

Title: How frequently do ordinary citizens practice hand hygiene at appropriate moments during the COVID-19 pandemic in Japan

Running Head: Hand hygiene in Japan during the COVID-19 pandemic

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Summary

We aimed to clarify the status of hand hygiene practices among ordinary citizens during the COVID-19 pandemic in Japan, in conjunction with the total frequency of daily hand hygiene as an indicator of education and evaluation. This cross-sectional study was based on an Internet survey completed by 2,149 participants (age range: 20–79 years, 51.0% men, response rate: 89.5%), selected during June 23-28, 2020. The participants responded regarding the frequency of implementing hand hygiene at 5 moments (after returning from a public place; after using the toilet; after touching something outside; before eating food; and after blowing your nose, coughing, or sneezing). Additionally, participants responded regarding the number of daily hand hygiene events. The cutoff value of the total number of daily hand hygiene events to determine whether hand hygiene was performed in all 5 moments was clarified using ROC analysis. The mean number of hand hygiene events was 10.2 times/day. The prevalence of implementing hand hygiene at each moment ranged from 30.2% to 76.4%; only 21.1% practiced in all moments. Both Youden Index and specificity were high when the cut-off value was 11 times/day. The criterion of hand hygiene: ≥ 11 times/day may be useful in education and evaluation.

Introduction

As of October 2020, the coronavirus disease (COVID-19) pandemic remains active. It is vital that personal protective measures are implemented by the public as a method to mitigate the epidemic of respiratory viruses such as COVID-19, especially before a well-matched vaccine becomes widely available (1). Transmission of COVID-19 occurs primarily via respiratory droplets from face-to-face contact and, to a lesser degree, via contaminated surfaces (2, 3). To reduce transmission via respiratory droplets, certain researchers and many health authorities have pointed out that wearing face masks in public spaces can be effective (4, 5). Regarding contact transmission, one of the personal protective measures recommended by the World Health Organization (WHO) during the COVID-19 pandemic is hand hygiene (6). Contact transmission occurs when contaminated hands come into contact with the mucosa of the mouth, nose, or eyes; the virus can also be transferred from one surface to another by contaminated hands, which facilitates indirect contact transmission (1, 7). Consequently, hand hygiene is extremely important for preventing the spread of the virus.

Providing detailed instructions and precise "moments" for practicing hand hygiene are important for this specific measure. The WHO recommends citizens to "regularly and thoroughly clean your hands with an alcohol-based hand rub or wash them with soap and

water" (6). On the other hand, the Japanese Ministry of Health, Labor and Welfare (MHLW), and United States Centers for Disease Control and Prevention (CDC) present specific moments that require hand hygiene, such as before meals and after returning home (8, 9). Showing specific moments for hand hygiene may be effective in increasing the number of hand hygiene events. The MHLW presents 6 specific situations or moments, while the CDC presents 12 situations(8, 9). This amount of information may be too much to disseminate to ordinary citizens, which could impede dissemination. Needless to say, it is ideal for ordinary citizens to understand moments when hand hygiene should be followed and actually practiced. However, ordinary citizens frequently have questions regarding how often hand hygiene should be practiced in daily life. With this in mind, we believe that it is possible to convey a more comprehensible and clearer educational message by indicating the number of hand hygiene practices and specific moments. Further, when evaluating the status of hand hygiene implementation of specific groups, such as employed workers and residents, it is necessary to know whether hand hygiene is being implemented in moments when the measure should indeed be performed. Nevertheless, inquiring about the status of implementation in each moment using a questionnaire, etc., is a difficult task given the large number of items, which can pose an obstacle in the evaluation of large groups. In contrast, the "number of hand hygiene events

per day" is an indicator that is easy to determine using a questionnaire. Using the number of events as a criterion allows for a relatively simple assessment of the status of implementation. In order to indicate the adequate number of hand hygiene practices, it is necessary to determine the approximate frequency at which hand hygiene is being practiced by a person performing the measure during appropriate moments, as well as the total number of events. To the best of our knowledge, there is yet to be a study of this kind.

Therefore, the purpose of this study was to elucidate the status of hand hygiene implementation among ordinary citizens in Japan under the COVID-19 pandemic and to clarify the number of hand hygiene practices per day as an indicator of awareness and assessment.

Materials and Methods

Study sample and data collection

This cross-sectional study utilized the data of the fourth wave of a longitudinal research, which aimed to clarify implementing personal protective measures by ordinary citizens during the COVID-19 pandemic in Japan. In this longitudinal research, the implementation status of preventive measures by ordinary citizens in the COVID-19

pandemic was investigated approximately every 6 weeks. In the first wave survey of this longitudinal study on February 25, 2020, a total of 2,400 men and women aged 20-79 years (sampling by sex and 10-year age groups; 12 groups, n=200 in each group) who were living in 7 prefectures (i.e., Tokyo, Kanagawa, Saitama, Chiba, Ibaraki, Tochigi, and Gunma), and who met the criteria to participate in this research were recruited from 8,156 registrants of a Japanese Internet research service company called MyVoice Communication, Inc., which had approximately 1.12 million registered participants as of January 2020. Detailed methods about sampling have been reported elsewhere (10, 11). The company reached out to these 2,400 potential respondents by e-mail to participate in the fourth wave of research on June 23, 2020. At the time, the daily number of reported COVID-19 cases in Japan was small (12), and the Japanese government had already lifted the state of emergency on May 25 (13). The questionnaires were placed in a secured section of a website, and potential respondents received a specific link in their e-mail. Participation was voluntary, and participants responded to the questionnaire by accessing the specified link. The response cutoff date was June 28, 2020. There was a total of 22 questions, and it took approximately 7 minutes for participants to respond. Reward points valued at 50 yen were provided as incentives for participation (approximately 0.5 US dollars as of June 2020). This study was approved by the Ethics Committee of Tokyo

Medical University, Tokyo, Japan (No: T2019-0234). Informed consent was obtained from all respondents.

Measurement

Assessment of the frequency of hand hygiene implementation in moments requiring hand hygiene

Among the moments where hand hygiene should be practiced as recommended by the MHLW and CDC to ordinary citizens, this study assessed the frequency of hand hygiene implementation in 5 moments which we felt was related to daily life behavior for many people (after returning from a public place; after using the toilet; after touching something outside; before eating food; and after blowing your nose, coughing, or sneezing) (8, 9).

In each of these 5 moments, participants were asked about the frequency of implementation of hand hygiene during the previous week and responded using a 4-point-Likert scale (1: "Always," 2: "Sometimes," 3: "Rarely," or 4: "Never").

Assessment of the total number of hand hygiene practices per day

Participants reported the average number of times for handwashing using soap and water per day, and the average number of times alcohol-based hand sanitizers were used

per day. The sum of the two was defined as the total number of hand hygiene practices per day.

Assessment of sociodemographic factors

In the first wave survey, participants stated their sex, age, smoking status (smokers/non-smokers), underlying diseases including heart diseases, respiratory diseases, kidney diseases, diabetes, and hypertension (yes/no), marital status (not married/married), working status (working/not working), and residential area (metropolitan area [i.e., Tokyo, Kanagawa, Saitama, and Chiba]/nonmetropolitan area [i.e., Ibaraki, Tochigi, and Gunma]). The research company also provided categorized data for the following parameters: living arrangement (with others/alone), educational attainment (university graduate level or above), and household income level (< 5 million yen or \geq 5 million yen).

Statistical analysis

Regarding the status of implementation in the 5 moments related to daily life behavior, when a participant responded with "1" ("Always") on the 4-point-Likert scale, it was considered that hand hygiene was being performed in that specific moment. We clarified the percentage of individuals practicing hand hygiene in each moment, and the percentage

of individuals practicing hand hygiene in all 5 moments.

Regarding the number of hand hygiene practices, first, the distribution of the total number of hand hygiene practices per day was described using histograms and boxplots.

Subsequently, receiver operating characteristic (ROC) curve analysis was performed using the Youden Index (14), and the cutoff value of the total number of hand hygiene practices per day—which determined whether hand hygiene was being practiced in all 5 moments—was clarified. Sensitivity, specificity, and area under the curve were reported.

Based on previous studies (15), area under the curve values were interpreted as excellent (≥ 0.90), good (0.80–0.89), fair (0.70–0.79), and poor (< 0.70).

R version 4.0.1 and "ROCR" from the R package were used to perform all statistical analyses.

Results

The Internet research company reached out to 2,369 participants, after excluding participants who were not registered with the company at the time of the fourth wave survey ($n=31$), and 2,149 participants responded to the questionnaire (Table 1).

Figure 1 shows the prevalence of individuals practicing hand hygiene in each moment. The percentage of individuals practicing hand hygiene ranged from 30.2% to 76.4%. In

particular, the prevalence of implementing hand hygiene after touching something outside, before eating food, and after blowing your nose, coughing, or sneezing were 51.9%, 50.1%, and 30.2%, respectively. The prevalence of participants who did not perform any hand hygiene in any moment was 2.4%, and only 21.1% of individuals practiced hand hygiene in all moments.

Figure 2 shows a histogram and boxplot of the total number of hand hygiene practices per day. The mean, median, 25th percentile, and 75th percentile for handwashing using soap and water was 6.6 times/day, 5 times/day, 3 times/day, and 10 times/day (range: 0-53); for hand hygiene, which included handwashing using soap and water and alcohol-based hand sanitizers, it was 10.2 times/day, 8 times/day, 5 times/day, and 13 times/day, respectively (range: 0-110).

Figure 3 and Table 2 show the results of the ROC curve analysis. When the cutoff value was 9 times/day, the Youden Index reached the maximum (Youden Index: 0.372, sensitivity: 74.9%, specificity: 62.4%). Further, when the cutoff values were 10 times/day or 11 times/day, although the Youden index was similar to the cutoff value of 9 times/day, a high specificity was obtained (10 times/day; Youden Index: 0.366, specificity: 65.9% / 11 times/day; Youden Index: 0.365, specificity: 74.4%).

Discussion

We set out to clarify the status of hand hygiene implementation among ordinary citizens during the COVID-19 pandemic and calculated the standard value of the number of hand hygiene practices per day as an indicator of education and assessment. As for the implementation status of hand hygiene in each moment, only 21.1% of individuals practiced hand hygiene in all 5 moments related to daily life behavior. This study elucidates that there is still room for improvement in the implementation status of hand hygiene among ordinary citizens. Furthermore, ROC curve analysis revealed the total number of hand hygiene practices per day to be 9-11 times/day or more among individuals who were able to practice the measure in all 5 moments. However, sensitivity and specificity were considerably different in these 3 frequencies. As a certain degree of specificity is essential for the implementation and education of more reliable preventive actions during a pandemic, it may be logical to set the standard value at 11 times/day or more for this purpose.

The overall implementation rate of hand hygiene practices in moments requiring hand hygiene was low at 30.2%-76.4%. In particular, the prevalence was low in moments after touching something outside, before eating food, and after blowing your nose, coughing, or sneezing, and lowest after blowing your nose, coughing, or sneezing. As coughing and

sneezing occur suddenly, it may be difficult to practice hand hygiene. Additionally, hand hygiene for this moment is mainly for mitigating the spread of infection to others from themselves, although the other four moments are moments to protect themselves from infection. Therefore, ordinary citizens may not pay as much attention to this moment, compared to the other four moments. The MHLW is already conducting educational activities for these moments through its website (8), however, implementation by citizens is still insufficient, and further educational activities are required.

It is ideal for ordinary citizens to understand specific moments when hand hygiene should be followed and practiced. On the other hand, we also believe the amount of information that is disseminated about these moments may be too much for ordinary citizens, which could be counterproductive. With this in mind, we suppose that it is possible to convey a more comprehensible and precise informative message when conducting educational activities on hand hygiene, such as by indicating the exact number of hand hygiene practices necessary with the appropriate hand hygiene moments.

Therefore, in this study, we used ROC curve analysis and calculated the standard number of hand hygiene practices per day, as an indicator of education and assessment. The Youden Index was at the highest when the cutoff value was 9-11 times/day. Specificity is considered to be important from the viewpoint of implementing certain preventive actions

and raising awareness. In other words, if the specificity is low, the false-positive rate becomes high, which could mean that persons are assessed as performing sufficient hand hygiene practices even if it was not practiced in the appropriate moments. From this perspective, the 62.4% specificity is an insufficient value if the number of events is 9 times/day. It may be more logical to set the cutoff value at 11 times/day or more, although it is debatable whether or not the 74.4% specificity (cutoff value: 11 times/day) is sufficient. Additionally, a previous study involving a telephone interview survey in Hong Kong during the severe acute respiratory syndrome pandemic reported that practicing hand hygiene 11 times/day or more was a protective factor against severe acute respiratory syndrome infection (16). This basis of this previous study and our study were self-reported evaluations, and the effect of recall-bias is unavoidable (17). Additionally, it is possible that social desirability bias may have led to an overestimation of the implementation status (18). Nevertheless, obtaining self-reported responses about whether hand hygiene was performed 11 times or more may be one indicator that reflects the actual status of hand hygiene implementation. Further, focusing on the specificity of the results of the ROC curve analysis, when the cutoff value was 16 times/day, the Youden Index was as low as 0.268, but specificity was 90% or more. If the pandemic worsens, which would require more rigorous education and assessment of preventive actions, it

may be favorable to set the handwashing standard at 16 times or more.

There are some limitations that should be considered in our study. First, the most important point is that in this study, participants were recruited among people enrolled in a single Internet research company, and thus, the results may have been affected by selection bias. Relatively little is known about the characteristics of people in online communities (19). According to the latest White Paper 2019 issued by the Japanese government (20), the percentage of those who use the Internet regularly were approximately 95% for people in their 20s to 50s, and 76.6% and 51.0% for those in their 60s and 70s, respectively. In addition, it has been reported that individuals who use the Internet regularly tend to have higher income, compared to non-users (20). Therefore, it can be said that participants in this study may be more educated or have higher income than the average Japanese population. Additionally, when comparing the age and sex composition of participants in this study to the latest population estimates reported by the Japanese government (21), there were more people in their 20s and fewer in their 40s in this study. Considering these facts, the results of this study, such as percentages, should be interpreted with caution, as they may have been affected by selection bias. Second, in this study, the frequency and number of hand hygiene practices were assessed using a self-reported questionnaire. Because self-reported questionnaires are subject to the

influence of recall-bias and social desirability bias, the frequency and number of events revealed in this study may be overestimated (17, 18). However, despite this fact, only 21.1% of individuals responded practicing hand hygiene in all moments. Finally, the results may not be applicable to other population groups. In the case of other populations with different cultural, ethnic, and geographical backgrounds, the frequency and number of hand hygiene practices may vary greatly when compared with those reported in the present survey. Despite these limitations, to the best of our knowledge, this is the first study to clarify the status of hand hygiene implementation of ordinary citizens during the COVID-19 pandemic and present a standard value of the number of hand hygiene practices per day, as an indicator of awareness and assessment.

In conclusion, only a limited number of individuals in Japan always practiced hand hygiene in moments that required hand hygiene during the COVID-19 pandemic—at a time where there is increased attention and awareness of preventive actions. Further educational activities on the implementing of hand hygiene are required. The criterion (total number of hand hygiene events: 11 times/day or over) may be beneficial for education and evaluation purposes.

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Conflict of interest

None to declare.

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References

1. Qualls N, Levitt A, Kanade N, et al. Community Mitigation Guidelines to Prevent Pandemic Influenza - United States, 2017. *MMWR Recomm Rep.* 2017;66:1-34.
2. Ferretti L, Wymant C, Kendall M, et al. Quantifying SARS-CoV-2 transmission suggests epidemic control with digital contact tracing. *Science.* 2020;368:eabb6936.
3. Wiersinga WJ, Rhodes A, Cheng AC, et al. Pathophysiology, transmission, diagnosis, and treatment of coronavirus disease 2019 (COVID-19): a review. *JAMA.* 2020;324:782-93.
4. Leung CC, Lam TH, Cheng KK. Mass masking in the COVID-19 epidemic: people need guidance. *Lancet.* 2020;395:945.
5. Feng S, Shen C, Xia N, et al. Rational use of face masks in the COVID-19 pandemic. *Lancet Respir Med.* 2020;8:434-6.
6. World Health Organization. Coronavirus disease (COVID-19) advice for the public. Available at <<https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public>> Accessed July 16, 2020.
7. World Health Organization. Recommendations to Member States to improve hand hygiene practices to help prevent the transmission of the COVID-19 virus. Available at <<https://www.who.int/publications/i/item/recommendations-to-member-states-to>

improve-hand-hygiene-practices-to-help-prevent-the-transmission-of-the-covid-19-virus> Accessed July 16, 2020.

8. Japanese Ministry of Health, Labor and Welfare. Prevention for new coronavirus.

Available at

<https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000121431_00094.html#yobou>

Accessed July 16, 2020. Japanese.

9. U.S. Centers for Disease Control and Prevention. When and how to wash your hands.

Available at <<https://www.cdc.gov/handwashing/when-how-handwashing.html>>

Accessed July 16, 2020.

10. Machida M, Nakamura I, Saito R, et al. Adoption of personal protective measures by ordinary citizens during the COVID-19 outbreak in Japan. *Int J Infect Dis.*

2020;94:139-44.

11. Machida M, Nakamura I, Saito R, et al. Incorrect use of face masks during the current COVID-19 pandemic among the general public in Japan. *Int J Environ Res*

Public Health. 2020;17:6484.

12. Japanese Ministry of Health, Labor and Welfare. Coronavirus disease (COVID-19) situation within the country. Available at <[https://www.mhlw.go.jp/stf/covid-](https://www.mhlw.go.jp/stf/covid-19/kokunainohasseijoukyou.html)

[19/kokunainohasseijoukyou.html](https://www.mhlw.go.jp/stf/covid-19/kokunainohasseijoukyou.html)> Accessed October 2, 2020. Japanese.

13. The Prime Minister of Japan and His Cabinet. [COVID-19] Press Conference by the Prime Minister regarding the Novel Coronavirus. Available at https://japan.kantei.go.jp/98_abe/statement/202005/_00003.html Accessed October 2, 2020.
14. Youden WJ. Index for rating diagnostic tests. *Cancer*. 1950;3:32-5.
15. Metz CE. Basic principles of ROC analysis. *Semin Nucl Med*. 1978;8:283-98.
16. Lau JT, Tsui H, Lau M, et al. SARS transmission, risk factors, and prevention in Hong Kong. *Emerg Infect Dis*. 2004;10:587-92.
17. Coughlin SS. Recall bias in epidemiologic studies. *J Clin Epidemiol*. 1990;43:87-91.
18. Paulhus DL. Two-component models of socially desirable responding. *J Pers Soc Psychol*. 1984;46:598-609.
19. Wright KB. Researching Internet-based populations: advantages and disadvantages of online survey research, online questionnaire authoring software packages, and web survey services. *J Comput Mediat Commun*. 2017;10.
20. Ministry of Internal Affairs and Communications, Japan. White Paper on Information and Communications in Japan 2019. Available at: <https://www.soumu.go.jp/johotsusintokei/whitepaper/eng/WP2019/2019->

index.html> Accessed October 2, 2020.

21. Statistics Bureau of Japan. Population Estimates by Age and Sex—February 1, 2020

(Final estimates), July 1, 2020 (Provisional estimates). Available at: <[https://www.e-](https://www.e-stat.go.jp/en/stat-search/files?page=1&layout=datalist&toukei=00200524&tstat=000000090001&cycle=1&year=20200&month=23070907&tclass1=000001011678&result_back=1)

[stat.go.jp/en/stat-](https://www.e-stat.go.jp/en/stat-search/files?page=1&layout=datalist&toukei=00200524&tstat=000000090001&cycle=1&year=20200&month=23070907&tclass1=000001011678&result_back=1)

[search/files?page=1&layout=datalist&toukei=00200524&tstat=000000090001&cycle=](https://www.e-stat.go.jp/en/stat-search/files?page=1&layout=datalist&toukei=00200524&tstat=000000090001&cycle=1&year=20200&month=23070907&tclass1=000001011678&result_back=1)

[1&year=20200&month=23070907&tclass1=000001011678&result_back=1](https://www.e-stat.go.jp/en/stat-search/files?page=1&layout=datalist&toukei=00200524&tstat=000000090001&cycle=1&year=20200&month=23070907&tclass1=000001011678&result_back=1)> Accessed

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Figure Legends

Figure 1. Distribution of frequency of hand hygiene implementation in each moment.

Regarding each of the 5 moments, the participants were asked about the frequency of implementing hand hygiene practices during the previous week and responded using a 4-point-Likert scale (1: “Always,” 2: “Sometimes,” 3: “Rarely,” or 4: “Never”). In this study, when a participant responded 1 (“Always”) on 4-point-Likert scale, it was considered that hand hygiene was performed in that specific moment.

Figure 2. Histogram and boxplot of the total number of hand hygiene practices per day

Figure 3. Receiver operating characteristic (ROC) curve analysis for the cutoff value of the total number of hand hygiene practices per day that determines whether hand hygiene was practiced in all 5 moments

The 5 moments are: after returning from a public place; after using the toilet; touching an item or surface that may be frequently touched by other people; before eating food; and after blowing your nose, coughing, or sneezing. AUC: 0.757 (95% confidence interval: 0.733-0.780)

Table 1. Participants' characteristics

	n=2,149 (100%)	
	n (%)	
Sex (men)	1,096	51.0%
Age, years*	50.3	16.1
Smoking (smoker)	311	14.5%
Underlying diseases ^a (yes)	549	25.5%
Marital status (married)	1,225	57.0%
Working status (working)	1,362	63.4%
Residential area (metropolitan area ^b)	1,945	90.5%
Living arrangement (with others)	1,697	79.0%
Educational attainment (university graduate level or above)	1,147	53.4%
Household income level (\geq 5 million yen)	1,118	52.0%

* mean (standard deviation)

a Underlying diseases included heart diseases, respiratory diseases, kidney diseases, diabetes, and hypertension.

b included Tokyo, Kanagawa, Saitama, and Chiba prefecture

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Table 2. Cutoff values and coordinates and Youden Index of the receiver operating characteristic (ROC) curve analysis

Cutoff value [total number of hand hygiene practices per day (times/day)]	Sensitivity (%)	Specificity (%)	Youden Index
0	100.0	0.0	0.000
1	100.0	2.1	0.021
2	99.8	4.5	0.043
3	99.3	9.6	0.090
4	98.2	16.9	0.151
5	96.9	24.7	0.216
6	94.7	33.7	0.284
7	87.9	44.9	0.328
8	83.5	51.9	0.354
9	74.9	62.4	0.372
10	70.7	65.9	0.366
11	62.1	74.4	0.365
12	57.3	77.8	0.351
13	49.6	81.5	0.310
14	44.5	84.2	0.287
15	42.7	85.5	0.282
16	36.3	90.4	0.268
17	34.8	92.2	0.270
18	31.9	93.0	0.249
19	28.6	93.8	0.224
20	28.4	93.9	0.223





