

Innovative Device for Enhancing Physical Distancing in the COVID-19 Situation

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ABSTRACT

Objective: During the COVID-19 pandemic, physical distancing is one of the non-pharmaceutical measures that was recommended to reduce COVID-19 spread. Studies regarding physical distancing intervention and its effectiveness in Thailand have rarely been reported. This study aimed to evaluate physical distancing compliance among newly developed media interventions.

Methods: We used accidental sampling and the data collection method was observation via CCTV, at the university canteen. Three interventions, including an attractive picture, a flashing red-light, a speech alarm sound and the conventional intervention were employed to 400 customers. Each intervention was monitored in non-prime hours.

Results: The quasi-experimental study of 400 participants, the success rate of developed intervention including a flashing red light (6.0%, $p = 0.279$), an attractive picture (5.0%, $p = 0.445$) and a speech alarm sound (4.0%, $p = 0.683$) in promoting physical distancing compliance was not statistically significant from conventional intervention (2.0%). However, there was a statistically significant enhancement of physical compliance in some marking positions in our intervention.

Conclusion: The effectiveness of the innovative device was not statistically significant to enhance physical distancing compliance among customers of the university canteen. The compliance statistically significantly enhances in some marking points. The integration of the use of media into conventional interventions provides an alternative for enhancing physical distancing.

Keywords: Physical distancing; COVID-19; innovative device (Siriraj Med J 2021; 73: 69-76)

INTRODUCTION

The COVID-19 pandemic has confronted an unprecedented challenge to the world, our societies, health care systems, and economies. Within six months (from January to June 2020), 210 countries and territories around the world have reported more than seven million confirmed cases including almost four hundred thousand deaths as of 8th June, 2020.¹ The SARS-CoV2, a highly infective

pathogen, causes moderate to severe clinical outcomes in about 20% of all recognized infected individuals leading to the risk of health system collapse due to overwhelming medical resources.² In addition to the global health care system threat, it also contributes to the risk of economic recession (e.g., an 8.1% contraction of this year gross domestic product according to the Bank of Thailand forecast, Thailand's biggest GDP decline ever.).³

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In the absence of a vaccine, public health responses have posed the use of varying level of non-pharmaceutical interventions (e.g., hand hygiene, wearing face mask, and physical distancing) to mitigate the impact of the COVID-19 pandemic.⁴ Physical distancing was recommended to reduce COVID-19 spread.⁵ The Thai government has correspondingly implemented social distancing measures including stay at home, the closure of schools, restaurants, and other public places since March 2020. When stringently applied and perpetuated, these measures profoundly provoke societal and economic disruption.⁶ Thus, individual physical distancing is the most effective way to balance competing risks between health system collapse and economic risks.

Although there have been several previous studies on effectiveness of non-pharmaceutical intervention and factors affecting physical distancing compliance, studies regarding physical distancing intervention and its effectiveness in Thailand during this ongoing COVID-19 pandemic have rarely been reported. Our study developed media interventions based on behavioral change theory. The study aimed to evaluate physical distancing compliance among interventions.

MATERIALS AND METHODS

Setting and sample

This is a quasi-experimental study. The sampling technique used is an accidental sampling by the first

100 participants starting at 11.00 AM. The study was conducted in the university canteen at Prince of Songkla University, where there was conventional intervention as a footprint standing sign to encourage people to keep physical distancing (Fig 1A).

Measurement of key variables

Independent variable: innovative device

We developed three different media interventions to be used in the university canteen setting. (1) An attractive picture developed from original concept⁷, then designed in a colorful adorable coronavirus graphic with a crying-face and “COVID-19” text (Fig 1B). (2) A flashing red-light developed from color psychology⁸ and attention theory⁹⁻¹² composed of flexible 10 W flashing red LED strip lights which are waterproof, silicone-coated and battery-powered. The light strip was stuck in front of the conventional marking standing positions and covered with transparent adhesive tape (Fig 1C). (3) A speech alarm sound based on attention theory^{13,14}, “Please keep at least 1-meter distance apart” in Thai, delivered by 12-inch speaker within normal hearing intensity every 30 seconds (Fig 1D).

Each intervention was monitored over lunchtime for four days in early August, 2020 until four interventions were completed. The study outcome was physical distancing compliance.

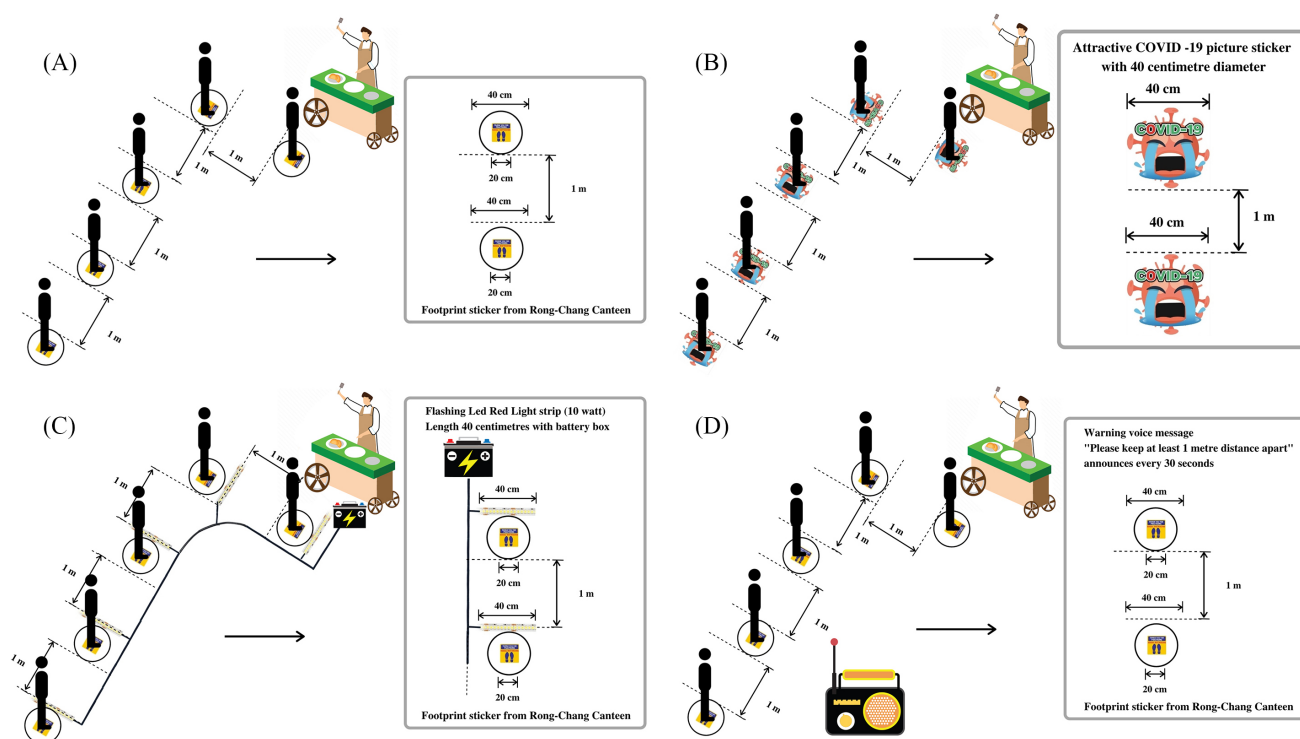


Fig 1. (A) Control (B) An attractive picture (C) A red flashing-light (D) A speech alarm sound.

Dependent variable: physical distancing

Physical distancing is defined as at least 1-meter distance among people.⁵ Successful physical distancing was defined according to the following criteria:

(1) Standing within the 40-centimeter-length marking position along the process of queueing.

(2) Moving out of the marked position 3 seconds and less each time is acceptable.

Other conditions which do not meet these criteria above are defined as a failure to keep physical distancing.

Factors affecting physical distancing

This study is a comparative behavioral observation study via CCTV. We established the protocol for CCTV data collection. After piloting the protocol for CCTV record, observers revised the established protocol to validate inconclusive situations. The revised protocol was applied in the data collection. We observed the characteristics of participants including age group (by observation), gender, university uniform, companion, and carrying item. The accessibility of the records is limited to our research team only at the study location and the records will not be published. These do not contain personal identification and will be deleted within 7 days according to the organization's security policy. All analyses were carried out on anonymized data and will be analyzed in aggregates. Moreover, the publication will not mention the dates and specific places. Therefore, we guarantee the confidentiality and the privacy of the participants and communities.

Statistical analysis

The statistical analysis included both continuous and categorized variables for physical distancing. The median and interquartile range (IQR) were used to describe the physical distancing as the data were not normally distributed. The Wilcoxon signed-rank test was used to compare the physical distancing regarding different interventions within the same cluster. Categorical variables were analyzed using a Chi-square or Fisher's exact test. The analysis was computed by R[®] 4.0.0.

The study was conducted in line with the Belmont Report and was approved by the Human Research Ethics Committee (HREC), Faculty of Medicine, Prince of Songkla University (REC.63-272-9-1).

RESULTS

There was a total of 400 participants observed over 4 interventions including the conventional one, an attractive picture, a flashing red-light, and a speech alarm sound. One quarter of the participants engaged in

each intervention. The participant demographic data was recorded in Table 1 as gender, age group (by observation), uniform wearing, coming with companion, and carrying items categorized in number and types. Considering characteristics, gender was solely not statistically different in an attractive picture ($p = 1.00$), a flashing red-light ($p = 0.764$), and a speech alarm sound ($p = 0.114$).

Comparing each intervention with the control group, there was no significant effect of all interventions on physical distancing compliance (Table 2). The highest average number of failures of physical distancing was an attractive picture (3 times). The number of failures of physical distancing of the other three interventions was 2 on average.

According to Table 3 and Fig 2, the failure of physical distancing at the first two marking points in all interventions were approximately 80% while the rest were apparently lower. In the attractive picture intervention, the failure of physical distancing went in an upward trend at marking point 3, 4 and 5. The flashing red-light intervention could significantly decrease 25.4% failure of physical distancing comparing to the control group at marking point 3 ($p = 0.011$). At the latter marking points, the failure of physical distancing in the speech alarm sound intervention continuously attenuated, demonstrating a similar trend to the control group. At the marking point 5, the failure of physical distancing declined. The decline was statistically significant ($p = 0.044$).

DISCUSSION

Our results demonstrated that failure of physical distancing compliance in all interventions declined compared to the control group. However, findings did not have enough strength to support the effectiveness of interventions on delivering the encouragement of behavioral change. Considering each marking point in all interventions, the first two positions bore noticeably high percentage of failure of physical distancing due to the distraction from menu selection. In position 3, 4 and 5 of the attractive picture intervention, there was an increasing failure of physical distancing (Fig 3). A message from an attractive picture might not efficiently be delivered to the participants. Failure of physical distancing at marking point 3 of the flashing red-light intervention decreased significantly since the intervention could establish an effect to draw attention.¹⁰⁻¹² The speech alarm sound intervention could improve behavior of participants in maintaining physical distance, especially at the latter marking points. Despite the fact that physical distancing, one of non-pharmaceutical interventions, is key to preventing spread of respiratory

TABLE 1. Background information of participant on the interventions (n=400).

Characteristics	Control (n=100)	An attractive picture (n=100)	P-value	A flashing red-light (n=100)	P-value	A speech alarm sound (n=100)	P-value
Gender, n (%)							
Male	65 (65)	66 (66)	1 _a	68 (68)	0.764 _a	53 (53)	0.114 _a
Female	35 (35)	34 (34)		32 (32)		47 (47)	
Age group by observation, n (%)							
Wearing university uniform	2 (2)	39 (39)	< 0.001 _{a*}	39 (39)	<0.001 _{a*}	8 (8)	0.105 _a
Not wearing university uniform	98 (98)	61 (61)		61 (61)		92 (92)	
Children (est. 0-11 years)	1 (1)	0 (0)	0.003 _{b*}	0 (0)	0.608 _b	0 (0)	< 0.001 _{b*}
Adolescences (est. 12-18 years)	12 (12.4)	0 (0)		4 (6.6)		1 (1.1)	
Adult (est. 19-64 years)	83 (84.6)	61 (100)		56 (91.8)		91 (98.9)	
Elderly (est. ≥65 years)	2 (2.1)	0 (0)		1 (1.6)		0 (0)	
With companion, n (%)							
No	66 (66)	86 (86)	0.002 _{a*}	82 (82)	0.016 _a	72 (72)	0.445 _a
Yes	34 (34)	14 (14)		18 (18)		28 (28)	
Carrying items, n (%)							
No carrying item	38 (38)	78 (78)	< 0.001 _{a*}	70 (70)	< 0.001 _{a*}	82 (82)	< 0.001 _{a*}
Carrying items	62 (62)	22 (22)		30 (30)		18 (18)	
Number and type of items, Median, [IQR]	1 [1,2]	1 [1,1]	0.093 _c	1 [1,1]	0.005 _{c*}	1 [1,1]	0.06 _c
1	41 (66.1)	19 (86.4)	0.09 _b	28 (93.3)	0.01 _{b*}	16 (88.9)	0.202 _b
2	19 (30.6)	2 (9.1)		2 (6.7)		2 (11.1)	
3	2 (3.2)	1 (4.5)		0		0	
Type of items, n							
Container	3	0		0		0	
Book	0	0		1		0	
Bag	44	12		20		12	
Mobile	26	7		7		5	
Other	7	6		3		2	

Abbreviation: IQR = interquartile range* P-value < 0.05, compared with control group, ^a Chi-squared test, ^b Fisher's exact test, ^c Wilcoxon rank-sum test

TABLE 2. Effects of the interventions on failure of physical distancing practice (n=400).

	Failure of physical distancing (n = 100)		Number of failure of physical distancing	
	n (%)	P-value	Median (IQR)	P-value
Control	98 (98.0)	-	2 (2,3)	-
An attractive picture	95 (95.0)	0.445 _a	3 (2,3)	0.293 _b
A flashing red-light	94 (94.0)	0.279 _a	2 (2,3)	0.866 _b
A speech alarm sound	96 (96.0)	0.638 _a	2 (2,2,2)	0.006* _b

Abbreviation: IQR = interquartile range

*P-value < 0.05, compared with control group, ^a Chi-square test, ^b Wilcoxon rank-sum test

TABLE 3. Failure of physical distancing practice by the marking point.

Marking point	Failure of physical distancing						
	Control	An attractive picture		A flashing red-light		A speech alarm sound	
	No. of failure/total (%)	No. of failure/total (%)	P-value ^a	No. of failure/total (%)	P-value ^a	No. of failure/total (%)	P-value ^a
1	87/99 (87.9)	76/99 (76.8)	0.062	85/97 (87.6)	1	80/95 (84.2)	0.596
2	81/99 (81.8)	84/100 (84.0)	0.825	85/99 (85.9)	0.562	81/98 (82.7)	1
3	22/42 (52.4)	32/71 (45.1)	0.578	20/74 (27.0)	0.011*	11/36 (30.6)	0.086
4	8/24 (33.3)	24/50 (48.0)	0.346	17/54 (31.5)	1	4/16 (25.0)	0.729
5	6/12 (50.0)	17/26 (65.4)	0.481	13/36 (36.1)	0.501	0/7 (0)	0.044*

*P-value < 0.05, compared with control group, ^a Pearson's Chi-squared test

diseases including COVID-19 as reported in previous studies¹⁵⁻¹⁹ interventions on physical distancing are scarce as a limited number of studies additionally investigated the factors affecting physical distancing.

When assessing the compliance on physical distancing at marking point 3, flashing red- light (73.0%, p-value = 0.011) could significantly increase customers practicing physical distancing compared to the control (47.6%). There were studies on the effect of flashing lights on behavioral change. The results supported that flashing lights were highly visible to draw enough attention with the potential to induce positive attitudes and a level of

behavioral change, and attention.¹⁰⁻¹² Moreover, Hill and Barton (2005) described the mechanism of the red effect, is that dressing red increases one's dominance, aggressiveness and testosterone and finally improves competitive outcome.⁹

The use of flashing red-light was appropriate with the university canteen setting. The red color was in contrast to the floor and the flashing light could draw attentions since there was ambient light without any stronger light within the setting.

In the speech alarm intervention, the compliance on physical distancing significantly increased 2.0% compared

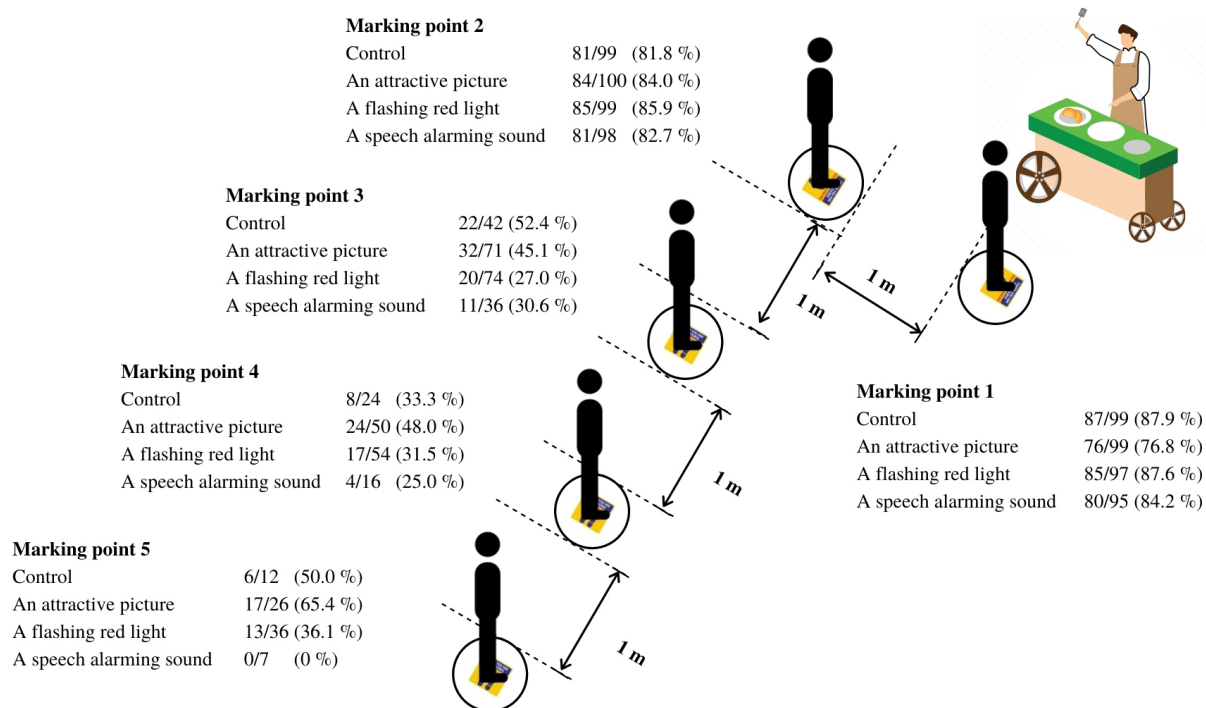


Fig 2. Overall failure of physical distancing compliance.

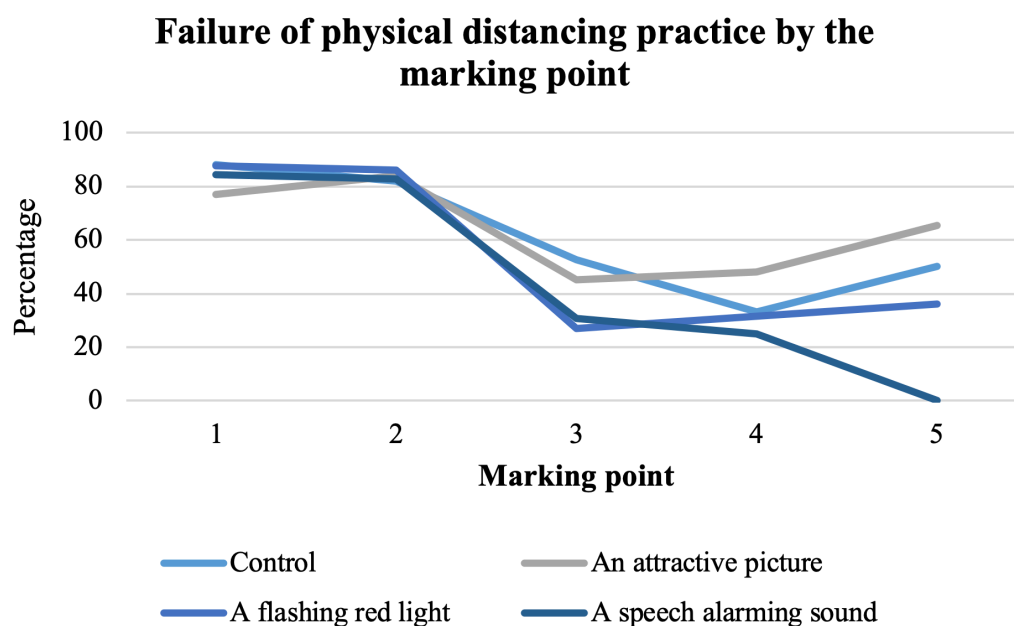


Fig 3. Failure of physical distancing practice by the marking point.

to the conventional one. There were two studies on the effect of using auditory modality on compliance. The results demonstrated that presenting warning information using auditory modality may also lead to greater warning attention and compliance.^{13,14}

In the attractive picture intervention, the compliance in physical distancing improved 3.0%. The crying-face

of an adorable COVID-19 picture painted in pink could bring out the cute emotion of customers. Jones et al.⁷ recorded and written about the cute-emotion is mainly a response to neotenic or baby-animal characteristics, such as big round eyes, small size, and softness. Commercial enterprises intentionally utilize adorable characteristics to generate cute-emotion responses by their customers

as it is such a powerful and effective approach. As in our setting, with the use of cute-emotion approach, the majority of adult customers could consequently perceive and positively respond to an attractive picture. Besides the control, the COVID-19 Figure tended to enhance the level of self-awareness by reinforcing the correlation between practicing physical distancing and the prevention of ongoing COVID-19 pandemic.

Limitations

Our largest limitation was the inadequate sample size since our study was part of the family medicine course, which had a short timeline for performing this study and the data collection from CCTV was a time-consuming process. However, our research team could not reach an adequate sample size regarding the marking point 4 and 5. This interfered with the validity of data interpretation. In addition, the results could be influenced by the researcher's personal judgement contributing to information bias, even though there were valid data collection protocol for observers and inclusion criteria documented to diminish this bias. Regarding to the small sample size at some marking points, and the period of data collection during zero COVID-19 cases, we dictate caution in the interpretation of these findings. In future studies, it would be advisable to increase number of times for each intervention exposure and extend the data collection period to obtain adequate sample size, in which subsequent subgroup analysis may provide a more significant outcome.

The second limitation was the inappropriate period of study. The study was held during the period with zero new COVID-19 infection reported in Thailand so that the participants' level of awareness altered. The researcher provided intervention correlating between COVID-19 situation and disease prevention. Though, it was inadequately promoting a behavioral change. Therefore, the result from our interventions might not characterize the participants' behavior during high incidence rate of infection episode. With time restriction, our interventions were not employed on scheduled workdays so that the characteristics of participants in the control group were varying and could not entirely be used to describe the effect of factors affecting physical distancing compliance. Lastly, the study was conducted at university canteen, mainly composed of university students. The result of physical distancing compliance among general population in this setting might not be widely applicable. Our interventions were simple and affordable to install and used locally available materials. Henceforward, future studies should be performed in other settings among general population

and containing a large number of participants would compare the behavioral impact of our interventions. Another explanation for limited generalizability of the outcomes is the pattern of queueing process which is unique in each setting. According to the size of intervention and a criterion to keep 1-meter distance apart, the previous compatible pattern of marking points was changed. The customers were not accustomed to the provided interventions. In consideration with the battery capacity, the extended period of data collection might not be practical for flashing red-light. Moreover, there was a need of experts to create further interventions.

CONCLUSION

In this quasi-experimental study of 400 participants over the effectiveness of innovative device on physical distancing compliance in the university canteen setting, the data suggests that innovative devices were statistically insignificant to enhance physical distancing compliance. The compliance was statistically significant to enhance at some marking points. Future studies containing a large number of participants would compare the behavioral impact of our interventions. The integration of the use of media into conventional interventions provides an alternative way of enhancing physical distancing.

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