ORIGINAL ARTICLE

# Effectiveness of COVID-19 Self-Risk Assessment Tool for Infection Prevention among Working-Age Population

Sompong Chaiopanont, MD[1], Praichon Tanaud, PhD[1], Prachaya Darnklang, BSc[1]

[1] Office of Senior Advisory Committee, Department of Health, Ministry of Public Health, Nonthaburi, Thailand

**Background**: Given the ongoing impact of the COVID-19 pandemic, self-risk assessment tools are crucial for individuals, particularly the working-age group, to evaluate their infection risk. There is a lack of such tools as of early 2021.

**Objective**: To develop and evaluate the effectiveness of the self-assessment test application named Thai Save Thai (TST) for determining individuals' risk level of COVID-19 infection before entering premises.

**Materials and Methods**: The present research consisted of two phases between April 2021 and July 2022. In the first phase, factory workers from all regions of the country were recruited using population allocation sampling. TST was used for self-assessment three times within two-week period to determine risk levels. The second phase evaluated the sensitivity, specificity and predictive value of TST among 320 subjects underwent reverse transcription polymerase chain reaction (RT-PCR) testing.

**Results**: TST showed varying percentages for each risk level: normal, 44.4%, 38.8%, 29.2%; low, 54.3%, 60.8%, 70.5%; high, 0.2%, 0.02%, 0.1%; very high, 1.1%, 0.36%, 0.21%; and infection results, 0.02%, 0%, 0.05%. TST indicated a sensitivity of 95.7% (95% CI 87.3 to 104.0), a specificity of 75.0% (95% CI 63.2 to 86.8) for detecting infection. Sensitivity for very high-risk level was 85.7% (95% CI 59.8 to 111.6) with 63.9% specificity (95% CI 51.9 to 76.0). The high-risk level had a sensitivity of 75% (95% CI 32.6 to 117) with specificity of 28.1% (95% CI 20.6 to 35.5), while the low-risk level had sensitivity of 90% (95% CI 71.4 to 109.0) with specificity of 27.1% (95% CI 19.8 to 34.3). The negative predictive value (NPV) were the same value as 97.5% at all results.

**Conclusion**: TST application is a self-risk screening tool that effectively discriminates between different risk levels and provides sensitivity for detecting infection with NPV for all assessment results. This application can enable individuals to assess their risk level of COVID-19 infection before entering any premises.

**Keywords**: Self-risk assessment; COVID-19; Infection; Verify of entry; Working-age

Received 28 March 2023 | Revised 19 May 2023 | Accepted 19 May 2023

**J Med Assoc Thai 2023;106(6):634-38**

**Website:** http://www.jmatonline.com

The situation of the pandemic COVID-19[(1)] had initially been detected from a patient at fresh food market in Wuhan, China since December 2019, later on spread around the world, which led to higher morbidity and mortality to many more people from its consequent mutation variants. The public health authorities of all countries established public health measures to control the pandemics. Thailand[(2)] went through successive episodes of the pandemics under good collaboration from all sectors of the country according to several social and health metrics. The second wave of the pandemic had begun since the 50th week of 2020[(3)], transmission via Thai female worker who contracted the infection from Myanmar-Thailand border. At the end of the year 2020, lessons learned from this episode led to the opinion to develop a tool to help everyone evaluate their own infectious risk before entering anyplace or at the point of entry, so the awareness to prevent spreading of the infection to others is enhanced. The present study was conducted from a set of questionnaires, which was urgently developed into an application naming Thai Save Thai (TST) in February 2020. During the outbreak of the second pandemic wave of the delta variant had begun in early 2021, overwhelmed by some illegally migrant Myanmar fishermen. By early April 2020, the government announced the prevention and control measures, the TST[(4)] was proposed to be used by the group of workers and people. Half a

**Correspondence to:**

Chaiopanont S.

Office of Senior Advisory Committee, Department of Health, Ministry of Public Health, Nonthaburi 11000, Thailand.

**Phone**: +66-2-5904159, Fax +66-2-5918147

**Email**: drs.pc@hotmail.com

**How to cite this article:**

Chaiopanont S, Tanaud P, Darnklang P. Effectiveness of COVID-19 Self-Risk Assessment Tool for Infection Prevention among Working-Age Population. J Med Assoc Thai 2023;106:634-38.

DOI: 10.35755/jmedassocthai.2023.06.13860

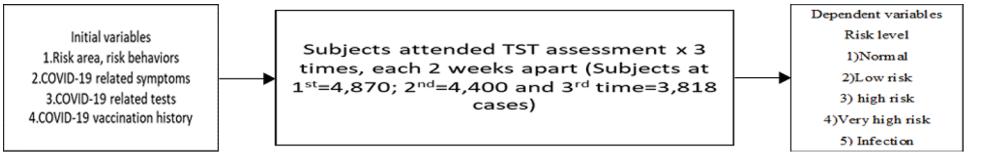


**Figure 1.** Discrimination infection risk power.

year later, the situation was under control with the collaboration of all sectors.

The purpose of the Research and Development (R&D) was to evaluate the effectiveness of a self-assessment tool for assessing COVID-19 risk, intended for public use as a verification of entry (VOE).

## Materials and Methods

The author drafted and developed a set of questionnaires, known as Thai Save Thai or TST, based on the input from the Strategic and Technical Advisory Group (STAG) of the Department of Health (DoH). Initially, TST was tested among DoH personnel and later transformed into the application TST in March 2021. In April 2021, the DoH proposed the Center for COVID Situation Administration[3] to declare TST as the designated VOE for factory workers. From April to July 2021, factory workers from all regions of the country were randomly selected as study subjects to evaluate the test's ability to discriminate COVID risk levels.

The sample size for phase 1 was calculated using Krejcie Morgan Table[5] and Proportional allocation in Sampling and Experimental Design[6]. The calculated sample was 384, as n=1,000,000; proportional allocation to 6 regions (North, North-eastern, East, West, South, and Middle regions) based on a total population of 57.06 million workers[7]. Therefore, n=6×384, resulting in a total sample size of 2,304. Considering 20% loss, the total sample size was adjusted to 2,765. The inclusion criteria were 1) Individuals within the working-age group of 15 to 60 years, of Thai nationality, with language literacy; 2) Subjects were provided orientation about TST, prior to taking the test; and 3) Participants voluntarily complete the test themselves. Those unwilling to participate were excluded. Data were collected through three separate TST assessments, each performed at 14-day interval, considering the incubation period ranging from 1.80 to 18.87 days[8]. After that, the power of risk discrimination was analyzed (Figure 1), however, the data were insufficient to evaluate the predictive value of the test, so the authors designed the second phase to study the predictive value of TST, conducting between April and July 2022 (Figure 2), amidst the declining situation of omicron variants, following an amended proposal protocol.

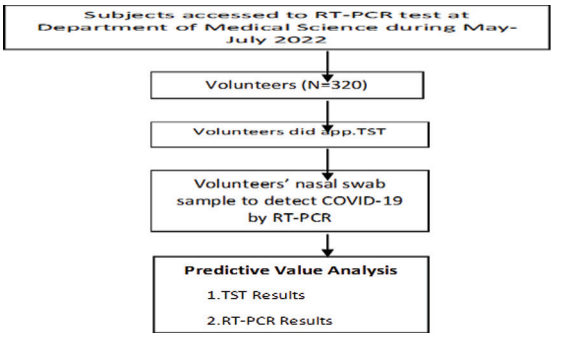


**Figure 2.** Predictive value.

Sample size of phase 2 was calculated from a set of formula[9] as N1 = (TP+FN)/P; TP+FN = $Z^2_{\alpha/2}$ [SN(1–SN)/W²]; N = 308+10%loss = 338 subjects (note: SN=sensitivity, SP=specificity, TP=true positive, FN=false negative). The inclusion criteria were 1) Thai individuals aged 15 to 60 years with proficiency in the Thai language who visited the Department of Medical Sciences for an RT-PCR test between May 2022 and July 2022; 2) Subjects were provided orientation about TST, prior to taking the test; and 3) Participants voluntarily complete the test by themselves. Those who were unwilling to participate were excluded. A complete data of 320 subjects were used for the analysis of predictive value (more than 308 calculated subjects).

Descriptive statistics and predictive value from C.I. Calculator: Diagnostic Statistics[10] were conducted to analyze the study data.

### Thai Save Thai application

TST could be digitally accessed via https://savethai.anamai.moph.go.th/main.php. TST consists of four main parts to assess: 1) risk symptoms, 2) risk locations and risk behaviors, 3) history of related examination results, and 4) history of vaccination. After checking all items in the four parts, the tool's

**Table 1.** COVID risk assessment via TST application between April and July 2021

| TST assessment | Risk level | | | | | Total (%) | Volunteers (n) |
|---|---|---|---|---|---|---|---|
| | Normal (%) | Low risk (%) | High risk (%) | Very high risk (%) | Infection (%) | | |
| 1st | 44.35 | 54.29 | 0.22 | 1.10 | 0.02 | 100 | 4,870 |
| 2nd | 38.84 | 60.77 | 0.03 | 0.36 | 0.00 | 100 | 4,400 |
| 3rd | 29.17 | 70.45 | 0.10 | 0.20 | 0.05 | 100 | 3,818 |
| Total | 38.07 | 61.18 | 0.12 | 0.60 | 0.02 | 100 | 13,088 |

TST=Thai Save Thai

**Table 2.** TST assessment in comparison with RT-PCR laboratory results between April and July 2022

| TST assessment results | RT-PCR laboratory results (n=320) | |
|---|---|---|
| | Detected (D) | Not detected (ND) |
| Normal | 1 | 39 |
| Low risk | 9 | 105 |
| High risk | 3 | 100 |
| Very high risk | 6 | 22 |
| Infection | 22 | 13 |
| Total | 41 | 279 |

TST=Thai Save Thai; RT-PCR=reverse transcription polymerase chain reaction

algorithm will decode and interpret the results as either normal, low risk (LR), high risk (HR), very high risk (VHR), or infection. Suggestions regarding the results would indicate what further actions should be taken. TST is available in three languages: Thai, English, and Myanmar.

### Ethical approval

The approval code for the research ethical committee of the Department of Health is 449/2564.

## Results

The present study showed how TST application functioned during early 2021. The objectives of launch TST were to prevent COVID-19 infections in crowded areas and enable self-screening for COVID-19 risk prior to emergency vaccine and the use of antigen test kit (ATK). Factory workers use TST to screen for COVID-19 risk before entering their assigned workplaces, the assessments were conducted three times, 14 days apart, in accordance with the estimated incubation period ranging from 1.80 to 18.87 days[8]. In April 2021, when the Delta variants emerged as the predominant cause of the new outbreaks, the authors aimed to ensure that the TST remained an effective self-screening tool.

Table 1 presented the results of the TST assessments. In the first assessment, a total of 4,870 volunteers participated, with the following results: normal 2,160 (44.35%), LR 2,644 (54.29%), HR 1 (0.22%), VHR 54 (1.10%), and infection 1 (0.02%). In the second TST assessment, there were 4,400 volunteers, and the results were as follows: normal 1,709 (38.84%), LR 2,674 (60.77%), HR 1 (0.03%), VHR 16 (0.36%), and infection 0 (0.00%). In the third assessment, there were 3,818 volunteers, and the results were: normal 1,114 (29.17%), LR 2,690 (70.45%), HR 4 (0.12%), VHR 8 (0.60%), and infection 2 (0.05%).

Table 2 showed the results of the TST assessment compared to the RT-PCR laboratory results (n=320): TST resulted as normal, whilst RT-PCR found D=1, and ND=39; TST resulted as LR whilst RT-PCR D=9, ND=105; TST resulted as HR whilst RT-PCR found D=3, ND=100; TST resulted as VHR whilst RT-PCR found D=6, ND=22; TST resulted as Infection whilst RT-PCR found D=22, ND=13.

Table 3 presented the predictive value of TST for different infection statuses: infection, VHR, HR, LR. The sensitivity values were 95.7%, 85.7%, 75.0%,

**Table 3.** Analysis of predictive value in comparison between results of TST and RT-PCR (n=320)

| TST results | Sensitivity (95% CI) | Specificity (95% CI) | PPV (95% CI) | NPV (95% CI) |
|---|---|---|---|---|
| Low risk | 90.0% (71.4 to 109.0) | 27.1% (19.8 to 34.3) | 7.9% (2.9 to 12.8) | 97.5% (92.7 to 102.3) |
| High risk | 75.0% (32.6 to 117.0) | 28.1% (20.6 to 35.5) | 2.9% (–0.3 to 6.2) | 97.5% (92.7 to 102.3) |
| Very high risk | 85.7% (59.8 to 111.6) | 63.9% (51.9 to 76.0) | 21.4% (6.2 to 36.6) | 97.5% (92.7 to 102.3) |
| Infection | 95.7% (87.3 to 104.0) | 75.0% (63.2 to 86.8) | 62.9% (46.8 to 78.9) | 97.5% (92.7 to 102.3) |

TST=Thai Save Thai; PPV=positive predictive value; NPV=negative predictive value; CI=confidence interval

and 90.0%, respectively. The specificity values were 75.0%, 63.9%, 28.1%, and 27.1%, respectively. Positive predictive value (PPV) for TST results indicating infection, VHR, HR, LR were 62.9%, 21.4%, 2.9%, and 7.9%, respectively. The negative predictive value (NPV) were the same value as 97.5% at all results.

## Discussion

As the prospective COVID-19 outbreak in Thailand still occurred, no one knew proper and strong intervention. Laboratory confirmation was done through RT-PCR. However, during that time, no easy or rapid test method for COVID-19 infection was available due to technical limitations in the laboratory. Thai-Chana was introduced to determine the crowdedness of the business locations, allowing the business owners to track-and-trace the customers, but without providing any risk level results[11]. Thus, the authors aimed to find a self-screening method to assess COVID-19 risk and prevent its spread among crowded populations. TST application was launched as an emergency respond to the new outbreak, but its accuracy was initially unknown. Subsequently, the authors conducted a study to assess the accuracy of the TST. The predictive value of TST for different infection statuses: infection, VHR, HR, LR. The sensitivity values were 95.7%, 85.7%, 75.0%, and 90.0%, respectively. The specificity values were 75.0%, 63.9%, 28.1%, and 27.1%, respectively. The PPV for TST results indicating infection, VHR, HR, LR were 62.9%, 21.4%, 2.9%, and 7.9%, respectively. The NPV was 97.5% for TST all results. According to the ROC curves[12], any tool with a sensitivity above 75% could be considered accountable in detecting abnormalities. The NPV for TST could reach 97.5% for all results. Therefore, TST should be properly used as a non-invasive self-screening tool before collecting sample for ATK tests or RT-PCR, while the results indicated VHR, HR, LR. Thus, TST could be used to detect the infection prior to period of public launching out rapid antigen test kit.

In April 2021, TST[4] was initially suggested to promote self-awareness and caution to prevent the spread of infection among worker groups. The risk level discrimination power of the first urgent phase study showed that infection results for the first, second, and third assessment were 0.02, null, 0.05, respectively. In comparison, the infection rates in the total population of 66.17 million[13] and the COVID-19 situation in Thailand[14-16] reported by CCSA on May 31, June 29, and July 30 in 2021 were 0.20%, 0.34%, and 0.71%, respectively. The infection rates among TST participants were significantly lower than those in the general population, with a difference of more than tenfold. This can be explained about the fact that the factory workers may have followed public health measures and utilized the TST app.

In conclusion, TST application serves as a risk screening tool and can be used as a self-risk assessment tool for COVID-19 infection for anyone to verify their entry into any place digitally without any charging fees. TST application demonstrates high sensitivity and moderately high specificity for infection and VHR levels, as well as moderate PPV and high NPV.

## What is already known on this topic?

Although, there are a few applications for screening COVID-19 infections, there is still lack of a self-risk assessment tool that can be accessed anywhere as VOE.

## What this study adds?

This study introduces a COVID-19 self-risk assessment application that can be accessed digitally, either through digital registration or offline, providing individuals with assessment results and suggestions on how to proceed, which can help prevent the infection transmission.


## Acknowledgement

The present study was funded by the Department of Health, Ministry of Public Health, Thailand. The authors would like to express our gratitude to Dr. Bancha KhaKhong, MD, Dr. Piya Sirilak, MD, Dr. Damrong Thamronglaohaphan, Dent., as well as the officers of the Department of Health, Department of Medical Sciences, regional health promotion centers, and all the research volunteers who supported and actively participated in the study.


## Conflicts of interest

The authors declare no conflict of interest.

## References


1. World Health Organization. Pneumonia of unknown cause-China, 2020 [Internet]. 2023 [cited 2023 Feb 24]. Available from: https://www.who.int/csr/don/05-january-2020-pneumonia-of-unknown-cause-china/en/.
2. Department of Disease Control Thailand. Coronavirus disease 2019 daily report [Internet]. 2023 [cited 2023 Feb 18]. Available from: https://media.thaigov.go.th/

uploads/public_img/source/301263.pdf.
3. The Centre for COVID-19 Situation Administration (CCSA). Coronavirus disease 2019 (COVID-19) May 31, 2021 [Internet]. 2023 [cited 2023 Mar 4]. Available from: https://media.thaigov.go.th/uploads/public_img/source/131263.pdf.
4. Watthanaying-Charoenchai S. Department of Health urged factory workers to pass self-assessment Thai save Thai as verify of entry for controlling COVID infection transmission in factories [Internet]. 2023 [cited 2023 Mar 1]. Available from: https://pr.moph.go.th/?url=pr/detail/2/02/158874/.
5. Krejcie VR, Morgan WD. Determining sample size for research activities. Educ Psychol Meas 1970;30:607-10.
6. Wu Ch, Chen J. Proportional allocation, Sample size allocation in Sampling and Experimental Design. Fall 2006 Lecture Notes of Department of Statistics and Actuarial Science University of Waterloo [Internet]. 2023 [cited 2017 Jul 30]. Available from: https://sas.uwaterloo.ca/~jhchen/stat332/total.pdf.
7. National Statistical Office. Thailand national population working status survey second trimester, 2021 [Internet]. 2023 [cited 2023 Mar 4]. Available from: http://www.nso.go.th/sites/2014/Pages/ViewAll_NewsUpdate.aspx.
8. Wu Y, Kang L, Guo Z, Liu J, Liu M, Liang W. Incubation period of COVID-19 caused by unique SARS-CoV-2 strains: A systematic review and meta-analysis. JAMA Netw Open 2022;5:e2228008.
9. Buderer NMF. Statistical methodology: I. Incorporating the prevalence of disease into the sample size calculation for sensitivity and specificity. In disease prevalence and sample size, buderer [Internet]. 2022 [cited 2022 Nov 5]. Available from: https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1553-2712.1996.tb03538.x.
10. Chinese University of Hong Kong. C.I. Calculator: Diagnostic Statistics [Internet]. 2023 [cited 2023 Jun, 2]. Available from: https://www2.ccrb.cuhk.edu.hk/stat/confidence%20interval/Diagnostic%20Statistic.htm.
11. Sambudhi K, Buathong T. Thai Chana-the application which had been developed from a web site [Internet]. 2023 [cited 2023 May 14]. Available from: https://www.bbc.com/thai/thailand-52850428.
12. Fawcett T. An introduction to ROC analysis. Pattern Recognition Letters 2006;27:861-74.
13. Thailand Board of Investment. General population information [Internet]. 2023 [cited 2023 Mar 4]. Available from: https://www.boi.go.th/index.php?page=demographic.
14. The Centre for COVID-19 Situation Administration (CCSA). Coronavirus disease 2019 (COVID-19) May 31, 2021 [Internet]. 2023 [cited 2023 Mar 4]. Available from: https://media.thaigov.go.th/uploads/public_img/source/310564.pdf.
15. The Centre for COVID-19 Situation Administration (CCSA). Coronavirus disease 2019 (COVID-19) June 30, 2021 [Internet]. 2023 [cited 2023 Mar 4]. Available from: https://media.thaigov.go.th/uploads/public_img/source/290664.pdf.
16. The Centre for COVID-19 Situation Administration (CCSA). Coronavirus disease 2019 (COVID-19) July 30, 2021 [Internet]. 2023 [cited 2023 Mar 4]. Available from: https://media.thaigov.go.th/uploads/public_img/source/300764.pdf.