

# Relationship between type of hand hygiene method and incidence of skin problems during Covid-19 pandemic in Ahvaz; Iran

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## Research

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# Abstract

**Background:** During the Coronavirus disease 2019 (COVID-19) outbreak, there was an increase in human activities in relation to hygiene, especially hand hygiene. The purpose of this study was to investigate the hand hygiene among volunteers during the COVID-19 pandemic in Ahvaz, southwest Iran during 2020.

**Methods:** Data validation was performed using WHO criteria. A web-based prospective cross-sectional descriptive study was conducted during 2020 in Ahvaz city, southwest Iran. The data collection was based on completion of the volunteer questionnaire. In our study, WhatsApp software was used.

**Results:** The number of participants in our study were 1000 persons. Based on the results of this study, the mean ages (mean  $\pm$  SD) of participants were  $32.84 \pm 10.74$  years for women and  $33.06 \pm 11.08$  years for men. According to the findings of this study, there was no relationship between the age of participants and hand-skin health scores ( $p > 0.05$ ).

**Conclusions:** It was concluded that during the COVID-19 pandemic all the assessed hand hygiene behaviors of Iranians were improved, compared with those before, but hand hygiene education is still necessary.

Therefore, the results of this study may be useful for health policymakers in order to cope with the emerging disease.

## 1. Background

COVID-19 pandemic has taken a heavy toll on the healthcare fraternity worldwide, and despite setting up added facilities to augment the number of beds and ventilators, the limited number of healthcare workers is a limiting factor. In 2019, a new unprecedented coronavirus called SARS-CoV-2 emerged in Wuhan, China, rapidly spreading from country to country, and became a global crisis, impacting every aspect of human life, economic devastation and social anxiety around the world [1, 2].

Confirmed COVID-19 cases have been reported in more than 212 *countries* and territories around the world. Based on reports the World Health Organization (WHO) declared COVID-19 is an ongoing global pandemic [3]. In the early stage of the outbreak in Wuhan, due to the high viral load of the upper respiratory tract and the close contact between the otolaryngologist and the patient's upper respiratory tract mucosa, the otolaryngologist had the highest hospital transmission rate [4]. The most common symptoms at onset of COVID-19 disease are dry cough, fever, shortness of breath, fatigue, and headache, and fatigue [5-11]. Medical care is the famous section of daily life that has impacted due to respiratory pandemic COVID-19 [12].

Health care-related infections are serious problems that influence patient's safety settings. Hand hygiene is the most effective method for preventing these infections [13]. One of the best ways to destroy

microorganisms is using alcohol-based hand hygiene gel [14]. For the prevention of nosocomial infections, hand hygiene is very important [14]. However, Hand washing is one of the most important factors in prevention of nosocomial infections, researches finding show that hand washing compliance in health care workers was not satisfying. The concept of compliance is effective hand hygiene in any opportunities for that. Other countries researches indicate that hand rubbing with alcohol-based solution adherence hand hygiene compliance [15]. The WHO recommended confirmed that two alcohol-based hand rub formulations (ethanol 70–95% and 2-propanol 70–100%) had an efficient virucidal activity in less than 60 s by more and equal  $4 \log_{10}$  ( $\geq 99.99$ ) approximately and could be used for disinfection in public health and health-care facilities [16].

The purpose of this study was to assess of hand hygiene among volunteers during the Covid-19 pandemic in Ahvaz, southwest Iran during 2020.

## **2. Material And Methods**

### ***2.1. The study area***

The study was carried out in the Ahvaz city of Khuzestan metropolis in southwestern of Iran, with a citizen count of ~1.3 million and is situated on (31°19'13"N and 48°40'09"E) (Figure 1). [17, 18]. The temperature sometimes exceeds 50 °C during summers and the humidity in some days reaches more than 90%.

### **2.2. Sample size and Sampling method**

A web-based prospective cross-sectional descriptive study which conducted during 2020 in Ahvaz city, southwest Iran. The data collection was based on completion of the volunteer questionnaire. To determine the minimum sample size, the ratio estimation formula was used for estimating a volunteer. For this purpose,  $\alpha = 0.05$ ,  $p = 0.5$ ,  $d = 0.05$  and a design effect equal to 1.5 were considered. A minimum sample size of 570 estimated for each district. Regarding to the unequal size of the districts and using a proportional to size sampling method, the final sample size needed for this study was estimated 1000 volunteers (people between 12 and 60 years old). People with known skin conditions or daily use of corticosteroids and skin medications were excluded from the study before the onset of the Covid-19 pandemic. In total, different work groups, family, NGO and student who were active in WhatsApp were selected and the questionnaire link was sent to the group members in coordination with the admin. Data collection tools were the standard self-assessment questionnaire of the skin of the hand attached to the three World Health Organizations (WHO) and the self-report questionnaire of demographic characteristics of the participants. The who skin self-assessment tool consists of four sections (hand skin appearance, integrity, moisture and hand skin sensation) with a score of 7-1, prepared by the World Health Organization. The validity of the skin self-assessment form has been confirmed by the World Health Organization.

### **2.3. Data Analysis**

The spreadsheet subsequently obtained in family, NGO and student who were active in WhatsApp by the participants was extracted into Microsoft Excel version 2019 for Windows, and data refining was done. The data was subsequently coded and analyzed using SPSS.

## **2.4. Statistical analysis**

Continuous variables are presented as mean $\pm$ SD or median with range. Categorical data are expressed as number (percentage). Descriptive analysis was used to determine the frequencies and proportion of responses. The normality of continuous variables was examined using the Shapiro-Wilk's W-test. Mann-Whitney U test was used to compare different continuous variables among two independent groups. The Spearman correlation coefficient was applied to evaluate the relationship between quantitative variables. Statistical analysis was performed using the statistical software SPSS 18.0.0. (SPSS Inc. Chicago, IL, USA).

## **2.5. Ethical Consideration**

Participation was voluntary without any coercion or deception. Ethics License of the present study was acquired from the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (Code of ethics: IR.AJUMS.REC.1399.406). According to the national guidelines, studies such as this do not require individual consent.

## **3. Results**

Of the 1000 participants in our study, 676 (67.6%) were female and 324 (32.4%) were male. The mean ages (mean  $\pm$  SD) were 32.84 $\pm$ 10.74 years for women and 33.06 $\pm$ 11.08 years for men. Demographic characteristics of the participants presented in Table 1.

<b>Table 1</b> Demographic characteristics of participants.	
<b>Participants' characteristics</b>	<b>Statistics</b>
Gender; n (%)	
Female	676 (67.6)
Male	324 (32.4)
Age (y); Mean $\pm$ SD (Min-Max)	
Female	32.84 $\pm$ 10.74 (11-70)
Male	33.06 $\pm$ 11.08 (10-69)
Total	32.92 $\pm$ 10.85 (10-70)
Occupation; n (%)	
Jobless	114 (11.4)
Student	232 (23.2)
Teacher	75 (7.5)
Healthcare worker	207 (20.7)
Housewife	48 (4.8)
Clerk	245 (24.5)
Worker	79 (7.9)
Education; n (%)	
Reading and writing skills	53 (5.3)
High school	75 (7.5)
Diploma	212 (21.2)
University	660 (66.0)

The overall liquid soap with rate of 24.47 % (275) and Alcoholic spray 46.87 % (793) were highest score between hand hygiene material's type. The observed compliance rates of the distribution of at work/ home equipment and hand hygiene material's type and their percent are presented in Table 2. **Table 2** The distribution of at work/ home equipment and hand hygiene material's type.

<b>At work/ home equipment and hand hygiene material's type</b>	<b>N (%)</b>
At work equipment	
Face mask	170 (15.12)
Solid soap	24 (2.14)
Liquid soap	275 (24.47)
Disposable gloves	173 (15.39)
Sterilizing surfaces by janitor	13 (1.16)
Hand- sterilize liquid	99 (8.81)
Alcohol for surfaces	228 (20.28)
All	85 (7.56)
None	57 (5.07)
Total	1124 (100)
Hand hygiene material outside of the home	
Solid soap	149 (8.81)
Liquid soap	252 (14.89)
Antibacterial soap	19 (1.12)
Hand washing gel without water	219 (12.94)
Alcoholic spray	793 (46.87)
Water	238 (14.07)
None	22 (1.30)
Total	1692 (100)
Hand hygiene material at home	
Solid soap	81 (3.64)
Liquid soap	906 (40.70)
Antibacterial soap	4 (0.18)
Hand washing gel without water	56 (2.52)
Alcoholic spray	503 (22.60)

Water	672 (30.19)
None	4 (0.18)
Total	2226

Among A total of 1000 completion of the volunteer questionnaire the distribution of preventive health behaviors from COVID-19 in participants shows in table 3. Wearing a mask, hand hygiene and social distancing were the highest level of observance among study participants.

**Table 3** The distribution of preventive health behaviors from COVID-19 in participants

<b>Preventive health behaviors</b>	<b>Statistics</b>
Individual behaviors; n (%)	
Wearing a mask	370 (16.73)
Hand hygiene	576 (26.05)
Social distancing	439 (19.86)
Washing shopping and groceries	283 (12.80)
Using disposable gloves	234 (10.58)
Incense	2 (0.09)
None	91 (4.12)
All	216 (9.77)
Total	2211 (100)
Number of hand hygiene outside of the home; Median: Q <sub>1</sub> -Q <sub>3</sub> (Min-Max)	
Female	5: 3-9 (0-30)
Male	4: 2-7 (0-20)
Total	5: 3-8 (0-30)
Number of hand hygiene at home; Median: Q <sub>1</sub> -Q <sub>3</sub> (Min-Max)	
Female	9: 5-11 (1-30)
Male	7: 4-10 (1-30)
Total	8: 5-10 (1-30)
Using alcoholic gel after hand hygiene; n (%)	
Yes	361 (36.1)
No	639 (63.9)
Number of alcoholic gel after hand hygiene; Median: Q <sub>1</sub> -Q <sub>3</sub> (Min-Max)	
Female	3: 2-4 (1-7)
Male	3: 2-4 (1-7)
Total	3: 2-4 (1-7)

The relationship between hand-skin conditions, gender, occupation in participants and  $P^{\text{£}}$  are presented in Table 4 and 5. The highest rate of observance of relationship between hand-skin conditions and gender in participants was seen skin's hydration and the lowest was seen pain, 0.059 and 0.448, respectively ( $p < 0.001$ ) (Table 4). Based on result Table 5 Skin's health and Skin appearance with 0.141 and 0.796 were the highest and the lowest relationship between hand-skin conditions and occupation in participants ( $p < 0.001$ )

<b>Table 4</b> The relationship between hand-skin conditions and gender in participants				
hand-skin conditions	Total	Female	Male	$P^{\text{£}}$
Skin appearance				
Mean±SD	2.56±2.56	2.60±2.56	2.48±2.57	0.349
Skin's health				
Mean±SD	3.39±2.22	3.44±2.25	3.28±2.14	0.377
Skin's Hydration				
Mean±SD	2.65±2.16	2.73±2.16	2.47±2.16	0.059
Pain				
Mean±SD	2.52±2.00	2.55±1.99	2.47±2.02	0.448
£ Mann-Whitney test.				

<b>Table 5</b> The relationship between hand-skin conditions and occupation in participants				
hand-skin conditions	Total	HCW	Other jobs	$P^{\text{¥}}$
Skin appearance				
Mean±SD	2.56±2.56	2.64±2.70	2.54±2.53	0.796
Skin's health				
Mean±SD	3.39±2.22	3.60±2.27	3.33±2.20	0.141
Skin's Hydration				
Mean±SD	2.65±2.16	2.70±2.21	2.63±2.15	0.776
Pain				
Mean±SD	2.52±2.00	2.61±2.05	2.50±1.98	0.541
¥ Mann-Whitney test, HCW: Health Care Worker.				

There was no relationship between age of participants and hand-skin's health scores ( $p>.05$ ). The relationship between hand-skin conditions and the number of hand washing times outside of the home, number of hand washing times outside of the home and number of using alcoholic gel after hand hygiene is presented in Table 6.

<b>Table 6</b> The relationship between hand-skin conditions and the number of hand washing times outside of the home, number of hand washing times outside of the home and number of using alcoholic gel after hand hygiene.			
<b>Hand-skin conditions</b>	<b>Number of hand hygiene outside of the home</b>	<b>Number of hand hygiene at home</b>	<b>Number of using alcoholic gel after hand hygiene</b>
Skin appearance	0.095 (0.035,0.157)	0.079 (0.020,0.140)	0.033 (-0.029,0.095)
Skin's health	0.099 (0.039,0.160)	0.102 (0.033,0.167)	0.074 (0.014,0.136)
Skin's Hydration	0.111 (0.053,0.166)	0.102 (0.037,0.164)	0.069 (0.009,0.130)
Feeling pain	0.067 (0.004,0.131)	0.113 (0.053,0.180)	0.045 (-0.018,0.107)
Values are presented as correlation coefficient (Confidence Interval 95%).			

## 4. Discussion

The most agents essential in reducing infection from the oral cavity and transfer to the upper and lower respiratory tract is hand hygiene. Centers for Disease Control recommends hand washing with soap and water can to prevent virus SARS-co-2 transmissions. Hand hygiene products may be effective against alter skin barrier integrity and COVID-19 [20].

According to the recommendations of World Health Organization (WHO) on using alcohol-base formulation for hand hygiene and it got used to among the general public because of the Covid-19 pandemic, this study was done with the aim of relationship between the type of hand hygiene method and the incidence of skin problems of alcohol-based hand rub with antiseptic and plain soap on hands of general public after the Covid-19 pandemic in Ahvaz, southwest Iran during 2020. The risk factors for the development of hand dermatitis, with further focus on the most common agents used among human.

The disease caused by the unprecedented novel coronavirus, spreads from country to country and quickly becomes a global crisis. Although governments have tried to stop or slow the outbreak of the emerging disease through various measures, the victims resulting from this disease are raising. Therefore, Hand hygiene education, Distribution of disinfectants among the people and low-income groups, high production of Hand hygiene, close contact among people should be avoided to reduce COVID-19 transmission [21-24, 9, 25]. Based on result different study, hand hygiene is of utmost importance for the prevention of COVID-19 among HCWs.

Abbasnia et al, in 2016 studied Evaluation of antibacterial effect of hand hygiene gel on different concentrations of bacteria. Based on their result the Hand hygiene gel was not effective when encountered with the highest concentration of bacteria in all four time-tested, and the entire surfaces of the plates were coated with bacteria, and with decreasing concentrations of bacteria and increasing the encounter duration, the number of bacteria reduced [14]. This study showed that basic hand hygiene gel was only effective when the number of bacteria was lower than CFU per milliliter and the exposure time was at least 40 seconds [14].

Araghi et al in 2020 studied hand hygiene among health care workers during COVID-19 Pandemic. They reported that applying alcohol-based hand rubs, washing hands properly with soap and water, and applying other antiseptic agents [26].

Baloochi and Saleh Moghaddam in 2008 the comparison of skin complications of alcohol-based hand rub with antiseptic soap and plain soap on hands of nursing personnels [27]. According to the result of skin complications in groups with four dimensions: appearance, intactness, moisture content and sensation. Among three groups, the alcohol-based hand rub in comparison with plain soap showed less skin complications in intactness ( $p=0.04$ ) [27].

In a similar study by Masakini et al. the efficacy of hand washings due to used waterless hand hygiene was investigated in Iran [28]. The findings showed that 30 samples were not grown on EMB medium but 30 samples of Blood agar, before and after washing with soap and liquid hand rub, were grown and applying hand rub alcohol liquid is most effective than washing with soap. Identification of bacteria in manitol salt agar medium and coagulase test revealed 80% were coagulase negative staphylococcus and 20% coagulase positive staphylococcus [28]. In this study washing with soap does not effect on hand hygiene of nurses but disinfectant with liquid alcohol shows significant correlation in reducing microbial load on personnels' hand that is revealed alcohol was more effective in reducing pollution [28].

Based on another study, Kampf and Löffler in 2003 evaluation of aspects a successful introduction and continuation of alcohol-based hand rubs for hygienic hand disinfection [29]. They showed that hand washing with a solution containing ethanol 80% has a significant reduction on skin microorganisms [29].

Based on the study of Samadipour et al. (2008), in Sabzevar, adherence to hand hygiene practice in internists was 34.4% in the surgical staff 21.3% in the intensive group 15.65% and in doctors 16.59% [30]. Out of 1356 situations of hand hygiene practice only in 306 cases hand hygiene was practiced. In general, the mean percentage for the four groups was 22.6%. According to their result, the hand hygiene practice while taking care of patients is low and unsatisfactory [30].

Keratin and lipids are the famous component of a healthy skin barrier is the stratum corneum [20]. Alkaline soaps and detergents, friction, dry skin, warm water, cold water, rough paper towels and use repeated glove are the most important cases that can negatively affect skin barrier function [20, 31]. Epidermal atrophy, reduced keratinocyte size, decreased free fatty acids are the most agents that increased infections. In a study performed by Lan et al in 2020 investigated of skin damage among

health care workers managing during the COVID-19 outbreak in Hubei, China. They reported that 66.1% of health care workers washed their hands more than 10 times per day, but only 22.1% applied moisturizers after hand washing [32].

A research conducted by Głąbska et al in 2020 on the influence of the COVID-19 pandemic on hand hygiene behaviors in the Poland indicated that the majority of circumstances of washing hands, including those associated with meals, personal hygiene, leaving home, socializing, health, and household chores, the share of respondents declaring always washing their hands was significantly higher for the period during the COVID-19 pandemic than for the period before ( $p < 0.0001$ ) [33].

Due to the cultural of Iranian such as visiting, to shake hands, participate in mourning and wedding ceremonies, increases the importance of preventive activity about this disease. Hand dermatitis prevention, products devoid of allergens, using products with added moisturizers and applying moisturizers after hand washing are the main actions that can decrease health skin risks to the people of the region and world. Therefore, continuous education about how correct use of hand washing, products detergent and use of moisturizing skin is a priority.

### **Limitations and strengths**

The major limitations of this study include the limitations of ecological studies which is the use of aggregated data. We only studied hand hygiene factor, but some sites could be related to more than this factor.

## **5. Conclusion**

Ahvaz is the largest metropolitan city in southwest Iran with a desert climate, so the findings of this study can have wide applications for desert cities in the world. Acquiring a proper as well as the correct knowledge about any disease as infective as COVID-19, as a health care worker, is of utmost importance not only to be able to impart effective treatment but also to successfully prevent the transmission from one. Accordingly, as the average numbers of bacteria on hands are far less than this threshold the routine use of hand hygiene gel is recommended, and in case of high pollution hands should be washed first. One of the most way reducing COVID-19 transmission is hand hygiene that can do it with the help of hand hygiene products.

## **Abbreviations**

COVID-19: coronavirus disease 2019

SARS-CoV-2: severe acute respiratory syndrome coronavirus 2

WHO: World Health Organization

# Declarations

## Ethics approval and consent to participate

Participation was voluntary without any coercion or deception. Considering the fact that the data collection method was observation and there were no human participants in the current study, obtaining informed consent is deemed unnecessary according to regulations; Ethics License of the present study was acquired from the Ethics Committee of Ahvaz Jundishapur University of Medical Sciences (Code of ethics: IR.AJUMS.REC.1399.406).

## Consent for publication

Not applicable.

## Availability of data and materials

Upon request, we can offer onsite access to external researchers to the data analyzed at Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. To do so, Dr. Maria Cheraghi should be contacted.

## Competing interests

The authors declare that they have no competing interests.

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## Authors' Contributions

PA, MC and M-JM were principal investigators of the study and drafted the manuscript. PA, M-BN, M-JM, EM and MC were advisors of the study. EM and MC performed the statistical analysis. All authors contributed to the design and data analysis and assisted in the preparation of the final version of the manuscript. All authors read and approved the final version of the manuscript.

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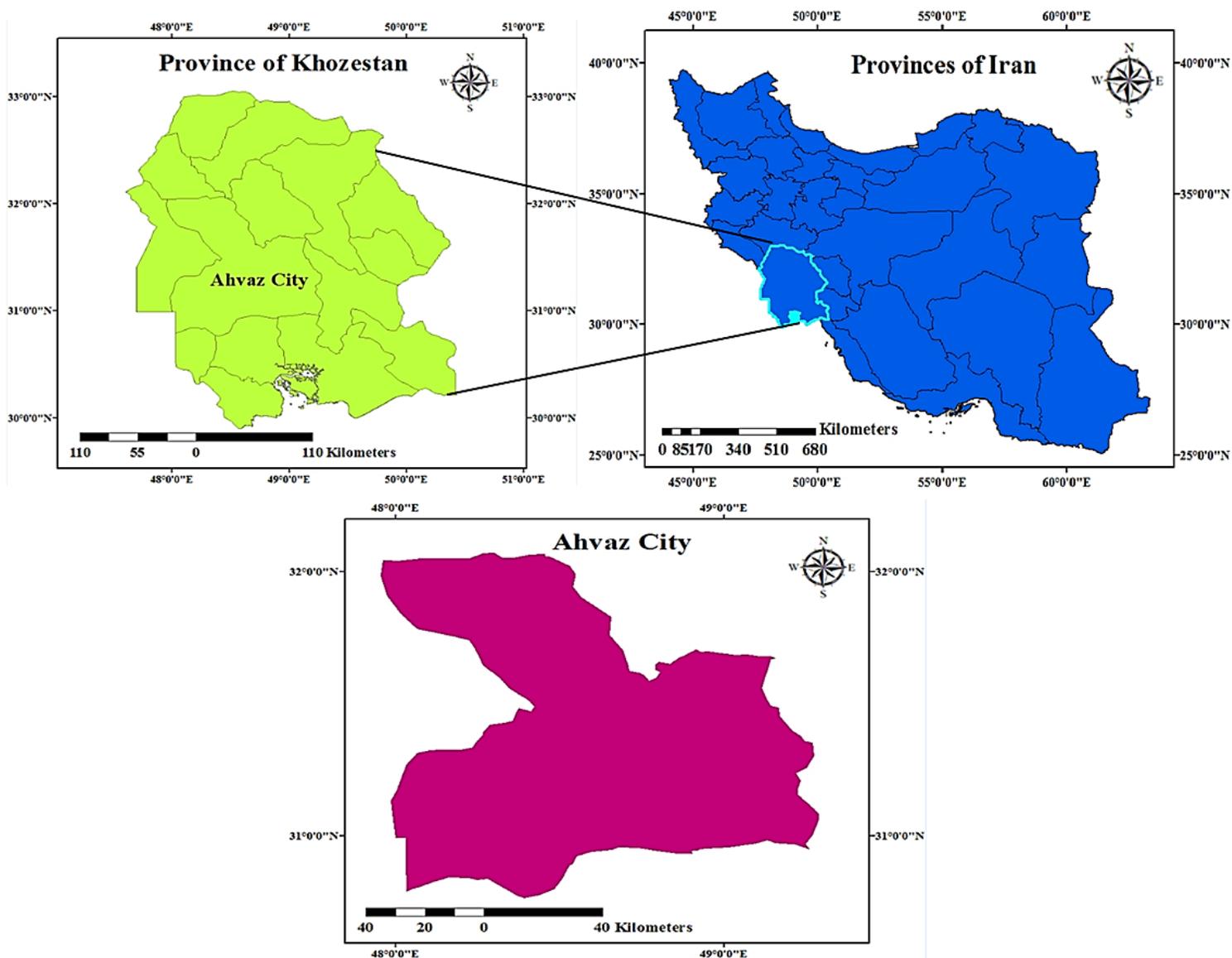
# References

1. Olivera-La Rosa A, Chuquichambi EG, Ingram GP. Keep your (social) distance: Pathogen concerns and social perception in the time of COVID-19. *Personality and Individual Differences*. 2020;166:110200.
2. Sun C, Zhai Z. The efficacy of social distance and ventilation effectiveness in preventing COVID-19 transmission. *Sustainable cities and society*. 2020;62:102390.
3. Tang B, Bragazzi NL, Li Q, Tang S, Xiao Y, Wu J. An updated estimation of the risk of transmission of the novel coronavirus (2019-nCov). *Infectious disease modelling*. 2020;5:248-55.
4. Chan JY, Wong EW, Lam W. Practical aspects of otolaryngologic clinical services during the 2019 novel coronavirus epidemic: an experience in Hong Kong. *JAMA Otolaryngology–Head & Neck Surgery*. 2020.
5. Chan JF-W, Yuan S, Kok K-H, To KK-W, Chu H, Yang J et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *The Lancet*. 2020;395(10223):514-23.
6. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y et al. Epidemiological and clinical characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *The Lancet*. 2020;395(10223):507-13.
7. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y et al. Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. *New England Journal of Medicine*. 2020.
8. Lippi G, Plebani M. Procalcitonin in patients with severe coronavirus disease 2019 (COVID-19): a meta-analysis. *Clinica chimica acta; international journal of clinical chemistry*. 2020;505:190.
9. Shereen MA, Khan S, Kazmi A, Bashir N, Siddique R. COVID-19 infection: Origin, transmission, and characteristics of human coronaviruses. *Journal of Advanced Research*. 2020.
10. Xiang N, Havers F, Chen T, Song Y, Tu W, Li L et al. Use of national pneumonia surveillance to describe influenza A (H7N9) virus epidemiology, China, 2004–2013. *Emerging infectious diseases*. 2013;19(11):1784.
11. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J et al. A novel coronavirus from patients with pneumonia in China, 2019. *New England Journal of Medicine*. 2020.
12. Robert G Uzzo M, MBA, FACS Alexander Kutikov, MD, FACS Daniel M Geynisman, MD. Coronavirus disease 2019 (COVID-19): Risks for infection, clinical presentation, testing, and management in patients with cancer. *UpTo Date*. 2020.
13. Y E, N B, N H, S F. Health Care Workers› Knowledge and Attitude Towards Hand Hygiene in Educational Hospitals of Zanjann in 2014. *Military Caring Sciences*. 2018;5(1):46-53. doi:10.29252/mcs.5.1.46.
14. abbasnia s, teymori f, moradpor m, derakhshan m, ghazvini k. Evaluation of antibacterial effect of hand hygiene gel on different concentrations of bacteria. *medical journal of mashhad university of medical sciences*. 2017;59(6):312-21. doi:10.22038/mjms.2017.9521.
15. Baloochi Beydokhti T, Gharcheh M, Bahri N, Basirimoghadam K. The Comparison of Hand Hygiene Compliance of alcohol-based solution and soap in Nurses of gonabad Hospitals- 2009. *Quarterly of*

- Horizon of Medical Sciences. 2010;16(3):64-70.
16. Noorimotlagh Z, Mirzaee SA, Jaafarzadeh N, Maleki M, Kalvandi G, Karami C. A systematic review of emerging human coronavirus (SARS-CoV-2) outbreak: focus on disinfection methods, environmental survival, and control and prevention strategies. *Environmental Science and Pollution Research*. 2020:1-15.
  17. Goudarzi G, Alavi N, Geravandi S, Yari AR, Alamdari FA, Dobaradaran S et al. Ambient particulate matter concentration levels of Ahvaz, Iran, in 2017. *Environmental geochemistry and health*. 2019;41(2):841-9.
  18. Khaefi M, Geravandi S, Hassani G, Yari AR, Soltani F, Dobaradaran S et al. Association of particulate matter impact on prevalence of chronic obstructive pulmonary disease in Ahvaz, southwest Iran during 2009–2013. *Aerosol and Air Quality Research*. 2017;17(1):230-7. doi:10.4209/aaqr.2015.11.0628.
  19. Zallaghi E, Goudarzi G, Sabzalipour S, Zarasvandi A. Effects of long-term exposure to PM 2.5 on years of life lost and expected life remaining in Ahvaz city, Iran (2008–2017). *Environmental Science and Pollution Research*. 2020:1-7.
  20. Rundle CW, Presley CL, Militello M, Barber C, Powell DL, Jacob SE et al. Hand hygiene during COVID-19: recommendations from the American contact dermatitis society. *Journal of the American Academy of Dermatology*. 2020.
  21. Centers for Disease Control Prevention. How COVID-19 spreads. <https://www.cdc.gov/onavirus/209-110ncov/prevent-getting-sick/how-covid-spreads>. 2020.
  22. Hsiao T-C, Chuang H-C, Griffith SM, Chen S-J, Young L-H. COVID-19: An Aerosol's Point of View from Expiration to Transmission to Viral-mechanism. *Aerosol and Air Quality Research*. 2020;20(5):905-10.
  23. World Health Organization. Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations: scientific brief, 27 March 2020: World Health Organization2020.
  24. Peng X, Xu X, Li Y, Cheng L, Zhou X, Ren B. Transmission routes of 2019-nCoV and controls in dental practice. *International Journal of Oral Science*. 2020;12(1):1-6.
  25. Bains VK, Bains R. Is oral hygiene as important as hand hygiene during COVID-19 pandemic? *Asian Journal of Oral Health and Allied Sciences*. 2020;10.
  26. Araghi F, Tabary M, Gheisari M, Abdollahimajd F, Dadkhahfar S. Hand hygiene among health care workers during COVID-19 pandemic: challenges and recommendations. *Dermatitis*. 2020;31(4):233-7.
  27. Baloochi Baydokhti T, Saleh Moghaddam A. The comparison of skin complications of alcohol-based hand rub with antiseptic soap and plain soap on hands of nursing personnels. *The Horizon of Medical Sciences*. 2008;14(3):18-22.
  28. Masakini F, Noorbakhsh F, Honarmand Jahromi S. Comparison between the efficacy of hand washings with waterless hand hygiene in hospital nurses. *Health and Safety at Work*. 2017;7(4):353-62.

29. Kampf G, Löffler H. Dermatological aspects of a successful introduction and continuation of alcohol-based hand rubs for hygienic hand disinfection. *Journal of Hospital Infection*. 2003;55(1):1-7.
30. Samadipour E DM, Salari MM. Hand hygiene practice in Sabzevar hospitals Iran. *Journal of Sabzevar University of Medical Sciences*. 2009;15(1):59-64.
31. Kantor J. Behavioral considerations and impact on personal protective equipment use: Early lessons from the coronavirus (COVID-19) pandemic. *Journal of the American Academy of Dermatology*. 2020;82(5):1087-8.
32. Lan J, Song Z, Miao X, Li H, Li Y, Dong L et al. Skin damage among health care workers managing coronavirus disease-2019. *Journal of the American Academy of Dermatology*. 2020;82(5):1215-6.
33. Głąbska D, Skolmowska D, Guzek D. Population-based study of the influence of the COVID-19 pandemic on hand hygiene behaviors—Polish adolescents' COVID-19 experience (PLACE-19) study. *Sustainability*. 2020;12(12):4930.

## Figures



## Figure 1

Geographical location of Ahvaz city in Iran [19]