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# A PATH MODEL OF FACTORS AFFECTING NUTRITIONAL STATUS OF CHILDREN AGE UNDER 48 MONTHS IN AGRICULTURAL HOUSEHOLDS, WARIN CHAMRAP DISTRICT, UBON RATCHATHANI PROVINCE, 1981

BY

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LIBRARY DIVISION

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE
(BIOSTATISTICS)

บัณฑิตวิทยาลัย มหิดล

IN THE

FACULTY OF GRADUATE STUDIES

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## Abstract

This research is focussed on the main purpose which studied the influence of direct and indirect effects of factors affecting nutritional status of children age under 48 months in agricultural households, Warin Chamrap district, Ubon Ratchathani provionce. The second purpose was to construct an appropriate path model for the explaination of causal relation among the causal factors and nutritional status. The samples in this study were 350 youngest children in the family which age were under 48 months from agricultural households in eight villages, Warin Chamrap district, Ubon Ratchathani province. Finally, from those 350 children, 181 children have the complete information of all variables that used in this analysis.

By using path analysis, it was revealed that child's


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morbidity, food supplementation of child, interval of pregnancy, diarrhea, parasitic infestation, and economic status of the household were the factors directly affecting the nutritional status indicated by weight for age and height for age. With regarding to weight for height, the factors causing direct effect on weight for height were economic status of the household, interval of pregnancy, and child's morbidity. In addition, household's sanitation, immunization, and mother's age were the indirect effects on nutritional status indicated by weight for age and height for age. Moreover, it was revealed that factors providing indirect effects on nutritional status indicated by weight for height were household's sanitation, immunization, mother's age, food supplementation of child, and parasitic infestation.

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| หัวข้อวิทยานิพนธ์ | รูปแบบเส้นทางความสัมพันธ์ของปัจจัยที่มีผลต่อภาวะโภชนาการเด็กอายุต่ำกว่า 48 เดือน ในครัวเรือนเกษตร อำเภอวารินชำราบ จังหวัดอุบลราชธานี, 2524 |
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| วันสอบป้องกันวิทยานิพนธ์ | 23 พฤษภาคม 2529 |

## บทคัดย่อ

การวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาอิทธิพลทั้งทางตรง และทางอ้อมของปัจจัยที่มีผลกระทบต่อภาวะโภชนาการเด็กอายุต่ำกว่า 48 เดือน และเพื่อสร้างรูปแบบที่เหมาะสม ในการอธิบายลักษณะของความสัมพันธ์ระหว่างปัจจัยต่าง ๆ ต่อภาวะโภชนาการเด็ก กลุ่มตัวอย่างได้แก่ เด็กคนสุดท้องอายุต่ำกว่า 48 เดือน ในครัวเรือนที่มีอาชีพเกษตรกร จาก 8 หมู่บ้าน ในอำเภอวารินชำราบ จังหวัดอุบลราชธานี จำนวน 350 คน แต่ในการวิเคราะห์ครั้งนี้ใช้ตัวอย่างที่มีข้อมูลของตัวแปรทุกตัวครบถ้วน ได้ตัวอย่างทั้งสิ้น 181 คน

จากการวิเคราะห์ข้อมูลโดยใช้การวิเคราะห์เส้นทางความสัมพันธ์ พบว่า ปัจจัยที่มีผลทางตรงต่อภาวะโภชนาการเด็กโดยใช้ค่าน้ำหนักตามอายุ และค่าส่วนสูงตามอายุ คือ การเจ็บป่วยของเด็ก, การให้อาหารเสริมแก่เด็ก, ระยะห่างของการตั้งครรภ์, การมีอาการท้องเดินของเด็ก, การมีพยาธิของเด็ก และฐานะเศรษฐกิจของครอบครัว แต่เมื่อภาวะโภชนาการเด็กใช้ค่าน้ำหนักตามส่วนสูง พบว่าปัจจัยที่มีผลทางตรงต่อค่าน้ำหนักตามส่วนสูง คือ การเจ็บป่วยของเด็ก, ระยะห่างของการตั้งครรภ์ และฐานะเศรษฐกิจของครอบครัว ส่วนปัจจัยที่มีผลทางอ้อมต่อค่าน้ำหนักตามอายุ และส่วนสูงตามอายุ คือ การสุขาภิบาลในครัวเรือน, การได้รับภูมิคุ้มกันโรคของเด็ก และอายุมารดา ปัจจัยที่มีผลทางอ้อมต่อค่าน้ำหนักตามส่วนสูง คือ การสุขาภิบาลในครัวเรือน, การได้รับภูมิคุ้มกันโรคของเด็ก, อายุมารดา, การให้อาหารเสริมแก่เด็ก และการมีพยาธิของเด็ก

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# CHAPTER I

# INTRODUCTION

## 1.1 Background of the Problem

Malnutrition is a widespread problem of infants and young children in the developing world and to a lesser extent in poverty areas in the industrailized nations. From 101 communities surveyed in 59 developing countries found that at least 101 million of the under 5 year old children suffer from Protein Energy Malnutrition (PEM) (WHO,1975). Bengoa (1974) reported that the proportion of children suffering from moderate and severe PEM in Latin America, Africa, Asia was 19%, 26%, and 31% successively. Besides, WHO conservatively estimates that more than 500 million children in each age cohort suffer from second degree malnutrition or worse (Scrimshaw and Taylor,1980). In Asia, the country whose populations are most subject to undernourishment is India. It was also reported by United Nation Organization that 2 in every 5 population suffer from malnutrition . Moreover, 15 million of the under 5 year old children have the calories intake less than one half of they need (Brown,1979).

In an agricultural country like Thailand, where 81.8 percent of the population depend upon subsistence farming (National Statistical Office,1981). Though Thailand exports a great deal of agricultural products, malnutrition is still a basic health and social problem which is widespread throughout the country. A recent surveillance data of preschool children all over the country by the Ministry of Public Health shows that the prevalence of PEM

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is 50.8 percent of varying degree with 35.7, 12.0, and 2.1 percent in the first, second, and third degrees, respectively. The problem is most pronounced in Northeast where 56.7 percent of preschoolers suffer from PEM (Ministry of Public Health,1983).

The high incidence of malnutrition in infants and preschool children is very critical because it affects both physical growth and mental development which subsequently affects behavior and learning ability. There is sufficient evidence to demonstrate conclusively that malnutrition impairs the body's defense mechanisms. Children with mild and moderate malnutrition have more severe and frequent infections than found in normal children, severely malnourished children have greatly increased mortality rates relative to normal children. Malnutrition weakens adults and decreases their capacity to produce goods and perform services(Tontisirin,1978; Brown,1979; Chanche,1979; Gurney,1979; Shakir,1979; Evand,1980; Meredith et al.,1983; Pellett,1983; Martorell and Ho,1984).

The purpose of this research is to investigate factors that affect the nutritional status of children age under 48 months in agricultural households, Warin Chamrap district, Ubon Ratchathani province by mean of causal relationship which will indicate the factors affecting nutritional status of the children directly and indirectly on the basis of data and information surveyed by Institute of Nutrition, Mahidol University. It is anticipated that this research will be very useful in planning to prevent and improve the nutritional status of Thai children in the near future.

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## 1.2 Objectives of the Study

1. To examine the direct and indirect effects of factors influencing the nutritional status of children age under 48 months.

2. To construct a suitable path model explaining causal relation among factors affecting the nutritional status of children age under 48 months.

## 1.3 Variables in the Study

The ultimate dependent variable is

-nutritional status of children which is measured in three different categories as :

-weight for age

-height for age and

-weight for height

The exogeneous variables are

-economic status of the household

-mother's age

-interval of pregnancy

The endogeneous variables are

-household's sanitation

-immunization

-food supplementation of child

-parasitic infestation of child

-child's morbidity

-diarrhea

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## 1.4 Definition of Terms

- Nutritional status : the condition of the body resulting from the intake, absorption and utilization of food and from factors of pathological significance. The level of nutritional status is justified from measurements of body weight and height at age intervals and sex by using the Thai standard weight for age, height for age, and weight for height prepared by Pensri Khanjanasthiti, Department of Pediatric, Ramathibodi Hospital.

- Diarrhea : the condition which stool appears as mucous with blood at least once in 24 hour or having watery stool more than 3 times in 24 hour

- Interval of pregnancy : the period (month) between the last second live birth children. The interval of pregnancy will be zero for the first pregnancy.

## 1.5 Hypotheses of the Study

1. Child's morbidity, diarrhea, food supplementation of child, parasitic infestation of child, economic status of the household, interval of pregnancy, and mother's age are the factors directly affecting the nutritional status of children.

2. Household's sanitation, and immunization are the factors indirectly affecting the nutritional status of children.

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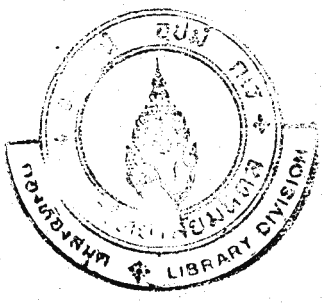
# CHAPTER II

# REVIEW OF LITERATURE




## Factors Affecting Nutritional Status of Children

### Mother's Age

Ware (1984) reported that there was a significant correlation between the age of the mother and weight for height of the child ( r=0.22 ) with teenaged mothers having lighter children as compared to children of older mothers concur with previous research which indicated that the age of the target child's mother was associated with the weight for age (Antrobus,1971; Desai,1968).

Swenson (1984) showed that there was a higher proportion of well-nourished children among mothers between the ages of 19 and 28 than among the children whose mothers were 18 years or younger or over the age of 29. The highest proportions of malnourished children were among those mothers less than 18 years of age when compared to the other maternal age categories.

### Economic Status of the Household

Stinson (1983) reported that the evaluation of socioeconomic status could indicate nutritional status of children in the community. One of the index of the economic status of the household is the size of working land. It was found from many sources of reports that the less the area of land possesing the more the number of malnourished children (Grewal, et al.,1973; Rawson and Valverde,1976; Valverde et al.,1977).

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Rao and Satyanarayana (1976) assessed the nutritional status of 1,350 individuals of all ages, both sexes in a rural area in Andra Pradesh. Results of the study showed that the proportion of persons having one or more signs of nutritional deficiencies was highest in the low income group. It was also found from the others study that the less the household's income the more the number of undernourished children (Chandrapanond, et al.,1960; Mckay,1969; Wray and Aguirre,1969; Grewal, et al.,1973; Tontisirin, et al.,1977; Valverde, et al.,1981; Martorell, et al.,1984).

Interval of Pregnancy

The interval between pregnancies is associated with infant birth weight. Fedrick and Adelstein (1973) found from a sample of 16,994 singleton births in England that when the interval between pregnancies had been less than 6 months, or more than 6 years, more low birth weight infants were likely to be delivered. Spires and Wang (1976) suggest that pregnancy intervals of less than six months should be avoided to delivery of a low birth weight baby. Eisner, et al. (1979) showed an increased risk of delivering low birth weight infant for both white and black multigravida women with an interpregnancy interval of less than six months.

In another study, Swenson (1978,1984) found that there were a higher mortality among children followed in close succession by another surviving live birth and these children had a high opportunity to be undernourished children.

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## Parasitic Infestation of Child

Even today, after successful campaign against hookworm infections, parasitic diseases in association with nutritional deficiencies are the primary killers of humans in many countries. The majority of the more serious infections occur in the so-call "Third world countries" while most dwellers within temperate regions are unaware of the magnitude of problems. For instance, of the approximately 60 million annaul worldwide deaths from all causes, 30 million deaths occur in children under 5 year old and half of these again (15 million) are attributed to the combination of malnutrition and intestinal infections (Howard,1971).

It has been observed that helminthic infections in some way interfere with protein absorption and utilization (Chen,1979; Haile,1982). Jelliffe (1953) has demonstrated that antihelminthic treatment of a child with prior growth failure, but without a change in diet, leads to an increase in body weight.

## Food Supplementation of Child

Early introduction of semi-solid food is very common among rural families, especially in North and Northeast region of Thailand (Valyasevi, et al.,1967; Yoddumnern,1975). Chewed glutinous rice and/or banana are usually given to the baby at the age of 3-7 days. Physiologically, at this age the digestive system cannot handle foods other than milk. The infants fed semi-solid food at earlier months of life tend to have distended stomach which results in decreased sucking reflex, which inturn reduces the stimulation for breast milk production.

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Several investigators have reported that introduction of supplementary foods before the age of four months does not have any significant benefit (Becroft and Bailey,1965; Venkatachalam, et al.,1976). Babies who are fed nothing but breast milk on demand usually grow normally for 4-6 months (Thomson and Black,1975; Ahn and Maclean,1980; Tontisirin, et al.,1983). Should they continue to receive breast milk alone after this period, they will be receiving good quality food in insufficient quantity for their increased needs. Severe faltering of growth is likely after 6 months, and the infants will thus develop mild to moderate PEM and many become seriously malnourished later (Gurney,1979). The late introduction of energy-rich foods, vegetable, fruit and fat is among the contributing factors to poor diets in preschoolers (Pigott and Kolasa,1979; Zainah, et al,1983).

Child's Morbidity

Infection and other factors will cause child's illness. If the children have frequently episodes of illness, they will cause a further deterioration of nutritional status (Mata and Behar,1977; Bhumisawad and Charoenyooth,1984).

Diarrhea

Infectious diseases, and in particular diarrheal diseases retard growth, it interferes with nutrient absorption (Burgress,1976). Many studies revealed that diarrheal diseases have been identified as precipitating factors in the etiology of malnutrition (Scrimshaw et al., 1967; Scrimshaw et al.,1968; Viteri

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and Torun,1980; Al-Dabbagh and Ebrahim,1984; Bhumisawad and Charoenyooth,1984; Martorell and Ho, 1984).

Household's Sanitation and Diarrhea

Moore (1965) surveyed the sanitary characteristic of 1,202 houses in Costa Rica. The houses were well supplied with piped water (94 percent) and facilities for sanitary excreta disposal (89 percent). The incidence of diarrhea was reduced where a good level of sanitation was found.

Teanchai (1984) studied in the diarrheal infants ( 0-1 year) and well infants in the Children's Hospital, found that family sanitary facilities had significant association with the occurence and severity of diarrhea in infants.

Factors Affecting Child's Morbidity

The children of preschool age are considered to be important. The rate of growth for this age is affected by physical, mental, and emotional development of the children. The children's health is an important factor because the chance of having episodes of illness is very high due to the fact that the level of immunization, by birth, has been decreasing as well as the chance of infection has been increasing. Therefore, it is necessary for the children of this age to have vaccination to increase immunity.

One of the fundamental factors to provide human society happiness and healthiness is clean and sanitary surrounding. If any housing is not always be kept clean and sanitary, illness and probably death will be conducted. Investigating in Central America and Panama, Teller and his party (1979) found that the improvement

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of sanitation of surrounding can reduce child's illness.

Several studies revealed that children come from the low income families have low birth weight and average height lower than the children come from the high income families. Moreover, the proportions of children in the low economic households have 2 times higher incidence of morbidity, that confined to hospital, 4 times longer duration of curative in hospital, and 2 times higher incidence of iron deficiency that induced anemia than the children in high economic households (George, 1972; Similey et al., 1972; Hedayat et al.,1981; Starfield, 1982).

Household's Sanitation and Parasitic Infestation

The study done by Henry (1981) in the West Indies, after the introduction of a piped water supply and construction of pit latrines, the prevalence of intestinal parasites dropped by 30-50 percent. These results demonstrate clearly that increased safe water utilization and properly used pit latrines have a considerable effect in reducing the prevalence and intensity of parasite infections.

In many of the rural endemic areas latrine facilities are poorly developed and even if they have been installed they are often unsatisfactory and in some cases only used by adults in the family children not being allowed to use them (Jordan and Webbe,1969). The prevalence of parasitism was least where a good level of sanitation was found (Davey and Wilson,1965; Moore, et al.,1965).

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Economic Status and Sanitation

Studying and researching in Muang Kham village, in Phan district of Chiengrai province, Sujumnong (1970) found that by taking annual income factors, the amount of land possessing, and together with the way-of-living status into consideration, he had concluded that the socioeconomic status had a directly relation to the latrine facilities and construction. It was found that those who had better socioeconomic status would afford more latrine facilities than those of poorer ones.

Mother's Age and Immunization

In the developing countries, immunization had not been generally available, so the childhood diseases have continued to be an important public health problem and they still contribute to the high infant mortality (Tomaszunas,1979).

Many studies about immunization acceptance reviewed that the factors affecting mothers in bringing their children to have vaccine immunized are age, education, and income of the mother together with the size of the family (Rosenstock, 1959; Markland and Durand, 1976; Selwyn, 1978).

Nakhapat (1979) studying the immunization acceptance in Ratchaburi province, found that young mother (15-29 year old) accepted immunization of child much more than older mother (30-34 year old).

Accordingly, the evidences from the past studies regarding the variables directly and indirectly causal relate to nutritional status give overall conceptual framework for

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constructing the appropriate path model to investigate the factors affecting nutritional status of children under 48 months in agricultural households, Warin Chamrap district, Ubon Ratchathani province. The path diagram in this study is shown in Figure 1 ( p. 19 ).

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# CHAPTER III

# RESEARCH METHODOLOGY

## 3.1 Data Collection and Samples

The data set used in this research is a part of the survey research carried out for comparing the effects of integrated health, nutrition education plus food supply and income generation on nutritional status of the infant and preschool children. The household survey that this study is based was the baseline data conducted during May 1981 by the Institute of Nutrition, Mahidol University.

According to the demographic data in Table 1, eight villages were selected from Warin Chamrap district,Ubon Ratchathani province and are located in 6 sub-districts, the selection based on certain criteria. These criterias are as follows :

1) village has the households more than 100 households but not more than 200 households in order to have enough samples and convenient in implementation

2) distance to town varies from 10 to 30 kilometers

3) people have a similar economic status and main occupation

4) does not have health center in the village

5) each village is far enough in order that people in the other village don't know about the implementation in another community

The total population of these 8 villages is 6,488, and with about

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100-160 households in each village. All villages do not have midwife centers which usually are 1-8 kilometers away. The distance to town varies from 10 to 30 kilometers.

The samples in this study were 350 youngest children in the family whose age were under 48 months from agricultural households in those 8 villages. Finally, from those 350 children, 181 children have the complete information of all variables that were used in this analysis.

These selected samples were interviewed by using a questionnaire, under the close supervision of the qualified staff members from the Institute of Nutrition, Mahidol University. The respondents were mothers or fathers of the samples in those 8 villages.

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Table 1 Demographic Data of the Study Area

| | VILLAGE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Non-Thieng | Non | Non-Bon | Yang | Sam-Rong | Whang | Non-Sai-Noi | Mod-Ngam | Total |
| No. of household | 135 | 146 | 158 | 117 | 100 | 123 | 115 | 143 | 1037 |
| No. of population | 877 | 831 | 939 | 731 | 680 | 774 | 681 | 975 | 6488 |
| No. of children age under 48 months | 76 | 51 | 81 | 92 | 69 | 53 | 66 | 104 | 592 |
| No. of the last children age under 48 months | 52 | 42 | 66 | 59 | 44 | 38 | 50 | 63 | 414 |
| No. of the last children age under 48 months in the agricultural households | 45 | 34 | 57 | 48 | 34 | 28 | 44 | 60 | 350 |
| Distance from village to town (km.) | 23 | 11 | 17 | 11 | 31 | 10 | 20 | 26 | |

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## 3.2 Data Analysis

The data were transformed into coding number and punched into diskette. The data in diskette were edited in order to make the data ready for further statistical analysis. The researcher used SPSS X package at Computing Center Mahidol University to analyse the data by path analysis.

Path analysis is a method that developed a linear causal models proposed by Sewall Wright (1934). Path analysis is useful in making explicit the rationale of conventional regression calculations. The interpretation of an independent variable's impact derived from a path model is generally more adequate because it is able to take into account the operation of indirect effects and spuriousness. Path analysis focuses on the problem of interpretation and does not purport to be a method for discovering causes. It may, nevertheless, be invaluable in rendering interpretations explicit, self-consistent, and susceptible to rejection by subsequent research (Duncan,1966; Lewis-Beck,1974).

The main assumptions that used in the model are as follows (Kerlinger and Pedhazur,1973) :

1) The relations among the variables in the model are linear, additive, and causal. Consequently, curvilinear, multiplicative, or interaction relations are excluded.

2) Residuals are not correlated with variables preceeding them in the model, nor are they correlated among themvelves.

3) There is a one-way causal flow in the system. That is, reciprocal causation between variables is ruled out.

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4) The variables are measured on interval or ratio scales.

In performing path analysis we use path diagrams to show the direction of the relationship between dependent and independent variables. In path diagrams, we use one-way arrows leading from each determining variable to each variable dependent on it. Unanalyzed correlations between variables not dependent upon others in the system are shown by two-headed arrows, and the connecting line is drawn curved, rather than straight, to call attention to its distinction from the paths relating dependent to determining variables. The quantities enterd on the diagram are symbolic or numerical values of path coefficient, or, in the case of the bidirectional correlations, the simple correlation coefficients.

In this analysis, the hypothesized model was tested by using a multiple regression technique. Each variable in the model is taken to be in standard form; that is, if $X_i$ is the i th variable as measured, then $Z_i = ( X_i - \bar{X}_i ) / \sigma_{Xi}$. The path coefficients are then nothing other than the standardized regression coefficients (beta coefficients, $\beta$'s) in a regression setup. Had some of the $\beta$'s turned out both non-significant and negligible in magnitude ($\beta < 0.05$), one could have erased the corresponding paths from the diagram and run the regression over, retaining only those independent varaibles found to be statistically and substantively significance.

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## Conceptual Framework

According to the review of literature, the important researchs that related to factors influencing nutritional status are applied to construct an appropriate path model of factors affecting nutritional status of children age under 48 months in agricultural households, Warin Chamrap district,Ubon Ratchathani province. In the path model, factors are arranged from the priority and the significance of events attaching the nutritional status. The path diagram in this study is shown in Figure 1.

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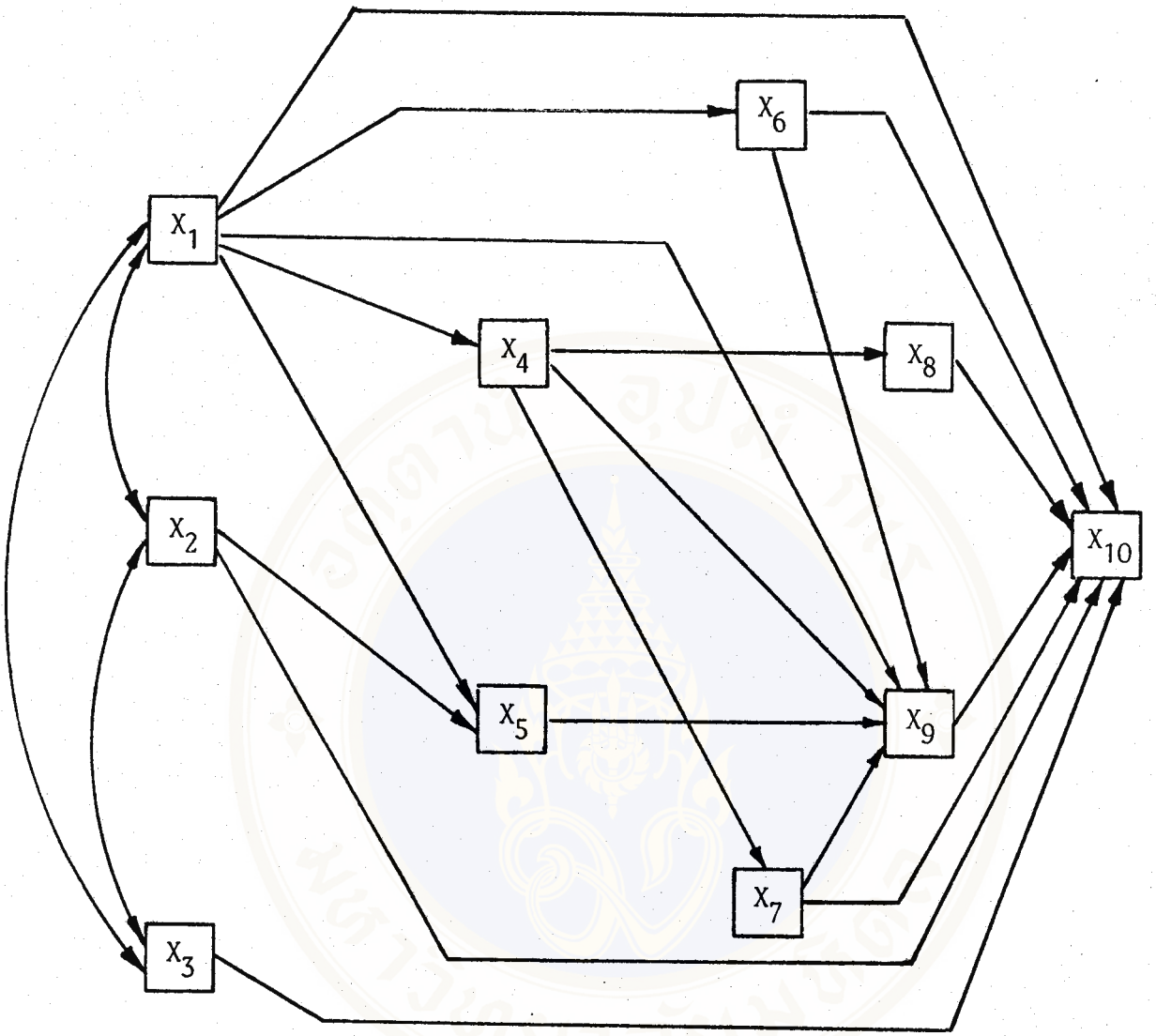


Figure 1 A Path Model of Factors Affecting Nutritional Status of Children under 48 Months in Agricultural Households, Warin Chamrap District, Ubon Ratchathani Province, 1981.

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## 3.4 Variables in the Path Model

There are 10 variables, including one ultimate dependent variable, three exogeneous variables, and six endogeneous variables shown below. Measurements of the variables are also indicated.

| Variables | No. | Symbol |
|---|---|---|
| Economic status of the household | 1 | $X_1$ |
| Mother's age | 2 | $X_2$ |
| Interval of pregnancy | 3 | $X_3$ |
| Household's sanitation | 4 | $X_4$ |
| Immunization | 5 | $X_5$ |
| Food supplementation of child | 6 | $X_6$ |
| Parasitic infestation of child | 7 | $X_7$ |
| Diarrhea | 8 | $X_8$ |
| Child's morbidity | 9 | $X_9$ |
| Nutritional status | 10 | $X_{10}$ |
| -Weight for age | 10 | $X_{10W}$ |
| -Height for age | 10 | $X_{10H}$ |
| -Weight for height | 10 | $X_{10WH}$ |

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| Variables | Measurement |
|---|---|
| 1. Economic status of the household | Scores of assets in the households<br>Harvested land : paddy land, upland, gardening<br>Land tenure<br>Housing |
| 2. Mother's age | Mother's age (years) at the interviewed date |
| 3. Interval of pregnancy | Score of the interval of pregnancy |
| 4. Household's sanitation | Type of toilet<br>Use of toilet<br>Gabage disposal<br>Drinking water storage |
| 5. Immunization | Score of immunization acceptance<br>- B.C.G.<br>- D.P.T.<br>- Polio |
| 6. Food supplementation of child | Age at introduction of supplementary foods<br>- Rice<br>- Banana<br>- Meat<br>- Egg<br>- Fish<br>- Vegetables and Fruit<br>- Legume |

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| Variables | Measurement |
|---|---|
| | - Oil for cooking |
| 7. Parasitic infestation of child | Score of parasitic infestation |
| 8. Diarrhea | Score of diarrhea |
| 9. Child's morbidity | Score of child's morbidity |
| 10. Nutritional status | Percent of Thai standard<br>- Weight for age<br>- Height for age<br>- Weight for height |

3.5 Scores of Some Variables in the Model

The model choosen for this study was based on quantitative data then quantification of the qualitative data was done. Weight assigned to the responses of different variables are referred to as scores throughout this research. General rule to assign scores were as follows (Saber,1980) :

1. The higher the socio-economic value the higher was the score
2. The higher the nutritional status the higher was the score

Scores assigned to different responses of the variables are shown below.

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| Variable | Response | Score |
|---|---|---|
| Assets | Car | |
| | Has (1 or more) | 4 |
| | Does not have | 0 |
| | Motorcycle | |
| | Has (1 or more) | 2 |
| | Does not have | 0 |
| | Bicycle | |
| | Has (1 or more) | 1 |
| | Does not have | 0 |
| | Tractor | |
| | Has (1 or more) | 3 |
| | Does not have | 0 |
| | Boat | |
| | Has (1 or more) | 2 |
| | Does not have | 0 |
| | Sewing machine | |
| | Has (1 or more) | 1 |
| | Does not have | 0 |
| | Refrigerator | |
| | Has (1 or more) | 3 |
| | Does not have | 0 |
| | Water pump | |
| | Has (1 or more) | 2 |
| | Does not have | 0 |
| | Television | |

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| Variable | Response | Score |
|---|---|---|
| | Has (1 or more) | 3 |
| | Does not have | 0 |
| | Radio | |
| | Has (1 or more) | 1 |
| | Does not have | 0 |
| Harvested land : paddy land, upland,gardening | 1-19 Rai | 1 |
| | 20-40 Rai | 3 |
| | >40 Rai | 5 |
| Ownership of the land | Whole rent | 1 |
| | Partially rent | 2 |
| | Does not rent | 3 |
| | Does not rent and for rent partially | 4 |
| Housing | Temporary hut | 1 |
| | Wall : bamboo,grass,leaf Roof : grass,leaf | 2 |
| | Wall : bamboo,grass,leaf Roof : metal,tile | 3 |
| | Wall : wood or partly wood Roof : grass,leaf | 4 |
| | Wall : wood or partly wood Roof : metal,tile | 5 |

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| Variable | Response | Score |
|---|---|---|
| Interval of pregnancy (month) | 1-6 | 0 |
| | 7-12 | 1 |
| | 13-24 | 2 |
| | 25-72 | 3 |
| | >72 | 0 |
| | The first pregnancy | 3 |
| Type of toilet | Does not have | 0 |
| | Pit toilet | 1 |
| | Water seal toilet | 2 |
| Use of toilet | Never, occasionally | 0 |
| | Always | 2 |
| Gabage disposal | Throw away | 0 |
| | Burn | 1 |
| | Use as fertilizer | 3 |
| Drinking water storage (a kerosine can = 15 liters) | 0-5 | 0 |
| | 6-10 | 1 |
| | 11-30 | 2 |
| | 31-50 | 3 |
| | 51-100 | 4 |
| | >100 | 5 |
| Immunization | B.C.G. | |

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| Variable | Response | Score |
|---|---|---|
| | No | 0 |
| | Yes | 1 |
| | D.P.T. | |
| | No | 0 |
| | Yes | 1 |
| | Polio | |
| | No | 0 |
| | Yes | 1 |
| Age at introduction of supplementary foods (month) | Rice, Banana, Egg | |
| | <1 | 0 |
| | 1-2 | 0 |
| | 3-5 | 2 |
| | 6-12 | 1 |
| | >12 | 1 |
| | Meat, Fish, Legume, Vegetable & Fruit | |
| | <1 | 0 |
| | 1-2 | 0 |
| | 3-5 | 1 |
| | 6-12 | 2 |
| | >12 | 0 |
| | Oil for cooking | |
| | <1 | 0 |
| | 1-2 | 0 |

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| Variable | Response | Score |
|---|---|---|
| | 3-5 | 1 |
| | 6-12 | 2 |
| | >12 | 0 |
| Parasitic infes-tation | Has | 0 |
| | Does not have | 1 |
| Diarrhea | Has | 0 |
| | Does not have | 1 |
| Child's morbidity | Has | 0 |
| | Does not have | 1 |

3.6 Transformation

From the first examination of the model by the path analysis which using a multiple regression technique concerning about the assumptions of normality, linearity, and homoscedasticity from examining of residuals scatterplots found that the assumptions are violated. Data transformations are offered as a remedy to normalize the error distribution, to achieve greater constancy of variance and to reduce the strain on the other assumptions made in analyzing the data (Dolby, 1963; Bartlett, 1947). Then the variables transformation are considered and shown below.

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$$V_1 = \ln (X_1 + 1)$$
$$V_3 = 1/(X_3 + 1)$$
$$V_6 = 1/(X_6 + 1)$$

The results are presented in the next chapter.

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# CHAPTER IV

# RESULTS

In this study the results are divided into two parts. The first part consists of general characteristics of the samples, and the second part present the results of path analysis.

## 4.1 General Characteristics of the Samples

According to the descriptive profile of general characteristics of the samples, as shown in Table 2-3, it can be seen that among 181 children, 54.7 percent are males and 45.3 percent are females. The means of child's age is 19.77 months. Regarding the nutritional status of children in this group, the means weight for age, height for age, and weight for height are 90.39, 94.91, and 92.95 percent respectively. The mean age of 181 mothers of these children is 30.16 years.

Mean, standard deviation of scores from some variables in the model are shown in Table 4.

The scores of economic status of the household ranged from 5 to 26 points and the mean of this score is 12.33 points.

The mean score of interval of pregnancy is 2.23, ranged from 0-3 points.

The mean score of household's sanitation is 1.97, ranged from 0-9 points.

The mean score of immunization is 1.24 , ranged from 0-3 points.

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The mean score of food supplementation of child 3.10 and the range is from 0-13 points.

The mean scores of diarrhea, child's morbidity, and parasitic infestation of child are 0.67, 0.37, and 0.65 respectively. The range of these scores is 0-1 point.

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Table 2 General Characteristics of the Samples

| | Number | Percent |
|---|---|---|
| Sex | | |
| male | 99 | 54.70 |
| female | 82 | 45.30 |
| | Mean | Standard Deviation |
| Age (month) | 19.77 | 12.40 |

Table 3 Mean, Standard Deviation of Variables

| Variable | Mean | Standard deviation |
|---|---|---|
| Mother's age (year) | 30.16 | 7.55 |
| Nutritional status | | |
| Weight for age | 90.39 | 11.18 |
| Height for age | 94.91 | 4.98 |
| Weight for height | 92.95 | 8.43 |

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Table 4 Mean, Standard Deviation of Scores from Some Variables in the Model (n = 181)

| Variable | Mean | S.D. | Range |
|---|---|---|---|
| Economic status of the household | 12.33 | 2.99 | 5-26 |
| Interval of pregnancy | 2.23 | 1.06 | 0-3 |
| Household's sanitation | 1.97 | 1.92 | 0-9 |
| Immunization | 1.24 | 1.15 | 0-3 |
| Food supplementation of child | 3.10 | 3.37 | 0-13 |
| Diarrhea | 0.67 | 0.47 | 0-1 |
| Child's morbidity | 0.37 | 0.48 | 0-1 |
| Parasitic infestation | 0.65 | 0.48 | 0-1 |

## 4.2 The Results of Path Analysis

The path model uses 10 variables to describe the causal relations as shown in the conceptual frame work. Multiple regression analysis is a statistical method to determine path coefficients, T, $R^2$, standard error, and F of the equation. The results of data analysis from the path model in Figure 1 are shown in Table 5 and Figure 2-4.

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Table 5 Path Coefficient, T, $R^2$, Standard Error, and F of Equation for Hypothesized Paths.

| Structural equation | Path coefficient | | T | SIG. T | $R^2$ | Standard error | F of equation | SIG. F |
|---|---|---|---|---|---|---|---|---|
| $y_4 = b_0+b_1 v_1$ | $P_{41}$ | = 0.35 | 5.01 | 0.00 | 0.12 | 1.80 | 25.08 | 0.00 |
| $y_5 = b_0+b_1 v_1+b_2 x_2$ | $P_{51}$ | = 0.08 | 1.06 | 0.29 | | | | |
| | $P_{52}$ | = -0.06 | -0.81 | 0.42 | 0.01 | 1.15 | 0.95 | 0.39 |
| $y_6 = b_0+b_1 v_1$ | $P_{61}$ | = -0.16 | -2.18 | 0.03 | 0.03 | 0.33 | 4.75 | 0.03 |
| $y_7 = b_0+b_4 x_4$ | $P_{74}$ | = 0.06 | 0.75 | 0.45 | 0.00 | 0.48 | 0.57 | 0.45 |
| $y_8 = b_0+ b_4 x_4$ | $P_{84}$ | = -0.06 | -0.80 | 0.43 | 0.00 | 0.47 | 0.63 | 0.43 |
| $y_9 = b_0+b_1 v_1+b_4 x_4$ | $P_{91}$ | = 0.00 | 0.04 | 0.97 | | | | |
| $+b_5 x_5+b_6 v_6+b_7 x_7$ | $P_{94}$ | = -0.04 | -0.50 | 0.62 | | | | |
| | $P_{95}$ | = -0.13 | -1.64 | 0.10 | | | | |
| | $P_{96}$ | = -0.09 | -1.19 | 0.23 | | | | |
| | $P_{97}$ | = 0.23 | 3.10 | 0.00 | 0.08 | 0.47 | 3.03 | 0.013 |
| $y_{10W} = b_0+b_1 v_1+b_2 x_2+b_3 v_3$ | $P_{10W1}$ | = 0.08 | 1.08 | 0.28 | | | | |
| $+b_6 v_6+b_7 x_7+b_8 x_8+b_9 x_9$ | $P_{10W2}$ | = 0.02 | 0.20 | 0.84 | | | | |
| | $P_{10W3}$ | = 0.11 | 1.48 | 0.14 | | | | |
| | $P_{10W6}$ | = 0.11 | 1.42 | 0.16 | | | | |
| | $P_{10W7}$ | = 0.09 | 1.22 | 0.23 | | | | |
| | $P_{10W8}$ | = 0.09 | 1.19 | 0.23 | | | | |
| | $P_{10W9}$ | = 0.15 | 2.00 | 0.05 | 0.09 | 10.91 | 2.30 | 0.03 |

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Table 5 continue

| Structural equation | Path coefficient | T | SIG. T | $R^2$ | Standard error | F of equation | SIG. F |
|---|---|---|---|---|---|---|---|
| $y_{10H} = b_0+b_1 v_1+b_2 x_2+b_3 v_3 +b_6 v_6+b_7 x_7+b_8 x_8+b_9 x_9$ | $P_{10H1} = 0.05$ | 0.69 | 0.49 | | | | |
| | $P_{10H2} = -0.04$ | -0.55 | 0.58 | | | | |
| | $P_{10H3} = 0.06$ | 0.87 | 0.39 | | | | |
| | $P_{10H6} = 0.12$ | 1.61 | 0.11 | | | | |
| | $P_{10H7} = 0.19$ | 2.53 | 0.01 | | | | |
| | $P_{10H8} = 0.10$ | 1.27 | 0.21 | | | | |
| | $P_{10H9} = 0.15$ | 1.98 | 0.05 | 0.11 | 4.78 | 3.11 | 0.00 |
| $y_{10WH} = b_0+b_1 v_1+b_2 x_2 +b_3 v_3+b_6 v_6+b_7 x_7 +b_8 x_8+b_9 x_9$ | $P_{10WH1} = 0.15$ | 1.93 | 0.06 | | | | |
| | $P_{10WH2} = -0.02$ | -0.27 | 0.79 | | | | |
| | $P_{10WH3} = 0.10$ | 1.27 | 0.21 | | | | |
| | $P_{10WH6} = 0.01$ | 0.18 | 0.86 | | | | |
| | $P_{10WH7} = 0.04$ | 0.52 | 0.61 | | | | |
| | $P_{10WH8} = -0.01$ | -0.12 | 0.91 | | | | |
| | $P_{10WH9} = 0.05$ | 0.64 | 0.53 | 0.04 | 8.44 | 0.92 | 0.49 |

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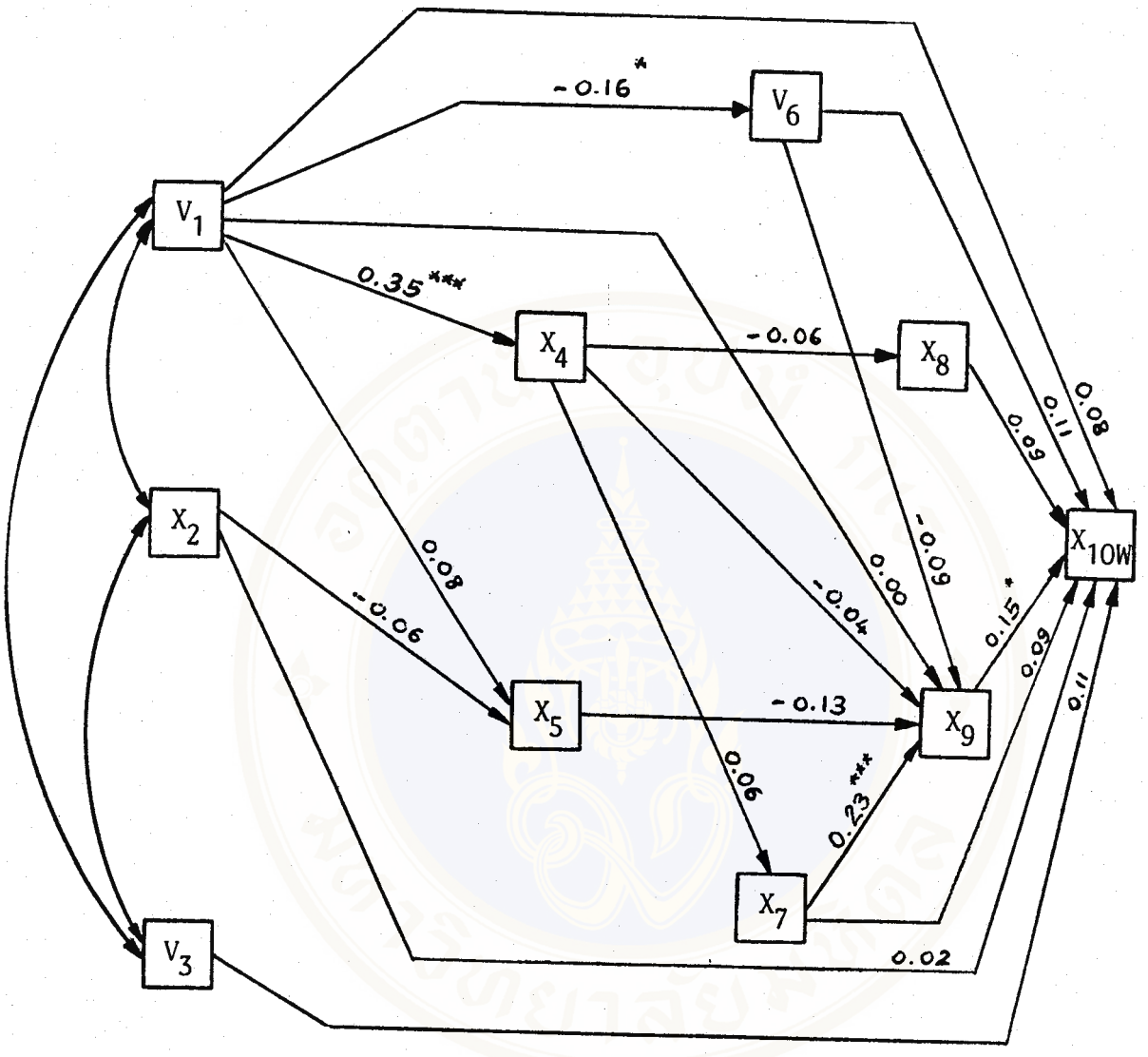


* Significance at $\alpha$ = 0.05

** Significance at $\alpha$ = 0.01

*** Significance at $\alpha$ = 0.001

Figure 2 An Original Path Model of Factors Affecting Nutritional Status : Weight for Age of Children Age under 48 Months in Agricultural Households, Warin Chamrap District, Ubon Ratchathani Province, 1981.

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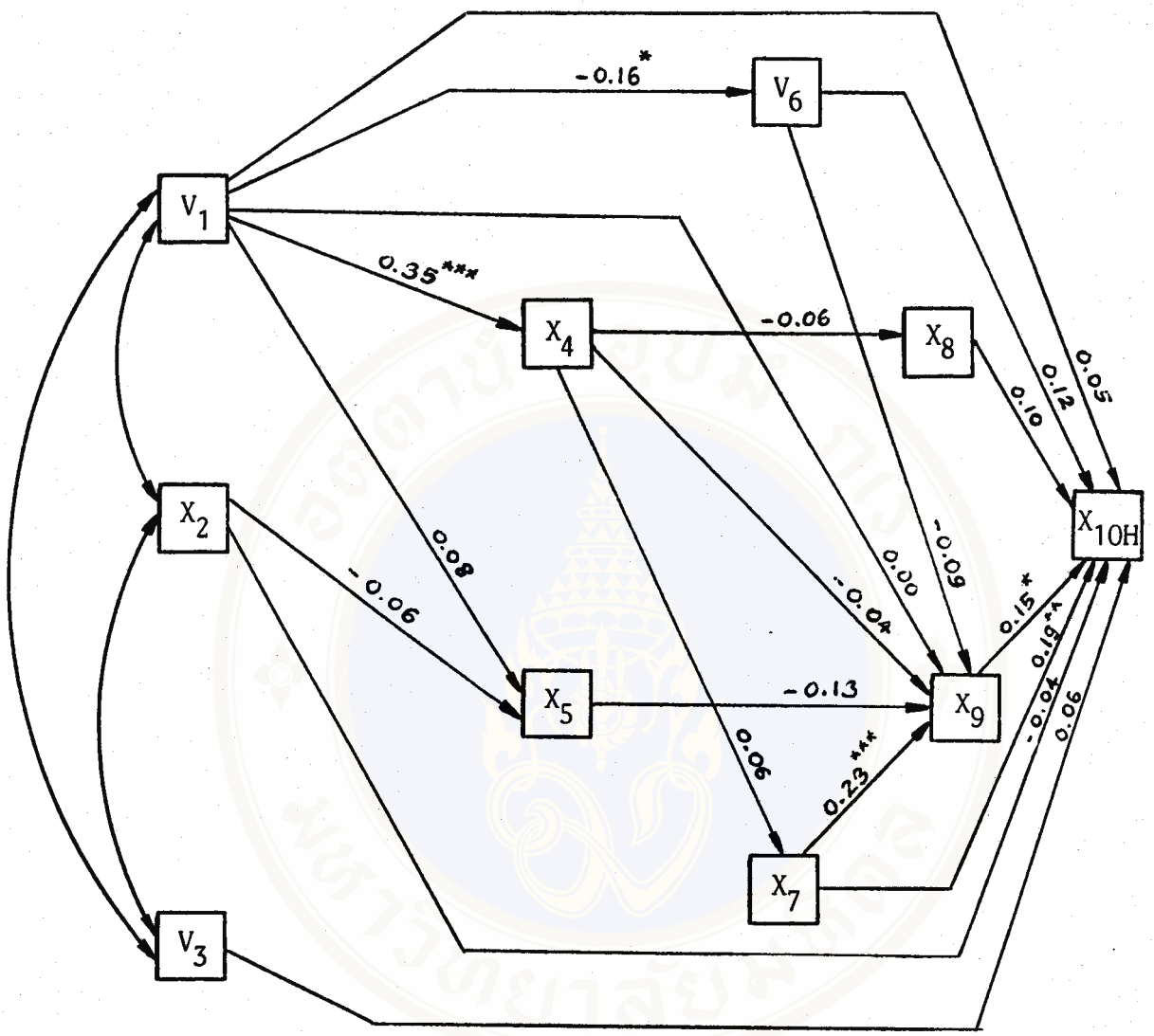


* Significance at $\alpha$ = 0.05

** Significance at $\alpha$ = 0.01

*** Significance at $\alpha$ = 0.001

Figure 3 An Original Path Model of Factors Affecting Nutritional Status : Height for Age of Children Age under 48 Months in Agricultural Households, Warin Chamrap District, Ubon Ratchathani Province, 1981.

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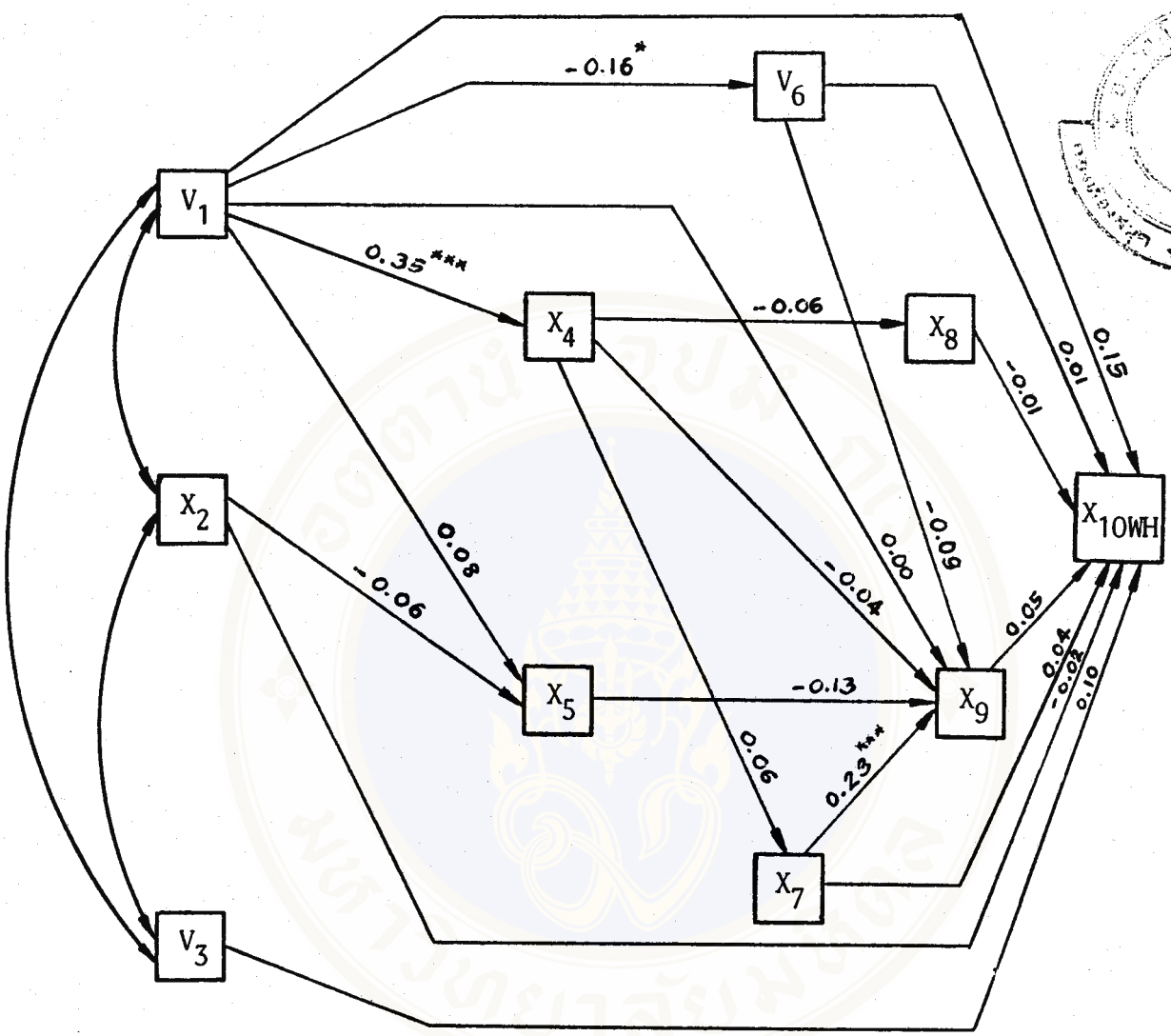


* Significance at $\alpha$ = 0.05

** Significance at $\alpha$ = 0.01

*** Significance at $\alpha$ = 0.001

Figure 4 An Original Path Model of Factors Affecting Nutritional Status : Weight for Height of Children Age under 48 Months in Agricultural Households, Warin Chamrap District, Ubon Ratchathani Province, 1981.

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The researcher will adopt a path model when path coefficients are satisfied with two conditions. First, T value must be significant at $\alpha = 0.05$ ( Sig. $T < 0.05$ ). Secondly, the value of the path coefficients having a significance must be greater than 0.05.

So, a second path analysis is then performed using only paths which are significant and greater than 0.05. The results of the recomputation are presented in Table 6. It should be noted that the path coefficients in Table 5 and 6 are relatively similar, thus the elimination of nonsignificance paths have little effect on the magnitude of the significance paths. As shown in Table 6, all path coefficients are satisfied with two conditions, resulting in the conclusion that the second path model (Figure 5-7) is the best suitable one.

The researcher classified the associations between variables into total causal association of original model and total causal association of reduced model. The calculation of total causal association of the reduced model are completely reported in Appendix. The results are summarized in Table 6 and Table 7.

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Table 6 Recomputed Significant Path Coefficient, T, $R^2$, Standard Error, and F of Equation for Hypothesized Paths.

| Structural equation | Path coefficient | | T | SIG. T | $R^2$ | Standard error | F of equation | SIG. F |
|---|---|---|---|---|---|---|---|---|
| $y_4 = b_0+b_1 v_1$ | $P_{41}$ | = 0.35 | 5.01 | 0.00 | 0.12 | 1.80 | 25.08 | 0.00 |
| $y_5 = b_0+b_1 v_1+b_2 x_2$ | $P_{51}$ | = 0.08 | 1.06 | 0.29 | | | | |
| | $P_{52}$ | = -0.06 | -0.81 | 0.42 | 0.01 | 1.15 | 0.95 | 0.39 |
| $y_6 = b_0+b_1 v_1$ | $P_{61}$ | = -0.16 | -2.18 | 0.03 | 0.03 | 0.33 | 4.75 | 0.03 |
| $y_7 = b_0+b_4 x_4$ | $P_{74}$ | = 0.06 | 0.75 | 0.45 | 0.00 | 0.48 | 0.57 | 0.45 |
| $y_8 = b_0+b_4 x_4$ | $P_{84}$ | = -0.06 | -0.80 | 0.43 | 0.00 | 0.47 | 0.63 | 0.43 |
| $y_9 = b_0+b_5 x_5+b_6 v_6$ | $P_{95}$ | = -0.13 | -1.79 | 0.08 | | | | |
| $+b_7 x_7$ | $P_{96}$ | = -0.09 | -1.24 | 0.22 | | | | |
| | $P_{97}$ | = 0.22 | 3.09 | 0.00 | 0.08 | 0.47 | 5.00 | 0.00 |
| $y_{10w} = b_0+b_1 v_1+b_3 v_3+b_6 v_6$ | $P_{10W1}$ | = 0.08 | 1.07 | 0.29 | | | | |
| $+b_7 x_7+b_8 x_8+b_9 x_9$ | $P_{10W3}$ | = 0.11 | 1.54 | 0.13 | | | | |
| | $P_{10W6}$ | = 0.11 | 1.43 | 0.16 | | | | |
| | $P_{10W7}$ | = 0.09 | 1.22 | 0.22 | | | | |
| | $P_{10W8}$ | = 0.09 | 1.21 | 0.23 | | | | |
| | $P_{10W9}$ | = 0.15 | 2.00 | 0.05 | 0.09 | 10.87 | 2.70 | 0.02 |

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Table 6 continue

| Structural equation | Path coefficient | T | SIG. T | $R^2$ | Standard error | F of equation | SIG. F |
|---|---|---|---|---|---|---|---|
| $y_{10H} = b_0+b_1 v_1+b_3 v_3+b_6 v_6 +b_7 x_7+b_8 x_8+b_9 x_9$ | $P_{10H1} = 0.05$ | 0.73 | 0.46 | | | | |
| | $P_{10H3} = 0.06$ | 0.79 | 0.43 | | | | |
| | $P_{10H6} = 0.12$ | 1.60 | 0.11 | | | | |
| | $P_{10H7} = 0.19$ | 2.52 | 0.01 | | | | |
| | $P_{10H8} = 0.09$ | 1.24 | 0.22 | | | | |
| | $P_{10H9} = 0.15$ | 2.00 | 0.05 | 0.11 | 4.77 | 3.59 | 0.00 |
| $y_{10WH} = b_0+b_1 v_1+b_3 v_3 +b_9 x_9$ | $P_{10WH1} = 0.15$ | 2.00 | 0.05 | | | | |
| | $P_{10WH3} = 0.09$ | 1.28 | 0.20 | | | | |
| | $P_{10WH9} = 0.06$ | 0.77 | 0.44 | 0.03 | 8.35 | 2.06 | 0.11 |

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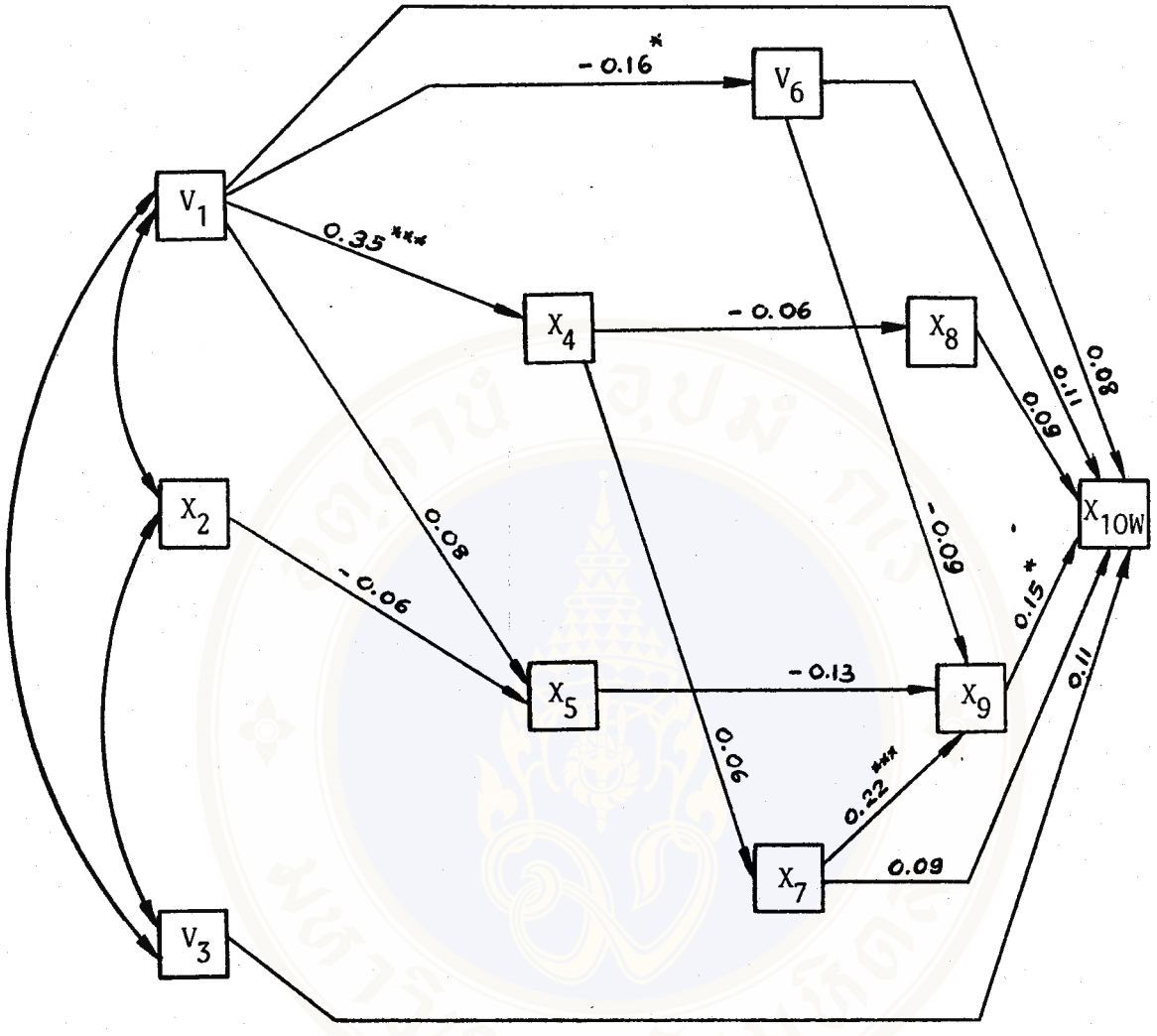


* Significance at $\alpha = 0.05$

** Significance at $\alpha = 0.01$

*** Significance at $\alpha = 0.001$

Figure 5 A Reduced Path Model of Significant Path Coefficients of Factors Affecting Nutritional Status : Weight for Age of Children Age under 48 Months in Agricultural Households, Warin Chamrap District, Ubon Ratchathani Province, 1981.

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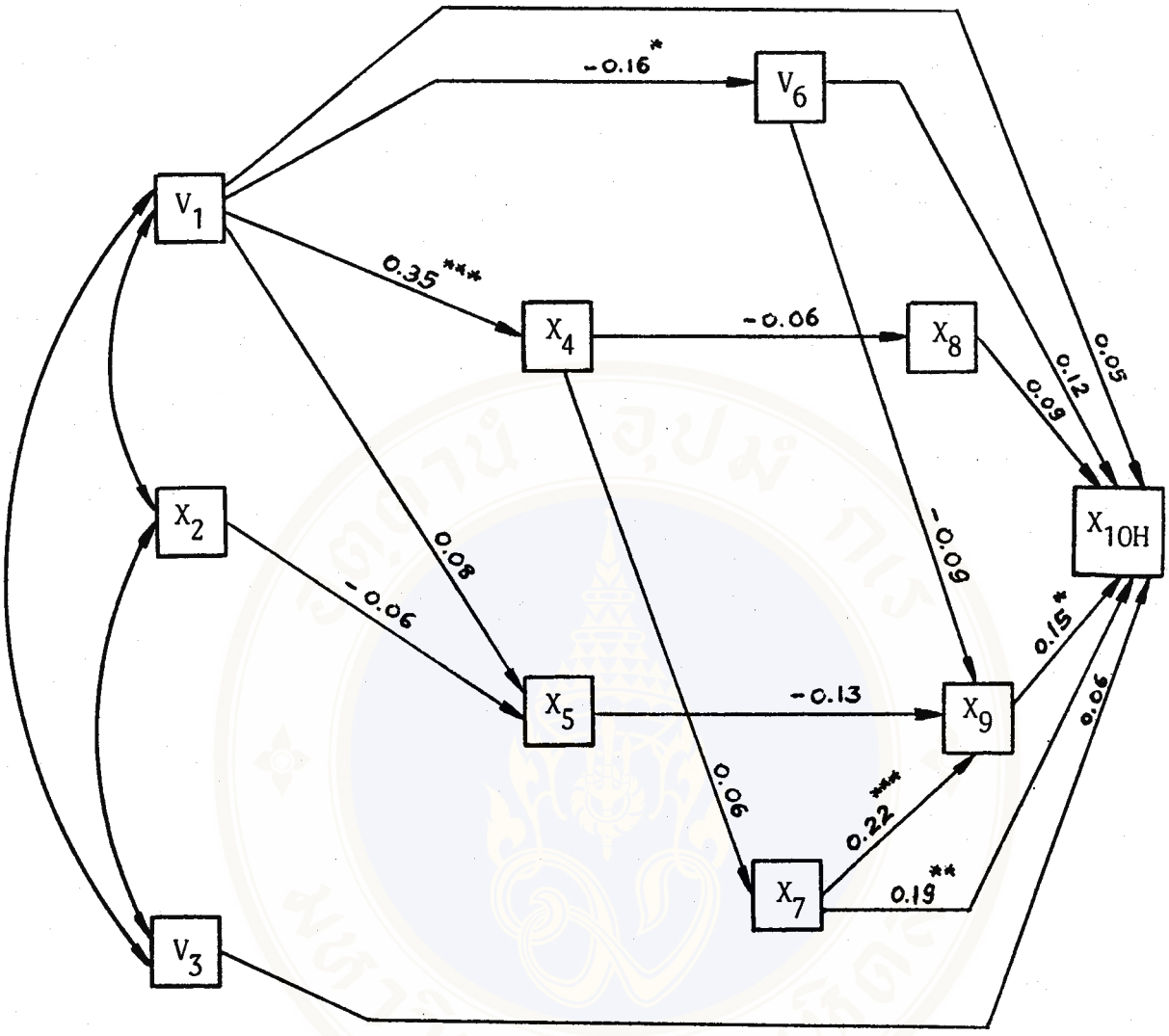


* Significance at $\alpha$ = 0.05

** Significance at $\alpha$ = 0.01

*** Significance at $\alpha$ = 0.001

Figure 6 A Reduced Path Model of Significant Path Coefficients of Factors Affecting Nutritional Status : Height for Age of Children Age under 48 Months in Agricultural Households, Warin Chamrap District, Ubon Ratchathani Province, 1981.

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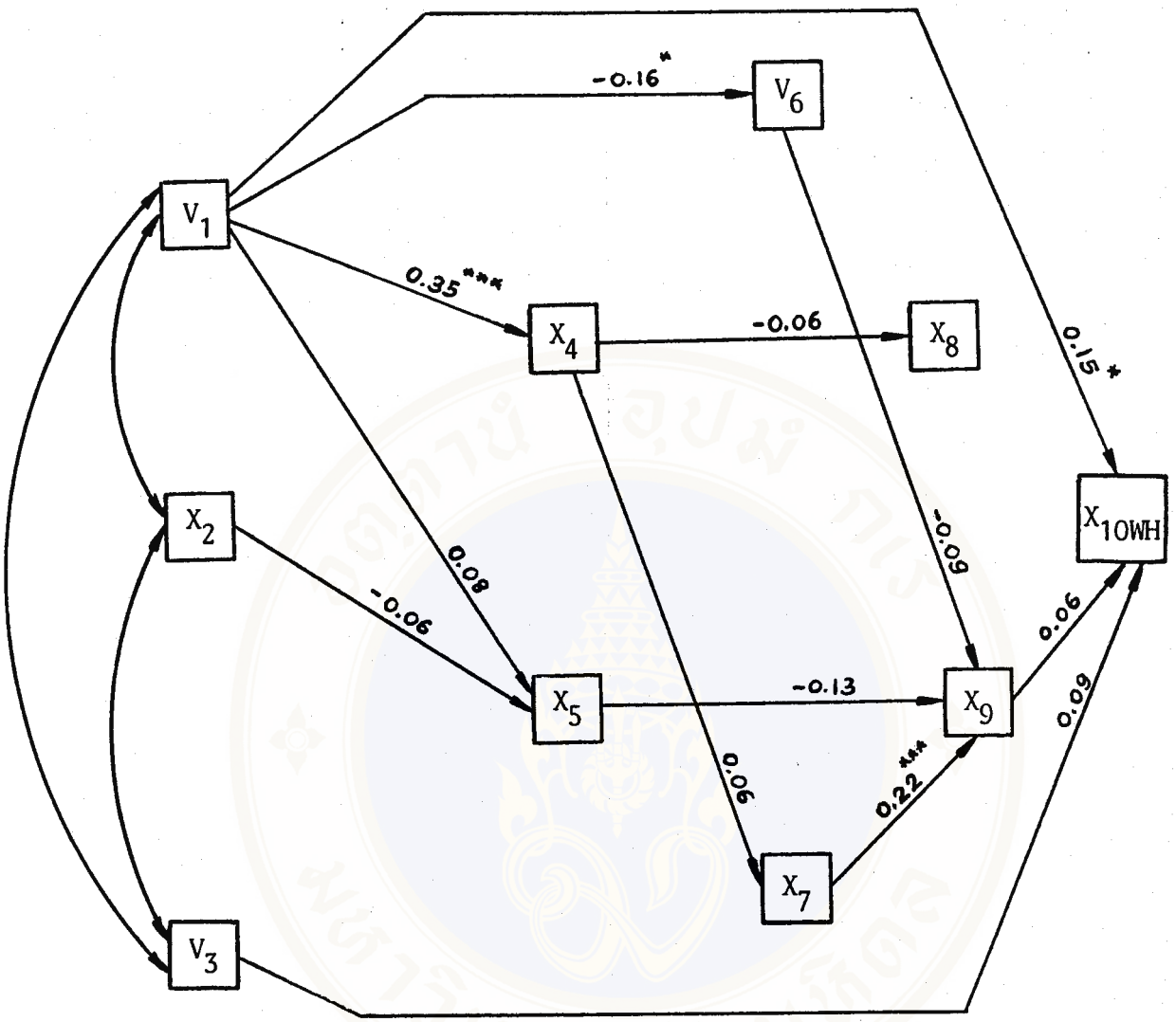


* Significance at $\alpha$ = 0.05

** Significance at $\alpha$ = 0.01

*** Significance at $\alpha$ = 0.001

Figure 7 A Reduced Path Model of Significant Path Coefficients of Factors Affecting Nutritional Status : Weight for Height of Children Age under 48 Months in Agricultural Households, Warin Chamrap District, Ubon Ratchathani Province, 1981.

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Table 7 Classification of Type of Association Between Variables

| Type of Association Association Between Variables | Total Causal Association of Original Model | Total Causal Association of Reduced Model | | | Difference between original and reproduced correlation |
|---|---|---|---|---|---|
| | | Direct Effect | Indirect Effect | Total | |
| $X_4$ $V_1$ | 0.35 | 0.35 | 0.00 | 0.35 | 0.00 |
| $X_5$ $V_1$ | 0.08 | 0.08 | 0.00 | 0.08 | 0.00 |
| $X_5$ $X_2$ | -0.07 | -0.06 | -0.01 | -0.07 | 0.00 |
| $V_6$ $V_1$ | -0.16 | -0.16 | 0.00 | -0.16 | 0.00 |
| $X_7$ $X_4$ | -0.05 | -0.05 | 0.00 | -0.05 | 0.00 |
| $X_8$ $X_4$ | 0.06 | 0.06 | 0.00 | 0.06 | 0.00 |
| $X_9$ $X_5$ | 0.14 | 0.13 | 0.00 | 0.13 | 0.01 |
| $X_9$ $V_6$ | 0.06 | 0.09 | 0.00 | 0.09 | -0.03 |
| $X_9$ $X_7$ | 0.24 | 0.22 | 0.00 | 0.22 | 0.02 |
| $X_{10W}$ $V_1$ | 0.08 | 0.08 | -0.02 | 0.06 | 0.02 |
| $X_{10W}$ $V_3$ | 0.12 | 0.11 | 0.00 | 0.11 | 0.01 |
| $X_{10W}$ $V_6$ | 0.07 | 0.11 | -0.02 | 0.09 | -0.02 |
| $X_{10W}$ $X_7$ | 0.16 | 0.09 | 0.01 | 0.10 | -0.06 |
| $X_{10W}$ $X_8$ | 0.14 | 0.09 | 0.01 | 0.10 | -0.04 |
| $X_{10W}$ $X_9$ | 0.20 | 0.15 | 0.01 | 0.16 | -0.04 |

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Table 7 continue

| Type of Association Association Between Variables | Total Causal Association of Original Model | Total Causal Association of Reduced Model | | | Difference Between Original and Reproduced Correlation |
|---|---|---|---|---|---|
| | | Direct Effect | Indirect Effect | Total | |
| $X_{10H}$ $V_1$ | 0.06 | 0.05 | -0.02 | 0.03 | 0.03 |
| $X_{10H}$ $V_3$ | 0.07 | 0.06 | 0.00 | 0.06 | 0.01 |
| $X_{10H}$ $V_6$ | 0.08 | 0.12 | -0.01 | 0.11 | -0.03 |
| $X_{10H}$ $X_7$ | 0.25 | 0.19 | 0.01 | 0.20 | -0.05 |
| $X_{10H}$ $X_8$ | 0.16 | 0.09 | 0.00 | 0.09 | -0.07 |
| $X_{10H}$ $X_9$ | 0.21 | 0.15 | 0.01 | 0.16 | -0.05 |
| $X_{10WH}$ $V_1$ | 0.14 | 0.15 | 0.00 | 0.15 | -0.01 |
| $X_{10WH}$ $V_3$ | 0.09 | 0.09 | -0.01 | 0.08 | 0.01 |
| $X_{10WH}$ $X_9$ | 0.07 | 0.06 | 0.01 | 0.07 | 0.00 |

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The findings of the study of factors affecting nutritional status of children age under 48 months in agricultural households, Warin Chamrap district, Ubon Ratchathani province by path analysis are as follows :

1) Economic Status of the Household ($V_1$)

Economic status of the household ($V_1$) has a direct effect as shown by path coefficients (p) on household's sanitation ($X_4$) ($p_{41}$ = 0.35), immunization ($X_5$) ($p_{51}$ = 0.08), food supplementation of child ($V_6$) ($p_{61}$ = -0.16) and nutritional status indicated by weight for age ($X_{10W}$), height for age ($X_{10H}$), weight for height ($X_{10WH}$) ($p_{10W1}$ = 0.08, $p_{10H1}$ = 0.05, $p_{10WH1}$ = 0.15). As can be seen from the path coefficients, the better economic status of any given household associates with the better household's sanitation. In the same way, the household with good economic status more awares of immunization than another, and has a better weight for age, height for age, and weight for height. On the contrary, economic status of the household has a negative direct effect on food supplementation of child indicates that the household with good economic status was found inadequate supplementation of the child.

Economic status of the household could explain the variations in household's sanitation only 12 percent, and in food supplementation of child only 3%.

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2) Mother's Age ($X_2$)

Age of mother has a direct effect on immunization ($X_5$) with the negative path coefficient being -0.06. An explanation for this relationship is that immunization is low while the age of the mother is high. The value of the indirect effect of this variable on immunization is -0.01.

3) Interval of Pregnancy ($V_3$)

Interval of pregnancy has a direct effect on nutritional status indicated by weight for age ($X_{10W}$), height for age ($X_{10H}$), and weight for height ($X_{10WH}$) with the positive path coefficients being 0.11, 0.06, and 0.09 respectively. These path coefficients indicate that the higher scores of interval of pregnancy lead to the better nutritional status indicated by weight for age, height for age, and weight for height.

4) Household's Sanitation ($X_4$)

Household's sanitation has a positive direct effect on parasitic infestation ($X_7$) ($p_{74}$ = 0.06) and negative direct effect on diarrhea ($X_8$) ($p_{84}$ = -0.06). These results indicate that the low incidence of parasitic infestation is found, while the household sanitation is good. But the relationship is conversely found between the evidence of diarrhea. the scores of parasitic infestation rise.

Household's sanitation could not explain the

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variations in parasitic infestation and diarrhea.

5) Immunization ($X_5$)

Immunization as an independent variable has a negative direct effect on child's morbidity ($X_9$) ($p_{95}$ = -0.13). That is the children who have even been immunized could be found to be sick.

Immunization as a dependent variable is directly affected by economic status of the household and mother's age. These variables could explain the variations in immunization fairly low.

6) Food Supplementation of Child ($V_6$)

Food supplementation of child has a positive direct effect on nutritional status indicated by weight for age ($p_{10W6}$ = 0.11), height for age ($p_{10H6}$ = 0.12). These results indicate that the weight for age, and height for age to be high, as the scores of food supplementation of child rise. The value of the indirect effect of this variable on weight for age and height for age are -0.02, and -0.01 respectively.

Conversely, food supplementation of child has a negative direct effect on child's morbidity ($X_9$) ($p_{96}$ = -0.09) indicates that the higher scores of food supplementation, the lower scores of child's morbidity they have.

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7) Parasitic Infestation of Child ($X_7$)

Parasitic infestation of a child has a direct effect on child's morbidity and nutritional status which is indicated by weight for age, height for age. The positive path coefficients are 0.22, 0.09, and 0.19 successively. These path coefficients show that the parasite free children have better nutritional status. And they also show the poor rate of morbidity. The value of the indirect effect of this variable on weight for age and height for age are -0.01, and -0.01.

8) Diarrhea ($X_8$)

Diarrhea has a positive direct effect on nutritional status indicated by weight for age ($X_{10}$) ($p_{10W8}$ = 0.09) and height for age ($X_{10H}$) ($p_{10H8}$ = 0.09). These path coefficients show that the children who have better nutritional status are less suffering from diarrhea. The value of the indirect effect of this variable on weight for age is 0.01.

9) Child's Morbidity ($X_9$)

Child's morbidity has a positive direct effect on nutritional status indicated by weight for age ($p_{10W9}$ = 0.15), height for age ($p_{10H9}$ = 0.15), and weight for height ($p_{10WH9}$ = 0.06). These show that the child who is less morbid leads to the better nutritional status . The value of the indirect effect of this variable on weight for age, height for age, and weight for

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height are equal to 0.01.

Child's morbidity as a dependent variable is directly affected by immunization, food supplementation, and parasitic infestation. These variables could explain the variations in child's morbidity only 8 percent.

10) Nutritional Status ($X_{10}$)

10.1) Weight for Age ($X_{10W}$)

Weight for age is affected by, in order of importance, child's morbidity ($p_{10W9}$ = 0.15), interval of pregnancy ($p_{10W3}$ = 0.11), food supplementation of child ($p_{10W6}$ = 0.11), parasitic infestation ($p_{10W7}$ = 0.09), diarrhea ($p_{10W8}$ = 0.09), and economic status of the household ($p_{10W1}$ = 0.08). Those variables could explain the variations in weight for age only 9 percent.The indirect effects values of them are economic status of the household, food supplementation of child, parasitic infestation, diarrhea, and child's morbidity on weight for age are -0.02, -0.02, -0.01, 0.01, and 0.01 respectively.

10.2) Height for Age ($X_{10H}$)

Height for age is affected by, in order of importance, parasitic infestation ($p_{10H7}$ = 0.19), child's morbidity ($p_{10H9}$ = 0.15), food supplementation of child ($p_{10H6}$ = 0.12), diarrhea ($p_{10H8}$ = 0.09), interval of pregnancy ($p_{10H3}$ = 0.06), and economic status of the household ($p_{10H1}$ = 0.05). The value of the indirect effects of economic status of the household, food supple-

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mentation of child, parasitic infestation, and child's morbidity on height for age are -0.02, -0.01, 0.01, and 0.01 respectively. Those variables could explain the variations in height for age 11 percent.

10.3) Weight for Height ($X_{10WH}$)

Weight for height is affected by, in order of importance, economic status of the household ($p_{10WH1}$ = 0.15), interval of pregnancy ($p_{10WH3}$ = 0.09), and child's morbidity ($p_{10WH9}$ = 0.06). The value of indirect effects of interval of pregnancy and child's morbidity are -0.01 and 0.01. Those variables could explain the variations in weight for height only 3 percent.

In conclusion, regarding to the test of the hypotheses in this study, the first hypothesis is partially supported by this result as shown in Table 8. Child's morbidity, food supplementation of child, interval of pregnancy, diarrhea, parasitic infestation, and economic status of the household are the factors directly affecting the nutritional status of the child indicated by weight for age and height for age. With regard to the weight for height, the findings show economic status of the household, interval of pregnancy, and child's morbidity are direct factors. But mother's age, food supplementation and parasitism are unexpected classified as indirect effects. The mother's age in particular, is also indirect factor of the other two anthropometric indicators i.e. weight for age and height for age.

The second hypothesis is also supported by this result as shown in Table 9, that is household's sanitation and

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immunization are indirect factors of the nutritional status of the child.

Table 8 Comparison of the Factors Directly Affecting the Nutritional Status Between Hypothesis and Results of the Study

| Hypothesis of the study | Results of the study | | |
|---|---|---|---|
| | W/A | H/A | W/H |
| Child's morbidity | yes | yes | yes |
| Diarrhea | yes | yes | - |
| Food supplementation of child | yes | yes | - |
| Parasitic infestation | yes | yes | - |
| Economic status of the household | yes | yes | yes |
| Interval of pregnancy | yes | yes | yes |
| Mother's age | - | - | - |

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Table 9 Comparison of the Factors Indirectly Affecting the Nutritional Status Between Hypothesis and Results of the Study

| Hypothesis of the study | Results of the study | | |
|---|---|---|---|
| | W/A | H/A | W/H |
| Household's sanitation | yes | yes | yes |
| Immunization | yes | yes | yes |
| | Mother's age | Mother's age | Mother's age |
| | | | Food supplementation |
| | | | Parasitic infestation |

## 4.3 Validity Test of the Path Model

After we adopt the best suitable path model, we have tested validity of the path model. The criteria is the discrepancies between the original and the reproduced correlations must be small ( $< 0.05$ ). As shown in Table 7 ( p.44-45 ), total causal association of original model is the original correlation and total causal association of reduced model is the

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reproduced correlation ( see Appendix ). The results of the study showed that most of the difference between the original and the reproduced correlations are less than or equal to 0.05. However, there are two paths that the discrepancies between the original and the reproduced correlations are greater than 0.05. Those are the paths from parasitic infestation of child to weight for age, and diarrhea to height for age. These errors are small when compared with all paths. Thus, we can conclude that the more parsimonious model ( Figure 5-7 ) can reasonably represent the old one.

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# CHAPTER V

# DISCUSSION SUMMARY AND CONCLUSIONS

## 5.1 Discussion

As a tool of nutritional assessment, there are advantages and disadvantages in all 3 measurements and more can be recommended singly.

Weight for age is the simplest indicator, however using a single value can be misleading since a stunted child with chronic or past malnutrition cannot be distinguished from the case of current or acute malnutrition.

Height for age on the other hand, is usually less sensitive to change in growth than weight but can measure past or chronic undernutrition.

Weight for height has the advantage because of its independent nature and it is useful in the assessment of populations where age is uncertain. It indicates current nutritional status and reflects the extent to which the individual is acutely malnourished (Keller, Donoso, and DeMaeyer,1976).

After going through the path analysis and previous knowledge of each nutritional status parameter, in conclusion there are different sets of the direct factors having influence on different nutritional status parameters.

The results of this study confirm the finding of Bhumisawad and Charoenyooth (1983). That is child's morbidity and diarrhea affect the nutritional status ( weight for age, height for age ). This finding also supported by the study of Pigott and

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Kolasa (1979) and Zainah, et al. (1983). That is food supplementation of child has an effect on nutritional status. Swenson (1978, 1984) indicated that the interval of pregnancy directly affect the nutritional status. This pattern is also supported by this study. Furthermore, results of this study confirm the findings of Wray and Aguirre (1969); Grewal, et al. (1973); Rawson and Valverde (1976); Tontisirin, et al. (1977); Martorell, et al. (1984) that economic status of the household directly affect the nutritional status.

In this study, data from a village level where many factors seem to be very homogeneous in many aspects. For instance, a lot of samples ( 70% ) have the household's sanitation scores range between 0 and 1, and 70 percent of the children don't have the episode of diarrhea; additionally most of scores of food supplementation and the scores of child's immunization line between 0-3. From this results it can be inferred that because of the homogeneous of these variables, the household's sanitation could not explain the variations in diarrhea and parasitic infestation of child.

In addition. household's sanitation, immunization, and mother's age are indirect factors affecting nutritional status indicated by weight for age. height for age, and weight for height; moreover, food supplementation of child and parasitic infestation are also the indirect factors affecting weight for height.

In this study, the finding shows the reverse result i.e. the child who has even been vaccinated is found to be sick. This odd result may due to record of imunization is focused on B.C.G., D.P.T. and Polio. But the most frequent of child's

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morbidity are diarrhea and upper respiratory infection which those immunization do not prevent the children from these infections. the child who has even been vaccinated is found to be sick. Thus, the vaccination child has been given a score even if an ctual condition he can not tolerate to infection.

It is an unexpected results that the mother's age has indirectly related to nutritional status of her child. Using the weight for height index, for instance, the explanation is done as follow. To begin with, the younger mother awares of immunization of her child. In addition to the explanation above, therefore the child having been vaccinated may not be wasted due to decreasing of morbidity. Eventually the conclusion is that the younger mother with awareness of immunization should have healthy child. Similarly, the discussion is done for the food supplementation and parasitism in connection to the occurence of wasting.

The second unexpected result is that the child being supplemented has the evidence of sickness. Again, this probably due to the record of food distribution and nutrition education of mother. Distribution did not follow whether the child has eaten such a supplementary food. Thus false supplementation was recorded. The resumption is that food supplementation may reduce morbidity. The final peculiar finding is the household with good economic status was found inadequate supplementation of the child. Perhaps the knowledge, attitude, and practice of his mother is one of the contributing factors.

Since this study is performed on the uses of secondary data aimed to be a baseline data for comparing the

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effects of integrated health, nutrition education plus food supply and income generation on nutritional status of infant and preschool children. There are some limitations in the availability of expected informations. Some of them may not well suited to be used as causal explaination study. However, this study is a first step in the path related to nutritional status of children under 48 months in Ubon Ratchthani province, Northeast of Thailand. Nevertheless, even with these limitations, we have achieved a preliminary understanding of the interrelationships among our selected variables within the Northeast villages.

## 5.2 Summary and Conclusions

In this study. first. focussed on the influence of direct and indirect effects of factors affecting nutritional status of children under the age of fourty-eight months. Secondly, constructing an appropriate path model for explaining causal relationships among the causal factors and nutritional status. The samples in this research were 350 youngest children in the family which age were under 48 months from agricultural households in eight villages, Warin Chamrap district, Ubon Ratchathani province. The data were collected by using a questionnaire. Finally, from those 350 children, 181 children have the complete information of all variables that used in this analysis. By using path analysis, the causal model included economic status of the household. mother's age, interval of pregnancy as the exogeneous variables. The endogeneous variables consisted of household's sanitation. immunization, food supplementation of child, parasitic infestation of child, diarrhea, child's morbidity. The ultimate dependent

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variable was nutritional status of children which was measured in different three categories as weight for age, height for age, and weight for height.

The results obtained from path model under this study indicated that

5.2.1) The six variables have direct effects on nutritional status indicated by weight for age which the path coefficients of direct and indirect effects are shown in Table 10. These six variables could explain the variations in weight for age only 9 percent.

5.2.2) Regarding height for age as an ultimate dependent variable, there are six variables have a direct effects on height for age. The path coefficients of direct and indirect effects of these variables are shown in Table 11. These six variables could explain the variations in height for age 11 percent.

5.2.3) There are three variables have a direct effects on nutritional status indicated by weight for height which the path coefficients of direct and indirect effects are shown in Table 12. These three variables could explain the variations in weight for height only 3 percent.

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Table 10 Comparison of the Effects of Six Variables Affecting the Nutritional Status : Weight for Age

| Variable | Direct Effect | Indirect Effect |
|---|---|---|
| Child's morbidity | 0.15 | 0.01 |
| Food supplementation of child | 0.11 | -0.02 |
| Interval of pregnancy | 0.11 | 0.00 |
| Diarrhea | 0.09 | 0.01 |
| Parasitic infestation | 0.09 | 0.01 |
| Economic status of the household | 0.08 | -0.02 |

$R^2 = 0.09$

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Table 11 Comparison of the Effects of Six Variables Affecting the Nutritional Status : Height for Age

| Variable | Direct Effect | Indirect Effect |
|---|---|---|
| Parasitic infestation | 0.19 | 0.01 |
| Child's morbidity | 0.15 | 0.01 |
| Food supplementation of child | 0.12 | -0.01 |
| Diarrhea | 0.09 | 0.00 |
| Interval of pregnancy | 0.06 | 0.00 |
| Economic status of the household | 0.05 | -0.02 |
| $R^2 = 0.11$ | | |

Table 12 Comparison of the Effects of Three Variables Affecting the Nutritional Status : Weight for Height

| Variable | Direct Effect | Indirect Effect |
|---|---|---|
| Economic status of the household | 0.15 | 0.00 |
| Interval of pregnancy | 0.09 | -0.01 |
| Child's morbidity | 0.06 | 0.01 |
| $R^2 = 0.03$ | | |

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On the whole, the models could explain the variations in nutritional status very low this is because there are external variables could explain the variations in nutritional status, such as, food intake, food habits, nutrition education of mother, and the remaining unknown factors. Therefore, further research should be carried out.

## 5.3 Recommendations

Finding in this research should be used as a guide for those who have to make decisions about the distribution and effective use of scarce resources. The decisions usually relate to planning of services or management and evaluation of existing program.

Though, in this study used the secondary data and emphasized on only agricultural households and at a village level where many factors seem to be very homogeneous. Since our analysis is a first step in the path analysis related to nutritional status of children age under 48 months in the Northeast of Thailand, and preparing some scores of the factors. We may make the suggestion that future research should design the questionnaire in order to measure the true scale of the interested variables, and try to modify the scoring technique. As mentioned in the conclusion, there will be the other factors that directly and indirectly affect nutritional status. To search these factors and the causal paths which affect the nutritional status, the further research should to be conduct in macro level such as in the region and the design of

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research should be the longitudinal studies or at least to be the case-control study. Since we recognize that the longitudinal studies are more costly and difficult to carry out than are cross-sectional ones, but the results will off course, portray more true picture than that by cross-sectional data.

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# APPENDIX

In order to find total causal association ($r_{ij}$) of factors affecting nutritional status a multiple regression technique is applied to compute path coefficients (Figure 5-7, p. 42-44 ). Expressing all variables in standard form (Z score), the equations are as follows :

$$Z_1 = e_1 = 0$$

$$Z_2 = e_2 = 0$$

$$Z_3 = e_3 = 0$$

Variables 1 to 3 have zeros as the path coefficients because they are exogeneous variables, or independents and do not have residuals to them.

Household's sanitation ( $X_4$ )

$$Z_4 = p_{41}Z_1 + e_4$$

$$r_{14} = p_{41}$$

$$= 0.35$$

Child's immunization ( $X_5$ )

$$Z_5 = p_{51}Z_1 + p_{52}Z_2 + e_5$$

$$r_{15} = p_{51} + p_{52}r_{12}$$

$$= 0.08 + (-0.06)(-0.07)$$

$$= 0.08$$

$$r_{25} = p_{51}r_{12} + p_{52}$$

$$= (0.08)(-0.07) + (-0.06)$$

$$= -0.07$$

Food supplementation of child ($X_6$)

$$Z_6 = p_{61}Z_1 + e_6$$

$$r_{16} = p_{61}$$

$$= -0.16$$

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Parasitic infection of child ($X_7$)

$$Z_7 = p_{74}Z_4 + e_7$$

$$r_{47} = p_{74}$$

$$= -0.05$$

Diarrhea ($X_8$)

$$Z_8 = p_{84}Z_4 + e_8$$

$$r_{48} = p_{84}$$

$$= 0.06$$

Child's illness ($X_9$)

$$Z_9 = p_{95}Z_5 + p_{96}Z_6 + p_{97}Z_7 + e_9$$

$$r_{59} = p_{95} + p_{96}\, p_{61}\, r_{15} + p_{97}\, p_{74}\, p_{41}\, r_{15}$$

$$= 0.13 + (0.09)(-0.16)(0.08) + (0.22)(-0.05)(0.35)(0.08)$$

$$= 0.13$$

$$r_{69} = p_{95}\, p_{51}\, r_{16} + p_{95}\, p_{52}\, r_{26} + p_{96} + p_{97}\, p_{74}\, p_{41}\, r_{16}$$

$$= (0.13)(0.08)(-0.16) + (0.13)(-0.06)(0.02) + 0.09 + (0.22)(-0.05)(0.35)(-0.16)$$

$$= 0.09$$

$$r_{79} = p_{95}\, p_{51}\, r_{17} + p_{95}\, p_{52}\, r_{27} + p_{96}\, p_{61}\, r_{17} + p_{97}$$

$$= (0.13)(0.08)(-0.06) + (0.13)(-0.06)(-0.04) + (0.09)(-0.16)(-0.06) + 0.22$$

$$= 0.22$$

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Nutritional Status ( weight for age : $X_{10W}$ )

$$Z_{10} = p_{101} Z_1 + p_{103} Z_3 + p_{106} Z_6 + p_{107} Z_7 + p_{108} Z_8 + p_{109} Z_9 + e_{10}$$

$$r_{110} = p_{101} + p_{103} r_{13} + p_{106} p_{61} + p_{107} p_{74} p_{41} + p_{108} p_{84} p_{41} + p_{109} p_{95} p_{51} + p_{109} p_{95} p_{52} r_{12} + p_{109} p_{96} p_{61} + p_{109} p_{97} p_{74} p_{41}$$

$$= 0.08 + (0.11)(-0.05) + (0.11)(-0.16) + (-0.09)(-0.05)(0.35) + (-0.09)(0.06)(0.35) + (-0.15)(0.13)(0.08) + (-0.15)(0.13)(-.06)(-0.07) + (-0.15)(0.09)(-0.16) + (-0.15)(0.22)(-0.05)(0.35)$$

$$= 0.06$$

$$r_{310} = p_{101}r_{13} + p_{103} + p_{106}p_{61}r_{13} + p_{107} p_{74}p_{41}r_{13} + p_{108}p_{84}p_{41}r_{13} + p_{109} p_{95}p_{51}r_{13} + p_{109}p_{95}p_{52}r_{23} + p_{109} p_{96}p_{61}r_{13} + p_{109}p_{97}p_{74}p_{41}r_{13}$$

$$= (0.08)(-0.05) + 0.11 + (0.11)(-0.16)(-0.05) + (-0.09)(-0.05)(0.35)(-0.05) + (-0.09)(0.06)(0.35)(-0.05) + (-0.15)(0.13)(0.08)(-0.05) + (-0.15)(0.13)(-0.06)(0.18) + (-0.15)(0.09)(-0.16)(-0.05) + (-0.15)(0.22)(-0.05)(0.35)(-0.05)$$

$$= 0.11$$

$$r_{610} = p_{101}r_{16} + p_{103}r_{36} + p_{106} + p_{107} p_{74}p_{41}r_{16} + p_{108}p_{84}p_{41}r_{16} + p_{109}$$

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$$p_{95}p_{51}r_{16} + p_{109}p_{95}p_{52}r_{26} + p_{109}$$
$$p_{96}p_{61}r_{16} + p_{109}p_{97}p_{74}p_{41}r_{16}$$
$$= (0.08)(-0.16) + (0.11)(-0.02) +$$
$$(0.11) + (-0.09)(-0.05)(0.35)$$
$$(-0.16) + (-0.09)(0.06)(0.35)$$
$$(-0.16) + (-0.15)(0.13)(0.08)$$
$$(-0.16) + (-0.15)(0.13)(-0.06)$$
$$(0.02) + (-0.15)(0.09)(-0.16)$$
$$(-0.16) + (-0.15)(0.22)(-0.05)$$
$$(0.35)(-0.16)$$
$$= 0.09$$

$$r_{710} = p_{101}r_{17} + p_{103}r_{37} + p_{106}p_{61}r_{17} +$$
$$p_{107} + p_{108}p_{84}p_{41}r_{17} + p_{109}p_{95}$$
$$p_{51}r_{17} + p_{109}p_{95}p_{52}r_{27} + p_{109}p_{96}$$
$$p_{61}r_{17} + p_{109}p_{97}p_{74}p_{41}r_{17}$$
$$= (0.08)(0.06) + (0.11)(0.06) +$$
$$(0.11)(-0.16)(0.06) + (0.09) +$$
$$(0.09)(0.06)(0.35)(0.06) +$$
$$(0.15)(0.13)(0.08)(0.06) +$$
$$(0.15)(0.13)(-0.06)(0.04) +$$
$$(0.15)(0.09)(-0.16)(0.06) +$$
$$(0.15)(0.22)(-0.05)(0.35)(0.06)$$
$$= 0.10$$

$$r_{810} = p_{101}r_{18} + p_{103}r_{38} + p_{106}p_{61}r_{18} +$$
$$p_{107}p_{74}p_{41}r_{18} + p_{108} + p_{109}p_{95}$$
$$p_{51}r_{18} + p_{109}p_{95}p_{52}r_{28} + p_{109}p_{96}$$
$$p_{61}r_{18} + p_{109}p_{97}p_{74}p_{41}r_{18}$$
$$= (0.08)(0.12) + (0.11)(-0.01) +$$
$$(0.11)(-0.16)(0.12) + (0.09)$$

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$$(-0.05)(0.35)(0.12) + (0.09) +$$
$$(0.15)(0.13)(0.08)(0.12) +$$
$$(0.15)(0.13)(-0.06)(0.04) +$$
$$(0.15)(0.09)(-0.16)(0.12) +$$
$$(0.15)(0.22)(-0.05)(0.35)(0.12)$$
$$= 0.10$$

$$r_{910} = p_{101}r_{19} + p_{103}r_{39} + p_{106}p_{61}r_{19} + p_{107}p_{74}p_{41}r_{19} + p_{108}p_{84}p_{41}r_{19} + p_{109}$$
$$= (0.08)(0.01) + (0.11)(0.08) + (0.11)(-0.16)(0.01) + (0.09)$$
$$(-0.05)(0.35)(0.01) + (0.09)$$
$$(0.06)(0.35)(0.01) + (0.15)$$
$$= 0.16$$

Nutritional Status ( height for age : $X_{10H}$ )

$$Z_{10} = p_{101}Z_1 + p_{103}Z_3 + p_{106}Z_6 + p_{107}Z_7 + p_{108}Z_8 + p_{109}Z_9 + e_{10}$$

$$r_{110} = p_{101} + p_{103}r_{13} + p_{106}p_{61} + p_{107} p_{74}p_{41} + p_{108}p_{84}p_{41} + p_{109}p_{95}p_{51} + p_{109}p_{95}p_{52}r_{12} + p_{109}p_{96}p_{61} + p_{109} p_{97}p_{74}p_{41}$$
$$= (0.05) + (0.06)(-0.05) + (0.12)$$
$$(-0.16) + (-0.19)(-0.05)(0.35) +$$
$$(-0.09)(0.06)(0.35) + (-0.15)$$
$$(0.13)(0.08) + (-0.15)(0.13)$$
$$(-0.06)(-0.07) + (-0.15)(0.09)$$
$$(-0.16) + (-0.15)(0.22)(-0.05)$$
$$(0.35)$$
$$= 0.03$$

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$$r_{310} = p_{101}r_{13} + p_{103} + p_{106}p_{61}r_{13} + p_{107}$$
$$p_{74}p_{41}r_{13} + p_{108}p_{84}p_{41}r_{13} + p_{109}$$
$$p_{95}p_{51}r_{13} + p_{109}p_{95}p_{52}r_{23} + p_{109}$$
$$p_{96}p_{61}r_{13} + p_{109}p_{97}p_{74}p_{41}r_{13}$$
$$= (0.05)(-0.05) + 0.06 + (0.12)$$
$$(-0.16)(-0.05) + (-0.19)(-0.05)$$
$$(0.35)(-0.05) + (-0.09)(0.06)$$
$$(0.35)(-0.05) + (-0.15)(0.13)$$
$$(0.08)(-0.05) + (-0.15)(0.13)$$
$$(-0.06)(0.18) + (-0.15)(0.09)$$
$$(-0.16)(-0.05) + (-0.15)(0.22)$$
$$(-0.05)(0.35)(-0.05)$$
$$= 0.06$$

$$r_{610} = p_{101}r_{16} + p_{103}r_{36} + p_{106} + p_{107}$$
$$p_{74}p_{41}r_{16} + p_{108}p_{84}p_{41}r_{16} + p_{109}$$
$$p_{95}p_{51}r_{16} + p_{109}p_{95}p_{52}r_{26} + p_{109}$$
$$p_{96}p_{61}r_{16} + p_{109}p_{97}p_{74}p_{41}r_{16}$$
$$= (0.05)(-0.16) + (0.06)(-0.02) +$$
$$(0.12) + (-0.19)(-0.05)(0.35)$$
$$(-0.16) + (-0.09)(0.06)(0.35)$$
$$(-0.16) + (-0.15)(0.13)(0.08)$$
$$(-0.16) + (-0.15)(0.13)(-0.06)$$
$$(0.02) + (-0.15)(0.09)(-0.16)$$
$$(-0.16) + (-0.15)(0.22)(-0.05)$$
$$(0.35)(-0.16)$$
$$= 0.11$$

$$r_{710} = p_{101}r_{17} + p_{103}r_{37} + p_{106}p_{61}r_{17} +$$
$$p_{107} + p_{108}p_{84}p_{41}r_{17} + p_{109}p_{95}$$
$$p_{51}r_{17} + p_{109}p_{95}p_{52}r_{27} + p_{109}p_{96}$$

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$$p_{61}r_{17} + p_{109}p_{97}p_{74}p_{41}r_{17}$$

$$= (0.05)(0.06) + (0.06)(0.06) + (0.12)(-0.16)(0.06) + (0.19) + (0.09)(0.06)(0.35)(0.06) + (0.15)(0.13)(0.08)(0.06) + (0.15)(0.13)(-0.06)(0.04) + (0.15)(0.09)(-0.16)(0.06) + (0.15)(0.22)(-0.05)(0.35)(0.06)$$

$$= 0.20$$

$$r_{810} = p_{101}r_{18} + p_{103}r_{38} + p_{106}p_{61}r_{18} + p_{107}p_{74}p_{41}r_{18} + p_{108} + p_{109}p_{95}p_{51}r_{18} + p_{109}p_{95}p_{52}r_{28} + p_{109}p_{96}p_{61}r_{18} + p_{109}p_{97}p_{74}p_{41}r_{18}$$

$$= (0.05)(0.12) + (0.06)(-0.01) + (0.12)(-0.16)(0.12) + (0.19)(-0.05)(0.35)(0.12) + (0.09) + (0.15)(0.13)(0.08)(0.12) + (0.15)(0.13)(-0.06)(0.04) + (0.15)(0.09)(-0.16)(0.12) + (0.15)(0.22)(-0.05)(0.35)(0.12)$$

$$= 0.09$$

$$r_{910} = p_{101}r_{19} + p_{103}r_{39} + p_{106}p_{61}r_{19} + p_{107}p_{74}p_{41}r_{19} + p_{108}p_{84}p_{41}r_{19} + p_{109}$$

$$= (0.05)(0.01) + (0.06)(0.08) + (0.12)(-0.16)(0.01) + (0.19)(-0.05)(0.35)(0.01) + (0.09)$$

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$$(0.06)(0.35)(0.01) + (0.15)$$

$$= 0.16$$

Nutritional Status ( weight for height : $X_{10WH}$ )

$$Z_{10} = p_{101}Z_1 + p_{103}Z_3 + p_{109}Z_9 + e_{10}$$

$$r_{110} = p_{101} + p_{103}r_{13} + p_{109}p_{95}p_{51} + p_{109}p_{95}p_{52}r_{12} + p_{109}p_{96}p_{61} + p_{109}p_{97}p_{74}p_{41}$$

$$= (0.15) + (0.09)(-0.05) + (-0.06)(0.13)(0.08) + (-0.06)(0.13)(-0.06)(-0.07) + (-0.06)(0.09)(-0.16) + (-0.06)(0.22)(-0.05)(0.35)$$

$$= 0.15$$

$$r_{310} = p_{101}r_{13} + p_{103} + p_{109}p_{95}p_{51}r_{13} + p_{109}p_{95}p_{52}r_{23} + p_{109}p_{96}p_{61}r_{13} + p_{109}p_{97}p_{74}p_{41}r_{13}$$

$$= (0.15)(-0.05) + (0.09) + (-0.06)(0.13)(0.08)(-0.05) + (-0.06)(0.13)(-0.06)(0.18) + (-0.06)(0.09)(-0.16)(-0.05) + (-0.06)(0.22)(-0.05)(0.35)(-0.05)$$

$$= 0.08$$

$$r_{910} = p_{101}r_{19} + p_{103}r_{39} + p_{109}p_{109}p_{96}p_{61}$$

$$= (0.15)(0.01) + (0.09)(0.08) + (0.06)$$

$$= 0.07$$

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Table A-1 Original Correlations for Variables in the Model

| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ | $X_9$ | $X_{10W}$ | $X_{10H}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $X_2$ | -0.07 | | | | | | | | | | |
| $X_3$ | -0.05 | 0.18 | | | | | | | | | |
| $X_4$ | 0.35 | -0.10 | 0.06 | | | | | | | | |
| $X_5$ | 0.08 | -0.07 | 0.00 | 0.19 | | | | | | | |
| $X_6$ | -0.16 | 0.02 | -0.02 | -0.01 | -0.23 | | | | | | |
| $X_7$ | 0.06 | 0.04 | 0.06 | 0.05 | -0.11 | -0.01 | | | | | |
| $X_8$ | 0.12 | 0.04 | -0.01 | -0.06 | -0.02 | -0.11 | 0.18 | | | | |
| $X_9$ | 0.01 | 0.00 | 0.08 | -0.05 | -0.14 | -0.06 | 0.24 | 0.23 | | | |
| $X_{10W}$ | 0.08 | 0.04 | 0.12 | 0.00 | -0.13 | 0.07 | 0.16 | 0.14 | 0.20 | | |
| $X_{10H}$ | 0.06 | -0.02 | 0.07 | -0.03 | -0.16 | 0.08 | 0.25 | 0.16 | 0.21 | 0.61 | |
| $X_{10WH}$ | 0.14 | -0.01 | 0.09 | 0.03 | -0.05 | -0.02 | 0.06 | 0.02 | 0.07 | 0.64 | -0.08 |

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