

# EFFECTIVENESS OF ENHANCEMENT STRATEGY FOR NEW CASE FINDINGS AT DISTRICT LEVEL AND IMPACT ON SUSTAINABLE LEPROSY ELIMINATION AND LEPROSY-FREE THAILAND

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**Abstract.** Effectiveness of enhancement strategy, acceleration of new case findings in districts using epidemiological indicators and impact on success of sustainable leprosy elimination towards a leprosy-free Thailand were evaluated employing retrospective descriptive and analytical studies of data from a Geographic Information System for Leprosy Control and a leprosy database 2010-2019 for Thailand. Three epidemiological indicators used were (1) new cases found every year for five consecutive years, 2) new cases in children found in any year during five consecutive years, and 3) 10 new cases or more during five consecutive years. Proportion of districts with new cases (25-60%) in districts with epidemiological indicators was significantly higher compared to districts without indicators (7-43%) ( $p$ -value <0.001). Districts with 3 epidemiological indicators had the highest rate of new case findings, following by districts with 2 epidemiological indicators. Among districts with only one epidemiological indicator, indicator 3 was the best for employment in new case findings. Trend of findings of new case with grade 2 disability in 2017-2019 in districts with epidemiological indicators was significantly reduced compared to districts without epidemiological indicators. In 2019, new leprosy cases with grade 2 disability in children were not found and rate of new cases with grade 2 disability was less than 0.3 case/10<sup>6</sup> population. In addition, 60% of 928 total districts were leprosy-free. In conclusion, applying strategy to accelerate findings of new leprosy case in areas with epidemiological indicators is still necessary for leprosy control and elimination under conditions of low prevalence to achieve a sustainable leprosy elimination and goal of a leprosy-free Thailand.

**Keywords:** district, epidemiological indicator, leprosy-free Thailand, new case finding, sustainable leprosy elimination

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## INTRODUCTION

Thailand has carried out a leprosy control program accordance with the World Health Organization (WHO) recommendations (Ramasoota, 2016a) and the program was graciously granted the patronage of His Majesty King Bhumibol Adulyadej the Great since 1956 (Ramasoota, 2016a). The leprosy control activities of Thailand are conducted by the Department of Disease Control (DDC), Ministry of Public Health and have achieved since 1994 leprosy elimination as a public health problem, a national prevalence of <1 case/10,000 population (Noordeen, 1992; Ramasoota, 2016b).

From 2012, a “sustainable leprosy elimination” program (WHO, 2005) was introduced (Ramasoota, 2016b). However, although the number of new leprosy cases in Thailand has continuously decreased each year, the problem of delay in new case findings still exists as evidenced from rate of new cases with grade 2 disability fluctuating between 10-17% (Techatraisak, 2018). WHO has a vision for a leprosy-free world and sets a goal to sustainably eliminate leprosy by reducing grade 2 disability in new leprosy cases to <1 case/10<sup>6</sup> population and having no children cases with grade 2 disability by 2020 (WHO, 2016). Thailand has set a goal to reduce grade 2 disability in new leprosy cases to <0.3/10<sup>6</sup> population and a total of ≤100 new

leprosy cases in the country by 2020 (DDC, 2019a).

In situations of low prevalence of a disease together with limitations in policy support, personnel and budget, it is necessary to adjust the enhancement strategy for leprosy control to be suitable under these conditions. The Raj Pracha Samasai Institute, Department of Disease Control, Ministry of Public Health, Thailand has introduced an enhancement strategy employing a set of epidemiological indicators to locate new leprosy cases before grade 2 disability becomes apparent in districts. The strategy was implemented in 2010 under a “50<sup>th</sup> Year Anniversary of Response to His Majesty Royal Wish by Raj Pracha Samasai Project”, with case finding activities conducted every year and through special campaigns on Royal Commemorative Anniversaries, such as assignments of village health volunteers to locate new leprosy cases in 2013, 2014, 2016 (Ramasoota, 2016b) and 2017, and in 2019, improvement of volunteers’ potential of finding new leprosy cases in communities through use of LINE applications (DDC, 2019b). This enhancement strategy aims to achieve the goal of sustainable leprosy elimination and a leprosy-free Thailand by 2020 according to WHO (2005) program and to fulfill the Royal Wish of His Majesty King Bhumibol Adulyadej the Great.

Effectiveness of the enhancement strategy for new case findings in districts with epidemiological indicators and its impact on success of sustainable leprosy elimination towards a leprosy-free Thailand by 2020 was evaluated from 2010 to 2019 by (i) comparing leprosy epidemiological situation among districts with and without epidemiological indicators, (ii) assessing accuracy of epidemiological indicators in predicting new leprosy case findings in target districts, (iii) assessing effectiveness of the enhancement strategy for new leprosy case findings in districts with epidemiological indicators, (iv) assessing impacts of implementing the enhancement strategy for new case findings on sustainable leprosy elimination towards a leprosy-free Thailand by 2020, and (v) utilizing the study results to improve efficiency and effectiveness of the enhancement strategy.

## MATERIALS AND METHODS

### Target districts

Out of total 928 districts in Thailand, 851 target districts (districts with epidemiological indicators) comprised 140 districts in 45 provinces, 119 districts in 40 provinces, 99 districts in 38 provinces, 84 districts in 40 provinces, 72 districts in 33 provinces, 69 districts in 34 provinces, 66 districts in 35 provinces, 53 districts in 26 provinces, 47 districts in 21 provinces, and 102 districts in 42 provinces in the study years 2010 to 2019, respectively.

### Study design

The study was a retrospective descriptive and analytical analyses of

leprosy epidemiological situation in districts with and without at least one of the three epidemiological indicators during 2010 to 2019 using data from two sources: (1) the situation report (in Thai) archived from the Geographic Information System (GIS) for leprosy control which was publicly available at [http://gisleprosy.ddc.moph.go.th:8010/lep\\_gis/index.php](http://gisleprosy.ddc.moph.go.th:8010/lep_gis/index.php) and (2) the leprosy database of Thailand which the permission to access the database was granted by the Ethics Committee for Research in Human Subjects, Department of Diseases Control (FWA00013622). Only numbers of leprosy patients were obtained from GIS website, while from leprosy database of Thailand, patients' names, identification numbers and addresses were redacted except for name of districts where new cases were found.

Epidemiological indicators were (1) new cases identified each year for five consecutive years, (2) new cases in children (<15 years of age) identified in any year during five consecutive years, and (3) a total of  $\geq 10$  new cases during five consecutive years (DDC, 2016). From 2017, epidemiological indicator 3 was changed to "a total of  $\geq 7$  new cases during five consecutive years" (DDC, 2017).

In 2019, epidemiological data were analyzed for the previous eight years to identify target districts with one of the following epidemiological indicators: i) new cases found every year for eight consecutive years, ii) new cases in children found in any year in the previous eight years, iii) a total of  $\geq 7$  new cases during the previous eight years (DDC, 2019b).

**Actions taken*****Enhancement strategy for active and passive case findings in districts with epidemiological indicators***

Enhancement strategy for new case findings were conducted in districts with epidemiological indicators by (i) raising awareness of leprosy through conducting 2-4 campaigns a year, (ii) screening population for suspected leprosy and referring for further diagnosis in villages with new cases during the previous five years (from 2010 to 2018) or in the previous eight years (conducted in 2019), and (iii) rapid village survey (RVS) in villages with new children cases in the previous five years (from 2010 to 2018) or in the previous eight years (conducted in 2019).

***Activities for new case findings in districts without epidemiological indicators***

Activities taken were (i) health education campaign to raise awareness of leprosy conducted once a year during Raj Pracha Samasai Week (week covering 16 January), (ii) health education in schools and communities in districts with new cases in the previous 10 years and (iii) health education to communities in areas with new cases in the previous 20 years.

***Activities for all areas, districts with and without epidemiological indicators***

Activities were (i) screening household contacts for new cases after a patient was registered for treatment, (ii) follow-up once a year for 10 continuous years and (iii) disease

investigation within one month when a new case was found.

**Statistical analysis**

Data were analyzed using descriptive statistics (frequency distribution and percentage) and a  $\chi^2$  test for comparative analysis using a STATA program (StataCorp, College Station, TX). A  $p$ -value  $< 0.050$  is considered statistically significant.

**RESULTS**

From 2010 to 2019, detection of new leprosy cases in the test districts with epidemiological (epi) indicators ranged 0.36-1.36/100,000 population (lowest in 2019 and highest in 2010) while that in districts without epi indicators ranged 0.12-0.45/100,000 population (lowest in 2019 and highest in 2010), and proportion of new cases with multibacillary leprosy in districts with epi indicators ranged 58.0-75.9%, while in districts without epi indicators ranged 67.8-87.5% (Table 1). Percent children among new leprosy cases in 2010 is significantly higher in districts with epi indicators when compared to districts without epi indicators ( $p$ -value = 0.001,  $\chi^2$  test), but this difference was not apparent by 2019 (Table 1).

Comparing leprosy epidemiological parameters over the same period the following properties were observed. Proportion of new leprosy cases with grade 2 disability in districts with epi indicators fluctuated between 7.5 and 15.7% with decreasing trend from 2017 to 2019, while that in districts without epi indicators ranged 10.9-21.0% and from 2017 to 2019 remained ~ 21% and

Table 1  
 Leprosy situation in test districts with and without epidemiological (epi) indicators in Thailand (2010-2019)

Parameter	District epi indicator status	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of new leprosy cases	I	205	124	79	63	70	53	45	51	32	38
	N	223	186	167	146	153	154	126	128	100	72
New cases detected per 100,000 population	I	1.36	0.95	0.70	0.70	0.88	0.72	0.59	0.80	0.67	0.36
	N	0.45	0.36	0.31	0.26	0.26	0.26	0.21	0.21	0.16	0.12
MB (%)	I	58.0	67.2	75.9	66.6	74.2	62.2	60.0	70.5	75.0	71.0
	N	73.5	74.7	74.8	67.8	83.6	72.7	87.5	74.2	79.0	70.0
LC (%)	I	10.7	7.5	5.0	3.1	5.7	1.8	6.6	9.8	9.3	2.6
	N	2.6	4.8	2.9	4.7	3.9	3.2	3.9	3.9	4.0	2.7

I: with epidemiological indicators; LC: children among total new leprosy cases; MB: multibacillary leprosy among total new leprosy cases; N: without epidemiological indicators

significantly higher than districts with epi indicators ( $p$ -value = 0.040,  $\chi^2$  test) (Fig 1A). Overall rate of new leprosy cases with grade 2 disability per 10<sup>6</sup> population in 2010 to 2019 was 1.01, 0.56, 0.60, 0.32, 0.53, 0.44, 0.37, 0.45, 0.37 and 0.25, respectively and number of children cases with grade 2 disability was 1, 2, 0, 0, 1, 0, 0, 1, 1 and 0, respectively. Proportion of districts with new cases (25-60%) in districts with epidemiological indicators was significantly higher compared to districts without indicators (7-43%) ( $p$ -value <0.001). Rate of new cases per district with all three epi indicators was highest (mean = 2.07, range: 1.00-3.71 cases/district), followed by districts with two epi indicators (epi indicators 1 + 2, mean = 0.60, range: 0-2.69; epi indicators 1 + 3, mean = 1.65, range: 0.25-6.00; and epi indicators 2 + 3, mean = 1.04, range = 0.57-1.50); then districts with one epi (epi 1, mean = 0.58, range: 0-1.20; epi 2, mean = 0.48, range: 0.15-1.02; and epi 3, mean = 0.98, range: 0.21-1.72) (Figs 1 B,C). Proportion of household contact cases from self-reporting was 35.2% (mean), range: 20.0-48.1%; from household contact screening 40.7% (mean), range: 0-66.6%; from school survey 0.2% (mean), range: 0-2.7%; from rapid village survey 20.1% (mean), range: 0-62.5%; and from referral system 3.4% (mean), range: 0-14.2% (Fig 1D). Proportion of new cases detected from household contact screening is significantly higher in districts with than without epi indicators (mean = 40.7, range: 0-66.6% *vs* mean = 30.6, range: 7.6-45.0%) (Fig 1E). Proportion of leprosy-free districts (district where no new case detected for

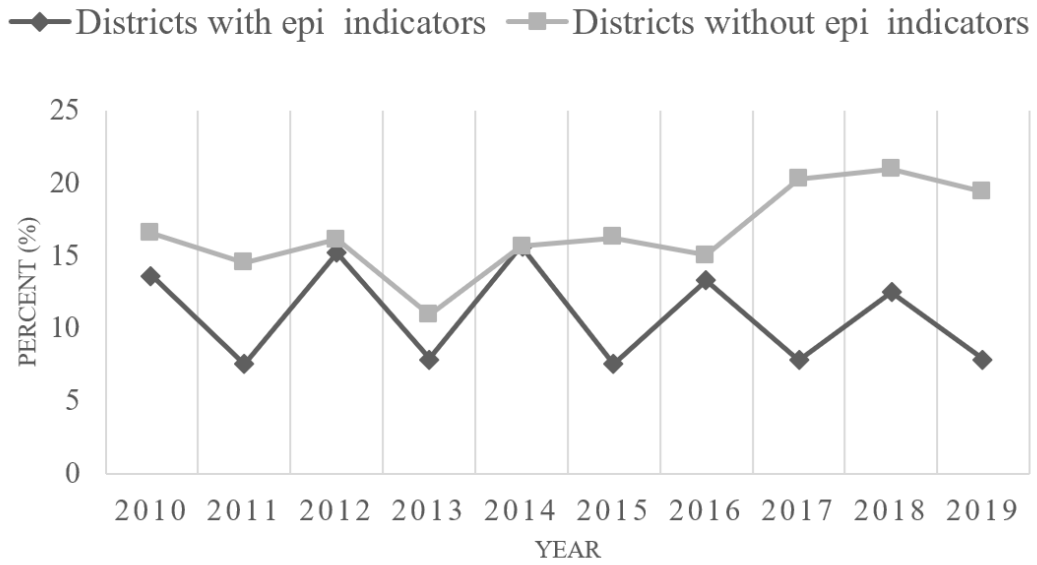
at least five consecutive years) in 2010 to 2019 was 36.0, 38.7, 44.1, 47.8, 49.1, 52.3, 55.3, 56.2, 57.9, and 59.6%, respectively.

## DISCUSSION

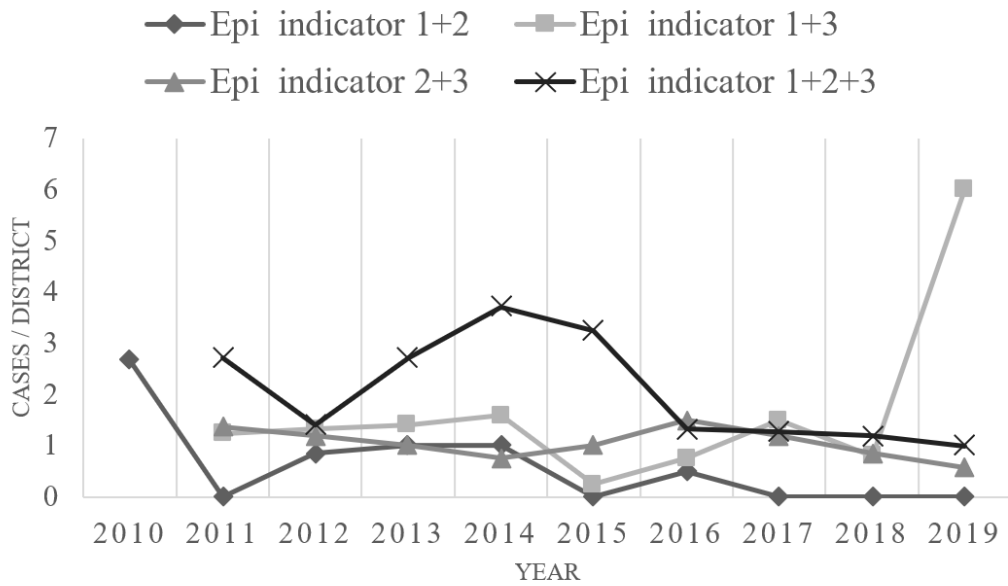
Accelerating findings of new leprosy case in areas with epidemiological indicators is an important facet of leprosy elimination program in Thailand, which was implemented under the principle of precision public health measures to support regions with low prevalence and confronted with problems of shortage in personnel working in the field of leprosy and limited resources. Previously, analysis of epidemiological situation of leprosy in the country was carried out to obtain an overall picture at district and province level. This study is the first stratified analysis of the epidemiological situation of leprosy classified between districts with and without epidemiological indicators in a retrospective analysis from 2019 to 2010, the latter being the year in which the criteria of epidemiological indicators based on data of new case findings in the previous five years were implemented. This stratified analysis had the objective to assess more clearly the effectiveness of accelerating new leprosy case findings in districts with epidemiological indicators and the appropriateness of the epidemiological indicators employed.

As the total number of new detected leprosy cases in the country continued to decrease from 2010 ( $n = 428$ ) to 2016 ( $n = 171$ ) and new cases were increasingly detected outside target districts, from 2017 epi indicator 3 (“a total of  $\geq 10$  new cases during five consecutive years”)

A

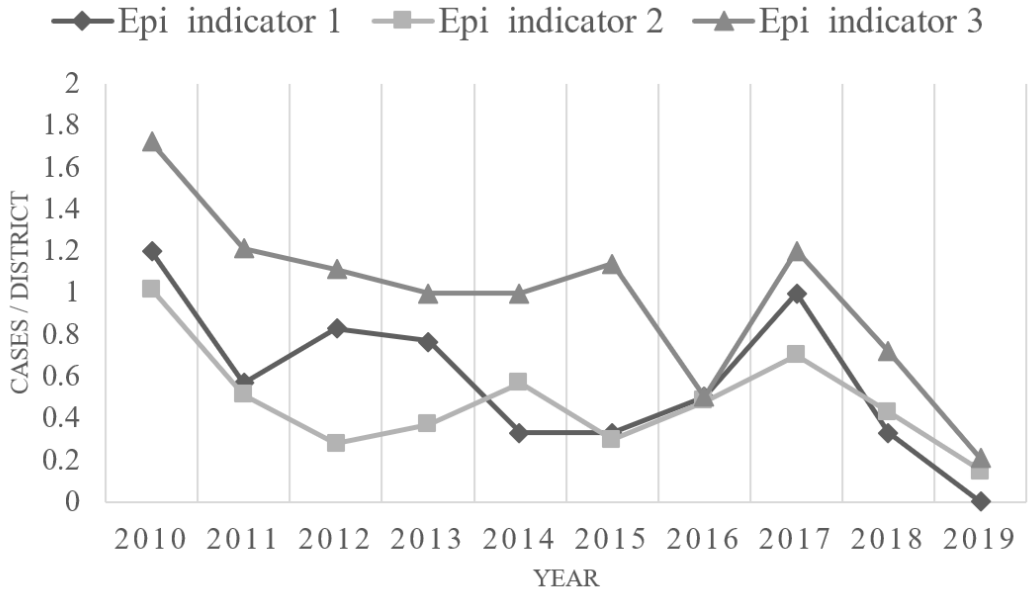


B

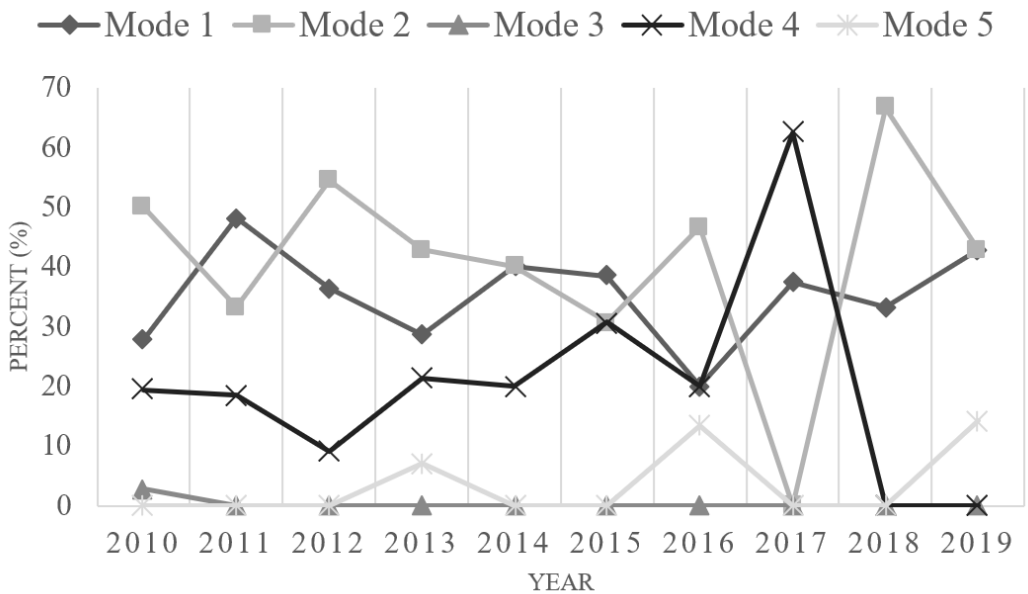


NEW LEPROSY CASE FINDINGS AT DISTRICT LEVEL

C



D



E

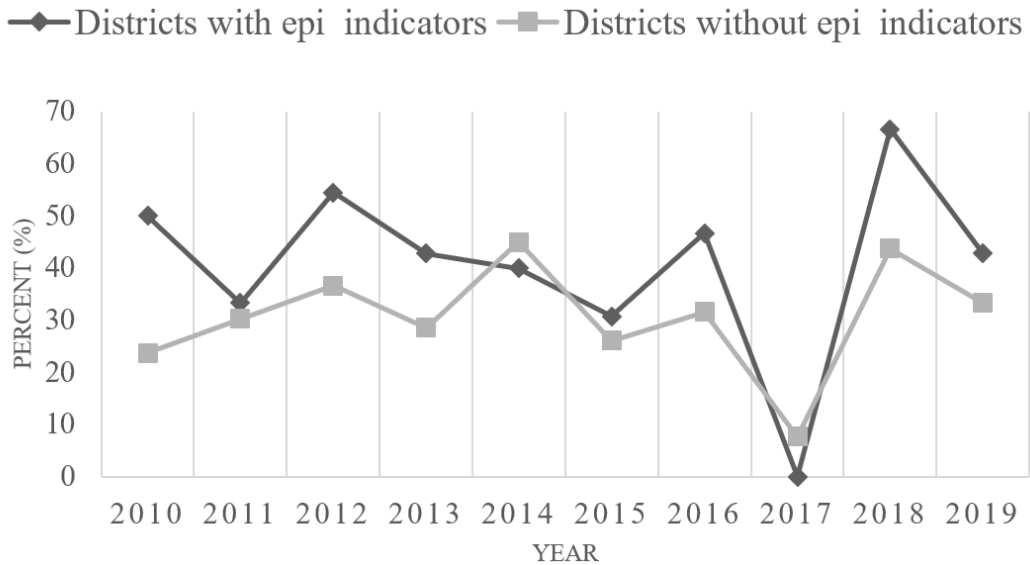


Fig 1 - Epidemiological parameters of leprosy in test districts with and without epidemiological (epi) indicators in Thailand (2010 - 2019)

(A) Percent new leprosy cases with grade 2 disability; (B) New leprosy cases per district based on two and three epi indicators; (C) New leprosy cases per district based on one epi indicator; (D) Percent new leprosy case findings from self-reporting (mode 1), household contact screening (mode 2), school survey (mode 3), rapid village survey (mode 4), and referral system (mode 5); (E) Percent new cases from household contact screening.

had been adjusted to “a total of  $\geq 7$  cases during five consecutive years” and in 2019 analysis of new case data in “the past five years” was expanded to “in the past eight years”. Utility of epi indicators was demonstrated both by significantly higher proportion of districts with new case findings, detection rates, and percent children among new cases compared to districts where epi indicators were not applied. Among the three epi indicators, use of indicator 3 provided the better parameter for finding

new leprosy cases.

The decrease from 2017 to 2019 in proportion of new leprosy cases with grade 2 disability in districts where epi indicators were employed reflected the success of continuous acceleration of case findings during the previous 10 years or more. This was highlighted in the increase in proportion of new cases with grade 2 disability in those districts without application of epi indicators over the same period.

Proportion of new leprosy cases resulting from household contacts among total new cases were not significantly different between districts with and without epi indicators (14 *vs* 21%; data not shown), a low percentage compared to disease transmission within communities. The rather low proportion (40%) of household contact cases from household contact screening even in districts with epi indicators indicated a problem in household contact tracing, which may be due (in part) to migration of households. Nevertheless, application of epi indicators indicated a more intensive household contact screening compared to districts without these indicators.

Positive impacts of implementing the enhancement strategy in new case findings for sustainable leprosy elimination and a leprosy-free Thailand were demonstrated by (i) rate of new cases with grade 2 disability <1 case per million population since 2011 and a continuous decreasing trend, (ii) in 2019, rate of new cases with grade 2 disability was <0.3 cases per million population and no new children case with grade 2 disability was found), and (iii) (iii) among 928 total districts, 60% were leprosy-free in 2019 compared to 36% in 2010. However, further improvements could be achieved if (i) epidemiological indicator criteria of the target districts be adjusted periodically according to the annual rate of new case finding in target districts; (ii) passive case finding activities focusing on raising leprosy awareness

be strengthened in areas both with and without epi indicators through application of digital technology, such as communication via LINE application, to enable public health officers provide knowledge of leprosy signs and symptoms, thereby enabling health volunteers to screen suspected leprosy subjects; in addition, artificial intelligence technology be employed to create novel screening tools applicable in local health care facilities; (iii) systems for household contact tracing in particular of multibacillary leprosy index cases be strengthened by enhancing communication among public health network using tools indicated in abovementioned recommendation (recommendation ii); and (iv) enhancement strategy for leprosy new case findings be focused on epidemiologically indicated districts to provide a good model for other contagious diseases of low prevalence.

In conclusion, implementation of enhancement strategy by accelerating new leprosy case findings in areas with epidemiological indicators illustrates a successful model for control and elimination of contagious diseases with low prevalence in regions where there is a shortage of health personnel working a disease of interest and limited resources. As regards the leprosy situation in Thailand, this strategy provides an important advancement in the country's goal of a sustainable elimination of leprosy and leprosy-free country according to the WHO goal (WHO, 2016) and fulfillment of His Majesty King Bhumibol Adulyadej the Great's Royal Wish of 1956.

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## REFERENCES

- Department of Disease Control (DDC). Raj Pracha Samasai Institute annual report 2016. Bangkok: NC Concept Company Limited; 2016. p.17-123. [in Thai]
- Department of Disease Control (DDC). Raj Pracha Samasai Institute annual report 2017, Bangkok: Aksorn Graphic and Design Publisher; 2017. p. 23-100. [in Thai]
- Department of Disease Control (DDC). Program for prevention and control of leprosy. In: Pittayawonganon C, editor. Guidelines for prevention and control of diseases and health hazards for areas, fiscal year 2020. Bangkok: Aksorn Graphic and Design Publisher; 2019a. p. 24-7. [in Thai]
- Department of Disease Control (DDC). Raj Pracha Samasai Institute annual report 2019, 2019b [cited 2020 Apr 13]. Available from: URL: <https://assets.adobe.com/public/4f715d09-1ff1-4473-4b35-87da1b40f2f7> [in Thai]
- Noordeen SK. Elimination of leprosy as a public health problem. *Lepr Rev.* 1992;83: 11-4.
- Ramasoota T. Leprosy Control Project following Royal's initiative Raj Pracha Samasai Theory: Royal's given Raj Pracha Samasai Institute/ Raj Pracha Samasai Foundation under the Royal patronage together with Raj Pracha Samasai School under the Royal patronage. In: Ramasoota T, editor. The history of leprosy in Thailand. Bangkok: Masterkey; 2016a. p. 122-37.
- Ramasoota T. Leprosy was successfully under control and elimination as the public health problem and developed to sustainable elimination in accordance with the Royal initiatives. In: Ramasoota T, editor. The history of leprosy in Thailand. Bangkok: Masterkey; 2016b. p. 178-205.
- Techatraisak C. Epidemiology of leprosy in Thailand after successful elimination of leprosy as a public health problem from 1994 - 2016. *Dis Control J* 2018;44: 325-36. [in Thai]
- World Health Organization (WHO). Global strategy for further reducing the leprosy burden and sustaining leprosy control activities (Plan period: 2006-2010), 2005 [cited 2020 Apr 13]. Available from: URL: <https://www.who.int/lep/resources/GlobalStrategy.pdf?ua=1>
- World Health Organization (WHO). Global leprosy strategy 2016-2020: accelerating towards a leprosy-free world, 2016 [cited 2020 Apr 13]. Available from: URL: [http://apps.who.int/iris/bitstream/handle/10665/208824/9789290225096\\_en.pdf](http://apps.who.int/iris/bitstream/handle/10665/208824/9789290225096_en.pdf)