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Determinants of Hand Hygiene Among Community-Dwelling Older Adults: A Quantile Regression Analysis*

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Ⅰ. Introduction

1. Background

As an infection control strategy, hand hygiene is both effective and readily implementable, supporting the maintenance of safety and health in everyday life (Song & Yang, 2015). In particular, since the COVID-19 pandemic, global attention to infection prevention behaviors has increased, further emphasizing the importance of hand hygiene (Arai et al., 2021). However, according to the 2024 Infectious Disease Prevention Survey, only 31.8% adhered to hand hygiene practices, defined as washing hands with soap and water after restroom use, and only 10.5% properly washed all hand surfaces with soap for at least 30 seconds, depending on the handwashing steps (Korea Disease Control and Prevention Agency [KDCA], 2024a). Despite increased social awareness of hand hygiene, these findings indicate a substantial gap between awareness and actual practice.

Older adults are particularly vulnerable to infections due to chronic diseases, decreased immunity, and cognitive decline (Kim et al., 2019). In fact, 94% of COVID-19 deaths occurred among individuals aged 60 and older (KDCA, 2024b), and the severity and mortality of the disease increased with age (Chinese Center for Disease Control and Prevention, 2020). The incidence of tuberculosis and pneumococcal infections is also high among older adults, at 83% and 65.5% respectively (KDCA, 2021; KDCA, 2024c), highlighting that hand hygiene in this population should be regarded as an important public health measure beyond individual health (Kang et al., 2022). However, while hand hygiene adherence among individuals in their 20s-50s is approximately 30%, it drops to 21.3%

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among those in their 60s and 16.7% among those aged 70 and older (KDCA, 2024a). This highlights the need to investigate hand hygiene behaviors and associated factors in older adults and to develop targeted improvement strategies.

Hand hygiene knowledge is a key factor in understanding situations that require hand hygiene and the specific procedures to be followed, playing an important role in motivating hand hygiene and enhancing its execution (Luo et al., 2022). The World Health Organization also notes that inadequate knowledge related to hand hygiene interferes with proper hand hygiene performance (World Health Organization [WHO], 2009a). However, most previous studies were conducted prior to the COVID-19 pandemic and therefore have limitations in reflecting the social and environmental changes that occurred after the pandemic. In particular, the COVID-19 pandemic has brought changes in awareness, information exposure, and educational experiences regarding hand hygiene (Szczuka et al., 2021), which may have affected older individuals' understanding of hand hygiene as well as their related practices. Considering the changes before and after the pandemic, there remains a need for empirical investigation to reassesses the relationship between hand hygiene knowledge and practice in older adults at the current time and examines the patterns of these changes.

The concept of health literacy involves the capacity to process and use information relevant to health in everyday situations. This capacity is a critical determinant of a wide range of health behaviors, including hand hygiene (Kirby & Lindly, 2024; Lim et al., 2021). Health literacy is conceptually distinct from simple health-related knowledge, as it encompasses broader cognitive and functional competencies. Older adults, in particular, may experience difficulties in translating health information into actual behaviors due to declines in cognitive and information-processing abilities (Li et al., 2022), demonstrating that this ability is essential for appropriate hand hygiene behaviors. This investigation focused on identifying factors associated with hand hygiene practice, including health literacy, hand hygiene knowledge, and hand hygiene performance levels, among community-dwelling older adults. Using quantile regression analysis, the study sought to examine the factors associated with hand hygiene practice across different distribution levels, thereby providing more detailed evidence for policy development and intervention design tailored to varying levels of hand hygiene adherence.

Ⅱ. Methods

1. Study design

This study employed a descriptive cross-sectional design using a survey approach. Factors associated with hand hygiene practices among community -dwelling older adults were examined.

2. Study Participants

Participants were adults aged 65 years or above who resided in the community used senior welfare centers in D District and G County of D Metropolitan City. The inclusion criteria were as follows: individuals capable of communicating during the study explanation, possessing sufficient proficiency in Korean to understand the questionnaire content, and understanding the purpose of the study and providing voluntary consent to participate.

The required number of participants was determined using G*Power program version 3.1.9.7. Multiple regression analysis was assumed for the calculation. Under these analytical conditions (effect size = 0.15, power = 0.80, α = 0.05) and with 10 predictors included, the estimated minimum sample size was 118. Considering potential dropout, a total of 142 participants were recruited. As there were no missing responses in the collected questionnaires, all 142 completed responses were retained for analysis.

3. Measures

The study employed a 48-item structured survey instrument, with eight items designed to capture general characteristics and hand hygiene-related factors among participants, 16 items on health literacy, 12 items on hand hygiene knowledge, and 10 items on hand hygiene practices. Permission to use each instrument was obtained via email from the respective developers.

1) General and hand hygiene-related characteristics

Items assessing participants' general characteristics were formulated by drawing on findings from earlier research and related literature and comprised six items: gender, age, residential area, educational level, income level, and subjective health status. Hand hygiene-related characteristics included two items: experience of hand hygiene education and exposure to hand hygiene information.

2) Health literacy

The participants' health literacy was assessed using the European Health Literacy Survey Questionnaire 16 items (HLS-EU-Q16) instrument (Pelikan & Ganahl, 2017), an abbreviated form of the HLS-EU-Q47, as proposed by Sørensen et al. (2013) to measure comprehensive health literacy, which was adapted by Chun and Lee (2020) for older adults in Korea. This instrument comprises 16 items covering three areas of health literacy, including health care (7 items), disease prevention (5 items), and health promotion (4 items). Responses are assessed using a four-point Likert format ranging from "very difficult" to "very easy." In accordance with the original scoring method, responses are dichotomized, with "very difficult" and "difficult" assigned a score of 0, and "easy" and "very easy" assigned a score of 1. Based on the total score, health literacy is categorized as 'inadequate' (0-8), 'problematic' (9-12), or 'adequate' (13-16). Higher scores represent better health literacy. The reliability of the instrument in Chun and Lee's (2020) study was Cronbach's α = .861, and in the present study, Cronbach's α = .924.

3) Hand Hygiene Knowledge

The participants' hand hygiene knowledge was assessed using a tool developed by Kim and Choi (2025) for adult inpatients, which was based on Lee's (2014) hand hygiene knowledge instrument and the World Health Organization's (WHO, 2009b) questionnaire for healthcare workers, and modified to suit the study population. For example, the item "Hand hygiene helps prevent hospital-acquired infections during hospitalization" was revised to "Hand hygiene helps prevent the spread of infectious diseases in daily life," and "Hand hygiene is performed with alcohol-based hand sanitizer when hands are contaminated with blood or sputum" was revised to "Hand hygiene is performed with alcohol-based hand sanitizer when visible contamination is present on the hands." The instrument comprised 12

items, with responses measured as 'True,' 'False,' or 'Don't know.' Responses were dichotomously coded (1 = correct, 0 = incorrect or "don't know"), producing possible scores between 0 and 12. Greater hand hygiene knowledge was reflected by higher total scores. In Kim and Choi's (2025) study, the reliability of the instrument was KR-20 = .58, and in the present study, KR-20 = .608.

4) Hand Hygiene Practices

Participants' hand hygiene practices were evaluated using an assessment instrument developed by Jeong et al. (2007) and later adapted by Song (2018) and Kim and Choi (2025) for use with family caregivers and hospitalized patients to capture hand hygiene behaviors in everyday life before hospitalization. The instrument consists of 10 items scored on a five-level response format, with options ranging from "never" (1) to "always" (5). Item scores are summed, with greater values reflecting more frequent hand hygiene practices. Internal consistency was reported as Cronbach's α = .86 in a previous study by Kim and Choi (2025), and the coefficient in the current study was .889.

4. Data Collection

The study data were gathered from two senior welfare centers in D Metropolitan City between November 1, 2024, and March 28, 2025. In collaboration with a local public health center, the researcher visited welfare centers on several occasions to inform potential participants about the study and obtain their informed consent. To recruit participants, a recruitment notice was posted on designated bulletin boards. Those who indicated their willingness to participate after viewing the notice were provided with an individual briefing by the researcher to explain the study purpose once more, after which they completed a consent form and participated in the survey.

The survey was conducted in relatively quiet spaces within the welfare centers, such as consultation rooms or calligraphy rooms. Structured self-reported questionnaires were distributed to collect the data. For participants who had difficulty completing the questionnaire, the researcher read each item aloud and recorded the participant's verbal responses on the questionnaire. After completing the survey, the researcher checked for missing items, collected the questionnaires, and stored them in sealable envelopes. A small incentive with an approximate value of 4,000 KRW was given to participants.

5. Data Analysis

Data were analyzed using Stata version 17.0 (StataCorp LLC, College Station, TX, USA). The following statistical procedures were applied.

- Participants' general characteristics, hand hygiene-related characteristics, health literacy, hand hygiene knowledge, and hand hygiene practices were analyzed using descriptive statistics.
- The relationships among participants' health literacy, hand hygiene knowledge, and hand hygiene practices were examined using Pearson correlation analysis.
- Factors associated with participants' hand hygiene practices were analyzed using multiple linear (Ordinary Least Squares) regression and quantile regression (25th, 50th, and 75th percentiles). Quantile regression is a statistical method that, unlike linear regression which estimates only the mean effect, allows the estimation of predictor effects across multiple

quantiles of the dependent variable distribution (Koenker & Hallock, 2001). By presenting quantile regression alongside linear regression, it becomes possible to determine whether determinants operate differently among individuals with low, median, or high levels of the outcome, thereby providing a more accurate characterization of distributional heterogeneity (Koenker & Hallock, 2001).

6. Ethical Considerations

All study procedures adhered to recognized ethical guidelines for research involving human participants after receiving approval from the Keimyung University Institutional Review Board (IRB No. 40525-202407-HR-033-02). Before data collection, eligible participants were provided with comprehensive information about the study, including study procedures, potential risks and benefits, voluntary participation and withdrawal rights, data confidentiality, and researcher contact information. Participation in the study was limited to individuals who provided documented agreement after being informed of the study details. To ensure confidentiality, unique identification numbers were assigned to all participants. Personal information, consent forms, and study-related records were safeguarded in a secure location. Electronic files for data analysis were saved on the researcher's personal laptop with password protection to prevent access by anyone other than the researcher.

Ⅲ. Results

1. Participants' General and Hand Hygiene -Related Characteristics

Participant demographics and hand hygiene -related variables are shown in Table 1. The mean age of participants was 73.60 ± 6.64 years. Regarding gender, 90 participants (63.4%) were female. The residential area was evenly distributed, with 71 participants (50.0%) from rual and 71 (50.0%) from urban area. Regarding hand hygiene-related characteristics, 77 participants (54.2%) had received hand hygiene education, while 65 (45.8%) had not. A total of 118 participants (83.1%) reported previous exposure to hand hygiene information. Participants demonstrated health literacy scores between 0 to 16; the mean score was 8.98 ± 5.21. Based on the scoring criteria, 65 participants (45.8%) were identified as exhibiting 'inadequate' levels of health literacy (0-8 points), 29 participants (20.4%) as 'problematic' (9-12 points), and 48 participants (33.8%) as 'adequate' (13-16 points).

2. Participants' Hand Hygiene Knowledge

Hand hygiene knowledge averaged 8.54 (SD = 2.12) on a 12-point scale, representing 71.1% of correct responses. Detailed item-level results are provided in Table 2. The items with the lowest correct response rates were: 'When hands are visibly soiled, hand hygiene should be performed using an alcohol-based hand sanitizer' (32.4%) and '(If not using an automatic faucet) Hands should be dried with a disposable towel after washing, and the used towel should be used to turn off the faucet' (40.8%). Other items with correct response rates below 70% included: 'It is not necessary to completely dry hands after washing', 'For infection prevention, antibiotic treatment is more effective than hand hygiene' and 'Using an alcohol-based hand sanitizer is as effective as washing hands with water and soap'.

3. Participants' Hand Hygiene Practices

The mean hand hygiene practice score was 3.69 ± 0.84 out of 5 points. Item-level performance is shown in Table 3. The highest practice scores were observed for hand hygiene before cooking (4.29 ± 0.87), after using the toilet at home (4.24 ± 0.89), and after using a public restroom (4.21 ± 1.05). In contrast, hand hygiene after handling money scored the lowest (2.74 ± 1.38), followed by hand hygiene after coughing or blowing the nose (3.27 ± 1.26).

4. Factors Related to Hand Hygiene Practices

To investigate factors related to hand hygiene practices, multiple linear regression and quantile regression analyses were conducted (Table 4). In the multiple regression analysis, statistically significant determinants of inadequate hand hygiene practices were male, low educational level, no experience of hand hygiene education, low health literacy, and low hand hygiene knowledge (all $p < .05$).

In the quantile regression analysis, gender and educational level were statistically significant across all quantiles (all $p < .05$). Both exposure to hand hygiene education and levels of hand hygiene knowledge were statistically significant at the 25th and 50th (all $p < .05$) percentiles but not at the 75th percentile. Health literacy was only statistically significant at the 25th percentile (Coef. = 0.34, $p = .026$).

Table 1. Characteristics of Participants (N=142)

Variable	Category	n (%)	Mean±SD
Age	65~74 years	82 (57.7)	73.60±6.64
	75 years and older	60 (42.3)	
Sex	Male	52 (36.6)	
	Female	90 (63.4)	
Education level	≤ Middle school	78 (54.9)	
	High school	48 (33.8)	
	≥ College	16 (11.3)	
Household income (month, KRW*)	< 1,000,000	71 (50.0)	
	1,000,000–2,999,999	48 (33.8)	
	≥ 3,000,000	23 (16.2)	
Residential area	Urban	71 (50.0)	
	Rural	71 (50.0)	
Perceived health status	Bad	41 (28.9)	
	Fair	64 (45.1)	
	Good	37 (26.1)	
Hand hygiene education experience	Yes	77 (54.2)	
	No	65 (45.8)	
Exposure to hand hygiene information	Yes	118 (83.1)	
	No	24 (16.9)	
Health literacy	Inadequate (0~8)	65 (45.8)	8.98±5.21
	Problematic (9~12)	29 (20.4)	
	Adequate (13~16)	48 (33.8)	

SD=Standard Deviation; KRW=Korean Won
* 1 USD ≈ 1,300 KRW at the 2025 exchange rate.

Ⅳ. Discussion

The present study examined levels of health literacy, hand hygiene knowledge, and hand hygiene practices among community-dwelling older adults, and identified factors associated with hand hygiene practices, thereby providing foundational data for infection prevention education and policy development. The main findings are discussed as follows.

Table 2. Hand hygiene knowledge level of participants (N=142)

No	Items	Correct answer (%)
2	Hand hygiene helps prevent the transmission of infectious diseases in daily life. (Correct answer: True)	94.4
4	Hand hygiene before meals reduces the risk of infectious diseases. (Correct answer: True)	93.0
5	Hand hygiene after urination or defecation is effective in preventing infectious diseases. (Correct answer: True)	91.5
1	Hand hygiene removes bacteria from the hands. (Correct answer: True)	87.3
9	Hand hygiene should involve friction on all six parts: palms, backs of hands, interlaced fingers, between fingers, fingernails, and under the nails. (Correct answer: True)	84.5
6	Hand washing is not required when wearing gloves. (Correct answer: False)	76.8
10	During hand hygiene, rubbing the hands for at least 15 seconds is appropriate. (Correct answer: True)	75.4
8	Using an alcohol-based hand sanitizer is as effective as washing hands with water and soap. (Correct answer: True)	66.2
3	For infection prevention, antibiotic treatment is more effective than hand hygiene. (Correct answer: False)	56.3
12	It is not necessary to completely dry hands after washing. (Correct answer: False)	54.9
11	(If not using an automatic faucet) Hands should be dried with a disposable towel after washing, and the used towel should be used to turn off the faucet. (Correct answer: True)	40.8
7	When hands are visibly soiled, hand hygiene should be performed using an alcohol-based hand sanitizer. (Correct answer: False)	32.4
	Mean±SD: 8.54±2.12 out of 12 points; mean correct answer rate: 71.1%	

SD=Standard Deviation

Table 3. Levels of Hand Hygiene Practice (N=142)

Variable	Mean±SD
2. Hand hygiene before cooking	4.29±0.87
1. Hand hygiene after using the toilet at home	4.24±0.89
8. Hand hygiene after using a public restroom	4.21±1.05
5. Hand hygiene after returning home from outside	4.08±1.16
3. Hand hygiene before eating at home	3.80±1.12
7. Hand hygiene before eating at a restaurant	3.48±1.28
9. Rubbing hands for at least 15 seconds during hand hygiene	3.45±1.32
10. Completely drying hands after washing with water and soap	3.39±1.39
4. Hand hygiene after coughing or blowing the nose	3.27±1.26
6. Hand hygiene after handling money	2.74±1.38
Mean overall hand hygiene practice score	3.69±0.84

SD=Standard Deviation

Table 4. Determinants of Hand Hygiene Practice among Older Adults (N=142)

Variables	Category	OLS regression		Quantile regression					
				25% quantile		50% quantile		75% quantile	
		Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Age	−	0.04	0.10	0.11	0.11	0.17	0.13	−0.02	0.13
Sex (ref. female)	Male	−4.15**	1.37	−3.44*	1.54	−5.85**	1.79	−6.19**	1.78
Education level (ref. ≥college)	≤ Middle school	−6.66**	2.15	−7.39**	2.41	−7.81**	2.80	−6.26*	2.78
	High school	−4.20*	2.03	−8.69***	2.28	−3.87	2.64	−1.36	2.63
Household income (ref. ≥ 3,000,000)	〈 1,000,000	3.06	1.93	0.53	2.16	2.07	2.50	3.19	2.49
	1,000,000–2,999,999	1.02	1.79	−1.00	2.01	0.79	2.33	1.40	2.32
Residential area (ref. rural)	Urban	−1.17	1.26	−0.99	1.41	−2.23	1.64	−2.70	1.63
Perceived health status (ref. good)	Bad	0.35	1.65	1.16	1.85	0.61	2.15	2.20	2.14
	Fair	1.07	1.52	1.87	1.71	1.45	1.98	1.65	1.97
Hand hygiene education experience (ref. yes)	No	−3.75*	1.43	−5.44**	1.60	−4.13*	1.86	−3.09	1.85
Exposure to hand hygiene information (ref. yes)	No	−0.74	1.77	−1.17	1.98	0.23	2.30	−1.38	2.28
Health literacy	−	0.37**	0.13	0.34*	0.15	0.29	0.17	0.31	0.17
Hand hygiene knowledge	−	1.06**	0.30	1.57***	0.34	1.50***	0.39	0.65	0.39

OLS=Ordinary Least Squares; Coef.=Coefficient; SE=Standard Error; $^{***}p$ 〈 .001, $^{**}p$ 〈 .01, $^{*}p$ 〈 .05

The mean hand hygiene practice score among community-dwelling older adults in this study was 3.69 out of 5 points, equivalent to 73.8 points on a 100-point scale. The observed score exceeded levels previously reported among adults before the COVID-19 pandemic on adults by Hwang and Jun (2023; 72.6 points), which used a different instrument, but lower than the 3.83 points (79.8 points) reported in Kim and Choi (2025), a study conducted among hospitalized patients using the same instrument as the present. These results suggest that, following the COVID-19 pandemic, awareness of the importance of hand hygiene has increased across society, leading community-dwelling older adults to practice hand hygiene at a relatively high level. However, the overall practice level was still suboptimal, and hand hygiene after handling money-previously identified as a low-performing area-remained insufficient (Kim & Choi, 2025), highlighting the need for more systematic and continuous management and education.

Hand hygiene knowledge was identified as a significant factor associated with hand hygiene practices among older adults. Evidence from earlier research supports the observed relationship between hand hygiene knowledge and practice (Kim et al., 2014; Kim & Choi, 2025; Park et al., 2008). In particular, high correct response rates were observed for items such as ‘the preventive effect of hand hygiene before meals’ and ‘the necessity of hand hygiene after defecation’, which corresponded to higher scores on related practice items, suggesting a relationship between knowledge and practice. Furthermore, quantile regression analysis showed that hand hygiene knowledge was statistically significant only among participants at the 25th and 50th percentiles of practice, suggesting that this association may be relevant for groups with lower practice levels.

Experience with hand hygiene education was also identified as a factor associated with hand hygiene practices, with significance confirmed at the 25th and 50th percentiles in the quantile regression analysis. In this study, 54.2% of participants had received hand hygiene education, which is higher than the 12.8% reported among general adults by Lee (2014), 50.3% among community-dwelling older adults reported by Song & Yang (2015), and 49.1% among hospitalized patients post-COVID-19 (Kim & Choi, 2025). These findings may reflect increased emphasis on infection prevention and expanded educational opportunities in the community following the pandemic, as well as heightened recognition of older adults as a high-risk group. Nevertheless, the overall hand hygiene practice score remained moderate, indicating a need for education that translates knowledge into actual behavior. Future hand hygiene education should go beyond mere information provision, employing repetitive and practice-oriented approaches to facilitate habitual implementation (Song & Yang, 2015), with particular focus on older adults with low or average practice levels.

Health literacy was a significant factor related to hand hygiene practices, with statistical significance observed only among participants at the 25th percentile of practice. Evidence from prior studies indicates that health literacy is closely related to hand hygiene practices among older populations (Hwang & Jun, 2023; Or et al., 2020). Health literacy is an important consideration in developing educational strategies to maintain and promote health (Jeong & Jee, 2024). In this study, the significance among participants with low practice levels suggests that education for

this group should focus on improving access to and comprehension of hand hygiene information. When designing educational programs, there is a need to evaluate participants' health literacy levels in advance and incorporate supportive strategies such as visual aids, hands-on practice, repetitive explanations, and the use of simple language to enhance understanding (Or et al., 2020; Song & Yang, 2015).

Several methodological constraints should be acknowledged. First, the participants were limited to older adults residing in a specific community, thereby restricting the generalizability of the findings to other older adult groups. Future studies should include older adults from diverse regions. Second, data were collected using self-reported questionnaires, as participants' responses may reflect personal judgment or a preference for socially acceptable answers. Therefore, future research employing direct observation to objectively assess hand hygiene practices and techniques is recommended. Finally, this study only included subjective health status as an independent variable and did not account for other health factors such as chronic diseases or physical functional decline that may affect hand hygiene practices. Future research should consider including a wider range of health-related factors, including chronic conditions and functional limitations.

Ⅴ. Conclusion

This research sought to determine factors related to hand hygiene practices and techniques in adults aged 65 years or older living in the community. Findings revealed that low hand hygiene knowledge, no experience of hand hygiene education, low health literacy, having a low educational level, and being male were significant risk factors for poor hand hygiene practices among older adults. Furthermore, the significance of each factor varied according to participants' hand hygiene practice levels: health literacy was significant only among those with low practice levels, whereas hand hygiene knowledge and education experience were significant among participants with low to moderate practice levels. These findings suggest that interventions aimed at improving hand hygiene practices should be tailored to participants' practice levels and characteristics.

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ABSTRACT

Determinants of Hand Hygiene Among Community-Dwelling Older Adults: A Quantile Regression Analysis*

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Purpose: Hand hygiene in older adults is an important aspect of public health. This study aimed to identify the factors related to hand hygiene performance among community-dwelling older adults. **Methods:** This study used a cross-sectional design. A total of 142 older adults participated in this study. Data on participants' hand hygiene performance, hand hygiene knowledge, health literacy, hand hygiene-related characteristics, and general characteristics were collected through a survey. Multiple linear regression and quantile regression analyses were performed using the Stata 17.0 program. **Results:** In the multiple regression analysis, the male gender, lack of experience with hand hygiene education, low health literacy, and low hand hygiene knowledge were significant risk factors for poor hand hygiene practice. In the quantile regression analysis, the male gender and a low educational level were significant factors across all quantiles, while lack of experience with hand hygiene education and low hand hygiene knowledge were significant at the 25th and 50th percentiles only. In addition, low health literacy was significant only at the 25th percentile. **Conclusion:** These findings suggest that tailored interventions are needed for older adults with low hand hygiene levels.

Key words : Hand hygiene, Aged, Risk factors, Regression Analysis

** This manuscript is based on the first author's (Mi-Seon Kwon) master's thesis.*