West African Journal of Allied Health Sciences
Advancing Allied Health Research in West Africa
www.wajahs.org
eISSN: 3115-4581 pISSN: 3115-4573

Original Article Volume 2, Issue 1, April 2026

Public Health Implications of Bacterial Contamination of Mobile Phones Among Students at the University of Delta, Agbor, Nigeria

Clement N. Isibor[1,*], Experience I. Efordili[2], Grandy A. Jaboro[2], Patience I. Abbah[1]

[1]*Department of Medical Laboratory Science, Faculty of Basic Medical Sciences, University of Delta, Agbor, Delta State, Nigeria,*

[2]*Microbiology Unit, Department of Biological Sciences, University of Delta, Agbor, Delta State, Nigeria*

[*]*Corresponding author: clement.isibor@unidel.edu.ng*

Abstract

Background: Mobile phones have evolved from simple communication devices into essential tools that support learning and daily human activities. However, their frequent handling makes them potential reservoirs for microbial contamination. This study investigated bacterial contamination of mobile phones among students at the University of Delta, Agbor, Nigeria. **Methods:** A cross-sectional study was conducted among 150 students ($n = 150$). Mobile phones were sampled using sterile swabs, and specimens were cultured and analyzed using standard microbiological techniques. **Results:** Seven bacterial species were identified: *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* spp., *Salmonella* spp., *Pseudomonas aeruginosa*, *Enterococcus* spp., and *Streptococcus* spp. The overall prevalence of contamination was 77.3% (116/150). *Staphylococcus aureus* was the most frequently isolated organism (26.7%), while *Streptococcus* spp. had the lowest occurrence (2.7%). Gender-based analysis showed slightly higher contamination among male students compared to females, although this difference was not statistically significant ($\chi^2 = 6.90$, $p > 0.05$). **Conclusion:** The findings confirm that mobile phones serve as potential reservoirs of pathogenic bacteria, posing a public health risk in academic settings. Improved phone hygiene practices and increased awareness of microbial contamination are recommended. Routine surveillance in community environments may further help mitigate associated risks.

Keywords: Mobile phones; bacterial contamination; students; fomites; public health.

 DOI: 10.5281/zenodo.19930980
Received: February 22, 2026 Revised: March 15, 2026 Accepted: March 16

Introduction

Mobile phones, including both keypad and smartphone devices, have become indispensable tools in contemporary society and are used daily by billions of individuals worldwide. They play a central role in modern telecommunications, facilitating communication, information exchange, and access to digital services across diverse social and economic settings Li & Yang, 2024; Meng et al., 2025; Nawaz et al., 2025. Mobile phones have increasingly become personal extensions of their users and consequently harbor components of the user's microbiome Meadow et al., 2014. As these devices are carried continuously across diverse environments, they are exposed to microorganisms from multiple sources and may facilitate the transfer of bacteria between locations or individuals.

These devices are used for a variety of purposes, including communication, academic research, social networking, photography, and online learning. Their multifunctionality has increased both the frequency of use and the extent of physical contact they undergo. On average, individuals interact with their mobile phones up to 200 times daily Li & Yang, 2024; Meng et al., 2025; Nawaz et al., 2025, a frequency that provides microorganisms with a steady supply of nutrients, including amino acids and minerals derived from desquamated skin cells and perspiration Swaney et al., 2023. In addition, heat generated during device operation, together with structural niches such as cracked screens and protective cases, creates favorable conditions that support bacterial survival and colonization Parasuraman et al., 2017; Sharma et al., 2023.

Fomite-based transmission occurs when microorganisms from an infected individual contaminate a non-living object and are subsequently transferred to another person. This route of transmission plays an important role in the spread of infectious diseases in both community and healthcare settings Gray & Penny, 2022; Stephens et al., 2019. Four major factors influence the risk of microbial transmission via fomites: the type of microorganism present, the microbial load, the surface characteristics of the fomite, and the frequency of human contact Olsen et al., 2020.

Mobile phones are known to harbor a wide range of bacteria, including potentially pathogenic organisms. These microorganisms can cause infections ranging from mild skin conditions to more severe diseases such as foodborne illnesses, respiratory infections, and urinary tract infections when transferred to mucosal surfaces or compromised skin barriers. Studies have shown that the transmissibility of transient microbial flora is influenced by both the species involved and the quantity of microorganisms present on contaminated surfaces Marples & Towers, 1979; Patrick et al., 1997.

In Nigeria, academic environments, particularly public tertiary institutions, face significant challenges related to public health surveillance and institutional hygiene. These challenges include limited real-time data, inadequate funding, and weak maintenance practices, which may contribute to increased risk of disease transmission. Despite growing global evidence on microbial contamination of mobile devices, there remains a paucity of local data on the extent and implications of bacterial contamination of mobile phones in academic settings. This knowledge gap limits awareness and the development of context-specific interventions among students. Therefore, this study aimed to evaluate the bacterial contamination of mobile phones among students at the University of Delta, Agbor, Nigeria.

Materials and Methods

Study Location, Design, and Participants: This was a cross-sectional descriptive study conducted to assess bacterial contamination of mobile phones and associated hygiene practices among students. A total of 150 students (75 males and 75 females) were randomly selected from the Faculty of Science, University of Delta, Agbor, Nigeria. Only students who provided informed consent were included in the study. Data collection was carried out between January and April 2025. The study was limited to students within the Faculty of Science, which may restrict the generalizability of the findings to other faculties or institutions.

Data Collection (Questionnaire Study): Data were collected using a pretested, structured, self-administered questionnaire distributed to participants during class sessions and retrieved immediately after completion. The questionnaire obtained information on sociodemographic characteristics (age and gender), as well as knowledge, attitudes, and practices related to mobile phone hygiene. Additional sections assessed patterns of mobile phone use, awareness of microbial transmission via mobile devices, and routine phone cleaning practices.

Ethical Considerations: Ethical approval was obtained from the Ethics Committees of the Department of Biological Sciences and Central Hospital, Agbor, Delta State, Nigeria. Participation was voluntary, and informed consent was obtained from all respondents prior to data collection.

Sample Collection: Sterile swabs (Sterilin, UK) pre-moistened with sterile normal saline were used to collect samples from mobile phone surfaces. Swabbing was performed across high-contact areas, including the screen, phone sides, switches, ear socket, and audio input ports. For devices with protective covers, additional samples were obtained from the external surfaces of the covers, following established procedures Hikmah & Anuar, 2020.

Bacterial Identification: Swab samples were immediately placed in peptone water within sterile containers and transported to the Microbiology Laboratory, Department of Medical Laboratory Services, Central Hospital, Agbor, within 30 minutes of collection. Samples were inoculated onto blood agar and MacConkey agar plates (Oxoid Ltd., Basingstoke, UK) using the standard streak plate method Cheesbrough, 2006. The inoculated plates were incubated aerobically at 37 °C for 24–48 hours. Preliminary identification was based on colony morphology and Gram staining. Further identification was performed using standard biochemical tests, including triple sugar iron (TSI), indole, citrate, oxidase, urease, motility, Voges–Proskauer, methyl red, mannitol fermentation, catalase, and coagulase tests Cowan & Steel, 1994.

Data Analysis: Data were entered into Microsoft Excel and exported to IBM SPSS version 27 for analysis. Descriptive statistics were presented as frequencies and percentages. Associations between categorical variables, such as gender and bacterial contamination, were assessed using the chi-square test. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 150 mobile phones belonging to undergraduate students who consented to participate in this study were analyzed. There was equal representation of male and female participants (75 each). Descriptive statistics were used to summarize the sociodemographic characteristics, mobile phone usage patterns, and hygiene practices of the respondents.

Table 1 presents the sociodemographic characteristics and mobile phone hygiene practices of the participants. The age distribution showed that the majority of respondents were within the 19–21 years age group (42.4%), followed by those aged 16–18 years (34.3%). Participants aged 22–25 years constituted 19.2%, while those above 25 years represented 4.0% of the sample. With respect to phone hygiene, cleaning practices varied considerably. Although over half of the respondents (59.3%) reported cleaning their phones, the frequency and methods differed. The most common cleaning method was the use of a wet cloth (35.3%), followed by a dry cloth (14.7%) and alcohol-based wipes (9.3%). A substantial proportion of respondents (40.7%) reported no routine phone cleaning. Hand hygiene prior to phone use was generally poor. More than half of the participants (56.6%) reported rarely washing their hands before using their phones, while 33.3% indicated that they never washed their hands prior to phone use. Only 10.1% reported occasionally washing their hands before handling their phones.

Table 1: Descriptive Characteristics of Respondents and Mobile Phone Hygiene Practices (n = 150)

Characteristic	Frequency	Percentage (%)
Age (years)		
16–18	34	34.3
19–21	42	42.4
22–25	19	19.2
>25	4	4.0
Gender		
Male	46	46.5
Female	53	53.5
Phone Cleaning Practice		
Yes	58	58.6
No	41	41.4
Method of Cleaning		
Wet cloth	35	35.4
Dry cloth	14	14.1
Alcohol wipes	9	9.1
None	41	41.4
Hand Washing Before Phone Use		
Never	33	33.3
Rarely	56	56.6
Sometimes	10	10.1

Table 2 shows the frequency distribution of bacterial species isolated from the mobile phones. Of the 150 devices examined, bacterial growth was observed on 116 phones (77.3%), while 34 phones (22.7%) showed no growth. *Staphylococcus aureus* was the most frequently isolated organism, accounting for 40 isolates (26.7%), followed by *Escherichia coli* and *Klebsiella* spp., each with 20 isolates (13.3%), and *Salmonella* spp. with 16 isolates (10.7%). Less frequently isolated species included *Enterococcus* spp. (8 isolates, 5.3%), *Pseudomonas aeruginosa* (8 isolates, 5.3%), and *Streptococcus* spp. (4 isolates, 2.7%).

Table 2: Frequency of Bacterial Species Isolated from Mobile Phones (n = 150)

Bacterial Species	Frequency (n)	Percentage (%)
Staphylococcus aureus	40	26.7
Escherichia coli	20	13.3
Klebsiella spp.	20	13.3
Salmonella spp.	16	10.7
Enterococcus spp.	8	5.3
Pseudomonas aeruginosa	8	5.3
Streptococcus spp.	4	2.7
No growth	34	22.7
Total	150	100

Tables 3 and 4 present the distribution of bacterial isolates by gender and the bacterial load across male and female students. Among male students, *Staphylococcus aureus* was the predominant isolate (n = 26, 34.7%), followed by *Escherichia coli* and *Salmonella* spp. (n = 10 each, 13.3%). Among female students, *Staphylococcus aureus* was also the most common isolate, although at a lower frequency (n = 14, 18.7%). *Klebsiella* spp. (n = 11, 14.7%) and samples with no growth (n = 21, 28.0%) were more frequently observed among females compared with males.

A chi-square test of independence was conducted to examine the association between gender and bacterial isolate distribution. The analysis showed no statistically significant association between gender and type of bacterial isolate, $\chi^2(7, N = 150) = 6.90, p > 0.05$.

Discussion

All respondents reported ownership and regular use of mobile phones across multiple environments, including lecture halls, hostels, and public spaces. The widespread use of accessories such as phone covers and screen protectors further increases the potential for microbial accumulation on device surfaces.

Staphylococcus aureus, a common human skin commensal with pathogenic potential, was the predominant organism isolated in this study. This finding corroborates previous reports that personal mobile devices act as reservoirs for potentially pathogenic bacteria Hamdan-Partida et al., 2022; Katsuse-Kanayama et al., 2017; Khadka et al., 2018; Touaitia et al., 2025. The frequent handling of mobile phones facilitates the transfer of skin flora onto device surfaces, thereby increasing the likelihood of contamination.

Similarly, the detection of *Escherichia coli* and *Klebsiella* spp. suggests possible fecal contamination and inadequate hand hygiene, particularly after restroom use or contact with contaminated surfaces. The presence of these enteric organisms supports earlier studies highlighting the risk of fecal–oral transmission through frequently handled objects such as mobile phones Cantrell et al., 2023; Mushabati et al., 2021; Sadeeq et al., 2021.

The isolation of *Pseudomonas aeruginosa* reflects environmental exposure and its potential role in opportunistic and healthcare-associated infections Harshitkumar, 2019; Thomas & Oller, 2016. In addition, the recovery of *Enterococcus* spp. and *Streptococcus* spp. indicates contributions from oropharyngeal and environmental sources. These findings are consistent with those of Maurici et al. (2023), who emphasized that frequent handling and inadequate disinfection promote microbial colonization of personal electronic devices.

Comparison of contamination patterns between male and female students showed that *Staphylococcus aureus* predominated among males, while females exhibited a broader diversity of isolates. Differences in microbial contamination by gender may be influenced by a combination of anatomical, hormonal, and behavioral factors that affect exposure, colonization, and immune response Dias et al., 2022.

The higher proportion of culture-negative samples observed among female students may be explained by behavioral and environmental factors related to mobile phone usage. Studies have shown that contamination patterns are strongly influenced by handling frequency, storage practices, and hygiene behaviors rather than biological sex alone Ya'aba et al., 2021; Yu & Kwon, 2025. Female students may be more likely to store phones in enclosed environments such as handbags, which can alter surface microbiota composition and reduce

Table 3: Association Between Gender and Mobile Phone Contamination ($n = 150$)

Gender	Total Samples (n)	Positive (n)	Negative (n)	Prevalence (%)	χ^2	p-value
Male	75	62	13	82.7		
Female	75	64	11	85.3	0.18	0.670
Total	150	126	24	84.0		

Note: χ^2 = Chi-square test; df = 1; not statistically significant at $p < 0.05$.

Table 4: Distribution of Bacterial Isolates by Gender ($n = 150$)

Bacterial Species	Male n (%)	Female n (%)	Total n (%)
Staphylococcus aureus	26 (34.7)	14 (18.7)	40 (26.7)
Escherichia coli	10 (13.3)	10 (13.3)	20 (13.3)
Klebsiella spp.	9 (12.0)	11 (14.7)	20 (13.3)
Salmonella spp.	10 (13.3)	6 (8.0)	16 (10.7)
Enterococci spp.	3 (4.0)	5 (6.7)	8 (5.3)
Pseudomonas aeruginosa	3 (4.0)	5 (6.7)	8 (5.3)
Streptococcus spp.	1 (1.3)	3 (4.0)	4 (2.7)
No growth	13 (17.3)	21 (28.0)	34 (22.7)
Total	75 (100)	75 (100)	150 (100)

Note: $\chi^2(7, N = 150) = 6.90, p > 0.05$; not statistically significant.

the recovery of viable bacteria during culture Ugwu et al., 2021. Furthermore, intermittent cleaning with disinfectants may reduce bacterial load below detectable levels without achieving complete sterilization Cicciarella Modica et al., 2020. These factors likely explain the observed differences in culture yield. However, the lack of statistically significant association between gender and bacterial distribution suggests that these variations may not be biologically meaningful.

This study has some limitations. First, quantitative assessment of bacterial load was not performed, limiting the ability to determine the density of microbial contamination per unit surface area. Second, fungal isolation was not undertaken due to technical constraints. Future studies should incorporate quantitative microbial analysis and include fungal cultures to provide a more comprehensive understanding of microbial contamination of mobile devices.

Conclusion

This study demonstrated that mobile phones used by students at the University of Delta are widely contaminated with diverse bacterial species, including both commensal and pathogenic organisms. These microorganisms have the potential to cause infections, particularly in individuals with compromised immunity. The findings underscore the importance of hand hygiene and routine device cleaning in reducing the spread of microbial pathogens. Increased awareness and implementation of hygiene practices are essential to mitigate the public health risks associated with mobile phone contamination.

Author Contributions

C. N. Isibor (CNI) and E. I. Efordili (EEI) conceptualized the study, collected specimens, and drafted the manuscript. E. I. Efordili (EEI) and P. I. Abbah (API) recruited study participants. E. I. Efordili (EEI) performed laboratory analyses. E. I. Efordili (EEI) and P. I. Abbah (API) conducted data analysis.

C. N. Isibor (CNI) and G. A. Jaboro (JGA) supervised the study. All authors reviewed and approved the final manuscript.

Funding

The authors received no specific funding for this study.

Conflict of Interest

The authors declare no conflict of interest.

Acknowledgment

The authors are grateful to all students who participated in this study and the staff of the department of laboratory services, Central Hospital, Agbor, Delta State Nigeria, for their invaluable support to this study.

References

Cantrell, M. E., Sylvestre, É., Wharton, H. C., Scheidegger, R., Curchod, L., Gute, D. M., Griffiths, J., Julian, T. R., & Pickering, A. J. (2023). Hands are frequently contaminated with fecal bacteria and enteric pathogens globally: A systematic review and meta-analysis. *ACS Environmental Au*, *3*(3), 123–134. https://doi.org/10.1021/acsenvironau.2c00039

Cheesbrough, M. (2006). *District laboratory practice in tropical countries. vol. ii*. Cambridge University Press.

Cicciarella Modica, D., Maurici, M., D'Alò, G. L., Mozzetti, C., Messina, A., Distefano, A., Pica, F., & De Filippis, P. (2020). Taking screenshots of the invisible: A study on bacterial contamination of mobile phones from university students of healthcare professions in rome, italy. *Microorganisms*, *8*(7), 1075. https://doi.org/10.3390/microorganisms8071075

Cowan, S. T., & Steel, K. J. (1994). *Cowan and steel's manual for the identification of medical bacteria*. Cambridge University Press.

Dias, S. P., Brouwer, M. C., & van de Beek, D. (2022). Sex and gender differences in bacterial infections. *Infection and Immunity*, *90*(10). https://doi.org/10.1128/iai.00283-22

Gray, L., & Penny, B. (2022). *Microbiology and infection control for health professionals*. Pearson Higher Education AU.

Hamdan-Partida, A., González-García, S., Martínez-Ruíz, F. J., Zavala-Sánchez, M. Á., Bustos-Hamdan, A., & Bustos-Martínez, J. (2022). Molecular characterization of staphylococcus aureus strains isolated from mobile phones. *Microorganisms*, *10*(3), 669. https://doi.org/10.3390/microorganisms10030669

Harshitkumar, J. S. (2019). Isolation and characterization of bacteria from mobile phones of employees at department of microbiology, gujarat vidyapith, sadra. *Present Day Biology: A Bastion for Social and Sustainable Development*, 17–21.

Hikmah, N. A., & Anuar, T. S. (2020). Mobile phones: A possible vehicle of bacterial transmission in a higher learning institution in malaysia. *Malaysian Journal of Medical Sciences*, *27*(2), 151–158. https://doi.org/10.21315/mjms2020.27.2.15

Katsuse-Kanayama, A., Takahashi, H., Yoshizawa, S., Tateda, K., Kaneko, A., & Kobayashi, I. (2017). Staphylococcus aureus surface contamination of mobile phones and presence of genetically identical strains on the hands of nursing personnel. *American Journal of Infection Control*, *45*(8), 929–931. https://doi.org/10.1016/j.ajic.2017.02.011

Khadka, S., Adhikari, S., Sapkota, S., & Shrestha, P. (2018). Methicillin-resistant staphylococcus aureus associated with mobile phones. *SOJ Microbiology and Infectious Diseases*, *6*(1), 1–6. https://doi.org/10.15226/sojmid/6/1/00190

Li, J., & Yang, H. (2024). Unveiling the grip of mobile phone addiction: An in-depth review. *Frontiers in Psychiatry*, *15*. https://doi.org/10.3389/fpsyt.2024.1429941

Marples, R. R., & Towers, A. G. (1979). A laboratory model for the investigation of contact transfer of micro-organisms. *Journal of Hygiene*, *82*(2), 237–248. https://doi.org/10.1017/S0022172400025651

Maurici, M., Pica, F., D'Alò, G. L., Cicciarella Modica, D., Distefano, A., Gorjao, M., Simonelli, M. S., Serafinelli, L., & De Filippis, P. (2023). Bacterial contamination of healthcare students' mobile phones: Impact of specific absorption rate (sar), users' demographics and device characteristics on bacterial load. *Life*, *13*(6), 1349. https://doi.org/10.3390/life13061349

Meadow, J. F., Altrichter, A. E., & Green, J. L. (2014). Mobile phones carry the personal microbiome of their owners. *PeerJ*, *2*, e447. https://doi.org/10.7717/peerj.447

Meng, S., Qi, K., Shen, P., Zhang, M., Zhang, Y., Onyebuchi, N., Zhan, G., Wei, F., Tong, W., Han, Y., & Ge, X. (2025). The effects of mobile phone addiction on learning engagement of chinese college students: The mediating role of physical activity and academic self-efficacy. *BMC Public Health*, *25*(1), 110. https://doi.org/10.1186/s12889-024-21250-w

Mushabati, N. A., Samutela, M. T., Yamba, K., Ngulube, J., Nakazwe, R., Nkhoma, P., & Kalonda, A. (2021). Bacterial contamination of mobile phones of healthcare workers at the university teaching hospital, lusaka, zambia. *Infection Prevention in Practice*, *3*(2), 100126. https://doi.org/10.1016/j.infpip.2021.100126

Nawaz, S., Bhowmik, J., Linden, T., & Mitchell, M. (2025). Exploring the impact of smartphone dependency on real-life recreational activities: A theory of planned behaviour study. *Entertainment Computing*, *52*, 100906. https://doi.org/10.1016/j.entcom.2024.100906

Olsen, M., Campos, M., Lohning, A., Jones, P., Legget, J., Bannach-Brown, A., McKirdy, S., Alghafri, R., & Tajouri, L. (2020). Mobile phones represent a pathway for microbial transmission: A scoping review. *Travel Medicine and Infectious Disease*, *35*, 101704. https://doi.org/10.1016/j.tmaid.2020.101704

Parasuraman, S., Sam, A., Yee, S. K., Chuon, B. C., & Ren, L. (2017). Smartphone usage and increased risk of mobile phone addiction: A concurrent study. *International Journal of Pharmaceutical Investigation*, *7*(3), 125. https://doi.org/10.4103/jphi.JPHI_56_17

Patrick, D. R., Findon, G., & Miller, T. E. (1997). Residual moisture determines the level of touch-contact-associated bacterial transfer following hand washing. *Epidemiology and Infection*, *119*(3), 319–325. https://doi.org/10.1017/S0950268897008261

Sadeeq, T., Arikan, A., Sanlidag, T., Guler, E., & Suer, K. (2021). Big concern for public health: Microbial contamination of mobile phones. *Journal of Infection in Developing Countries*, *15*(6), 798–804. https://doi.org/10.3855/jidc.13708

Sharma, S., Mohler, J., Mahajan, S. D., Schwartz, S. A., Bruggemann, L., & Aalinkeel, R. (2023). Microbial biofilm: A review on formation, infection, antibiotic resistance, control measures, and innovative treatment. *Microorganisms*, *11*(6), 1614. https://doi.org/10.3390/microorganisms11061614

Stephens, B., Azimi, P., Thoemmes, M. S., Heidarinejad, M., Allen, J. G., & Gilbert, J. A. (2019). Microbial exchange via fomites and implications for human health. *Current Pollution Reports*, *5*(4), 198–213. https://doi.org/10.1007/s40726-019-00123-6

Swaney, M. H., Nelsen, A., Sandstrom, S., & Kalan, L. R. (2023). Sweat and sebum preferences of the human skin microbiota. *Microbiology Spectrum*, *11*(1). https://doi.org/10.1128/spectrum.04180-22

Thomas, W., & Oller, A. (2016). Staphylococcus and pseudomonas isolated from mobile phones and cheek and ear locales. *British Journal of Medicine and Medical Research*, *11*(6), 1–8. https://doi.org/10.9734/BJMMR/2016/20616

Touaitia, R., Mairi, A., Ibrahim, N. A., Basher, N. S., Idres, T., & Touati, A. (2025). Staphylococcus aureus: A review of the pathogenesis and virulence mechanisms. *Antibiotics*, *14*(5), 470. https://doi.org/10.3390/antibiotics14050470

Ugwu, M. C., Onyekwelu, C. M., Morikwe, U. C., Ezejiegu, K. C., & Okafor, U. C. (2021). Bacterial contamination of mobile phones of university students in eastern nigeria: Hand-phone hygiene practices among students and antibiogram of bacterial contaminants. *Journal of Antimicrobial Agents*, *7*(7), 1–4.

Ya'aba, Y., Chuku, A., Okposhi, U. S., Hadi, N. S., & Ramalan, S. A. (2021). Bacterial contamination associated with mobile cell phones among undergraduate students of federal university of lafia, nasarawa state, nigeria. *Nigerian Journal of Basic and Applied Sciences*, *28*(2), 36–42. https://doi.org/10.4314/njbas.v28i2.5

Yu, J. S., & Kwon, M. S. (2025). Factors influencing smartphone overdependence in university students: An ecological model: A descriptive study. *Journal of Korean Academy of Nursing*, *55*(1), 64–80. https://doi.org/10.4040/jkan.24092