowest level of performance was observed among the older anemic children. The adjustment ratings failed to yield any statistically significant findings. The only finding which suggested a between group behavioural difference was the rating related to conduct problems. Anemic students tended to have more severe conduct disturbances than non-anemic students, regardless of age.

A well-controlled experimental study on the relationship between iron deficiency anemia and school performance was conducted

in Semarang, Indonesia (24). This study included 9 to 12 old children from three rural schools. Prior to the first behavioural evaluation, children were treated for parasites to ensure effective absorbtion of iron supplements. The children were classified as either iron deficient anemic or non-anemic and then tested with and IQ test (Raven Progressive Matrices), a concentration test , and an achievement test which included four subject areas : biology, language, arithmetic, and social studies. The iron deficient anemic children and non-anemic control children were then randomly assigned to either and iron treatment group (receiving iron supplements) or a place no treatment group (no iron supplement). Three months after treatment, the children took for a second time the achievement school measures and the concentration task. The iron body indicators (hemoglobin and transferrin saturation) of the iron deficiency children who had been treated with iron had significantly changed, and were at the same level as that of the non-anemic control children. In the first evaluation, the iron deficient anemic children scored significantly behind the control children in the concentration task and in the school achievement measure. Following the iron treatment intervention there was a statistically significant improvement in the school lost performance of the iron deficient anemic children receiving iron supplements. Conversely, the mean scores in all tests of the other three groups were not significantly difference between the first and second evaluations. This study provides some of the most clear experimental evidence currently available of the salutary effects of

iron treatment on learning of school-age children who are iron deficient.

In this thesis, the effect of nutrition status (PEM and anemia) on academic achievement and intellectual function in school age, was evaluated in several primary schools in Angthong province, Thailand. Among those schools, the quality of schooling, the training of the teachers, the availability of books and educational materials exemplify exogenous factors that influence the quality of the formal educational processes are grossly similar. Although the endogenous factors classified as the education of parents, the income of family, the child's care taking arrangement, his health and dietary intake, are somewhat different among them. The standardized tests of Department of Curricula and Instruction Development, Ministry of Education was used in addition to the regular testing of school to minimized the problems from exogenous and endogenous factors. The results of this study was expected to show the strong correlation between malnutrition (PEM and anemia) and intellectual function or academic achievement.

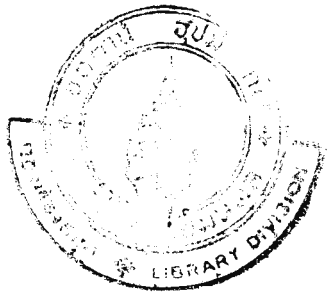
It was also hoped that this study could be useful for policy planning or improvement of the quality of primary education in Thailand.

SPECIFIC OBJECTIVE

The specific aims of this study are to study :-

1. The relationship between protein-energy malnutrition and academic achievement in primary school children of Angthong province.

2. The relationship between anemia and academic achievement in school children.



CHAPTER 3

MATERIAL AND METHOD

3.1 Subject

Primary school children both boys and girls aged 8-15 years were studied, during December 1984 and March 1985. These subjects were selected from the pupils, who were studying in grade 3 or 4 (Pratom 3 or 4) of the government school in Angthong province, Central region. The schools were divided into 2 areas : Urban and Rural. About 186 subjects from urban schools were involved from Wat Angthon and Wat Makham school, which locate in Amphur Muang Angthong and Amphur Chaiyo, respectively. The 3 rural schools were Wat Chaiyasittharam and Ban Chawai school in Amphur Chaiyo, and Thairatwittaya school (Wat Srakaew) in Amphur Pamoke. These schools are approximately 20, 25, 50 kilometers from the center of province, respectively,there were about 360 children in this study. The principals of all schools were explained the detail of the research and agreed to support the project before the beginning of the study.

Detail of the research activities is shown in figure 1.

3.2 Academic achievement data

The scores from the records of the pupils from the first semester examination were collected for comparison with the academic scores obtained from the standardized tests. The tests covered

4 areas : Thai language, arithmetics, life experiences and basic skills. The questions of the standardized tests were developed by the Department of Curriculum and Instruction Development, the Ministry of Education. These tests have been regularly used for evaluation of educational achievement in primary school. In this research were performed by 546 students in December, 1984 and January, 1985.

3.3 Physical examination and anthropometric measurement

The students involved were examined for the signs of clinical deficiency diseases using a check list format to look for anemia, angular stomatitis, dental caries, enlarged thyroid gland, skin diseases and other general health problems. This screening examination was conducted in January and Febuary 1985 along with the anthropometric measurements.

The subjects were weighed with minimal clothing on a beam balance which is sensitive to 0.1 kg. The height was measured by a standard anthropometric rod sensitive to 0.1 cm. in standing position. Verified ages of the children were obtained from student records.

Thai growth reference of school children from Burana Chavalittamrong (23) and the NCHS (National Centre for Health Statistics) of the U.S. were used to assess the protein energy status of the subjects (24).

lower 85% of mean reference body weight = PEM based on weight for age (Thai ref.)

lower 90% of mean reference body height = PEM based on height for age (Thai ref.)

lower - 1 S.D. of mean reference body weight = PEM based on weight for age (NCHS ref.)

lower - 1 S.D. of mean reference body height = PEM based on weight for age (NCHS ref.)

lower - 1 S.D. of mean reference body weight for height = PEM based on weight for height (NCHS ref.)

3.4 Hematocrit and hemoglobin determination

Hematocrit was measured by duplicate samples of micro-hematocrits and hemoglobin was determined by spectrophotometer using Drabkin's solution. These determinations were done within 12 hours after blood samples were taken at the Pamoke District Hospital. The WHO's criteria of a hemoglobin of less than 12 g/dl or a Hematocrit of less than 36 percent for anemia were used in this study (23). Finger stick using autoclix Blood was allowed to have free flow.

3.5 Questionaires

Following a screening physical examination and anthropometric measurements, students were interviewed using a set of questionaires as shown in the annex. The questions covered

- name, age, sex
- living area and condition
- history of illness
- parental status
- history of learning i.e. repettion or failure

- absenteeism rate
- growth (wt,ht) record

3.6 Statistical analysis

Data were analysed and presented as percent prevalence of mean ±SD. Significant analysis performed by using λ^2 test and test for proportion. Linear regression was also calculated for correlation.

All statistical manipulations were conducted by computer with SPSS version at Mahidol University Computing Center.

December 1984	January 1985	Febuary 1985	March 1985
- tested achievement in learning with standardized tests	- physical examination		- Biochemical tests Hematocrit Hemoglobin
- collected data from student record in questionaire	- Anthropometry		

Fig 1. Experimental activities

CHAPTER 4

RESULTS

Altogether 546 children from 5 primary schools in Angthong province were included in this study. The data collected from this study are presented as follows.

4.1 Prevalence of PEM

The prevalence of PEM based on weight for age were compared between the assessment based on Thai reference and NCHS reference as shown in Table 1 and Fig 1-3

The prevalence of PEM based on Thai reference combineded the first, second and third degree were 0.5 percent in urban school children and 5.6 percent in rural school. Total prevalence of PEM in urban and rural school children were 3.8 percent.

If NCHS reference of body weight was used, the prevalence of PEM were strikingly higher being 62.9 and 71.1 percent in urban and rural school children, respectively.

As shown in Fig 1, the prevalence of PEM slightly increased in NCHS reference.

Table 2 and Fig 1-3 also showed prevalence of PEM based on height for age, compared between the assessment based on Thai reference and NCHS reference. The prevalence of PEM of all degrees were 3.6, 17.2, 12.6 percent in urban, rural and total areas, respectively.

By using NCHS reference, the prevalence of PEM had been 48.9, 77.5, 67.8 percent in urban, rural and total areas,respectively.

Prevalence of PEM in school children based on weight for height of NCHS reference were 29.0, 17.5, 21.4 percent in urban, rural and total areas, respectively as shown in Fig 1-3 and Table 3.

It was also noticed that the highest prevalence of PEM were 70.1, 77.5 percent in rural school based on weight for age and height for age of NCHS reference.

4.2 Prevalence of anemia

Prevalence of anemia based on the measurements of hematocrit and hemoglobin were comparable as shown in Table 4 and Fig 4. The average prevalence of anemia in children of 5 school student was 23 percent with the range between 7-32 percent. The highest prevalence was observed in the Thairatwittaya school, follow by Ban Chawai school, both are in the rural area of the province.

Table 8 and Fig 5 showed the comparison of the prevalence of anemia in school children between urban and rural schools, being about 16 and 27 percent, respectively. The average of hematocrit and hemoglobin values in children of 5 school student were 37.6 percent, 13.1 g/dl respectively.

4.3 Academic achievement

Academic achievement was evaluated by using the standardized tests of the Department of Curriculum and Instruction Development, Ministry of Education, and also using the teachers'tests. The assessment covered 4 basic areas : mathematics, Thai langauge, life experience and basic skill. The percentages of children who passed

70 percents marks or failed below this marks were shown in Table 6-9 for those basic areas tested, and also illustrated in Figure 6-9.

The percentages of children with tests mark of 70% percent using ehe standardized or teachers' test were quite similarly in all 4 areas examined(Table 6-11). Urban school children showed higher percentage passing the 70% marks than the rural children in mathematic, Thai language and basic skill. For life experience the rural children showed slightly higher percentages passing that marks than urban counterpart. (Table 8 and Figure 6-7). It was quite interesting to note that the mathematics was the subject that rural children in this study showed the least achievement (Table 6).

The data from this study suggested that disparity between the quality of education in urban and rural area was still very much in evidence. In general, students in urban area performed much better that those in the rural area.

4.4 Association between academic achievement and protein-energy status

Table 12 showed the association between the mathematic achievement of both standardized and teacher tests, and protein energy status of children assessed both by using Thai and NCHS reference. There were significant association between mathematic achievement of both tests and height for age based on both Thai and NCHS reference. The association seemed to be more significant if NCHS reference was used.

The association between language achievement and weight/age

or height/age using either Thai or NCHS reference were also observed. However if weight/height was used, the association was not existed as shown in Table 13.

If was quite interesting to find that there was no significant association between life experience achievement and protein-energy status of school children as shown in Table 14.

The association between basic skill achievement and protein energy status were highly significant only of NCHS reference was used as criteria for weight/age and height/age. The association was also observed when standardized tests was used and nutrition status was based on height/age of Thai reference as shown in Table 15.

4.5 Association between academic achievement and hematocrit and hemoglobin levels

There were significantly high association between hematocrit and hemoglobin levels and the academic achievement in all areas tests, which included mathematic, Thai language, life experience and basic skill as shown in Table 16 and 17. The relationship between the scores or the marks of each area of academic achievement test and hematocrit, and also hemoglobin levels were illustrated in Fig 10-17. These relationships were strikingly highly significant especially between mathematic achievement and hematocrit or hemoglobin level (Fig 10 and 17).

Table 18 summarized the measurements that showed significant association between energy status, hematocrit and hemoglobin level

and academic achievement in school children.

4.6 Illness detected by physical examination

Percent prevalence of various signs of illness which were observed in school children by physical examination was shown in Table 19.

4.6.1 Anemia was evaluated by conjunctival examination for sign of pallor. Higher prevalence of anemia was observed in rural school children. There were 3.3 percent of obvious anemia detected.

4.6.2 Enlarged Thyroid

Only few cases (1-3) had been noticed in urban and rural school children who had enlarged Thyroid gland.

4.6.3 Dental Caries

About 50 percent of rural and urban school had dental caries.

4.6.4 Skin diseases

The high prevalence of skin diseases was observed in rural school children which were about 60-70 percent, the prevalence was highest in Wat Srakaew school, Amphur Pamoke, Angthong province. A few cases of skin disease were observed on urban school.

4.6.5 Eye diseases

There were only few cases of conjuctivitis or red eyes observed among school children in this survey. The prevalence of

conjuctivitis was less than 1%.

4.6.6 Ear diseases

There were few cases of perforation of ear drums resulting in purulent discharge from middle ear.

Table 1 Percent prevalence of PEM based on weight/age in school children, Angthong province, compared between * Thai and NCHS references.

School	No of children surveyed	%PEM (Thai ref.)	%PEM (NCHS ref.)
Wat Angthong Wat Makham	186	0.5	62.9
Wat Chaiyasittaram Ban chawai Thairat wittaya 6	360	5.6	71.1
Total No and % average	546	3.8	68.3

* Thai ref. adapted from Burana Chawalittamrong

Table 2 Percent prevalence of PEM based on height/age in school, Angthong province, compared between Thai and NCHS references.

School	No of children surveyed	%PEM (Thai ref.)	%PEM (NCHS ref.)
Wat Angthong Wat Makham	186	3.8	48.9
Wat Chaiyasittaram Ban chawai Thairat Wittaya 6	360	17.2	77.5
Total No and % average	546	12.6	67.8

Table 3 Percent prevalence of PEM based on wt/ht in school children, Angthong province, compared between urban and rural schools, using NCHS reference.

School	No of children surveyed	%PEM
Urban Wat Angthong Wat Makham	186	29.0
Rural Wat Chaiyasittaram Ban chawai Thairat wittaya 6	360	17.5
Total No and % average	546	21.4

Figure 1 Prevalence of PEM based on wt/age , ht/age, wt/ht , combind sex compared between Thai and NCHS reference in Angthong primary – school children

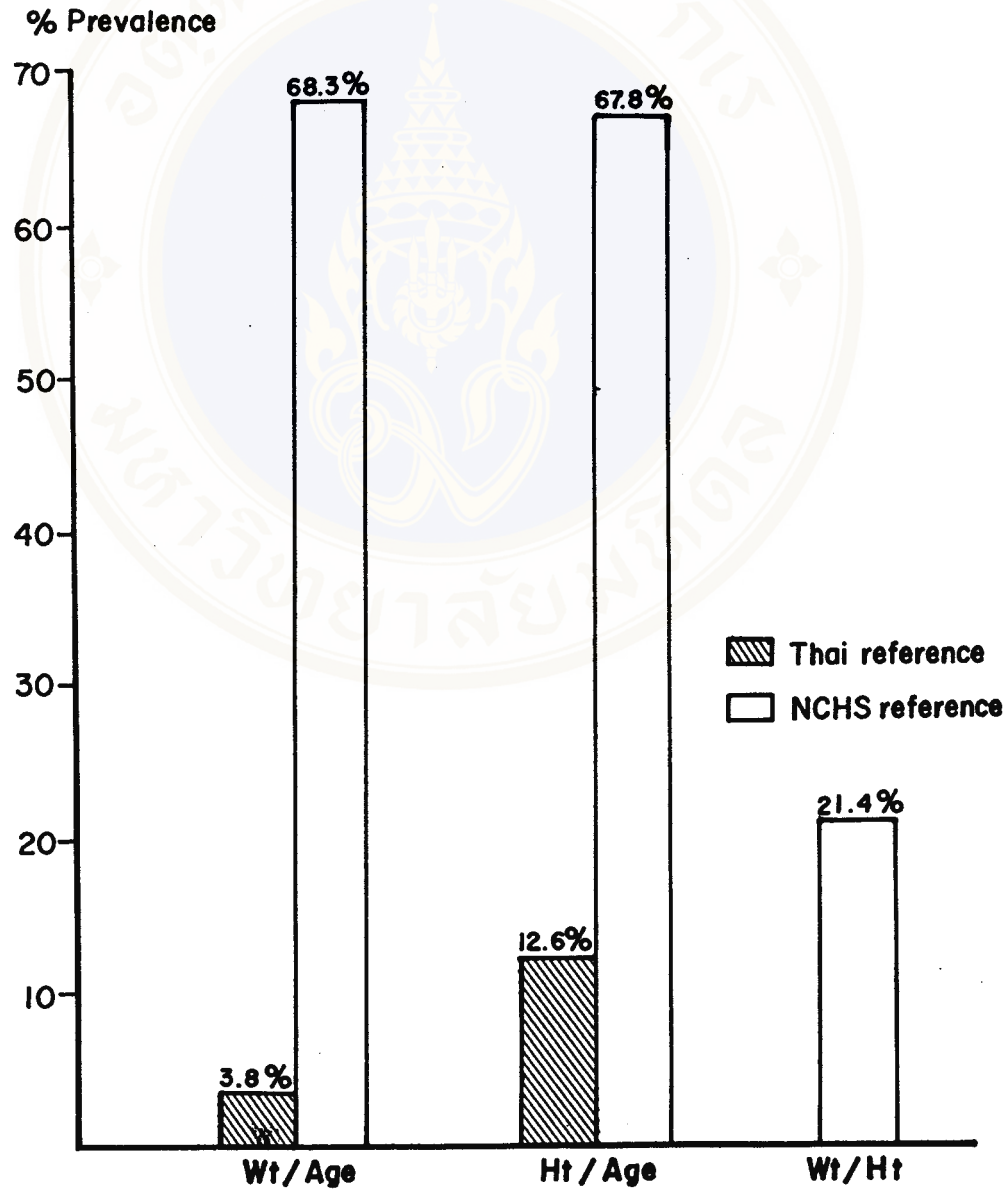


Figure 2 Prevalence of PEM based on wt /age, ht/age, in school children , Angthong province,compared between urban and rural school (Thai reference)

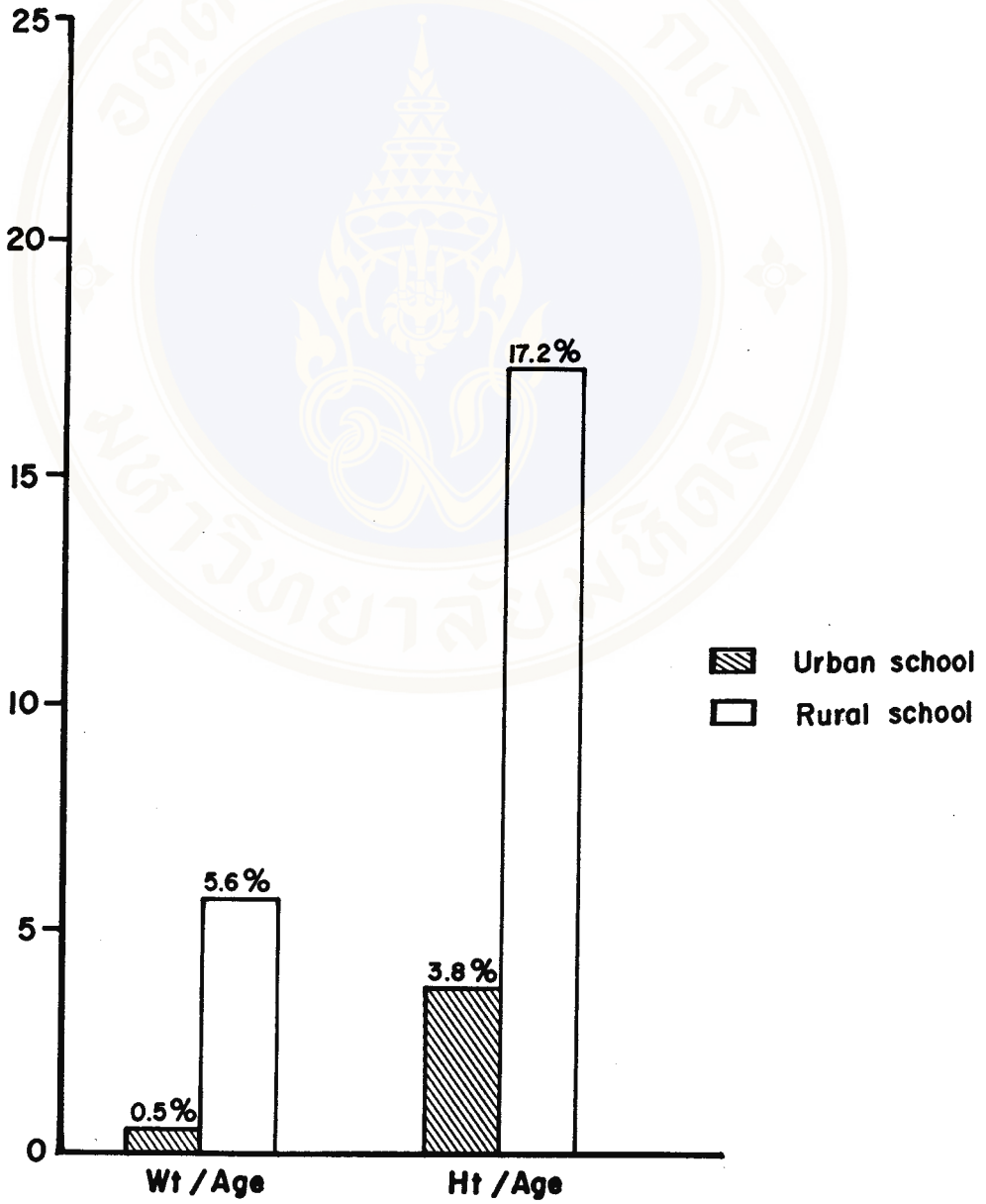


Figure 3 Prevalence of PEM based on wt/age, ht/age, wt/ht in school children, Angthong province, compared between urban and rural school (NCHS reference)

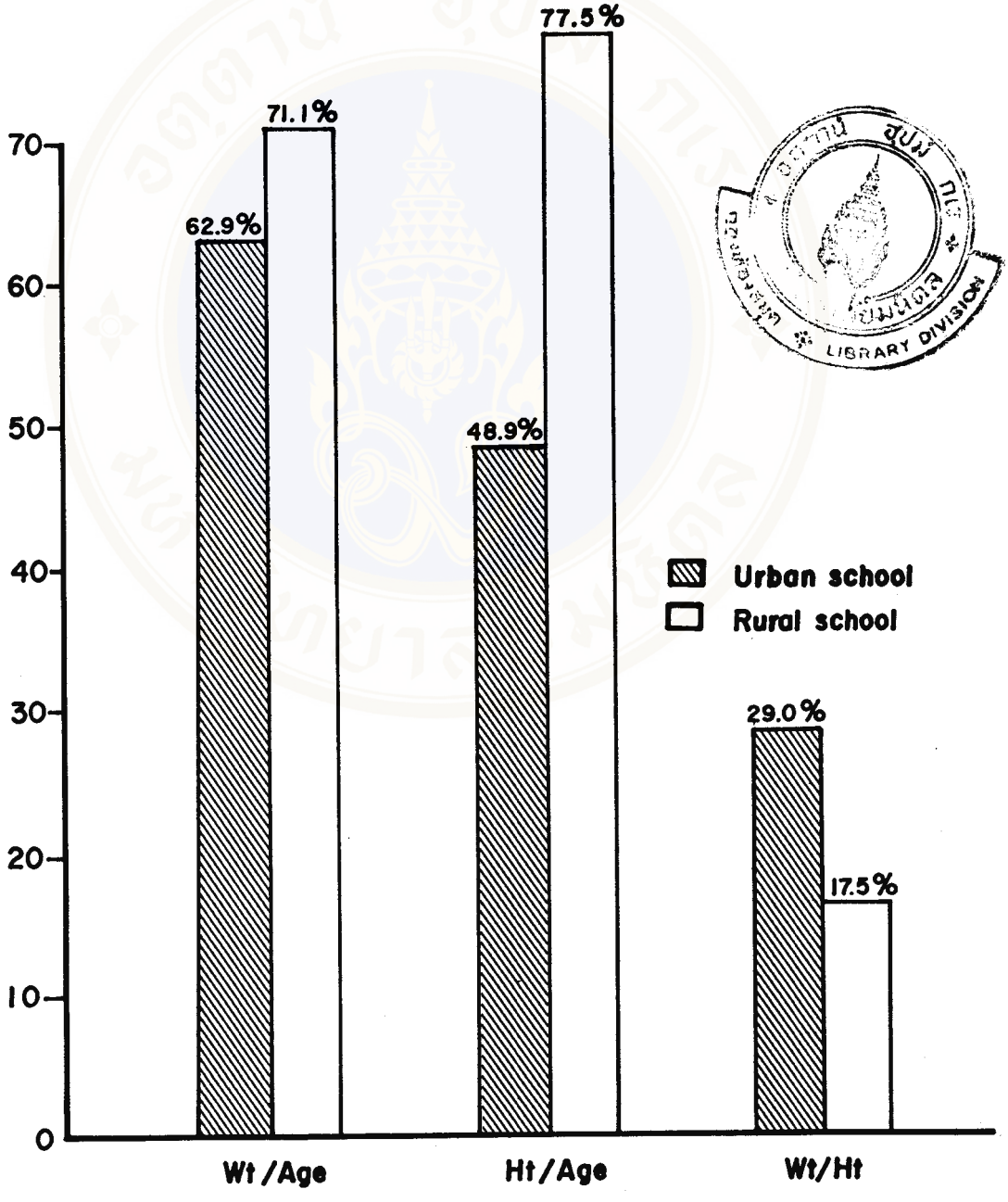


Table 4 Percent prevalence of anemia in school children, Angthong province.

School	No of children surveyed	%anemia (Hct<36%)	%anemia (Hb <12g/dl)
Wat Angthong	127	16.5	15.7
Wat Makham	59	13.8	15.5
Wat Chaiyasittaram	68	10.3	7.4
Ban chawai	94	27.7	25.5
Thairat wittaya 6	197	32.0	32.0
Total No and % average	544	23.0	22.4

Table 5 Percent prevalence of anemia in school children, Angthong province, compared between urban and rural schools.

School	No of children surveyed	%anemia (Hct<36%)	%anemia (Hb<12g/dl)
Urban Wat Angthong Wat Makham	185	15.6	15.9
Rural Wat Chaiyasittaram Ban chawai Thairat wittaya 6	359	26.7	25.6
Total No, and % average	544	23.0	22.4

Figure 4 Prevalence of anemia based on hematocrit and hemoglobin values in Angthong school children

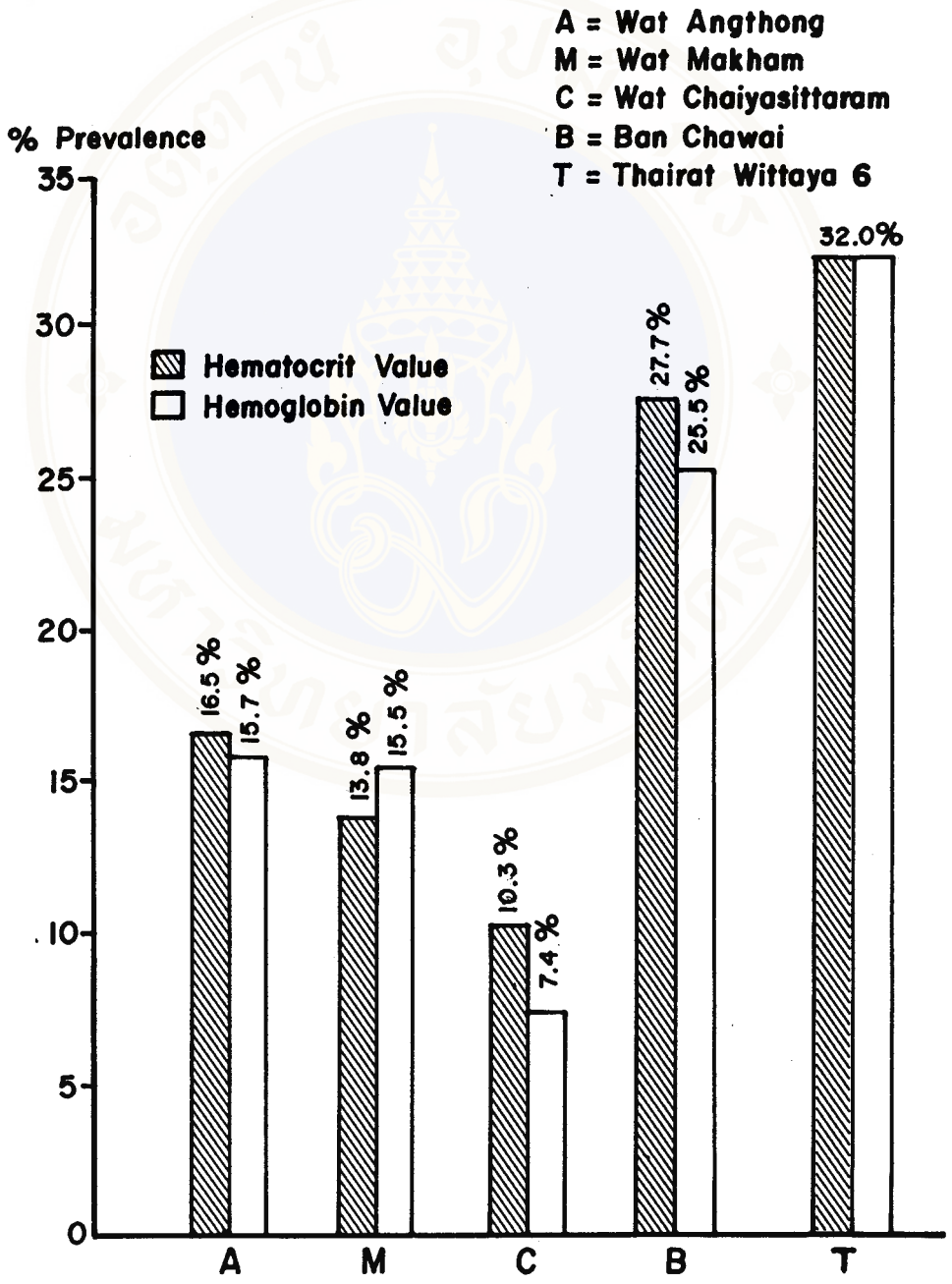


Figure 5 Prevalence of anemia in school children, Angthong province, compared between urban and rural school

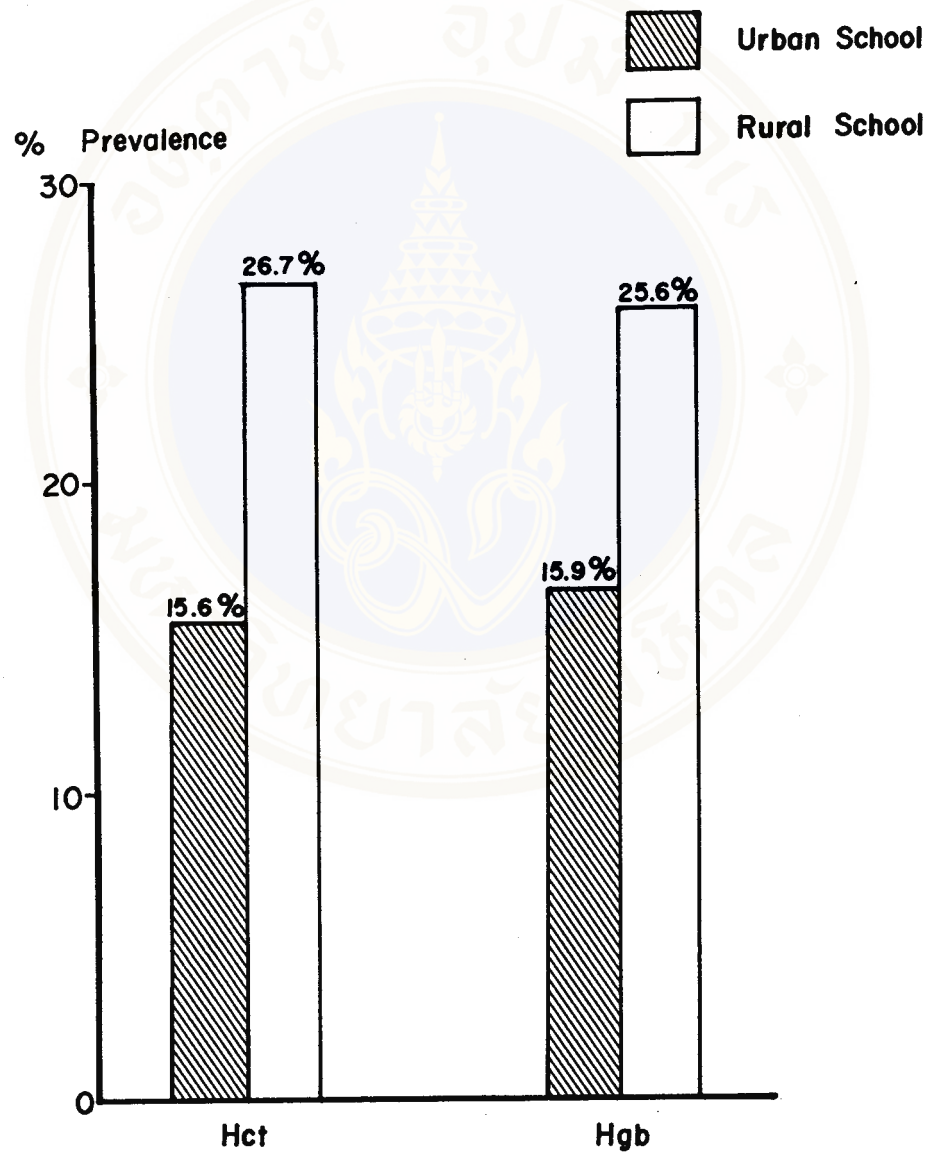


Table 6 Mathematic achievement of grade (Pratom) 3-4, school children, Angthong province, compared between standardized tests and Teachers'tests.

School	No of children surveyed	Percent prevalence standardized tests ≤grade 2	Percent prevalence standardized tests ≥grade 2	Percent prevalence Teachers'tests ≤grade 2	Percent prevalence Teachers'tests ≥grade 2
Wat Angthong Wat Makham	186	57.5	42.5	58.1	41.9
Wat Chaiyasittaram Ban chawai Thairat wittaya 6	360	81.4	18.6	81.1	18.9
Total No and % average	546	73.3	26.7	73.3	26.7

grade 2 refers to the test score between 60-69%

Table 7 Thai language achievement of grade (Pratom) 3-4, school children, Angthong province, compared between Standardized tests and Teachers' tests.

School	No of children surveyed	Percent prevalence Standarized tests ≤grade 2	Percent prevalence Standarized tests ≥grade 2	Percent prevalence Teachers' tests ≤grade 2	Percent prevalence Teachers' tests ≥grade 2
Wat Angthong Wat Makham	186	49.5	50.5	51.1	48.9
Wat Chayasittaram Ban chawai Thairat wittaya 6	360	61.7	38.3	61.1	38.9
Total No and % average	546	57.7	42.3	57.5	42.5

Table 8 Life experience achievement of grade (Pratom) 3-4, school children, Angthong province, compared between Standardized tests and Teachers'tests.

School	No of children surveyed	Percent prevalence Standardized tests ≤grade 2	Percent prevalence Standardized tests >grade 2	Percent prevalence Teachers'tests ≤grade 2	Percent prevalence Teachers'tests >grade 2
Wat Angthong Wat Makham	186	59.7	40.3	58.6	41.4
Wat Chaiyasittaram Ban chawai Thairat wittaya 6	360	55.6	44.4	55.8	44.2
Total No and % average	546	56.8	43.2	57.0	43.0

Table 9 Basic skill achievement of grade (Pratom) 3-4, school children, Angthong province, compared between Standardized tests and Teachers'tests.

School	No of children surveyed	Percent prevalence Standardized tests ≤grade 2	Standardized tests >grade 2	Percent prevalence Teachers'tests ≤grade 2	Teachers'tests >grade 2
Wat Angthong Wat Makham	186	53.2	46.8	54.3	45.7
Wat Chaiyasittaram Ban chawai Thairat wittaya 6	360	76.6	23.6	76.1	23.9
Total No and % average	546	68.7	31.3	68.5	31.5

Figure 6 Percent achievement in school children , Angthong province by teacher's tests , compared between urban and rural school

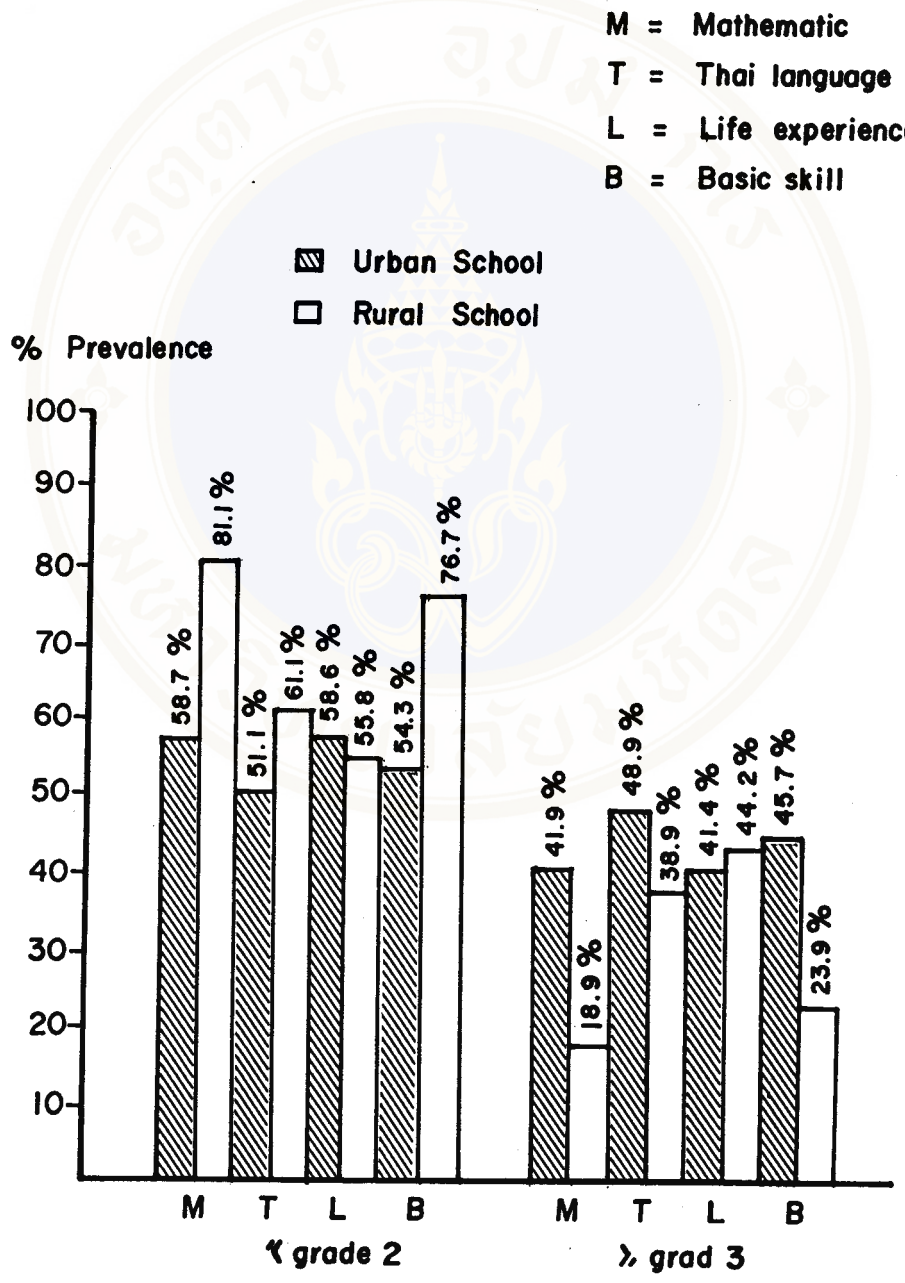


Figure 7 Percent achievement in school children, Angthong province, by standardized tests, compared between urban and rural school.

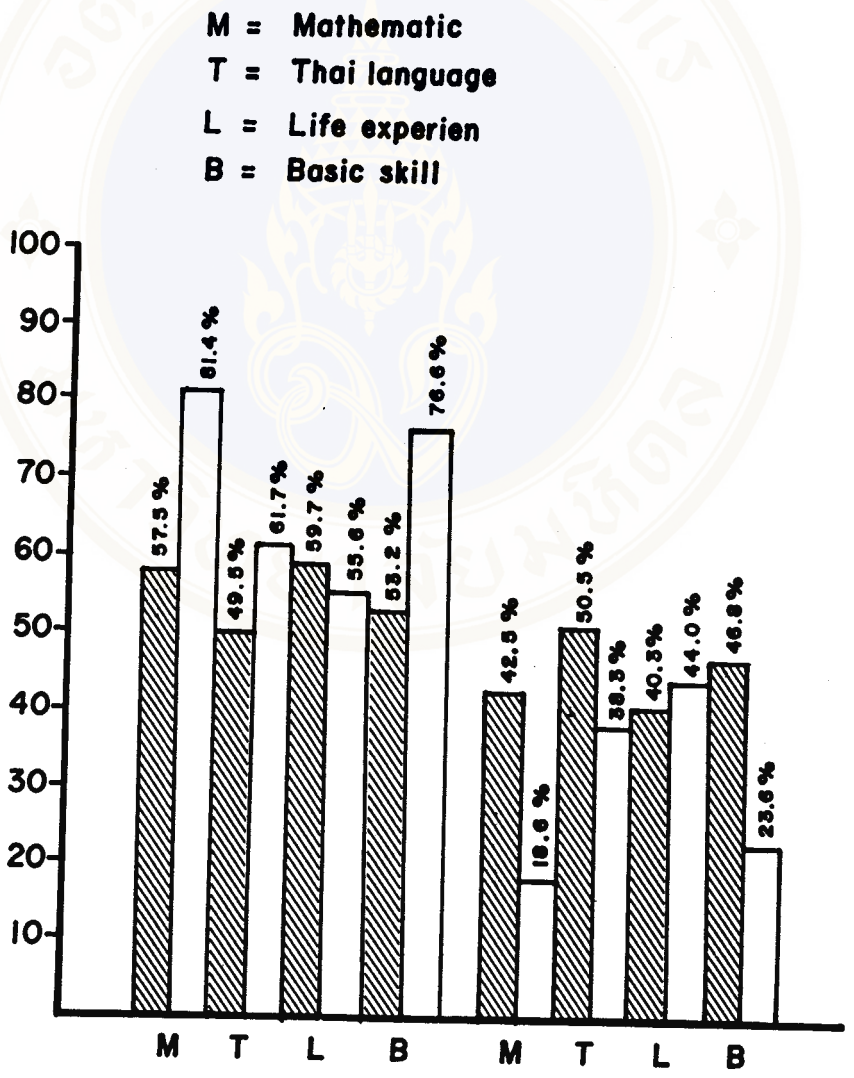


Table 10 Summary of standardized tests of grade (Pratom) 3-4, school children, Angthong province.

Subjects	Percent prevalence				
	grade 0	grade 1	grade 2	grade 3	grade 4
Mathematic	10.6	39.2	23.4	16.8	9.9
Thai language	3.3	30.4	23.8	25.6	16.8
Life experience	3.3	24.5	29.1	29.5	13.6
Basic skill (Thai + Math)	6.2	38.8	25.3	20.5	9.2

Table 11 Summary of Teachers'tests of grade (Pratom) 3-4, school children, Angthong province.

Subjects	Percent prevalence				
	grade 0	grade 1	grade 2	grade 3	grade 4
Mathematic	14.1	35.2	34.5	16.3	10.4
Thai language	5.7	28.2	23.8	25.8	16.5
Life experience	4.6	23.3	28.9	29.9	13.4
Basic skill (Math + Thai)	6.2	37.5	25.6	21.6	9.0

Figure 8 Percent achievement in Mathematic and Thai-language in school children, Angthong province, compared between standardized tests and teacher's tests

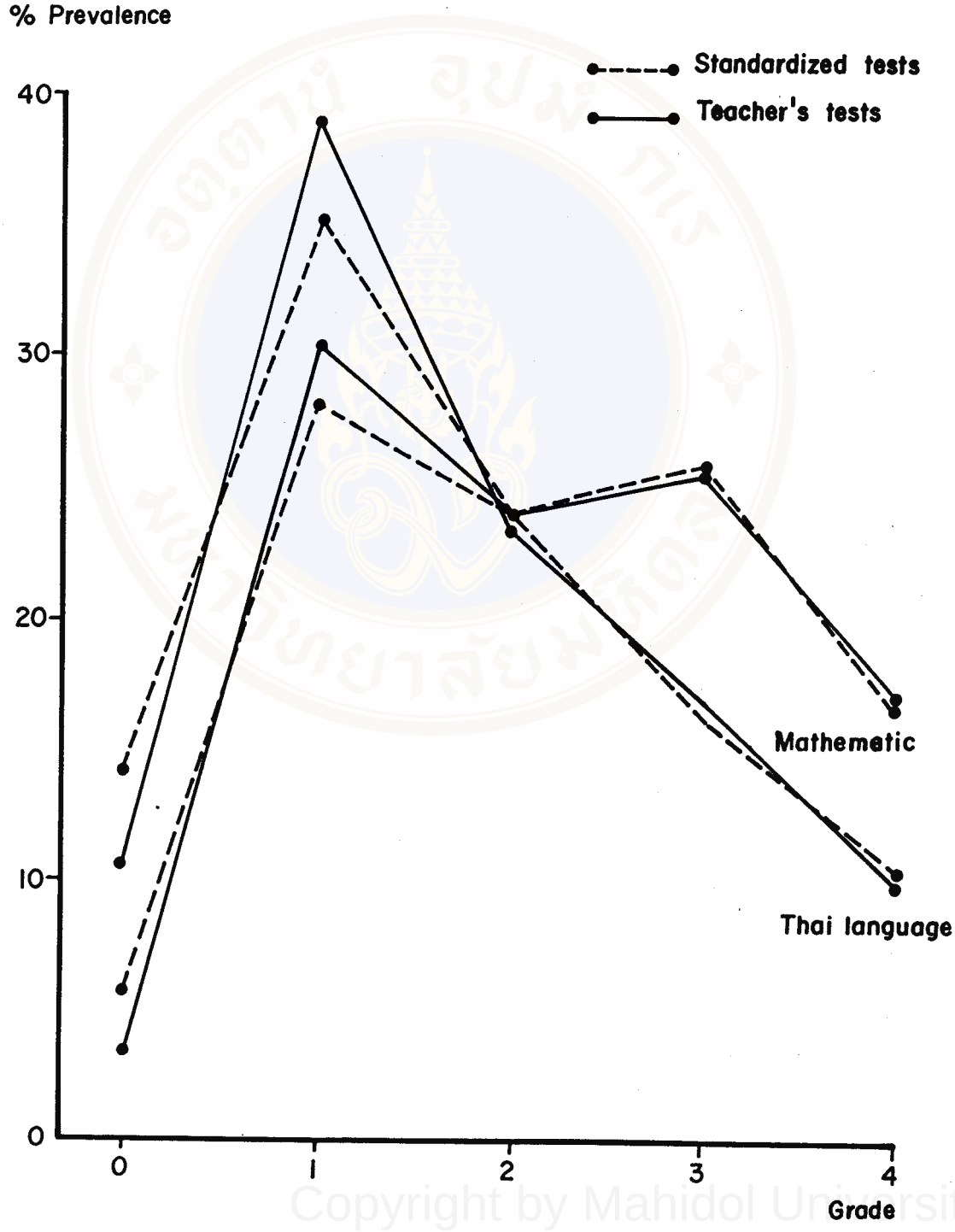


Figure 9 Percent achievement in life experience and basic skill in school children , Angthong province , compared between standardized tests and teacher's tests.

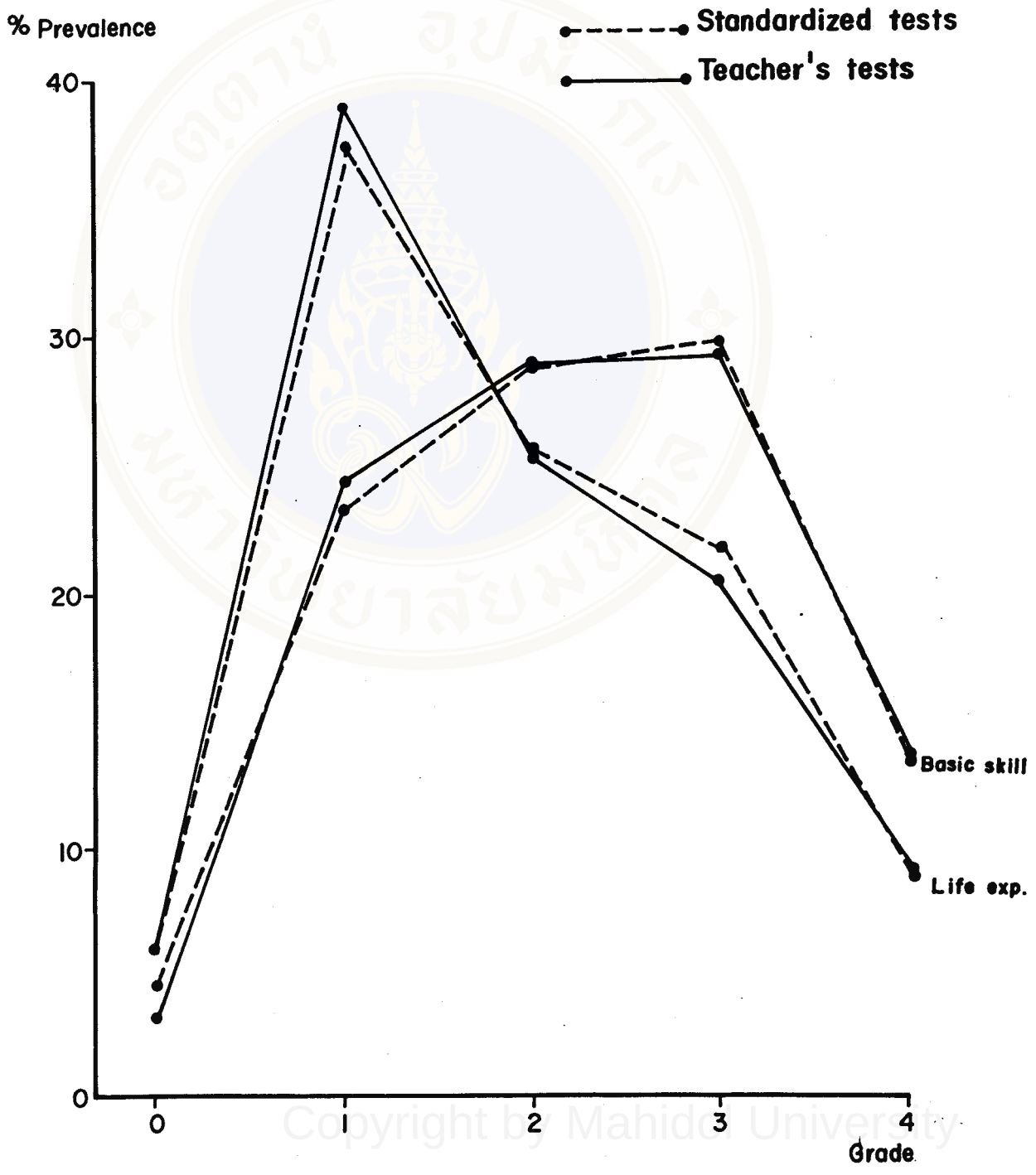


Table 12 Association between Mathematic achievement and PEM in school children, Angthong province, compared between Standardized tests and Teachers'tests.

Measurements	No of children surveyed	Standardized tests			Teachers'tests		
		λ^2	df	P-value	λ^2	df	P-value
Thai reference							
wt/age	546	1.3127	1	0.2875	1.13127	1	0.13127
ht/age	546	4.09106	1	0.0431	4.09106	1	0.0431
NCHS reference							
wt/age	546	3.68763	1	0.0548	3.68763	1	0.0548
ht/age	546	7.72863	1	0.0054	6.62114	1	0.0101
wt/ht	546	0.27226	1	0.6018	6.57371	1	0.4488

Table 13 Association between Thai language achievement and PEM in school children, Angthong province, compared between standardized tests and teachers'tests.

Measurements	No of children surveyed	Standardized tests			Teachers'tests		
		λ^2	df	P-value	λ^2	df	P-value
Thai reference							
wt/age	546	3.96489	1	0.0465	3.90067	1	0.0483
ht/age	546	5.27959	1	0.0216	4.02162	1	0.0449
NCHS reference							
wt/age	546	4.18280	1	0.048	5.25114	1	0.0219
ht/age	546	7.43075	1	0.064	7.76889	1	0.0053
wt/ht	546	0.21827	1	0.6404	0.40110	1	0.5265

Table 14 Association between life experience achievement and PEM in school children, Angthong province, compared between standardized tests and teachers'tests.

Measurement	No of children surveyed	Standardized tests			Teachers'tests		
		λ^2	df	P-value	λ^2	df	P-value
Thai reference							
wt/age	546	0.47813	1	0.4893	0.06717	1	0.7955
ht/age	546	1.82819	1	0.1763	0.36515	1	0.5457
NCHS reference							
wt/age	546	0.00006	1	0.9940	0.76925	1	0.3804
ht/age	546	0.00000	1	1.0000	0.20120	1	0.6538
wt/ht	546	2.26387	1	0.1324	1.55798	1	0.2120

Table 15 Association between basic skill achievement and PEM in school children, Angthong province, compared between standardized tests and teachers'tests.

Measurement	No of children surveyed	Standardized tests			Teachers'tests		
		λ^2	df	P-value	λ^2	df	P-value
Thai reference							
wt/age	546	1.02702	1	0.3109	0.99315	1	0.3190
ht/age	546	5.21520	1	0.0224	2.01375	1	0.1559
NCHS reference							
wt/age	546	7.68763	1	0.0056	6.97779	1	0.0083
ht/age	546	14.11115	1	0.0002	13.16696	1	0.0003
wt/ht	546	0.66899	1	0.4134	0.03715	1	0.8472

Table 16 The association between academic achievement and hemoglobin value in school children, Angthong province, compared between Standardized tests and Teachers'tests.

Subjects	No of children surveyed	Standardized tests			Teachers'tests		
		λ^2	df	P-value	λ^2	df	P-value
Mathematic	546	45.4162	1	0.0000	45.9212	1	0.0000
Thai language	546	39.5915	1	0.0000	36.4854	1	0.0000
Life experience	546	9.54686	1	0.0200	6.30185	1	0.0121
Basic skill (Math + Thai)	546	49.6287	1	0.0000	49.0870	1	0.0000

Table 17 The association between academic achievement and hematocrit value in school children, Angthong province, compared between standardized tests and teachers'tests.

Subjects	No of children surveyed	Standardized tests			Teachers'tests		
		λ^2	df	P-value	λ^2	df	P-value
Mathematic	546	80.5864	1	0.0000	84.2374	1	0.0000
Thai language	546	68.5199	1	0.0000	56.1836	1	0.0000
Life experience	546	17.1685	1	0.0000	19.2427	1	0.0000
Basic skill (Math + Thai)	546	84.9820	1	0.0000	87.5191	1	0.0000

Figure 10 Relationship between hematocrit value and mathematic achievement in school children, Angthong province, compared between standardized test and teacher's tests

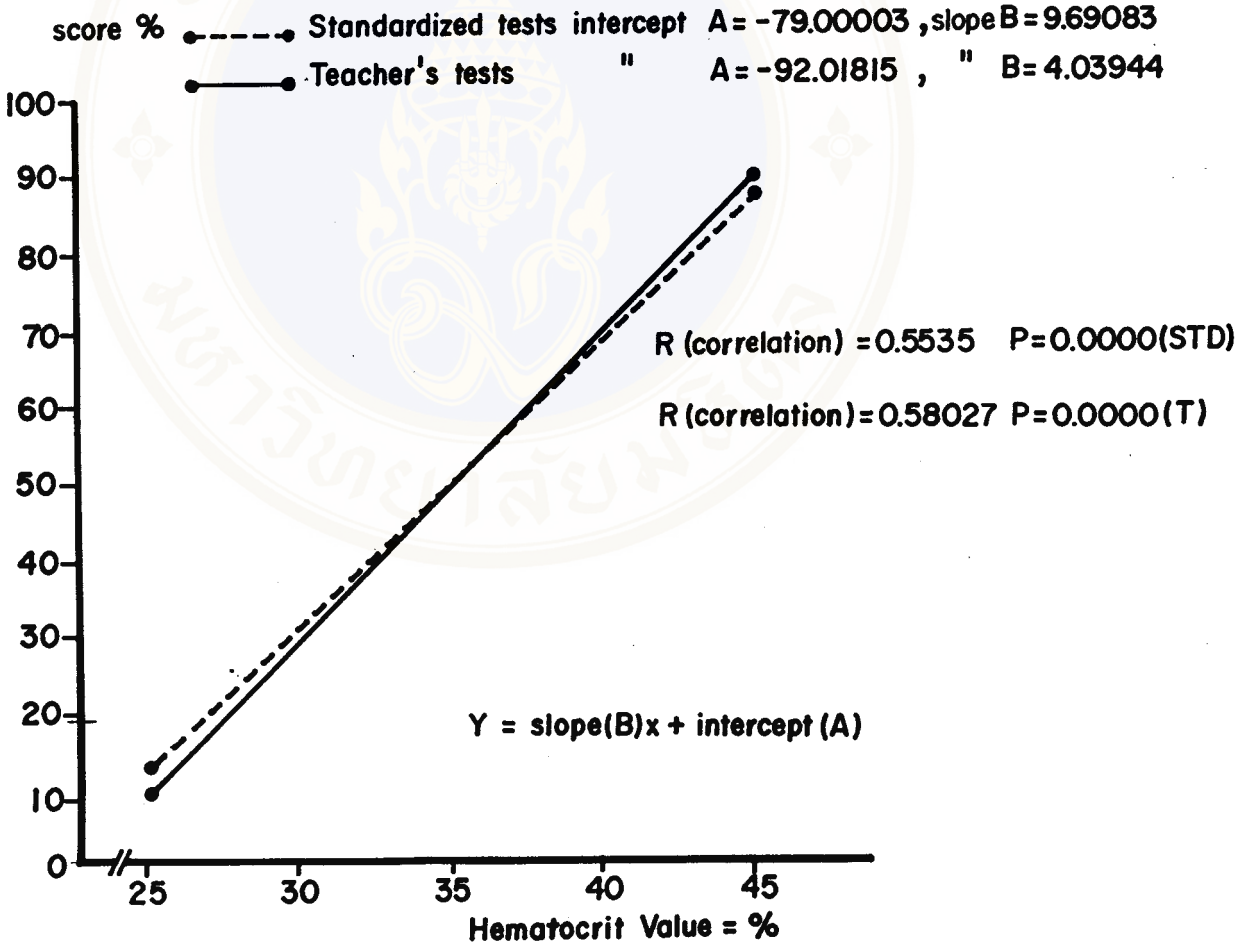


Figure 11 **Relationship between hematocrit value and Thai — language achievement in school children , Angthong province , compared between standardized tests and teacher's tests.**

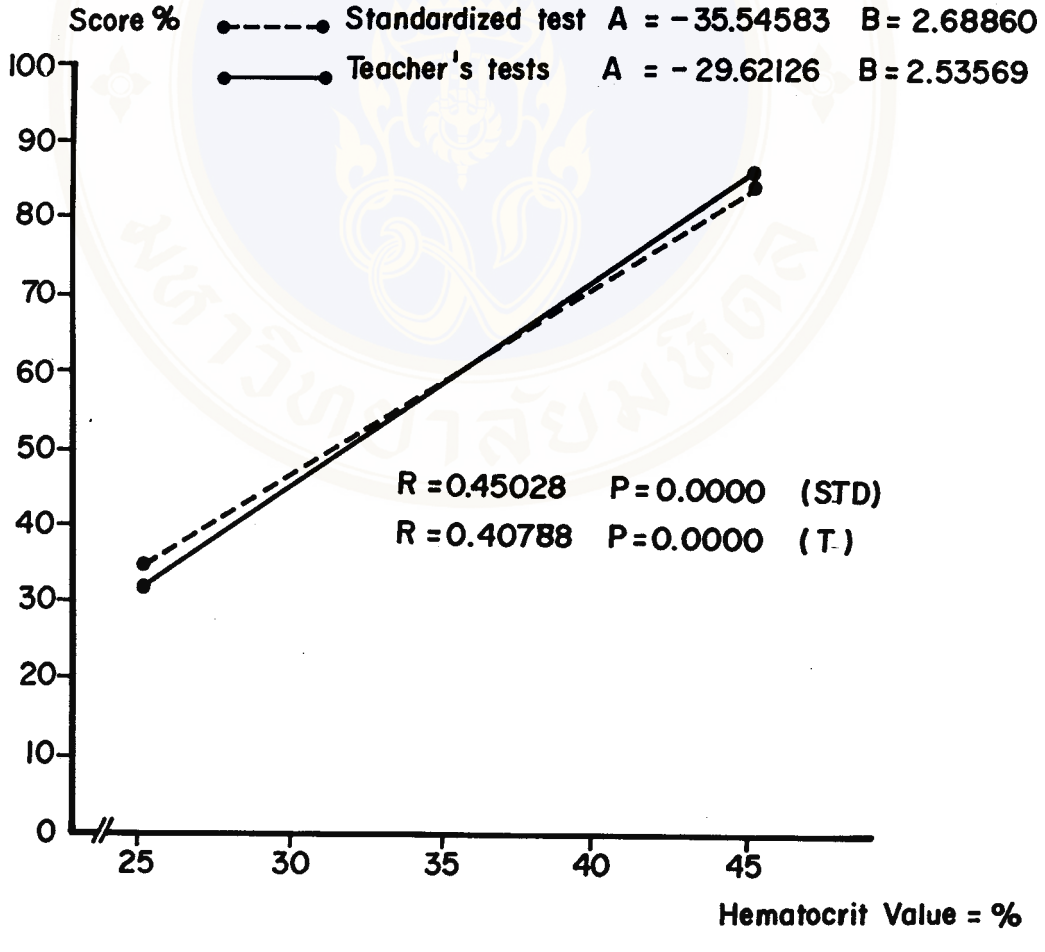


Figure 12 Relationship between hematocrit value and life experience achievement in school children, Angthong province, compared between standardized tests and teacher's tests.

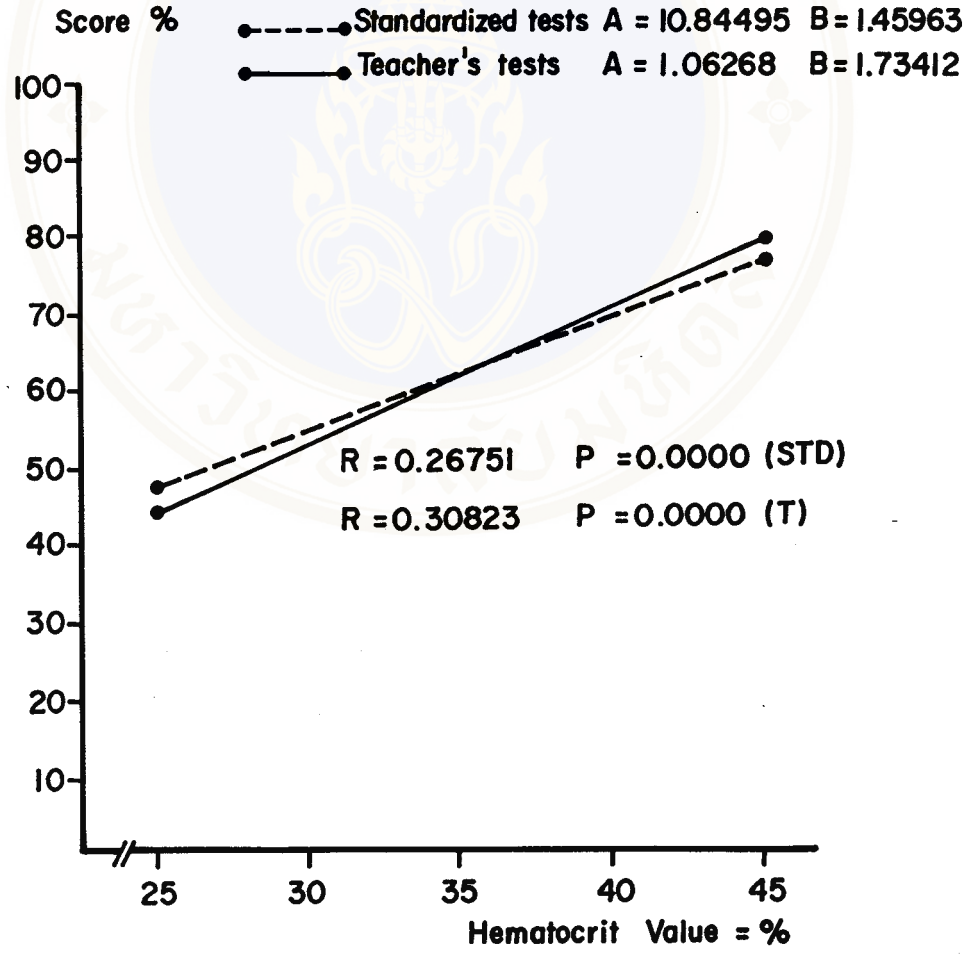


Figure 13 Relationship betweent hematocrit value and basic skill achievement in school children , Angthong province , compared between standardized tests and teacher's tests

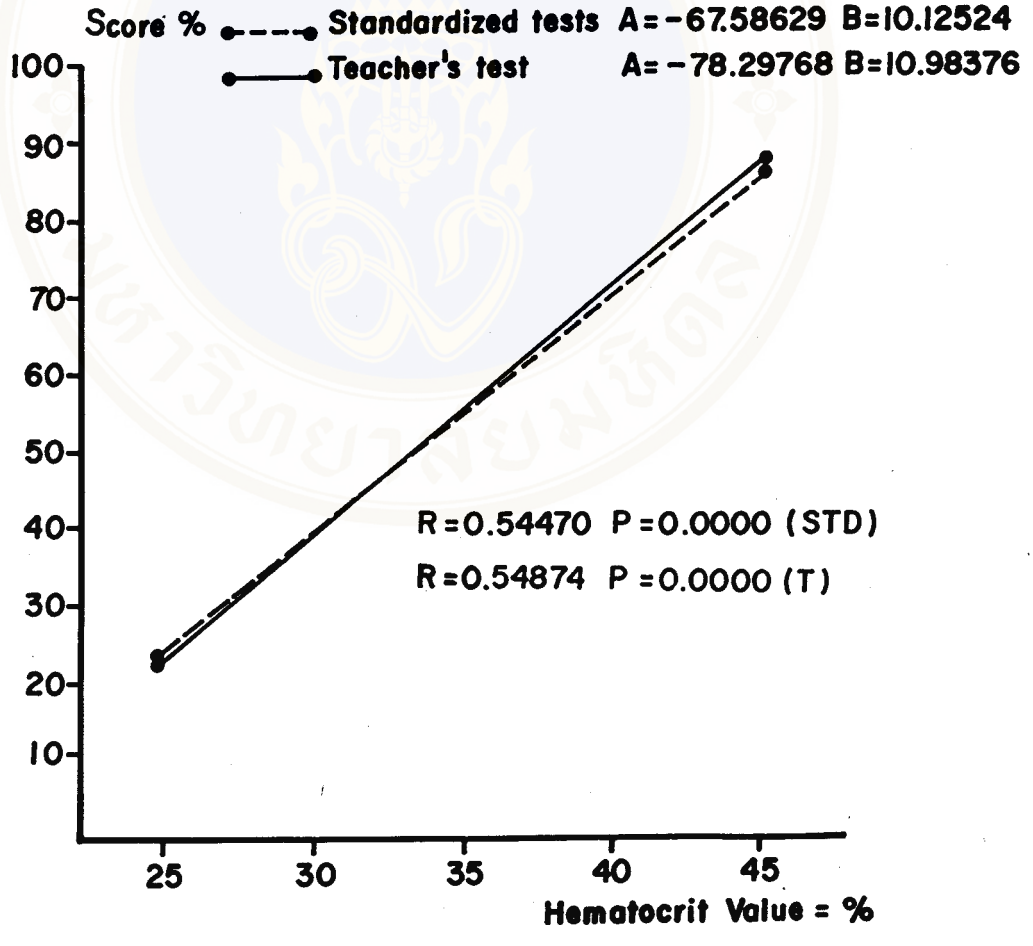


Figure 14 Relationship between hemoglobin value and mathematic achievement in school children , Angthong province , compared between standardized tests and teacher's tests.

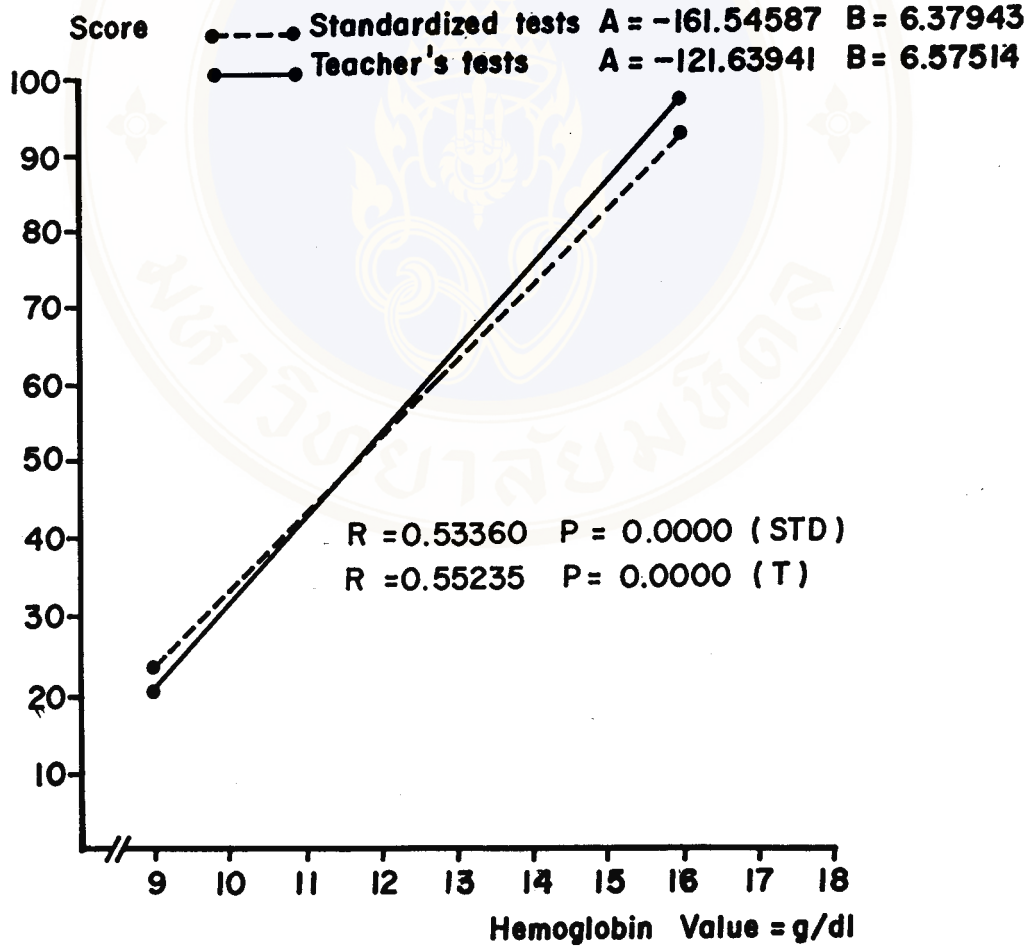


Figure 15 Relationship between hemoglobin value and Thai language achievement in school children, Angthong province, compared between standardized tests and teacher's tests.

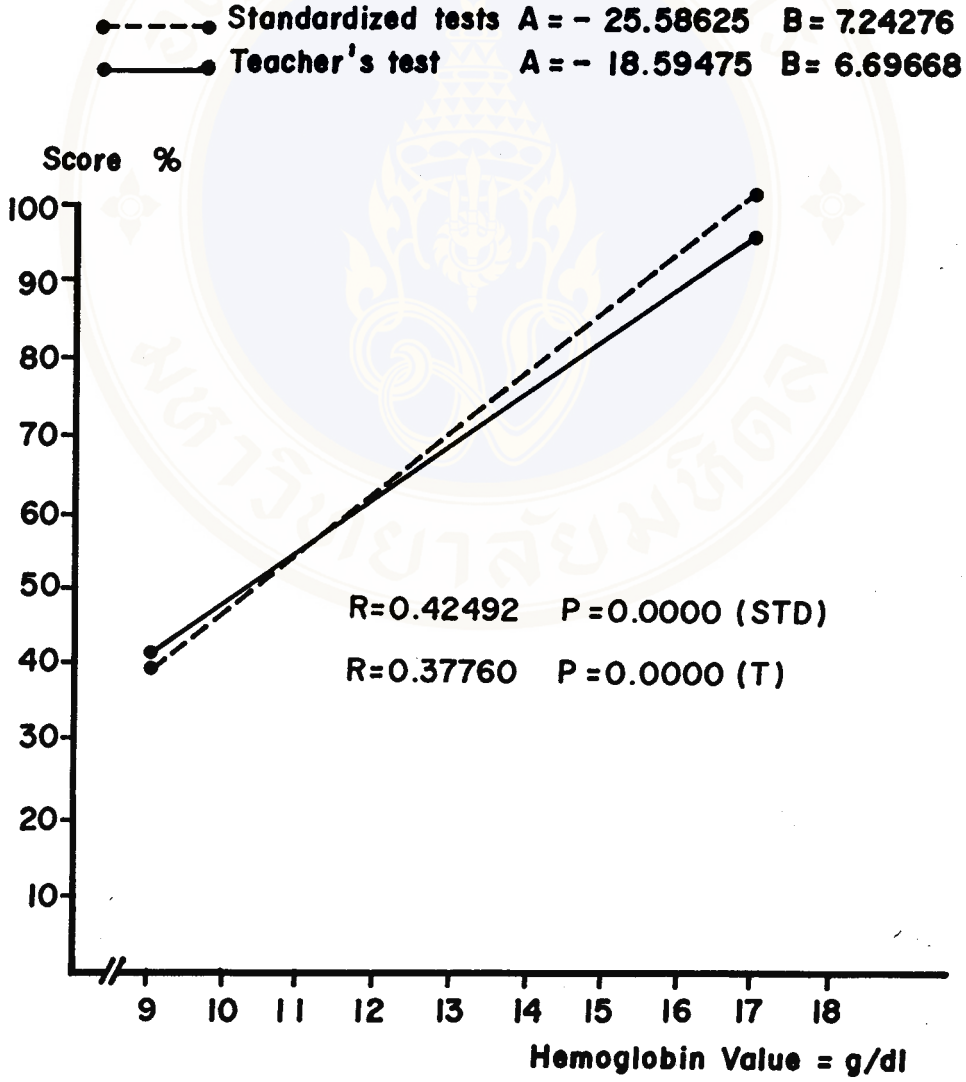


Figure 16 Relationship between hemoglobin value and life experience achievement in school children , Angthong province , compared between standardized tests and teacher's tests.

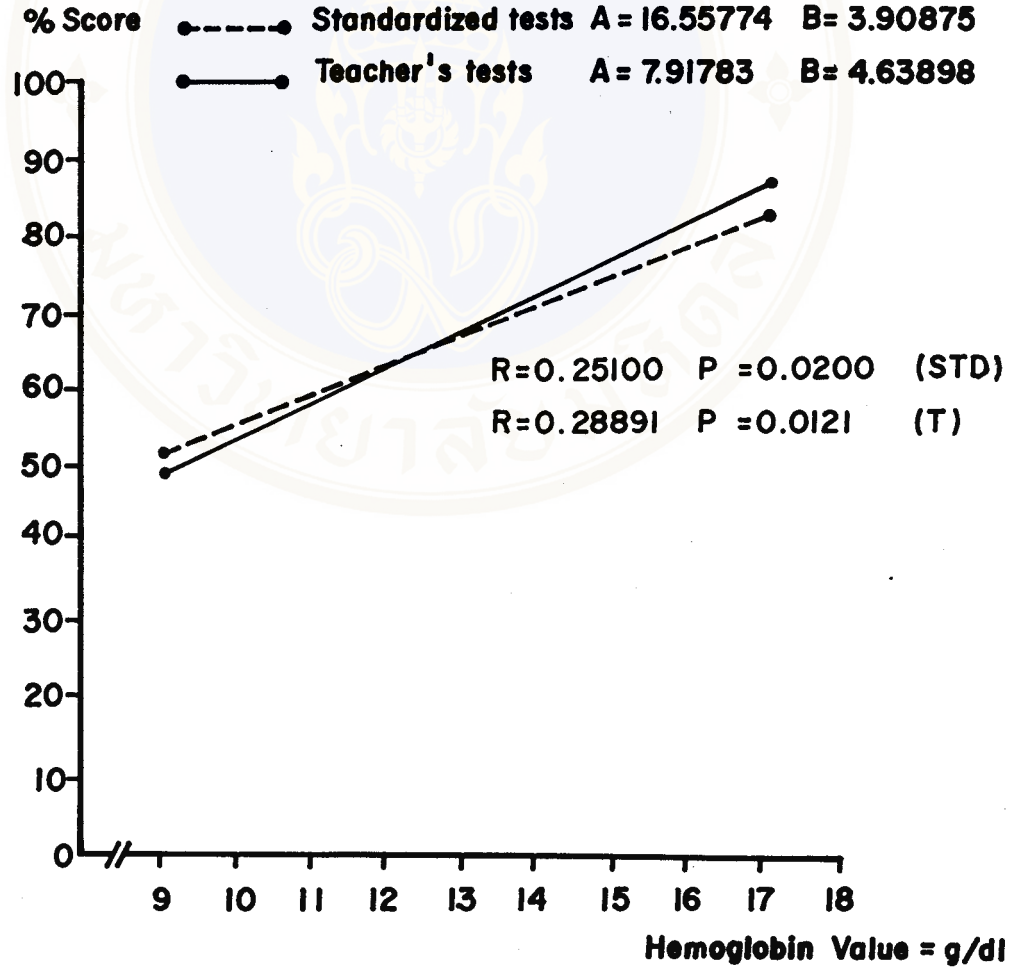


Figure 17 Relationship between hemoglobin value and basic skill achievement in school children , Angthong province , compared between standardized tests and teacher's tests.

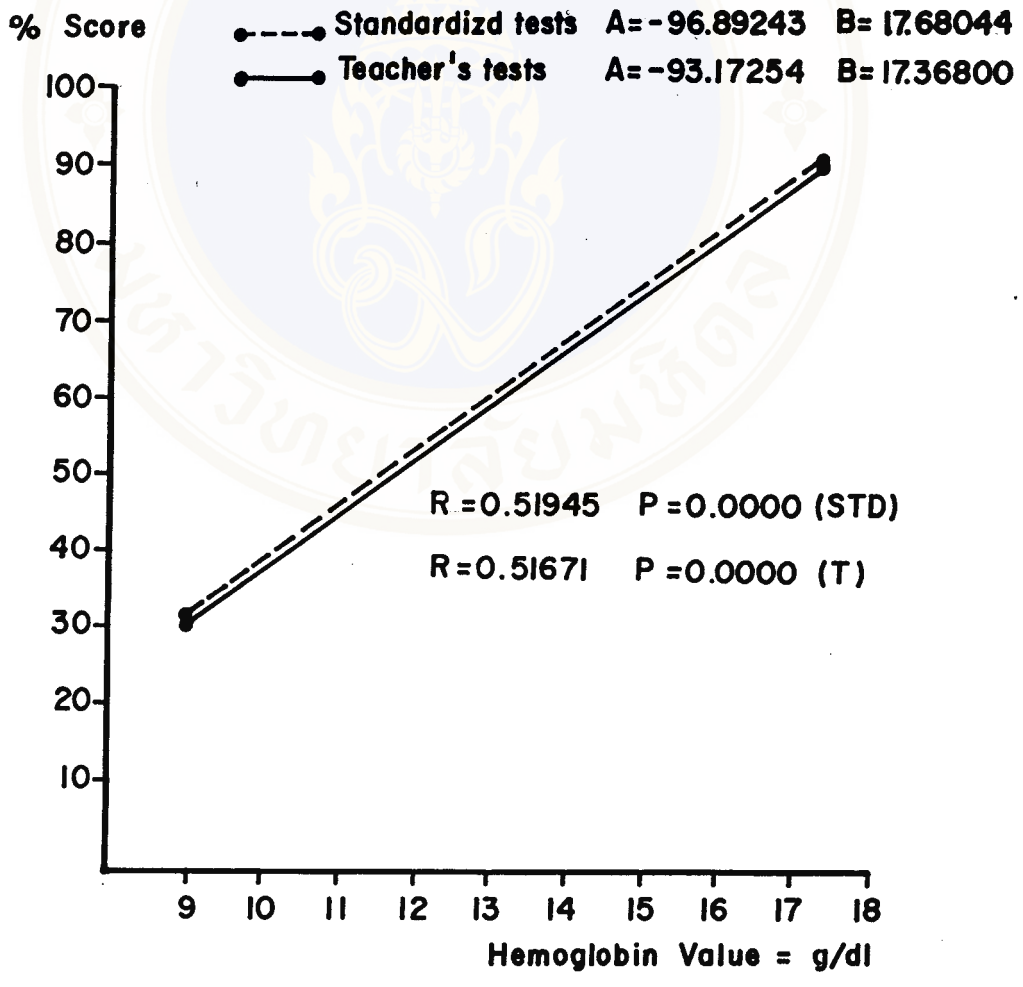


Table 18 Summary of the realationships between PEM, anemia and academic achievement in school children, Angthong Province.

factors	Kind of achievement tests	Reference	λ^2	df	P-Value
PEM (Ht/age):Math	STD	Thai	4.09106	1	0.0431
PEM (Ht/age):Math	T	Thai	4.09106	1	0.0431
PEM (Wt/age):Thai	STD	Thai	3.96489	1	0.0465
PEM (Wt/age):Thai	T	Thai	3.90067	1	0.0483
PEM (Ht/age):Thai	STD	Thai	5.27959	1	0.0216
PEM (Tt/age):Thai	T	Thai	4.02162	1	0.0449
PEM (Ht/age):Basic skill	STD	Thai	5.21520	1	0.0224
PEM (Ht/age):Math	STD	NCHS	7.72063	1	0.0054
PEM (Ht/age):Math	T	NCHS	6.62114	1	0.0101
PEM (Wt/age):Thai	STD	NCHS	4.18280	1	0.0408
PEM (Wt/age):Thai	T	NCHS	5.25114	1	0.0219
PEM (Ht/age):Thai	STD	NCHS	7.43075	1	0.0064
PEM (Ht/age):Thai	T	NCHS	7.76886	1	0.0053
PEM (Wt/age):Basic skill	STD	NCHS	7.68763	1	0.0056
PEM (Wt/age):Basic skill	T	NCHS	6.97779	1	0.0083
PEM (Wt/age):Basic skill	STD	NCHS	14.11115	1	0.0002
PEM (Wt/age):Basic skill	T	NCHS	13.16696	1	0.0003
Hct:Math	STD	WHO	80.5864	1	0.0000

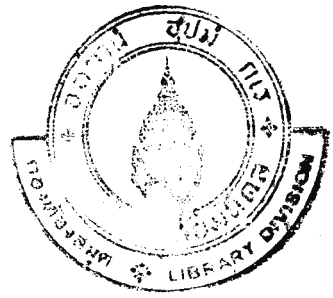


Table 18 (continued)

factors	kind of achievement tests	Reference	λ^2	df	P-Value
Hct:Math	T	WHO	84.2374	1	0.0000
Hct:Thai	STD	WHO	68.5199	1	0.0000
Hct:Thai	T	WHO	56.18361	1	0.0000
Hct:Life experience	STD	WHO	17.1685	1	0.0000
Hct:Life experience	T	WHO	19.2427	1	0.0000
Hct:Basic skill	STD	WHO	84.9820	1	0.0000
Hct:Basic skill	T	WHO	87.5191	1	0.0000
Hb :Math	STD	WHO	45.4162	1	0.0000
Hb :Math	T	WHO	45.9212	1	0.0000
Hb :Thai	STD	WHO	39.4854	1	0.0000
Hb :Thai	T	WHO	36.4854	1	0.0000
Hb :Life experience	STD	WHO	9.54686	1	0.020
Hb :Life experience	T	WHO	6.30185	1	0.0121
Hb :Basic skill	STD	WHO	49.6287	1	0.0000
Hb :Basic skill	T	WHO	49.0870	1	0.0000

CHAPTER 5

DISCUSSION

5.1 Association between the prevalence of protein-energy malnutrition and academic achievement

There were highly significant association between prevalence of PEM and academic achievement as shown in Table 22.

Most of those were the association between PEM based on height for age, weight for age and learning achievement in mathematic, Thai language which were major intellectual development subjects for school children.

The prevalence of PEM could be used as warning indicator for the intellectual development in the areas of mathematic, Thai language and basic skill. Both height and weight for age measurement could be used to predict the history of growth retardation in children.

The high prevalence of malnutrition among infants and young children has serious developmental implications, because these age period are critical in the growth and development of children. Basic aptitudes and attitudes are shaped in infancy and early children. Moreover, during these developmental period there is a high demand for energy to meet biological and social challenges of growth and maturation, Likewise the socio-economic context of malnutrition becomes particularly relevant when it is seen in the light of what

is currently known on environmental determinants of psychobiological development. Children with a history of malnutrition are generally born in families with the lowest income, and with the lowest levels of education as compared to other families within the same community. This environmental context can accentuate the adverse effects of the nutritional deficiencies and vice versa (25).

As children grows older biological malnutrition tends to move them-as in all living organisms-towards a normal course of development. In other words, adverse developmental effects from early trauma may be reversible with maturation if the child is exposed to a salutary social environement. However, the invironmental conditions in which malnourished children generally live may preclude this process of reorientation. The socio-economic conditions of the family and the biophysical environment to which these children are exposed is far from salutary. Moreover, these adverse environmental conditions generally do not undergo any significant changes as the child grows older. This continuity works agains re-routing the development of children with a history of malnutrition towards a normal path (26).

There are ten studies reported that in comparison to well-nourished controled group, children with a history of malnutrition scored significantly lower in intelligence test scores and school achievement scores. The magnitude of the deficits however observed in the malnourished children is not uniform across studies (27).

While some reports serve cognitive deficits in the undernorished children and large differences in intellectual function between these children and their controls (28), others report very mild effects from early undernutrition. For the example, on the one hand Stoch and Smythe, 1976 (29) in their 15 years old follow-up of children with a history of severe undernutrition in infancy reported that they had a 25 IQ point deficit incomparison to their control group. The mean IQ of the boys with a history of undernutrition was as low as 55.7. On the other hand, the IQs and school achievement of children with a history of malnutrition who were placed for adoption in a Korean agency and adopted by families in the United States (30), were lower than that of their controls. However, their IQ and school performance were similar to, or higher than that of the United States standards.

Children with low calorie intake over long period of time reach a state of energy balance through reductions in activity level. Activity is a key mechanism where by children explore, and relate to their social and physical environment. Thus, reductions in activity represents a loss of significance opportunities for learning. These is no information regarding the cognitive effects that may result, among undernourished children, from going to school without having had a meal after and over night fast. Compensatory mechanisms may protect cognitive function from the adverse effects of low caloric intake during school hours, among children who are used to this type of feeding schedule (30).

In this study, children from Thairat wittaya school were among the most disadvantageous group. The prevalance of PEM was highest as a consequence the academic achievement in various areas tests was the lowest.

Nutrition is an endogenous factor that affects learning ability and skill before and after the child is in school. However, both in the nutritional and educational literature, nutrition has recieved little attention as a determinant of school progress. Yet, as this study and other show there are data clearly show that malnutrition in infants and children is a potent contributor to school wastage.

5.2 Association between anemia and academic achievement

From the results of this study as shown in table 20, 21, there was highly significant association between anemia and all achievement tests which could be explained by the role of iron. In addition to it recognized role in oxygen transport as a component of hemoglobin, iron is also a structural part or cofactor for enzymes critical in oxidative metabolism, DNA synthesis and neurotransmitter synthesis, and catabolism (31). Until recently it was believed that these iron dependent enzymes was affected only very late in the development of iron deficiency. However, animal studies have shown that some tissue derangements may precede the development of anemia and respond more rapidly than the hemoglobin concentration to iron therapy (32). Iron deficiency anemia has been implicated in behavioral and cognitive changes in infants, adolescents and adults (33).

The iron-deficiency is typically described as irritable and demonstrating a lack of interest in surroundings. However, there is conclusive evidence that it has a debilitating effect on worker's productivity, as evidenced in this study on the learning ability of children.

The iron-deficient infant is typically characterized as "irritable" and demonstrating "a lack of interest in surroundings"(34). These characteristics are believed to disappear within several days after the institution of long iron therapy before any significant rise in hemoglobin has occurred. In more recent years the behavioral characteristics of the iron-deficient child have been more closely examined. Studies have suggested that iron-deficient children have lower IQ scores, decreased attentiveness, restricted perception, and impaired performance in measures of latency and associative reactions (35,36). Young adolescents, who were presumably iron deficient, were found to score lower on tests of academic performance than did nonanemic control subjects (37). These same students were judged to be more disruptive, irritable, and lazien in the classroom (38).

Studies on intellectual function in iron-deficient children have purported to demonstrate varying adverse effects of anemia on one or more cognitive process. A study of Eldwood and Hughes (39) using adults as experimental subjects showed that anemia had a nonsignificant effect on psychological test performance. In this study, 47 women with H/b values below 10.5 gm/dl were randomly

divided into two treatment groups for an 8-week period; one group received a placebo, while the other received 150 mg of elemental iron as ferrous carbonate daily. Before and after treatment they were given a battery of tests covering a range of psychomotor functions. Statistical analysis showed nonsignificant intraindividual differences in the tests before and after treatment; there were also no significant interindividual differences after treatment. The only trend found among the results was the improved performance observed among those women with the largest rise in Hgb level.

Except for a few instances (22,23), available reports on investigations of children are published in the Proceedings of Conferences. With the exception of the report by Sulzer and associates, they provide brief descriptions of methods and subjects, which make it difficult to assess the methodologic rigor and the exact objective(s) of the studies. The following review is limited to the more detailed and informative reports (23,40), and to one brief abstract from a longitudinal study (41).

In one project, Sulzer and associates (35) studied over 230 male and female,4 to 5 year old black children enrolled in a Head Start Program in New Orleans. Of this group, 11.7% had hemoglobin values below 10.5 gm/dl. Two batteries of psychological tests were used. The first included a global, allegedly culture-free IQ tests, a vocabulary test, and measures of moral development and grouping behavior. The other battery comprised reaction time, attentive recall and cranking tasks. When compared with control subjects, the

performance of anemia subjects (Hgb < 10 gm/dl) was significangly poorer on the vocabulary tests and showed similar, but not significant, trends on all other measures. The score differentials between groups became more statistically evident when the cutoff point in hemoglobin values was 10.5 gm/dl, which increased the sample of anemia subjects. Compared with the control group, the anemic subjects had significantly lower scores on the IQ measure, the vocabulary test, and the latency and associative reaction measures. An important finding was that younger anemic children were unable to integrate effectively experience accumulated during different steps of the associative reaction test. The authors suggested that the younger group may have been more vulnerable to the possible effects of iron deficiency anemia on cognition. It is also possible, of course, that the timing of iron deficiency relative to the ontogenesis of the CNS is a factor in terms of possible permanent sequelae.

Recognizing that the nutritional history of the child (independent of current anemia) may have contributed to the observed results, the investigators compared the test scores of tall and short children. (Physical growth is an accepted indicator of nutritional status (42,43). When the age variable was controlled, differences (the authors do not specify which tests differed) between tall and short children were small. The data did indicate, however, that the combination of a history of inadequate nutrition and current low hemoglobin value was the best predictor of inferior performance.

In contrast, Howell (44) has reported markedly decreased attentiveness, narrow attention span, and perceptual restriction among 3- to 5-year-old iron-deficient children (hemoglobin levels of less than 10 gm/dl). Howell's report, unfortunately, is too incomplete to establish the validity of her data, or the possible source of their conflict with findings of Sulzer and colleagues.

Iron deficiency anemia and scholastic achievement in young adolescents was investigated in Philadelphia by Webb and Oski (22). Subjects were 12- to 14-year-old male and female junior high school students in an economically deprived, mostly black community. Following a hematologic survey of 1807 children, 92 subjects were considered anemic (hemoglobin values ranged from 10.1 to 11.4 gm/dl). All anemic subjects had hypochromic, microcytic red cell indices and evidenced neither sickle cell hemoglobin nor red cell glucose-6-phosphate dehydrogenase deficiency. It was presumed that all were iron deficient, although no attempt was made to exclude either alpha- or beta-thalassemia traits. A control group of 101 students with hemoglobin values ranging from 14.0 to 14.9 gm/dl was also tested. A measure of scholastic performance was obtained from the composite score on the Iowa Tests of Basic Skills, Levels A-F/Form 3. This score represented performance across the following subtests: vocabulary, reading knowledge and use of reference materials, arithmetic concepts, and problem solving.

The scores of the anemic subjects were significantly lower

($P<0.025$) than those of nonanemic students. Further, the older anemic male subjects displayed a progressive departure in performance from the non-anemic control subjects. The authors acknowledged that they had insufficient information to interpret the sex difference in the decline of scores as a function of age. In a subsequent study the performance of both groups of children on a standard visual afterimage task was investigated. The subjects' reports on the visualization of an afterimage showed that the iron-deficient anemic children had a longer latency period than the nonanemic s bjects.

A third study by Webb and Oski (23), on 74 of these 92 anemic children and 36 control subjects, employed a Behavior Problem Checklist and showed a differential trend between the two Observational ratings from 13 English teachers, who did not know the group to which each child belonged, provided the basis for behavioral comparisons. The information provided by the checklist focused on : (a) conduct problems, (b) personality disturbances, and (c) inadequacy-immaturity. The results showed a nonsignificant between-group difference in the scores on personality disturbances and inadequacy-immaturity. The difference in the conduct scale reached the 0.10 level of probability; the authors interpreted this difference to mean that the anemic subjects tended to have more conduct disturbances than the nonanemic subjects. The age by hematologic condition interaction in the statistical analysis proved to be

statistically insignificant for each of the scales. In summary, the authors conclude that the scholastic performance of the anemic children was compromised by disturbances in attention and perception.

It is unclear from the above data whether the poor performance, perceptual disturbances, and conduct problems observed in the anemic subjects were consequences of anemia, per se, iron deficiency alone, or a general nutritional inadequacy of which iron deficiency was only a readily identifiable component. The possibility that anemia per se, was the determining factor in the low performance of these students must be questioned because two other studies (45,46). found no significant relationship between IQ measures and the degree of anemia secondary to sickle cell disease, among children.

The reported investigations in New Orleans and Philadelphia suffer from weak study designs that raise critical questions about their internal validity. They were expost factor limited to a static-group comparison, and neither provided a way to certify that the groups would have been equivalent had it not been for the iron deficiency.

A longitudinal study by Cantwell (41), undertaken to determine whether hypoxemia from anemia causes brain damage. involved 61 full-term infants from comparable socioeconomic groups. At 6 to 18 months of age, 32 of the infants exhibited iron deficiency anemia (Hgb values ranged from 6.1 to 9.5 gm/dl). Twenty-nine infants had received neonatal iron dextran injections and were not anemic (Hgb ranged from 11.5 to 12.9 gm/dl. Neurologic examinations were done at

6 to 7 years of age, and the examiners had no knowledge of the presence or absence of previous anemia. The anemic group had a higher incidence of "soft" neurologic signs, such as clumsiness in balancing on one foot, tandem walking, and repetitive hand or foot movements. They were also less attentive and more hyperactive than control subjects. The authors do not include statistical data in their abstract and report that IQ scores averaged 98 and 92 for the nonanemic and anemic groups, respectively. In the absence of protein calorie malnutrition, the authors specify that anemia in infancy appears to be one cause of possibly permanent minimal brain dysfunction.

In Thailand there have not had any studies in this field to support this conclusion. Although , there was a study in Semarang, Indonesia by Sumantri and Pollitt, 1984 (24) conversly, the mean scores in all tests of the other three group were not significantly difference between the first and second evaluation. In this present study the results confirmed the studies of Web & Oski in 1973, 1974 since there was highly significant association between anemia and academic achievement.

5.3 Hunger and academic achievement

A recently published paper (47) focussed on the short term fasting and its effects on problem-solving among 9 to 11 years old well-nourished middle class children. Among well-nourished children a nineteen to twenty hour fasting period affects attention, and the

capacity to solve problems of visual-perceptual organization. There is also suggestive evidence from evaluations of school feeding programes in developed countries that not taking breakfast affected performance in reading and aritnmetic tests.

5.4 Consequence of malnutrition in school children

The most direct impact of malnutrition is its effect on the health of individuals. This effect ranges in severity from physical inconvenience diminution of competence. To more serious from illness, to death. Other detrimental effects that follow are increased medical expenditure both at the family and national level, reduced productivity and hence income of the level force, more frequent absence from work because of low resistance to other disease, and finally, in its most severe form, permanent loss of ability to work, e.g. blindness caused by vitamin A deficiency, etc.

On more indirect front, there are social and economic of effects of malnutrition on educational development of children. Probably the most significant period in this aspect is from conception to period of pregnancy to the first year of infanthood to weaning. It is likely that malnutrition of the mother during pregnancy and lactation will result in physical deficiency and reduced intellectual potential of the child.

Apart from the level of intelligence, children who suffer from malnutrition will lack enthusiasm, curiosity of incentive to perform and thus low ability to learn. This kind of situation can be widely observed in Thai rural areas. For school age children. The

educational effects of malnutrition can be looked at in term of the effects on the child's potential performance and on the duration and continuity of this education (48).

The long-term effect of malnutrition on education present themselves in various sections of the population, particularly the employee and the adult women, as well as in the population at large. Illiteracy of the general population is regarded as a major obstacle to the development, although literacy alone is not sufficient to ensure the availability of capable personal suitable for modernization of agriculture as well as diversification of industry and adoption of new technology.

As far as adult woman are concerned, lack of knowlege on proper nutrition for themselves and their families can have detrimental effects on their health.

This we can see that there is a vicious circle of malnutrition which involves various social, economic, as well as cultural factors.

5.5 Conclusion

The evidence presented above, and the conclusion that have been advanced indicated that it is imperative to include nutrition as a determinant of school performance and achievement. Early malnutrition and poor nutrition status among student can, and will have significant effects over school progress, and contribute significantly to school wastage children whose learning is slow and

have difficulties mastering school material are candidates with high chances of repeating grade and dropping out early from school.

Demands for definition of the specific mechanisms through which early severe and chronic malnutrition affects subsequent school performance or for the definition of the process through which PEM and anemia affects attention can not be presently satisfied. The information is not available, and there is no way at present of assessing accurately the risks involved. However, it is necessary not to equate risk assessement with risk management. The data available is conclusive to demonstrate that the protection of the child's nutritional status during his early formative years and during the school period will result in a better student, and will significantly decrease the human and capital costs of school wastage. Accordingly in this study, early supplementation, multifocal inter ventions and school feeding programe can use to prevent or as therapeutic effect.

CHAPTER 6

SUMMARY

The survey of PEM and anemia had been conducted during December 1984 to March 1985 in 546 children, aged 8-15 years, Pratom 3-4, in the elementary school of rural and urban school in Angthong province, Central region of Thailand.

The results from this study showed the prevalences of PEM were 0.5, 5.6 percent for urban and rural school children based on weight for age of Thai reference, and were 3.8, 17.2 percent based on height for age. When the NCHS reference was used the prevalence of PEM for urban and rural based on weight for age, height for age, weight for height were 62.9, 71.1, 48.9, 77.5, 29.0, 17.5 percent, respectively. The prevalence of anemia were about 15, 26 percent in urban and rural school children.

There were highly associations between four areas of academic achievements i.e. mathematic, Thai language basic skill and life experience and prevalence of anemia, in both standardized and teachers tests. There was also significant association between PEM based on weight for age, height for age of Thai and NCHS references and the achievement in mathematic, Thai language and basic skill in both tests.

The highest educational risk was found among those children. The intellectual function during school age, and the educational

progress of children with a history of early, severe and chronic malnutrition born into conditions of severe social and economic deprivation were at high risk. It is expected that the children will have low school achievement, and tend to repeat grades, therefore maintain a high drop-out rate.

The contribution to education wastage by undernourished children will depend on the prevalence of severe malnutrition in the country. This relationship will be maintained unless there are specific compensatory programes directed to remedial the effects of undernutrition prior to the enrollment of children in school.

ANNEX

No of questionair.....

Student record

History of Life

Name.....Surname.....Date of Birth....

Sex ☐ male ☐ female

Class..... School.....

Age.....years.....months

Stay with

☐ parents ☐ relative

☐ monk ☐ other.....

Brother/sister.....persons

History of mobidity, presentieesm

Frequency of illness in a year ☐ often ☐ seldom ☐ never

Common disease ☐ Cold.....times/semester

☐ Diarrhea .....times/semester

☐ Dermatitis.....times/semester

☐ other disease.....times/semester

Absentieesm total.....days/school year

Academic achievement

1. History of learning from student record

Repeat grade ☐ yes ☐ no

Academic achievement in teachers'tests

Mathematic.....% grade ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

Thai language.....% grade ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

Life experience.....% grade ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

Basic skill.....% grade ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

2. Academic achievement in Standardized tests

Mathematic.....% grade ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

Thai language.....% grade ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

Life experience.....% grade ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

Basic skill.....% grade ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

Weight/height measurement

		PEM Status		
	Normal	1° degree	2° degree	3° degree
Date of examination 1 .....weight....Kg	☐	☐	☐	☐
2 .....weight....Kg	☐	☐	☐	☐
3 .....weight....Kg	☐	☐	☐	☐

Rate of increasing weight.....kgs/6 months

		PEM Status		
	Normal	1° degree	2° degree	3° degree
Date of examination 1 .....height....Cm	☐	☐	☐	☐
2 .....height....Cm	☐	☐	☐	☐
3 .....height....Cm	☐	☐	☐	☐

Rate of increasing height.....cm/6 months

Weight/height ☐ normal ☐ 1°degree ☐ 2°degree ☐ 3°degree

Physical finding

General appearance	☐ thin	☐ normal	☐ fat
Anemia (eye/hand)	☐ yes	☐ no	
Head	☐ normal	☐ abnormal	
Hair	☐ normal	☐ abnormal	
Ear	☐ normal	☐ abnormal	
Eye	☐ normal	☐ abnormal	
Teeth(Dental Caries)	☐ normal	☐ abnormal	
Angular Stomatitis	☐ yes — Lesion / Sear	☐ no	
Tongue	☐ normal	☐ abnormal	
Thyroid gland	☐ normal	☐ abnormal	
Skin	☐ normal	☐ abnormal	
Activity	☐ normal	☐ abnormal	

Biochemical measurement

Hamatocrit .....%

☐ anemia ☐ non-anemia

Hemoglobin .....g/dl

☐ anemia ☐ non-anemia

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