APPLICATION OF GEOGRAPHIC INFORMATION SYSTEM IN TSH NEONATAL SCREENING FOR MONITORING OF IODINE DEFICIENCY AREAS IN THAILAND

Wiyada Charoensiriwatana[1], Pongsant Srijantr[2], Noppavan Janejai[1] and Supaphan Hasan[1]

[1]Department of Medical Sciences, Ministry of Public Health, Nonthaburi;
[2]Department of Soil Science, Faculty of Agriculture at Kamphaeng Saen, Kasetsart University, Nakhon Pathom, Thailand

Abstract. By applying the WHO/UNICEF/ICCIDD guidelines for the Assessment of Iodine Deficiency Monitoring using Thyroid Stimulating Hormone (TSH) with the use of a Geographic Information System technique, the degree of severity of iodine deficiency for various areas can be evaluated. In this study, TSH data for neonates born in all 76 provinces of Thailand during 2003-2006 were classified according to their spatial demographic information. The results show that all provinces in Thailand suffer from iodine deficiency at mild to moderate levels, and the degree of severity increases year by year. The number of provinces with iodine deficiency were 10, 12, 35 and 36 for the years 2003, 2004, 2005 and 2006, respectively. This trend shows that each province in Thailand is at risk for iodine deficiency. Public health decision makers need to be aware of this problem and develop a program to eliminate iodine deficiency.

INTRODUCTION

Iodine Deficiency Disorders (IDD) have always been a major health problem, especially in developing countries. The Neonatal Screening Program in Thailand started as a pilot project with the technical assistance of the International Atomic Energy Agency (IAEA) in 1995 by using the immunometric assay technique (IRMA) to determine TSH levels in blood spot specimens (Charoensiriwatana, 1995). After the pilot program, it was concluded there was a need to establish a program of nationwide screening due to the high incidence of congenital hypothyroidism, especially in iodine deficient areas of the country (Hetzel, 1987; Delange, 1994). The program was automated because there are about 800,000 - 1,000,000 births per year. The technique was then changed from IRMA to ELISA and isotope techniques were used as a gold standard method to calibrate the standard blood spots. From the year 2000, the Neonatal Screening Program for Congenital Hypothyroidism covered all 76 provinces of Thailand and was provided to all newborn Thai babies free of charge. In 2005, this program became mandatory and the screening service was provided to all newborns in all hospitals in Thailand. In each year, approximately 760,000 babies (95% of newborns) are screened via TSH levels, in order to diagnose congenital hypothyroidism. The WHO/UNICEF/ICCIDD issued a guideline (WHO, 1994) on the assessment of iodine deficiency monitoring using TSH levels. The frequency of neonatal TSH levels above 5 mU/l is below 3.0% of newborn babies in conditions of normal iodine supply (non-IDD). A frequency of 3.0-19.9% indicates mild iodine deficiency and frequencies of 20.0-39.9% and above 40.0% indicate moderate

Correspondence: Wiyada Charoensiriwatana, Department of Medical Sciences, Ministry of Public Health, Nonthaburi 11000, Thailand.
Tel: 66 (0) 2965-9725; Fax: 66 (0) 2591-1654
E-mail: wiyada@health.moph.go.th

to severe iodine deficiency, respectively. By following the above guideline for iodine deficiency monitoring and classifying, it is possible to monitor the degree of severity of iodine deficiency at the community level using TSH neonatal blood spots (Dussault *et al*, 1976; Delange, 1999) in combination with spatial demographic information.

MATERIALS AND METHODS

The specimens were collected routinely from 48-hour old neonates onto a collection card as a heel prick or a dorsal hand vein blood spot (NCCLS, 1997). The card was then allowed to air dry horizontally at ambient temperature and mailed to one of four national screening laboratories depending on the birth area. The central laboratory at the National Institute of Health has served as the reference laboratory for the neonatal screening program. The samples were checked for quality and only good quality samples were sent to the laboratory for testing. The laboratory procedure performed to determine the TSH level was the ELISA technique (Dussault *et al,* 1976; Delange, 1999). Due to the urgent requirement for results the laboratories run assays daily using in-house quality control (QC) specimens and QC specimens from the National Institute of Health. The UK Neonatal Screening External Quality Assessment Scheme and the US CDC Newborn Screening Quality Control Program were also performed by the National

Table 1
The number of provinces, districts and sub-districts by degree of IDD severity in Thailand for the years 2003-2006.

WHO/UNICEF/ICCIDD Guideline degree of IDD severity	Non-IDD (0.0-2.9%)	Mild IDD (3.0-19.9%)	Moderate IDD (20.0-39.9%)	Severe IDD (>40.0%)
Year 2003				
Number of Provinces	0	66	10	0
Year 2004				
Number of Provinces	0	64	12	0
Year 2005				
Number of Provinces	0	41	35	0
Year 2006				
Number of Provinces	0	40	36	0
Year 2003				
Number of districts	20	725	181	0
Year 2004				
Number of districts	7	706	213	0
Year 2005				
Number of districts	0	472	432	22
Year 2006				
Number of districts	1	524	398	3
Year 2003				
Number of sub-districts	742	5,020	1,578	70
Year 2004				
Number of sub-districts	522	5,022	1,788	88
Year 2005				
Number of sub-districts	88	3,733	3,245	344
Year 2006				
Number of sub-districts	105	4,233	2,967	105

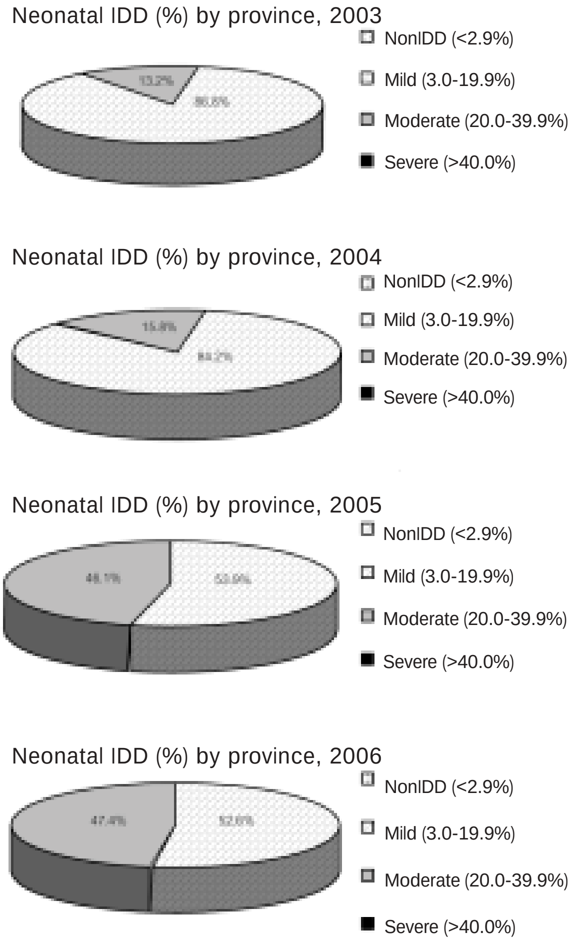

Fig 1–The percentage proportion of the provinces classified as mild and moderate IDD in Thailand during the years 2003-2006.

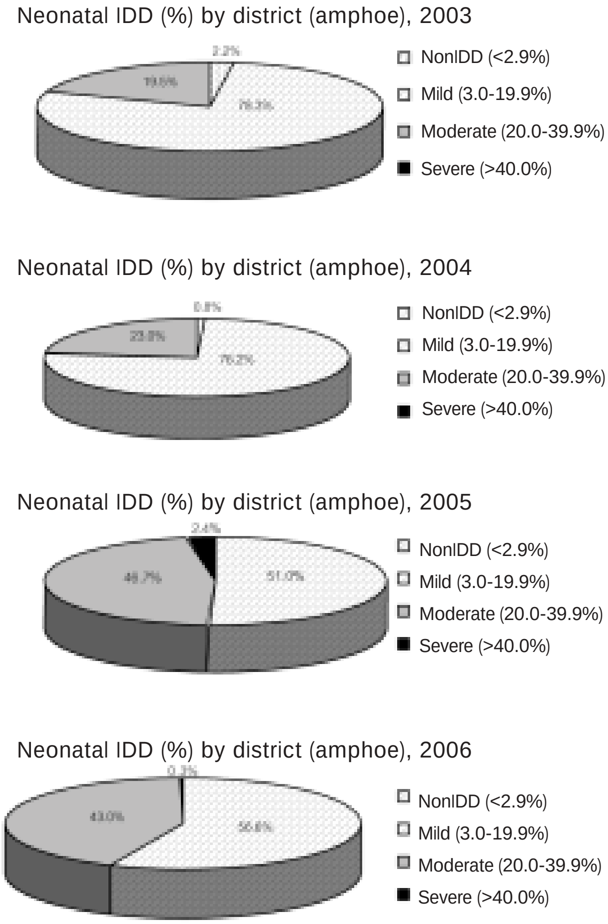

Fig 2–The percentage proportion of the districts classified according to the WHO/UNICEF/ICCIDD degree of iodine deficiency severity in Thailand during the years 2003-2006.

Central Laboratory. Data obtained from the neonatal blood spots were processed and classified by province (Changwat), district (Amphoe) and sub-district (Tambon) levels according to their spatial demographic information. With the use of the Geographic Information System (GIS) technique, the degree of severity of IDD could be assessed using WHO/UNICEF/ICCIDD guidelines for iodine deficiency monitoring. The demographic data for each specimen was checked and grouped by home town. If the information provided at birth was not clearly identified, the specimens were excluded from the study. During the years 2003, 2004, 2005 and 2006, the number of original specimens obtained were 550,927, 543,121, 639,583 and 766,392, respectively. The percentages of babies with a TSH level > 5.0 mU/l divided into provinces, districts and sub-districts as spatial information. A GIS/MapInfo software program was then used for mapping the data.

RESULTS

During the years 2003-2006, the GIS maps showed that all 76 provinces of Thailand suffered from iodine deficiency either

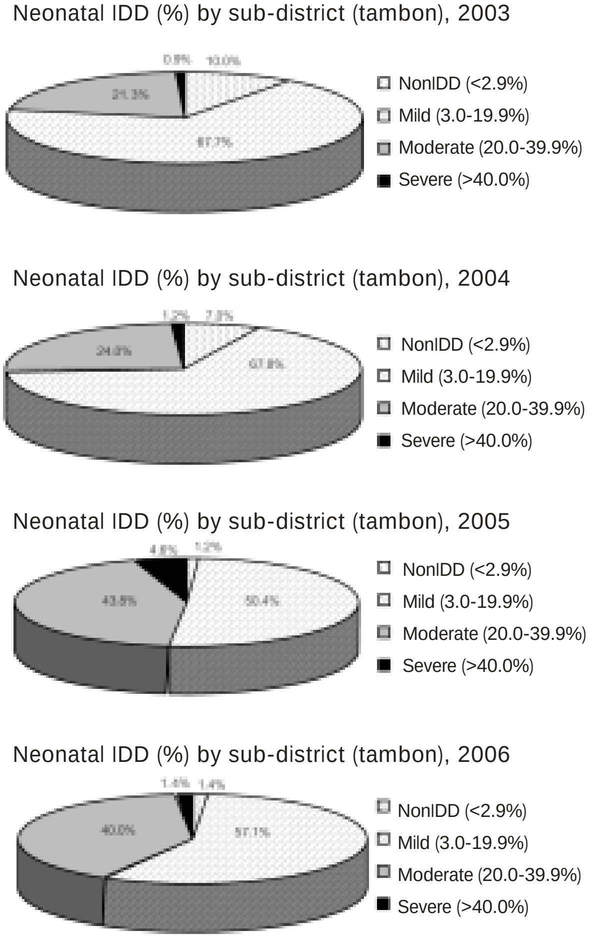

Fig 3–The percentage proportion of the sub-districts classified according to the WHO/UNICEF/ICCIDD degree of iodine deficiency severity in Thailand during the years 2003-2006.

mildly or moderately (Table 1 and Fig 4). None of the provinces were IDD disease free or had severe IDD. The distribution of disease severity by province is shown in Fig 1. The degree of severity increased from mild IDD (3.0-19.9%) to moderate IDD (20.0-39.9%) from year to year. The percentages of provinces with moderately severe IDD increased from 13.2% to 15.8%, and 46.1% to 47.4% (Fig 1). At the district level, the percentage of non-IDD (0-2.99%) areas were 2.2, 0.8, 0.0 and 0.1 for 2003, 2004, 2005, and 2006, respectively, and of severe IDD (>40%) were 2.4% and 0.3% for the years 2005 and 2006, respectively, with an increasing trend as shown in Fig 2. At the sub-district level, the percentages with non-IDD changed from 10.0% to 7.0%, and 1.2% to 1.4% between the years 2003 and 2006. The severe IDD areas were 0.9%, 1.2%, 4.6% and 1.4% for the years 2003, 2004, 2005 and 2006, respectively (Fig 3). Fig 4 shows the GIS maps of Thailand in regard to the degree of IDD severity for each province.

DISCUSSION

By using the TSH data from the neonatal screening program for the years 2003-2006 with the application of GIS techniques, we found iodine deficiency endemic areas in Thailand. The problem has increased in severity from year to year. Further research is needed to correlate this problem with daily behavior. Further studies are needed in IDD areas to survey healthy housewives age 14-45 years by evaluating their diets, as well as collection of urine to determine the excretion of iodine. The results of such a program can be used to solve the IDD problem in our country. The application of GIS mapping to assess the severity of IDD using neonate TSH levels is an important tool for public health monitoring and evaluating iodine deficiency. IDD exists in developing countries. This problem to be addressed by national and international development programs. The pilot program in Thailand shows that appropriate technical cooperation with the IAEA has developed an important monitoring tool for the elimination of IDD and may be utilized successfully to strengthen the country through the Technical Cooperation Development Program in the region.

ACKNOWLEDGEMENTS

The authors would like to thank the IAEA for their technical assistance, and especially Dr RD Piyasena who devoted his efforts to

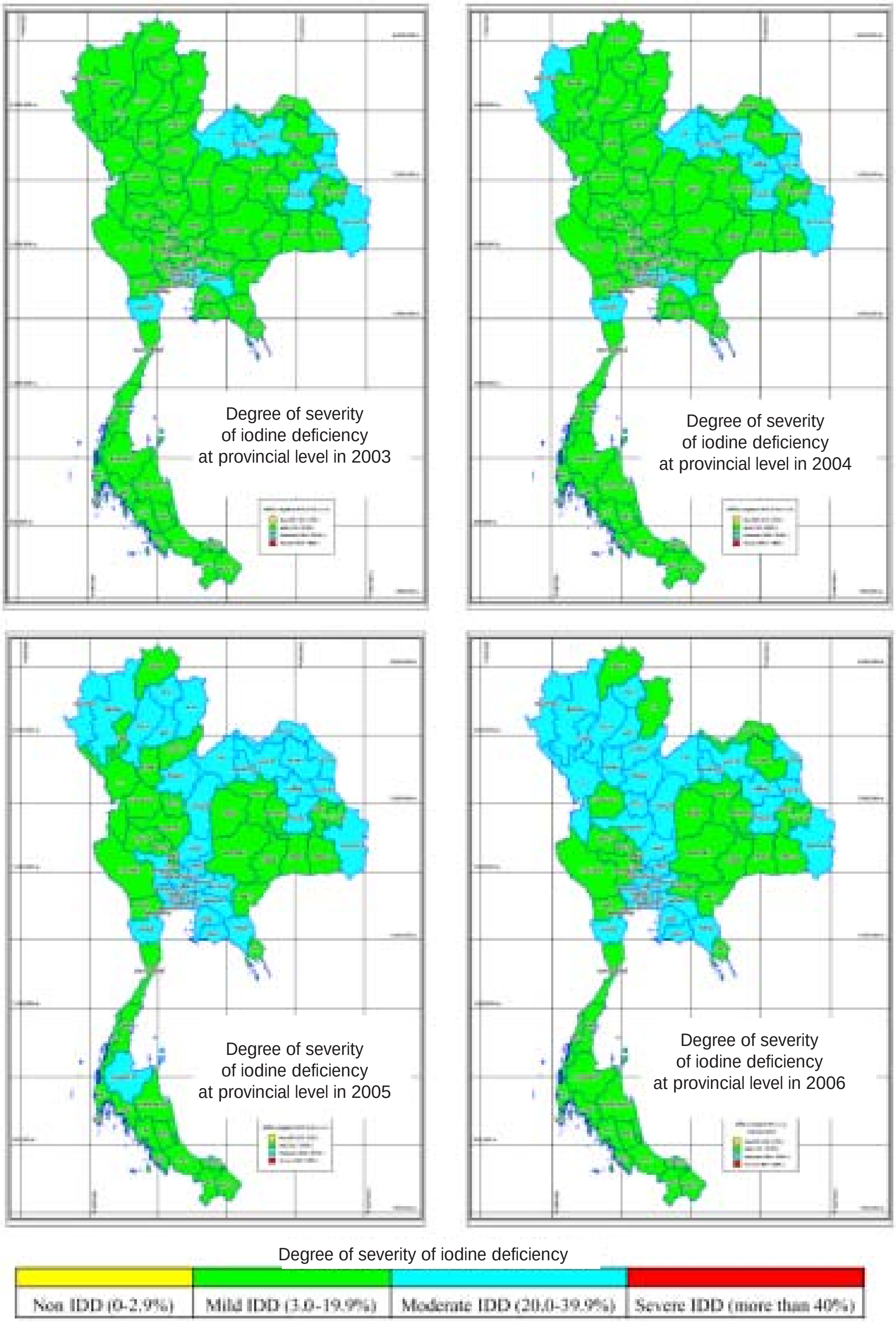

Fig 4–The GIS maps of Thailand regarding degree of severity of IDD detailed by provincial levels during the years 2003-2006.

assist in demonstrating the importance of congenital hypothyroid screening to the government of Thailand.

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