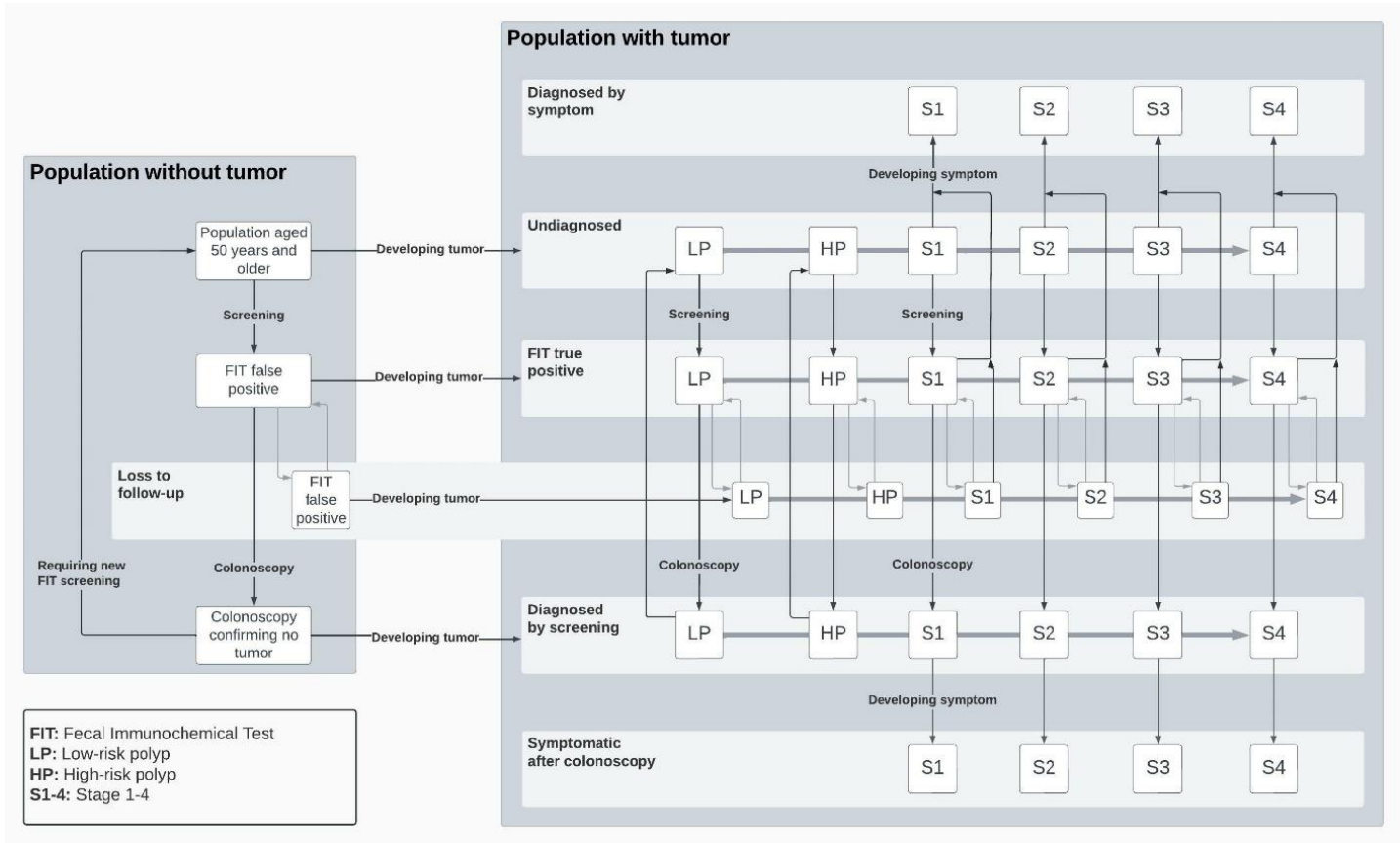


*Supplementary materials for*

**Cost-effectiveness Analysis of Increasing Access to Colorectal  
Cancer Diagnostic Approaches: an Example from Thailand**

Online data repository: [*removed due to ISDC policies about anonymity*]

## S1. Model Overview



**Fig. S1. Model overview** – see ISDC paper #1164 for details.

**Table S1. Data inputs**

Parameter	Value	Unit	Reference
Accessibility to diagnostic colonoscopy from screening policy	0.72	Dmnl	[1]
Accessibility to FIT from screening policy	0.62	Dmnl	[1]
Accessibility to FIT ratio in population without tumors	1.17	Dmnl	1 <sup>st</sup> article*
Accessibility to symptom evaluation relative to the baseline from symptom evaluation policy	3.43	Dmnl	1 <sup>st</sup> article
Average time in FIT positive waiting for a colonoscopy	1	Year	Assumption
Colonoscopy capacity	200,000	People/year	[2]
Crude death rate of HRP	0.017	Per year	1 <sup>st</sup> article
Crude death rate of LRP	0.017	Per year	1 <sup>st</sup> article
Crude death rate of population without tumors	0.017	Per year	1 <sup>st</sup> article
Crude death rate of symptomatic diagnosed CRC stage 1	0.05	Per year	[3]
Crude death rate of symptomatic diagnosed CRC stage 2	0.08	Per year	[3]
Crude death rate of symptomatic diagnosed CRC stage 3	0.18	Per year	[3]

Parameter	Value	Unit	Reference
Crude death rate of symptomatic diagnosed CRC stage 4	0.4	Per year	[3]
Crude death rate ratio in undiagnosed and asymptomatic diagnosed CRC	0.47	Dmnl	1 <sup>st</sup> article
DMC 1st year treatment CRC stage 1	50,955	Baht/people	[4]
DMC 1st year treatment CRC stage 2	98,947	Baht/people	[4]
DMC 1st year treatment CRC stage 3	113,444	Baht/people	[4]
DMC 1st year treatment CRC stage 4	121,084	Baht/people	[4]
DMC bleeding complication	16,004	Baht/people	[4]
DMC colonoscopy with biopsy	4,115	Baht/people	[4]
DMC colonoscopy without biopsy	3,264	Baht/people	[4]
DMC FIT screening	42	Baht/people	[4]
DMC other years treatment CRC stage 1	5,337	Baht/people /year	[4]
DMC other years treatment CRC stage 2	22,485	Baht/people /year	[4]
DMC other years treatment CRC stage 3	27,078	Baht/people /year	[4]
DMC other years treatment CRC stage 4	121,084	Baht/people /year	[4]
DMC perforation complication	37,420	Baht/people	[4]
DMC short course training per one doctor and nurse	50,000	Baht/people	[5,6]
DNMC 1st year treatment CRC stage 1	21,170	Baht/people	[4]
DNMC 1st year treatment CRC stage 2	53,937	Baht/people	[4]
DNMC 1st year treatment CRC stage 3	64,679	Baht/people	[4]
DNMC 1st year treatment CRC stage 4	103,361	Baht/people	[4]
DNMC bleeding complication	2,339	Baht/people	[4]
DNMC colonoscopy	1,085	Baht/people	[4]
DNMC diagnosis	1,430	Baht/people	[4]
DNMC FIT negative	267	Baht/people	[4]
DNMC FIT positive	283	Baht/people	[4]
DNMC other years treatment CRC stage 1	5,168	Baht/people /year	[4]
DNMC other years treatment CRC stage 2	15,313	Baht/people /year	[4]
DNMC other years treatment CRC stage 3	19,415	Baht/people /year	[4]
DNMC other years treatment CRC stage 4	103,361	Baht/people /year	[4]
DNMC perforation complication	11,949	Baht/people	[4]
Incidence rate of bleeding from colonoscopy	0.0026	Per year	[7]
Incidence rate of perforation from colonoscopy	0.0005	Per year	[7]
Initial fraction undiagnosed CRC stage 1	0.003	Dmnl	1 <sup>st</sup> article
Initial fraction undiagnosed CRC stage 2	0.0004	Dmnl	1 <sup>st</sup> article
Initial fraction undiagnosed CRC stage 3	0.0007	Dmnl	1 <sup>st</sup> article
Initial fraction undiagnosed CRC stage 4	0.0003	Dmnl	1 <sup>st</sup> article
Initial fraction undiagnosed HRP	0.0137	Dmnl	1 <sup>st</sup> article
Initial fraction undiagnosed LRP	0.1419	Dmnl	1 <sup>st</sup> article
Progression rate from CRC stage 1 to CRC stage 2	0.3	Per year	[8]
Progression rate from CRC stage 2 to CRC stage 3	0.45	Per year	[8]
Progression rate from CRC stage 3 to CRC stage 4	0.5	Per year	[8]

Parameter	Value	Unit	Reference
Progression rate from HRP to CRC stage 1	0.05	Per year	[8]
Progression rate from LRP to HRP	0.015	Per year	[8]
Progression rate from population without tumor to LRP	0.015	Per year	1 <sup>st</sup> article
Rate of coming back to observed FIT positive	0.01	Per year	Assumption
Sensitivity of colonoscopy in CRC	0.95	Dmnl	[9]
Sensitivity of colonoscopy in HRP	0.85	Dmnl	[9]
Sensitivity of colonoscopy in LRP	0.75	Dmnl	[9]
Sensitivity of FIT in CRC	0.67	Dmnl	[10]
Sensitivity of FIT in HRP	0.24	Dmnl	[11]
Sensitivity of FIT in LRP	0.076	Dmnl	[11]
Sensitivity of FIT+RS in CRC	0.7	Dmnl	[12]
Sensitivity of FIT+RS in HRP	0.464	Dmnl	[12]
Sensitivity of FIT+RS in LRP	0.076	Dmnl	[12]
Specificity of FIT	0.95	Dmnl	[10]
Specificity of FIT+RS	0.864	Dmnl	[12]
Symptomatic detected rate CRC stage 1	0.006	Per year	1 <sup>st</sup> article
Symptomatic detected rate CRC stage 2	0.088	Per year	1 <sup>st</sup> article
Symptomatic detected rate CRC stage 3	0.344	Per year	1 <sup>st</sup> article
Symptomatic detected rate CRC stage 4	0.657	Per year	1 <sup>st</sup> article
Utilities CRC stage 1**	0.74	Dmnl/people	[13]
Utilities CRC stage 2**	0.67	Dmnl/people	[13]
Utilities CRC stage 3**	0.61	Dmnl/people	[13]
Utilities CRC stage 4**	0.25	Dmnl/people	[13]
Utilities population without tumor/polyp**	0.83	Dmnl/people	[13]

FIT: Fecal immunochemical test, HRP: High-risk polyp, LRP: Low-risk polyp, CRC: Colorectal cancer, DMC: Direct medical cost, DNMC: Direct non-medical cost, RS: using the 8-point risk score

\* We refer to another submission to ISDC 2023 for full details about the model (including model description, formulation, and calibration): submission #1164 titled “Dynamics of Colorectal Cancer Screening in Low and Middle-Income Countries: A Modeling Analysis from Thailand.”

\*\* These parameters have a Beta distribution. All other parameters have a uniform distribution.

## S2. Strategy details

**Table S2. Descriptions for each strategy**

Strategy	Definition	Parameter names	Baseline value	Strategy value	References
Strategy-I	Improving access to screening at achievable rates, estimated in a previous study in Thailand	Accessibility to FIT	3%	62%	[1]
		Accessibility to diagnostic colonoscopy	10%	72%	[1]
Strategy-II	Improving access to symptom evaluation in each stage, projected to result in mean sojourn time of five years in 2032 (assuming to reach the USA level; reported to be five years in 1997-2010). All undiagnosed CRC cases have no symptoms and a mortality rate equal to the population without a tumor.	Accessibility to symptom evaluation relative to the baseline	1	3.43	1 <sup>st</sup> article
Strategy-III	Combination of strategy-I and II				
SC	Increasing colonoscopy capacities to a sufficient level for the strategies	Colonoscopy capacity	200,000	See Table S3	[2]
RS	Combining FIT screening with risk stratification using the 8-point risk score	Specificity of primary screening	95%	86%	[12]
		Sensitivity of primary screening in high-risk polyp detection	22%	46%	[12]
		Sensitivity of primary screening in CRC detection	63%	70%	[12]

**Table S3. Colonoscopy demands**

Strategy	Maximum colonoscopy demand during 2023-2047 (people/year)
Status quo	156,000
Strategy-I	667,000
Strategy-I + RS	1,230,000
Strategy-II	258,000
Strategy-II + RS	264,000
Strategy-III	728,000
Strategy-III + RS	1,250,000

Note: Each strategy with SC has equal colonoscopy demand to the strategy without SC

**Table S4. The current level of resources required for colonoscopy capacity building in public hospitals, Thailand (extracted on 20<sup>th</sup> March, 2023)**

Category	Resource	Value	Unit	References
Medical devices				
	Colonoscopy	500	Piece	Assumption
	CT scan	160	Pieces	[14]
Colonoscopy units				
	Operating room	1,955	Room	[14]
	Tertiary care	96	Place	[14]
	Quaternary care	29	Place	[14]
Healthcare workforces				
	Gastroenterologist	227	People	[14]
	General surgeon	1,402	People	[14]
	Colorectal surgeon	44	People	[14]
	Internal medicine doctor	1,768	People	[14]
	General practitioner	5,194	People	[14]
	Nurse	138,252	People	[14]

Experts believed that the current colonoscopy capacity is more than 200K people per year, which is reported in the literature. Thus, we estimated the range of possible colonoscopy capacity and we used this range to perform sensitivity analysis. We calculate the upper bound of the range by using an assumption from interviews—gastroenterologists and surgeons (general and colorectal) can handle at most 10 and 4 patients per week, resulting in colonoscopy capacity of 419K patients per year. We used 200K people per year as the lower bound of the range.

**Table S5. Description of the 8-point risk score [12]**

The 8-point risk score		
Sex		
	Male	1
	Female	0
Age		
	≥ 70 years	3.5
	60-69 years	3
	50-59 years	2
	40-49 years	0
CRC family history		
	Presence of ≥ 2 first-degree relatives with CRC	2
	Others	0
Body mass index		
	> 22.5 Kg/M <sup>2</sup>	0.5
	≤ 22.5 Kg/M <sup>2</sup>	0
Smoking history		
	> 18.5 pack-years	1
	≤ 18.5 pack-years	0

### S3. Results

**Table S6. Key results of the budget impact and strategy analyses, 2023-2047**

Strategy	QALY	QALY gained	Cost (THB)	Additional cost compared to the status quo	ICER (THB)
Status quo	669,751,658	0	442,697,979,634	0	-
Strategy-I	670,084,149	332,492	525,925,098,081	83,227,118,447	250,313
Strategy-I+RS	669,972,089	220,432	502,776,941,930	60,078,962,296	272,552
Strategy-I+SC	671,080,637	1,328,979	549,685,963,439	106,987,983,805	80,504
Strategy-I+RS + SC	671,431,020	1,679,362	541,677,340,468	98,979,360,834	58,939
Strategy-II	670,856,713	1,105,056	531,289,884,298	88,591,904,664	80,170
Strategy-II + RS	670,860,978	1,109,320	531,280,206,571	88,582,226,937	79,853
Strategy-II + SC	670,857,421	1,105,763	531,491,792,870	88,793,813,236	80,301
Strategy-II + RS + SC	670,862,049	1,110,392	531,654,214,190	88,956,234,556	80,112
Strategy-III	671,063,941	1,312,283	607,787,162,972	165,089,183,338	125,803
Strategy-III + RS	670,987,458	1,235,800	586,123,396,772	143,425,417,138	116,059
Strategy-III + SC	672,068,216	2,316,559	611,295,555,868	168,597,576,234	72,779
Strategy-III + RS +SC	672,367,089	2,615,431	601,084,957,846	158,386,978,212	60,559

QALY = quality-adjusted life year; ICER = incremental cost-effectiveness ratio; RS = risk-stratification (8-point risk score); SC = sufficient colonoscopy capacity

**Table S7. Key results of the probabilistic sensitivity analyses, 2023-2047**

Strategy	Probability to be cost-effective compared to the status quo	Probability to be the most cost-effective strategy		
		WTP of 110K THB (1-time per capita GDP)	Current WTP of 160K THB (1.5 time per capita GDP)	WTP of 320K THB (3-time per capita GDP)
Status quo	-	0.08	0.00	0.00
Strategy-I	0.30	0.00	0.00	0.00
Strategy-I + RS	0.41	0.00	0.00	0.00
Strategy-I + SC	0.68	0.00	0.00	0.00
Strategy-I + RS + SC	0.85	0.01	0.00	0.00
Strategy-II	1	0.10	0.07	0.02
Strategy-II + RS	1	0.10	0.08	0.03
Strategy-II + SC	1	0.00	0.00	0.00
Strategy-II + RS + SC	1	0.00	0.00	0.00
Strategy-III	0.89	0.00	0.00	0.00
Strategy-III + RS	0.94	0.00	0.00	0.00
Strategy-III + SC	0.91	0.05	0.04	0.06
Strategy-III + RS +SC	0.95	0.66	0.80	0.89

## References:

- 1 Khuhaprema T, Sangrajrang S, Lalitwongsa S, *et al.* Organised colorectal cancer screening in Lampang Province, Thailand: preliminary results from a pilot implementation programme. *BMJ Open* 2014;**4**:3671. doi:10.1136/bmjopen-2013
- 2 Tiankanon K, Aniwat S, Rerknimitr R. Current status of colorectal cancer and its public health burden in Thailand. *Clin Endosc.* 2021;**54**:499–504. doi:10.5946/ce.2020.245-IDEN
- 3 Kittrongsiri K, Wanitsuwan W, Prechawittayakul P, *et al.* Survival analysis of colorectal cancer patients in a Thai hospital-based cancer registry. *Expert Rev Gastroenterol Hepatol* 2020;**14**:291–300. doi:10.1080/17474124.2020.1740087
- 4 Kittrongsiri K, Praditsitthikorn N, Chaikledkaew U, *et al.* รายงานวิจัยฉบับสมบูรณ์  
โครงการพัฒนารูปแบบการตรวจคัดกรองมะเร็งลำไส้ใหญ่และไส้ตรงในระดับประชากร.
- 5 Digestive endoscopy training center RH. Digestive nurse endoscopy training. 2561.
- 6 Digestive endoscopy training center RH. Short course training: basic diagnostic and therapeutic endoscopy. 2562.
- 7 Reumkens A, Rondagh EJA, Bakker CM, *et al.* Post-colonoscopy complications: A systematic review, time trends, and meta-analysis of population-based studies. *American Journal of Gastroenterology.* 2016;**111**:1092–101. doi:10.1038/ajg.2016.234
- 8 Heresbach D, Chauvin P, Grolier J, *et al.* Cost-effectiveness of colorectal cancer screening with computed tomography colonography or fecal blood tests. *Eur J Gastroenterol Hepatol* 2010;**22**:1372–9. doi:10.1097/MEG.0b013e328333eaa71
- 9 Knudsen AB, Rutter CM, Peterse EFP, *et al.* Colorectal Cancer Screening: An Updated Decision Analysis for the U.S. Preventive Services Task Force Acknowledgments. 2021. www.ahrq.gov
- 10 Lee JK, Liles EG, Bent S, *et al.* Accuracy of Fecal Immunochemical Tests for Colorectal Cancer. *Ann Intern Med* 2014;**160**:171–81. doi:10.7326/m13-1484
- 11 Lin JS, Perdue LA, Henrikson NB, *et al.* Evidence Synthesis Number 202 Screening for Colorectal Cancer: An Evidence Update for the U.S. Preventive Services Task Force. 2021. www.ahrq.gov
- 12 Sekiguchi M, Kakugawa Y, Ikematsu H, *et al.* Risk Stratification Score Improves Sensitivity for Advanced Colorectal Neoplasia in Colorectal Cancer Screening: The Oshima Study Workgroup. *Clin Transl Gastroenterol* 2021;**12**:e00319. doi:10.14309/ctg.0000000000000319
- 13 Phisalprapa P, Supakankunti S, Chaiyakunapruk N. Cost-effectiveness and budget impact analyses of colorectal cancer screenings in a low- and middle-income country: example from Thailand. *J Med Econ* 2019;**22**:1351–61. doi:10.1080/13696998.2019.1674065
- 14 Thailand Health Resource and Geographic Information Systems M of PH. Health resources in Thailand. 2023.