Development of Screening Indicators for Ranking Areas at Risk of Vitamin A Deficiency in Thailand

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Abstract

The objective of this study was to develop community based screening indicators for identifying areas at risk of vitamin A deficiency. Three hundred children aged 24-71 months in 12 villages of 3 provinces who were previously identified to have various degrees of vitamin A deficiency were randomly selected to participate in the study. These villages were located in Songkhla, Yala and Narathiwat provinces. Data collection included anthropometric measurements, serum retinol analysis, data on dietary intake, illness, and socioeconomic status. Subsamples of 120 children were taken for Modified Relative Dose Response. Statistics used for data analysis were factor analysis, discriminant analysis and Receiver Operating Characteristic curves. Sensitivity and specificity of the screening indicators were calculated and compared with the rate of vitamin A deficiency at $\geq$ 15 per cent of children with serum retinol < 0.70 µmol/l.

Findings revealed that the screening indicators could identify areas at risk of vitamin A deficiency with 83.3 per cent efficiency. Data to be used for identifying areas at risk of vitamin A deficiency included home and land ownership for agriculture, dietary intake of vitamin A, access to social services (maternal education and antenatal care), vaccination, infectious diseases (diarrhoea and upper respiratory tract infection with fever) and nutritional status.

Key word : Screening Indicators, Vitamin A Deficiency Disorders, Areas at Risk of Vitamin A Deficiency, Thailand

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Vitamin A Deficiency Disorders (VADD) caused by insufficient vitamin A or provitamin A consumption in the diet adversely affects young children, leads to xerophthalmia, blindness, weakens innate and acquired host defenses, exacerbates infection and increase the risk of death(1,2). The present analysis indicates that there are about 127 million and 4.4 million preschool children with vitamin A deficiency (serum retinol < 0.70 μmol/L or displaying abnormal impression cytology) and xerophthalmia, respectively(3).

A review of the available vitamin A deficiency prevalence data in Thailand indicated a declining trend in the severity of vitamin A deficiency and the xerophthalmia cases occurred in pocket areas over the past decade. The basic community based approaches for solving vitamin A deficiency included dietary diversification and quality improvement (a long-term and sustainable strategy), fortification of food (an interim measure), and supplementation (a short-term control). In addition to, the aforementioned intervention programmes to combat vitamin A deficiency, complementary strategies were recommended(4-9). Lessons learned from the experience on the eruption of active xerophthalmic cases in the districts of a southernmost region and Omkoi district, a northern region because "the tip of the ice-berg" which underlines the importance of cost-effectiveness in order to curb the problem in time.

Since then, considering a large population is considered "at risk of vitamin A deficiency" any breakthrough in tackling the high risk areas for emergency action will be vitally important. There are several indicators for identifying vitamin A deficiency of the community, serum retinol is the most widely used method for the biological indicators. The disadvantages of biological indicators may limit the application in some developing countries due to high expense and excessively sophisticated instruments with the requirement of advanced training personnel (10). There is, thus, an urgent need to provide community based screening indicators to identify vitamin A deficiency areas at high risk in support of criterion of biological indicators.

This study, therefore, aimed at developing community based screening indicators and a scoring system for identifying areas at risk of vitamin A deficiency in Thailand.

MATERIAL AND METHOD

Population and sample

Based on a previous study in 1996(11), 300 children aged 24-71 months were selected by estimated proportion(12). 12 villages were purposively selected from Songkhla, Yala and Narathiwat provinces. These provinces were known to have various degrees at risk of vitamin A deficiency(4,11). 25 households with children 24-71 months of age from each village were randomly selected. When there was more than one eligible child from each household, the youngest one was selected.

Research instruments and measured

Community-based screening indicators were developed from the current indicators derived from WHO, 1996 and the XX International Vitamin A Consultative Group (IVACG) meeting in Hanoi, Vietnam in February 2001(10,13) and parameters of vitamin A status assessment among the target areas from previous surveys(4,11). The protocol was approved by the Committee on Human Rights related to Research Involving Human Subjects, Mahidol University. It was a cross sectional study. The data collection was done during the early rainy season (August 2002) which included anthropometric measurement, serum retinol analysis, dietary intake, illness and socioeconomic by interview. Sub-samples of 120 children were taken for Modified Relative Dose Response. Retinol (R) and dehydroretinol (DR) were measured by high-performance liquid chromatograph (HPLC).

Data analysis

Statistics used for data analysis were factor analysis, discriminant analysis and Receiver Operating Characteristic (ROC curves). Sensitivity and specificity of the screening indicators were calculated and compared with the rate of vitamin A deficiency classified by ≥ 15 per cent of children with serum retinol < 0.70 μmol/L.

RESULTS

Selection for the screening indicators and function

Factor analysis was used for lineage of the 41 observed variables into potential indicators. This method could select 8 potential indicators. Further discriminant analysis was used to delineate the highly potential 6 screening indicators and forming a linear function.

Screening indicators to be used for identification of areas at risk of vitamin A included home and land ownership for agriculture, dietary intake of vitamin A, access to social service (maternal education and antenatal care), vaccination, infectious diseases (diarrhoea and upper respiratory tract infection with fever) and nutritional status.

The discriminant function was the screening indicators score (D).

D = 10.00 + (0.5 X ownership of home and land for agriculture indicators) + (0.5 X dietary intake of vitamin A indicator) + (0.4 X access to social service indicators) + (0.3 X vaccine indicator) - (0.3 X infectious diseases indicators) + (0.3 X nutritional status indicators)

To establish the cut-off points of each screening indicator in order to separate areas at high risk of vitamin A deficiency from areas at low risk of vitamin A deficiency, a ROC (Receiving Operating Characteristic) curve was drawn. The curve showed the balance between sensitivity and specificity, built by the representation of sensitivity and by (1-specificity)

ROC curve could be widely applied in defining the primary cut-off points of children and secondary cut-off points of areas at high risk of vitamin A deficiency (Table 1).

Scoring system

The data were based on the cut-off point of each screening indicator for high risk areas of vitamin A deficiency. Used all incidental percentages or prevalences to transform the scores for each screening indicator (Table 2). The score of each screening indicator was 1 or (-1).

The scores for each screening indicator were added up to give the screening indicators score (D). The cutting score of these screening indicators was 10. For the classified group, after calculation of the screening indicators score had been established, the screening indicators score and the cutting score were compared. If the screening indicators score in each area was less than the cutting score (10.00), then the areas were classified in to high risk of vitamin A deficiency. The efficiency of identification was 83.3 per cent correct.

DISCUSSION

One of most the important screening indicators of high risk of vitamin A deficiency is lack of

Table 1. Incidental prevalences of the screening indicators defining areas at high risk of vitamin A deficiency.

Screening indicator	Incidental prevalence (%)
Nutrition and diet-related	
Dietary intake of vitamin A	
Score of Modified Dietary Assessment (MDA) < 80 scores (<50% of Thai recommended dietary allowances of vitamin A)	≥ 25
Protein energy malnutrition (< -2SD from standard curve of Thai population)	
Underweight	≥ 15
Stunting	≥ 25
Wasting	≥ 5
Illness related	
Vaccine	
Incomplete immunization	≥ 10
Infectious disease	
Fever	≥ 55
Diarrhoea	≥ 10
Socioeconomic status	
Ownership of home and land for agriculture	
The absence of home ownership	≥ 20
The inadequate access to land ownership for agriculture (< 0.5 Rai)	≥ 25
Access to social service	
Illiterate mother	≥ 10
Mother had not received ante natal care from a primary care unit	≥ 5

Table 2. The scoring system for areas at risk of vitamin A deficiency.

Screening indicator	Incidental percentage/ prevalence (%)	Score
Nutrition and diet-related		
Dietary intake of vitamin A		
Score of Modified Dietary Assessment (MDA) ≥ 80 scores (≥ 50% of Thai recommended dietary allowances of vitamin A)	> 75	1
	≤ 75	-1
Nutritional status (> -2SD from standard curve of Thai population)		
Weight for age	> 85	1
	≤ 85	-1
Height for age	> 75	1
	≤ 75	-1
Weight for height	> 95	1
	≤ 95	-1
Illness related		
Vaccine		
Complete immunization	> 90	1
	≤ 90	-1
Infectious disease		
Upper respiratory tract infection with fever	≥ 55	1
	< 55	-1
Diarrhoea (DIARR)	≥ 10	1
	< 10	-1
Socioeconomic status		
Ownership of home and land for agriculture		
Home ownership	> 80	1
	≤ 80	-1
Adequate access to land ownership for agriculture (≥ 0.5 Rai)	> 75	1
	≤ 75	-1
Access to social service		
Literate mother	> 90	1
	≤ 90	-1
Mother had received ante natal care from primary care unit	> 95	1
	≤ 95	-1

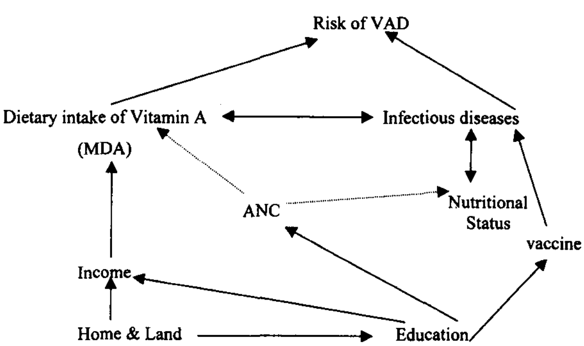

Fig. 1. The appraisal of the screening indicators utilization.

access to home and land for agriculture. Support for houses from governmental and non governmental agencies, as well as from community fund groups, contribute to the health of households and communities. Landless agriculture labourers and their households, who often receive food as wages which is often an irregular and uncertain food source, are among those most threatened by food insecurity. Education empowers people to participate in decisions effecting their health benefits. The formal education indicator, especially of the mother, is a particularly powerful discriminant of children at risk of vitamin A deficiency (Fig. 1).

Utilization of antenatal care service may be a part in shaping good maternal and child health outcomes. The ease with which the mother can reach facilities is also important.

Table 3. Community Based Vitamin Deficiency Disorder screening tool (CB-VADD tool).

Screening indicators for identifying areas at risk of vitamin A deficiency.

Primary care unit........ Subdistrict...............District...............Province............

Date.............

Name of village	Number of total children (24-71 Months)	Number of reported children (24-71 months)	The screening indicators																				
			H.own		L.own		MDA		ANC		EDU		EPI		URI		DIARR		NUTR		TOTAL	Areas of VADD	
			%	score	%	score	%	score	%	score	%	score	%	score	%	score	%	score	%	score	Scores	Low	High
Total																							

Calculate total scores for each village

To practice, use the data on the scoring system. Classify whether the village is high risk of vitamin A deficiency or not. For the classified group, the scores for each screening indicator were added up and calculated total scores of the screening indicators (D). If the total scores in each village was less than 10.00, then the areas were classified into high risk of vitamin A deficiency.

$$D = 10 + .5\,(\text{H.own or L.own}) + .5\,(\text{MDA}) + .4\,(\text{ANC or EDU}) + .3\,(\text{EPI}) - .3\,(\text{URI or DIARR}) + .3\,(\text{NUTR})$$

Many studies showed that the socioeconomic indicator and the possession of home and land ownership were the main socioeconomic indicators of people in Thai communities(14,15). Mother's education and coverage of health care services were significant determinants of child survival in many studies(16-18).

Reducing the incidence of infectious diseases improves vitamin A status of serum retinol levels because infection, in addition to causing losses of vitamin A, increase vitamin A utilization in the immune system, decrease food intake and interfere with vitamin A absorption(1). Serum levels of acute phase protein rise in response to significant infections resulting in suppression of the synthesis of transport proteins like albumin and retinol binding protein (RBP) by hepatocytes in relation to decreasing serum retinol(19).

Immunizations to prevent infectious diseases is essential. Immunization against measles has been shown to result in symptomless, minimal invasion of the cornea. In Thailand, as well as other developing countries, measles and vitamin A deficiency are known to explain the xerophthalmic cases in rural areas.

The cut-off value for defining underweight was < - 2SD. Thus, growth faltering becomes an important sign for early detection and it becomes the screening indicator of the children that determines the risk of vitamin A deficiency or prevention of severe vitamin A deficiency. In most children vitamin A deficiency was due to low dietary intake(1). However, this is neither due to the constraints on availability of food sources nor to the economy of some groups of the rural population of southernmost Thailand but to the ignorance about nutritive values and the advantage of eating food rich in vitamin A(20). Dietary vitamin A intake on the score of the Modified Dietary Assessment; MDA can be used as the screening indicator to identify risk of vitamin A deficiency and also provide useful information for planning and implementation of a food based program as well as nutrition education strategies.

In conclusion, the observed variables in the present study that made up the screening indicators were themselves associated with the risk of vitamin A deficiency. The importance of the screening indicator depended on the degree of association (the weight) with the risk of vitamin A deficiency. The purpose of the scoring system was to permit the classification of areas into different risks of vitamin A deficiency.

Therefore, it is recommended that the Community Based Vitamin A Deficiency Disorders (CB-VADD) tool (Table 3) be available at all health offices of primary care units for establishing a data base that will help them to focus their attention on public health problems. Some of the screening indicators could be obtained from existing surveillance reports. The highest efficiency of the tool was derived when the scores were based on a combination of all screening indicators, it is therefore, important to be aware of the limitations of some screening indicators. Consequently, the CB-VADD tool could provide intervention beneficial to those who are in a less fortunate population. Ultimately, this system will be able to monitor the progress of the prevention and promotion programs of vitamin A deficiency.

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การพัฒนาตัวชี้วัดเพื่อคัดกรองพื้นที่เสี่ยงต่อการขาดวิตามินเอในประเทศไทย

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การศึกษานี้มีวัตถุประสงค์ เพื่อพัฒนากลุ่มตัวชี้วัดที่ช่วยในการคัดกรองพื้นที่เสี่ยงต่อการขาดวิตามินเอ กลุ่มตัวอย่างได้จากการสุ่มตัวอย่างแบบง่ายจากเด็กวัยก่อนเรียน อายุ 24-71เดือน จำนวน 300 คน ใน 12 หมู่บ้านของ 3 จังหวัดภาคใต้ตอนล่างของประเทศไทย ซึ่งผลการศึกษาในอดีตพบว่ามีระดับภาวะเสี่ยงต่อการขาดวิตามินเอที่แตกต่างกัน ได้แก่จังหวัดสงขลา ยะลาและนราธิวาส การรวบรวมข้อมูลประกอบด้วย การชั่งน้ำหนักและวัดส่วนสูง เพื่อประเมินภาวะการขาดสารอาหารโปรตีนและพลังงาน การใช้แบบสอบถามมารดาหรือผู้เลี้ยงดูเด็กเกี่ยวกับการบริโภคอาหารวิตามินเอ ประวัติสุขภาพเด็กและข้อมูลพื้นฐานของครอบครัว การตรวจวิเคราะห์ทางชีวเคมีของระดับวิตามินเอในเลือด (serum retinol) รวมทั้งการสุ่มตัวอย่างเด็กเพื่อการตรวจวิเคราะห์ทางชีวเคมีของระดับวิตามินเอที่สะสมในตับ (Modified Relative Dose Response; MRDR) จำนวน 120 คน การวิเคราะห์ข้อมูลใช้โปรแกรมสำเร็จรูปวิเคราะห์สถิติเชิงพรรณา การวิเคราะห์องค์ประกอบ (Factor analysis) การวิเคราะห์จำแนกประเภท (Discriminant analysis) และการวิเคราะห์พื้นที่ใช้กราฟ (Receiver operating characteristics) สำหรับความไวและความจำเพาะของค่าร้อยละหรืออัตราความชุกของตัวชี้วัดที่ใช้ในการ คัดกรองพื้นที่เสี่ยงต่อการขาดวิตามินเอ ประเมินโดยนำมาเปรียบเทียบกับระดับวิตามินเอในเลือด < 0.70 μmol/l ที่อัตราความชุก 15%

ผลการศึกษาได้นำตัวชี้วัดมากำหนดเครื่องมือในการคัดกรองพื้นที่ที่มีความเสี่ยงสูงต่อการขาดวิตามินเอ ตัวชี้วัดที่มีความสำคัญ ประกอบด้วย ครอบครัวมีบ้านและที่ดินเพียงพอเพื่อการเพาะปลูกเป็นของตนเอง การบริโภคอาหารที่มีวิตามินเอ การเข้าถึงบริการทางสังคมของแม่จากระดับการศึกษาและการฝากครรภ์ การได้รับวัคซีนตามแผนการสร้างเสริมภูมิคุ้มกันโรค การเจ็บป่วยด้วยโรคติดเชื้อและภาวะโภชนาการ กลุ่มตัวชี้วัดที่ได้จากการศึกษาครั้งนี้ มีประสิทธิภาพในการจำแนกกลุ่มได้ถูกต้องร้อยละ 83.3

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