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Individual medical face mask use behavior and development of Ultraviolet-C irradiation disinfection system in rural areas

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Abstract

The COVID-19 outbreak has impacted on the living of people in communities and around the world. The medical face mask use is an effective way to protect people from the spread and infection of the disease. The objectives of this study were to study the individual behavior of medical face mask use in the community area in Thailand and to evaluate the effectiveness of medical face mask disposal using Ultraviolet-C (UV-C) irradiation. The study also aimed to understand the medical face mask behavior use of people in Chiang Khruea Subdistrict, Mueang District, Sakon Nakhon Province, Thailand. Data of medical face mask use were collected using questionnaires. The results show that people not only used approximately 1-3 medical face masks per day, but also wore them during daily activities and interacting with others. The study also evaluated the effectiveness of infectious medical face masks exposed UV-C irradiation for 5, 10, 15, and 20 minutes for decontamination. The results demonstrate that UV-C irradiation exposed for 20 minutes completely eliminated microorganisms on infectious medical face mask surfaces. Therefore, UV-C irradiation has the effectively ability to kill bacteria on the medical face mask surface.

Keywords: Bacterial disinfection, Prevention, Infection, Outbreak, Medical face mask

1.Introduction

The COVID-19 pandemic, which has occurred since 2019, has severely impacted public health systems worldwide and resulted to widespread changes in public self-protection behavior. The use of medical face mask has become a primary preventative measure recommended by the World Health Organization (WHO) and other public health agencies around the world due to its significant effectiveness in reducing the spread of respiratory viruses)Chen et al., 2020; Howard et al., 2021). The use of face masks in Thailand, particularly in rural areas, has increased rapidly and reflects in public awareness of the importance of infection prevention. However, the widespread and continued use of medical face masks has posed new challenges in infectious waste management including the problem of pathogen contamination on medical face mask surfaces after use, which can be a source of secondary infections if not properly managed.

Studies on medical face mask use behavior in several countries have found that socio-economic factors, education level, and access to information significantly influence medical face mask use behavior)Betsch et al., 2020; Haischer et al., 2020; Channuwong & Ruksat, 2022(. In Thailand, most studies focused on urban areas and highly educated populations; therefore, data on medical face mask use behavior in rural areas limited, particularly regarding frequency of use, daily use duration, and post-use management patterns. The understanding of medical face mask use behavior is essential for appropriately designing mask management systems in rural areas. The waste management from medical face masks has become an important environmental and public health issue. According to various environmental organization estimations, medical face mask waste has multiplied during the pandemic)Prata et al., 2020; Silva et al., 2021). Previous microbiological studies show that the types of pathogens and the environments affected bacteria and virus survival on the surfaces of medical face masks for a long time)van Doremalen et al., 2020; Chin et al., 2020; Jam et al., 2025). Consequently, inappropriate handling and disposal of used medical face masks results risk of infection. The development of effective and appropriate disinfection technologies for the community is therefore essential. Ultraviolet-C (UV-C) disinfection technology has gained significant attention during the pandemic due to its ability to effectively disrupt the genetic structure of microorganisms. The mechanism of action of UV-C is based on the DNA and RNA destruction of microorganisms by forming pyrimidine linkages, so

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microorganisms could not divide and grow)Guan et al., 2022; Probst et al., 2021). Several studies found that UV-C at 254 nm wavelength is highly effective for killing bacteria and viruses including SARS-CoV-2)Bhardwaj et al., 2021; Heilingloh et al., 2020). The advantages of UV-C irradiation are without chemicals, without residue, and room temperature operation (García-Alcantara et al., 2021). However, most studies were carried out in laboratories with strictly controlled conditions and lacked actual conditions with local communities. The literature review identified three key research gaps: (1) lack of in-depth data on medical face mask use behavior in rural areas in Thailand, (2) lack of linkage between medical face mask use behavior and development of appropriate disinfection technologies, and (3) lack of data on the effectiveness of UV-C systems in disinfecting medical face masks under existing usage conditions. Therefore, the objectives of this study were to fill these gaps by studying medical face mask use behavior in rural communities and to develop the disinfection system that match the actual demand of the communities.

The specific objectives of this research were (1) to study the medical face mask use behavior of people in Chiang Khruea Subdistrict, Mueang District, Sakon Nakhon Province, by focusing on the frequency of the medical face mask use, the daily medical face mask use duration, and disposal of the infectious medical face masks; (2) to evaluate the effectiveness of UV-C irradiation exposed 5, 10, 15, and 20 minutes to decontaminate the infectious medical face masks, and (3) to prepare the formal guideline for medical face mask disposal, which match with community requirements. The findings were developed the integrated medical face mask disposal to reduce infection risks and community environmental impacts.

Materials and Methods

This research study consisted of 2 main parts. The first part was the survey research on the behavior of medical face mask use in the community. The objective was to study the patterns and the individual behaviors of medical face mask use in the community by using questionnaires as the main tool for collecting data from the purposively selected sample group. The second part was to evaluate the UV-C sterilization technology for eliminating bacteria contamination on the medical face mask surfaces. We set the contamination situations, and the medical face mask were exposed UV-C irradiation for 5, 10, 15, and 20 minutes. To measure bacteria elimination efficacy, we compared the bacteria amounts before and after UV-C irradiation. The two parts were linked together, so the results of medical face mask use behavioral were used as the guideline for appropriate medical face mask disposal in communities.

2.1 The study of medical face mask use behavior in the community

This study was the survey research that aimed to focus on the individual behavior of medical face mask use. These people contacted others regularly. The subjects in this study were 30 people, who were selected by purposive sampling. Data were collected using questionnaires, which were verified by both specialists and the preliminary trial with a test group. We distributed questionnaires to the subjects for 3 weeks and checked immediately after the completion of the questionnaires. The tools for data collection were questionnaires developed based on relevant research articles and examined the content validity by three specialists. The reliability of the questionnaires was at a good level since Index of Item-Objective Congruence (IOC) value was between 0.80–1.00. The preliminary trial was tested with 15 people, who were similar to the subjects. Cronbach's Alpha Coefficient was calculated, which was 0.87. The number indicate that the questionnaires had a high level of reliability and was suitable for the collecting data.

2.2 The behavior uses of medical face masks of the subjects:

Data obtained from the questionnaires on the behavior use of medical face masks were analyzed using descriptive statistics. Frequency and percentages were reported to show medical face mask duration per day, the number of used medical face masks per day, analysis of medical face mask duration per day. The data were divided into (1) less than 1 hour per day, (2) 1–3 hours per day, (3) 4–6 hours per day, and (4) 7–9 hours per day. The number of samples in each group was calculated to find the percentages of medical face mask duration and the number of used medical face mask per day. The data of used medical face masks were divided into (1) 1–3 pieces per day, (2) 4–6 pieces per day, and (3) more than 6 pieces per day. Frequency and percentage analysis indicated the used medical face masks of each subject group as shown in Tables. According to the infectious medical face mask disposal, data obtained from the questionnaires were analyzed using descriptive statistics including frequency and percentages to describe the behavior originated from each question. Data obtained from the subjects were analyzed to display the frequency and percentages of 10 answers in each level for evaluating the infectious medical face mask disposal. The questions were categorized into three main groups: (1) appropriate medical face mask use, (2) the behavior of the used medical face mask, and (3) proper mask disposal. The frequency and percentages were displayed to reflect to the propriate, or risky behaviors of the infectious medical face mask disposal as shown in Tables.

2.3 Study of UV-C irradiation efficiency

This part of the study focused on evaluating the efficacy of Ultraviolet-C (UV-C) irradiation technology in eliminating bacteria on medical face mask surfaces. The objective was to study the effect of irradiation duration on the amounts of remaining bacteria after UV-C exposure. Three medical face masks were contaminated with bacteria and were kept in a zip-lock bag with the complete seal. To count the initial amounts of bacteria, the contaminated medical face masks were placed on a Petri dish containing culture medium and incubated at 37°C for 24 hours. The contaminated medical face masks were then exposed UV-C irradiation for 5, 10, 15, and 20 minutes. To count the remaining amounts of bacteria, the UV-C exposed medical face masks were placed on a Petri dish containing culture medium and incubated at 37°C for 24 hours. The initial amounts of bacteria were compared with the remaining amounts of bacteria for evaluating effectiveness of UV-C irradiation and identifying the optimal UV-C irradiation duration for bacterial decontamination.

The inside of the irradiation room was 30 cm-width, 20 cm-length, and 20-cm height. The room consisted of a 30W low-pressure mercury lamp with 254-nm wavelength (Philips TUV, the Netherlands). The lamp was a highly efficient UV-C irradiation source, emitting 254- nm radiation and 0.5–15.0 mW per cm^2. To ensure the stable and efficient function, UV-C irradiation worked at 20°C temperature and 60% relative humidity. To measure and calibrate the radiation intensity at various locations, the room was equipped with a UV meter (model UVP UVX-254, Analytik Jena, Germany), so the radiation was consistent throughout the room.

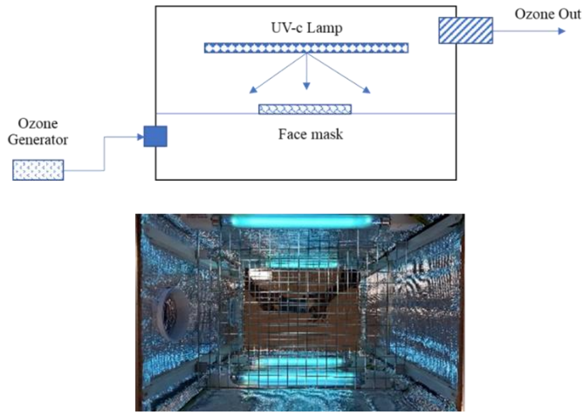

Fig. 1. UV-C irradiation instrument for evaluating the bacterial contamination on the medical face mask surfaces

3. Results

3.1 Results of the behavior use of the medical face masks of people in Chiang Khruea Subdistrict, Mueang District, Sakon Nakhon Province

Data of behavior use of medical face mask of people in Chiang Khruea Subdistrict, Mueang District, Sakon Nakhon Province were analyzed using a computer statistical program. The subjects consisted of 30 people.

Demographic characteristics of the subjects. The subjects in this study consisted of 30 people, of which 27 were female or equivalent to 90% of the total sample. In terms of age, 18 people or equivalent to 60% were the highest proportion, which was between 38-54 years old. The results show that the majority of the subjects were in middle adulthood with family and community responsibilities. According to the education background, 9 subjects or equivalent to 30% of the total sample completed secondary high or vocational schools. In other words, the results demonstrate that the educational diversity was diverse in the community. Based on the occupation data, 11 people or equivalent to 36.7% of the total sample were housekeepers, which were the highest number. Sixteen people or equivalent to 53.3% of the total sample had an monthly income less than or equal to 10,000 Baht. Therefore, the economic conditions of the community were middle to lower.

Twenty-three people or equivalent to 76.7% of the total sample lived with only the partners. All of them lived in the houses with wide space; consequently, it was beneficial for maintaining social distancing and preventing the spread of disease.

The use behavior of the medical face masks. The results indicate that all of them used the medical face masks regularly. In other words, they had experience to use the medical face masks before and always wore the medical face masks when they worked or met other people. The use of the medical face masks became the part of their daily life in the community. Third teen people or equivalent to 43.3% of the total sample wore the medical face masks between 4-6 hours every day, which is an appropriate length of time for outdoor activities and work. The percentage of 83.3 used 1-3 medical face masks per day. To summarize, people in the community were highly aware of infection prevention. They wore the medical face masks for 4-6 hours as the recommendations of public health organizations.

3.2 Management of infectious medical face masks.

The results in this study present the management of the infectious medical face mask with 30 people as the subjects. The survey results show the variety of the medical face mask disposal. For example, some followed the recommended guidelines, while others had to improve. According to the most rejected recommendation, they did not follow the guidelines for reusing the medical face masks. Seventy percentages report that they did not practice in the guideline due to many reasons such as safety concerns, discomfort in cleaning, or lack of knowledge about safe reuse methods. On the other hand, the highest following guideline was washing their hands after the medical face mask disposal. In other words, 70% of them did it as shown in Table 2. Handwashing after the medical face mask disposal demonstrated awareness of hygiene and prevention of cross-contamination

Table 1: Information on the duration use and the amounts of the daily use of the medical face masks in the subjects

Information on the use of the medical face masks in the subjects (N=30).	**Samples**	**Percentage**
Approximate duration of the medical face mask wearing during daily activities and interactions with people (hours).		
Less 1 hour per day	6	20.0
Between 1-3 hours per day	7	23.3
Between 4-6 hours per day	13	43.3
Between 7-9 hours per day	4	13.3
The approximately daily use amount.		
1-3 pieces per day	25	83.3
4-6 pieces per day	4	13.3
More than 6 pieces per day	1	3.3

Table 2**:** Behavior of the infectious medical face mask disposal in the subjects

Management of the infectious medical face masks.	**None**	**Some time**	**Every time**
Always wear the medical face masks outside the houses.	0 (0%)	12 (40%)	18 60%)
2. When wearing the medical face masks, avoid touching the outside of the medical face masks.	6 (20%)	17 (56.7%)	7 (23.3%)
Wash your hands carefully after handling the medical face masks.	2 (6.7%)	7 (23.3%)	21 (70.0%)
Reusing the medical face masks to reduce environmental contamination.	21 (70%)	7 (23.3%)	2 (6.7%)
You always wear the medical face masks when you are outside the houses.	4 (13.3%)	18 (60%)	8 (26.7%)
Do not pull the medical face masks down to your chin.	8 (26.7%)	20 (66.7%)	2 (6.7%)
Dispose the used medical face masks in covered trash	5 (16.7%)	9 (30.0%)	16 (53.3%)

Management of the infectious medical face masks.	None	Some time	Every time
cans.			
Dispose of the used medical face masks in sealed, labeled bags or in mask disposal containers.	3 (10.0%)	17 (56.7%)	10(33.3%)
Dispose of the used medical face masks in general trash cans.	10 (33.3%)	13 (43.3%)	7 (23.3%)
Dispose of the used medical face masks in the infectious trash cans at hospitals or health centers.	8 (26.7%)	11 (36.7%)	11 (36.7%)

3.3 Study of the efficiency of ultraviolet-C irradiation

This study examined the effectiveness of using Ultraviolet-C (UV-C) irradiation exposed at different times to eliminate bacteria on the medical face masks. After sample preparation, the bacterial count was determined through colony counting. Then the infectious medical face masked were placed in UV-C irradiation room for 5-, 10-, 15-, and 20-minutes. After finishing experiments, the infectious medical face masked were placed on a Petri dish containing culture medium and incubated at 37°C for 24 hours. The results demonstrate that the percentages of bacterial reduction on the infectious medical face masked exposed UV-C radiation for 5, 10, 15, and 20 minutes were 13, 33, 56, and 100, respectively, as shown in Table 3. The results of the study showed the positive relationship between exposed UV-C irradiation duration and efficiency of the bacterial elimination on the medical face masks as shown in Table 3 and in Figures 2-6. The results indicate that UV-C irradiation for 20 minutes completely eliminated bacteria. UV-C irradiation technology is the potential method of the bacterial decontamination of the infectious medical face masks.

Table 3: Efficiency of the bacterial elimination on the medical face masks exposed UV-C irradiation for different times

Retention Time (minute)	5	10	15	20
Before UV-C irradiation (CFU/mL)	152	152	152	152
Before UV-C irradiation (CFU/mL)	133	102	67	0
Efficiency of the bacterial elimination (%)	13	33	56	100

Note: CFU/mL = Colony Forming Units per milliliter UV-C = ultraviolet-C irradiation

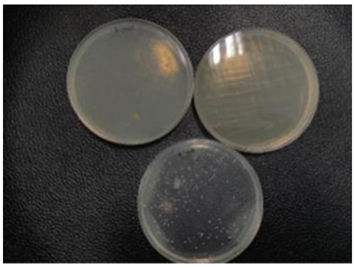

Figure 3. The remaining bacteria after 5-minute exposed UV-C irradiation were 133 CFU/mL.

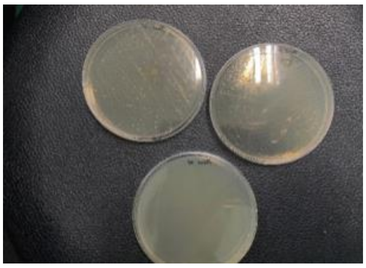

Figure 4. The remaining bacteria after 10-minute exposed UV-C irradiation were 102 CFU/mL.

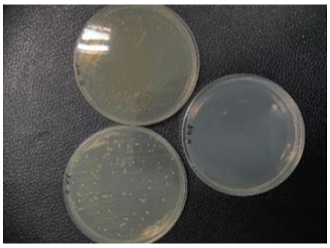

Figure 5. The remaining bacteria after 15-minute exposed UV-C irradiation were 67 CFU/mL.

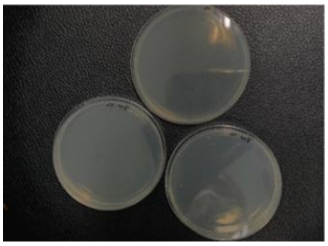

Figure 6. The remaining bacteria after 20-minute exposed UV-C irradiation were 0 CFU/mL.

Conclusions

This study aimed to investigate the efficacy of Ultraviolet-C irradiation for bacterial decontamination of the infectious medical face masks. The results show that UV-C irradiation was highly effective in killing bacteria on the medical face mask surfaces. The amounts of bacteria were placed on the medical face masks, and then the infectious medical face masks were exposed UV-C irradiation with ozone for 5, 10, 15, and 20 minutes. The amounts of bacteria on the medical face masks before UV-C irradiation were compared with those after UV-C irradiation. The results demonstrate that the numbers of bacteria decreased significantly when the exposure time of UV-C irradiation increased. Particularly, the percentages of bacteria reduction on the medical face masks exposed UV-C irradiation for 5, 10, 15, and 20 minutes were 13, 33, 56, and 100, respectively. Based on the results, it can conclude that 20 minutes of UV-C exposure was sufficient to kill bacteria on the medical face masks.

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References

Betsch, C., Korn, L., Sprengholz, P., Felgendreff, L., Eitze, S., Schmid, P., & Böhm, R. (2020). Social and behavioral consequences of mask policies during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences*, *117*(36), 21851-21853.

Bhardwaj, S. K., Dhanjal, D. S., Sharma, D., Singh, J., & Bhardwaj, K. (2021). An overview on UV-C disinfection technology and its widespread applications.*Environmental Science and Pollution Research*, *28*, 24861-24885.

Channuwong, S., & Ruksat. (2022). Buddhist teachings for improving mental health during the COVID-19 pandemic. The Journal of Behavioral Sciences, 17(2), 29-41.

Chen, X., Ran, L., Liu, Q., Hu, Q., Du, X., & Tan, X. (2020). Hand hygiene, mask-wearing behaviors and its associated factors during the COVID-19 epidemic: A cross-sectional study among primary school students in Wuhan, China. *International Journal of Environmental Research and Public Health*, *17*(8), 2893.

Chin, A. W., Chu, J. T., Perera, M. R., Hui, K. P., Yen, H. L., Chan, M. C., Peiris, M., & Poon, L. L. M. (2020). Stability of SARS-CoV-2 in different environmental conditions. *The Lancet Microbe*, *1*(1), e10.

García-Alcantara, E., López-Baltazar, J., Rojas-Valencia, M. N., & Hernández-López, S. (2021). Combined UV-C and ozone disinfection: Synergistic effects on pathogen inactivation. *Water Science and Technology*, *84*(10-11), 2756-2768.

Guan, Y., Shan, L., & Huang, M. (2022). Virucidal efficacy of different wavelengths of ultraviolet light for inactivation of coronaviruses. *Applied and Environmental Microbiology*, *88*(8), e00408-22.

Haischer, M. H., Beilfuss, R., Hart, M. R., Opielinski, L., Wrucke, D., Zirgaitis, G., Diebold, T., & Hunter, S. K. (2020). Who is wearing a mask? Gender-, age-, and location-related differences during the COVID-19 pandemic. *PLoS One*, *15*(10), e0240785.

Heilingloh, C. S., Aufderhorst, U. W., Schipper, L., Dittmer, U., Witzke, O., Yang, D., Zheng, X., Sutter, K., Trilling, M., Alt, M., Steinmann, E., & Krawczyk, A. (2020). Susceptibility of SARS-CoV-2 to UV irradiation. *American Journal of Infection Control*, *48*(10), 1273-1275.

Howard, J., Huang, A., Li, Z., Tufekci, Z., Zdimal, V., Van Der Westhuizen, H. M., Von Delft, A., Price, A., Fridman, L., Tang, L. H., Tang, V., Watson, G. L., Bax, C. E., Shaikh, R., Questier, F., Hernandez, D., Chu, L. F., Ramirez, C. M., & Rimoin, A. W. (2021). An evidence review of face masks against COVID-19. *Proceedings of the National Academy of Sciences*, *118*(4), e2014564118.

Prata, J. C., Silva, A. L., Walker, T. R., Duarte, A. C., & Rocha-Santos, T. (2020). COVID-19 pandemic repercussions on the use and management of plastics. *Environmental Science & Technology*, *54*(13), 7760-7765.

Probst, C., Jäger, T., Werkmeister, T., & Bauer, N. (2021). Inactivation of microorganisms by UV-C radiation: Systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, *18*(11), 5831.

Jam, F. A., Khan, T. I., & Paul, J. (2025). Driving brand evangelism by Unleashing the power of branding and sales management practices. Journal of Business Research, 190, 115214.

Silva, A. L., Prata, J. C., Walker, T. R., Duarte, A. C., Ouyang, W., Barcelò, D., & Rocha-Santos, T. (2021). Increased plastic pollution due to COVID-19 pandemic: Challenges and recommendations. *Chemical Engineering Journal*, *405*, 126683.

Van Doremalen, N., Bushmaker, T., Morris, D. H., Holbrook, M. G., Gamble, A., Williamson, B. N., Tamin, A., Harcourt, J. L., Thornburg, N. J., Gerber, S. I., Lloyd-Smith, J. O., de Wit, E., & Munster, V. J. (2020). Aerosol and surface stability of SARS-CoV-2 as compared with SARS-CoV-1. *New England Journal of Medicine*, *382*(16), 1564-1567.