

A survey of knowledge, attitude, and performance of Kerman residents on segregation and recycling of household solid wastes during COVID-19 period

Hoda Amiri^{1,2}, Majid Hashemi^{1,2}, Moghadameh Mirzaei³, Abedin Iranpour⁴, Ramin Moradi^{1,2*}

¹Environmental Health Engineering Research Center, Kerman University of Medical Sciences, Kerman, Iran

²Department of Environmental Health Engineering, Faculty of Public Health, Kerman University of Medical Sciences, Kerman, Iran

³Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran

⁴HIV/STI Surveillance Research Center, and WHO Collaborating Center for HIV Surveillance, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran

Abstract

Background: Awareness, knowledge, and attitude towards waste management, environmental factors of waste disposal sites and citizens' as well as waste generators' behaviors should be considered for implementing a waste segregation plan at the source.

Methods: The statistical population of this cross-sectional study includes 150 000 households living in Kerman. The sample size is calculated as 444 individuals using a stratified sampling method considering a 15% withdrawal probability. The correlation between Kerman citizens' demographic data (age, gender, mean income, and household head's educational level) and behavioral patterns (knowledge and awareness, attitude and behavior) regarding waste management and environmental factors of waste disposal sites was evaluated using SPSS software.

Results: Examining the variables indicates that attitude, environmental factors, behavior, awareness, and knowledge have the highest mean and standard deviation, respectively. The highest mean score of awareness and knowledge was observed among individuals who earned 40 million IRR and higher income (2.55 ± 0.24) and those who had a PhD degree (2.63 ± 0.27). The results show that one unit increase in the score of awareness and knowledge, attitude and environmental factors could increase the mean behavior score.

Conclusion: Teaching the households waste-related environmental issues and how to properly separate recyclable waste as well as providing correct information regarding the current (COVID-19 period) and future plans and policies of the waste management organization, and developing suitable motivational mechanisms could improve the performance level of a society.

Keywords: Humans, Health knowledge, Attitudes, Practice, COVID-19

Citation: Amiri H, Hashemi M, Mirzaei M, Iranpour A, Moradi R. A survey of knowledge, attitude, and performance of Kerman residents on segregation and recycling of household solid wastes during COVID-19 period. Environmental Health Engineering and Management Journal 2023; 10(4): 409-417. doi: 10.34172/EHEM.2023.44.

Article History:

Received: 8 January 2023

Accepted: 10 July 2023

ePublished: 10 October 2023

*Correspondence to:

Ramin Moradi,

Email: raminmoradi5994@gmail.com

Introduction

Due to the increased waste generation, land scarcity for landfilling in urban areas, and concerns for ecological and environmental damage by hazardous waste, urban waste management is of particular importance (1-3). Municipal solid waste management is a fundamental bio-environmental issue in human societies in all developed and developing countries. Urbanization growth in Iran and increased welfare level and, consequently, more goods consumption and services have increased waste generation (4). Due to the increased municipal waste generation, greater attention should be paid to its management, in

such a way that estimates have indicated waste generation will increase in Iran in the coming years (5).

Every Iranian citizen generates an average of 700-1000 g of waste per day, 70%, 29%, and 1% of which are food waste, recyclable dry waste, and hazardous waste, respectively (5,6). In other words, with 81 million people, Iran is the 18th most populous country in the world, which produces annually over 18 million tons of municipal solid waste (7).

Solid waste management, especially waste separation at the source in large cities is a key prerequisite for safe handling and disposal of wastes in the COVID-19



outbreak, which is influenced by various factors. Individuals' knowledge and attitude, incentives, and situational factors such as the existence of a place for waste storage are among the factors influencing waste recycling and segregation at the source (8-10). These factors could increase citizen participation in segregation plans. In developed countries, high public participation is reported to be among the reasons for their success (11). Not only focusing on public perceptions is necessary for increasing public participation, but also a proper waste management system is required for the successful implementation of programs. Thus, appropriate equipment and facilities, expert human resources, and proper policies should be used. The main challenges observed in the field of waste management are mostly of infrastructural type in developing countries, i.e., these countries could not provide equipment, human resources, and collection methods. The best programs and policies will not be efficient when there are no infrastructure facilities. Studies have implemented various programs to improve waste segregation, but these programs have failed due to the lack of a clear policy. The organization or program policies should be derived from problems and attempt to solve them (12). Unlike other waste management sectors, developing waste segregation plans at the source does not significantly depend on technology and economic problems. Increasing public participation is the only way to achieve this goal (13).

Participation could be defined as the role of citizens in the political and socioeconomic life of the country to achieve comprehensive goals. In other words, participation refers to the centralized actions taken by citizens to coordinate with the management system (14). Research on the people's knowledge, attitudes, and practices (KAP) regarding solid waste management programs is one of the best tools for evaluating public attitude and involvement toward waste management issues (15). Daryabeigi Zand et al have investigated the KAP of residents in Tehran City towards municipal solid waste management (MSWM) after the COVID-19 from August 2021 to March 2022 (7). According to the results, 64.9% and 56.6% of residents had adequate knowledge and attitude regarding MSW management during the COVID-19 pandemic, while 33.1% performed moderate practice. Vaezi Heir and Daryabeigi Zand conducted a study in District 5 in Tehran Municipality and found that about a quarter of the people's awareness of waste segregation methods at the source and waste reduction methods was at the moderate level and higher (16). Hajizadeh et al reported women's awareness, attitude, and performance related to household waste recycling plans were favorable, moderate, and poor, respectively (8). Gravand et al investigated housewives' awareness, attitude, and performance regarding waste recycling in Kouhdasht and reported that awareness of recycling was

low among three-quarters of women and attitude was at a moderate level among more than half of them. Therefore, citizens, especially housewives, should be informed about different waste disposal methods, so that this issue should be placed on the agenda of the responsible organizations (17). Bahrami et al investigated "knowledge and performance of Rafsanjan residents towards municipal solid waste management" and reported that residents' awareness of MSWM was low. Therefore, holding training courses, increasing general knowledge, and building culture in this field could improve awareness (18). Ebrahimi et al investigated Yazd residents' awareness and performance regarding MSWM in 2008 and reported that the residents had moderate to good awareness of waste recycling such as paper and cardboard, glass, metals, and plastic. Reducing waste production and disposal methods were not favorable. The citizens' awareness of diseases transmitted by waste and its effects was at a moderate to good level (19). Malakootian and Yaghmaean indicated the majority of people had sufficient information on municipal solid waste in Kerman (20). Social behaviors could be predicted by examining people's views and awareness in the community, evaluating households' opinions, and being aware of the current situation, and then, could be used for proper MSWM (19).

The present research investigated the KAP of Kerman residents on segregation and recycling of household solid wastes during COVID-19 period.

Materials and Methods

Study area and sample collection

This study was conducted in Kerman (Figure 1). Kerman, with an area of nearly 240 km², is a metropolis and the capital city of Kerman Province in the southeast of Iran. This city is located at 30° 28' N and 57° 02' E and is 1755 m above sea level. Kerman comprises 4 urban areas based on the SIB system and includes about 780 000 people. The amount of waste produced in Kerman in 2019 was 107 548 478 ton. Due to the COVID-19 outbreak in 2020, this value increased to 113 619 719 ton (21).

Determining sample size

The statistical population included 150 000 households living in Kerman. The sample size was calculated as Eq. (1):

$$n = \frac{\left(z_{1-\frac{\alpha}{2}} \sigma \right)^2}{d^2} \quad (1)$$

where n is the statistical sample size, Z and α are considered 0.95 and 0.05, respectively, σ is the attitude deviation (this variable is set to 0.57 based on the study of Zare et al in 2018), and d is the accuracy (0.1) (22).

The sample size was calculated as 385 individuals. The final sample size was considered 444 individuals considering a 15% withdrawal probability (Table 1). The

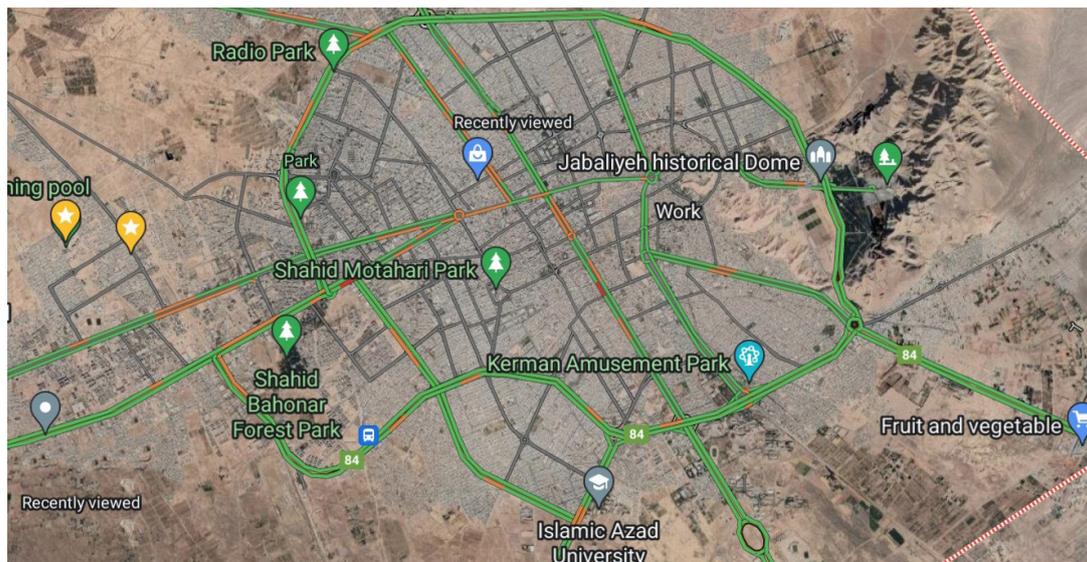


Figure 1. The study area of Kerman residents on KAP of separation and recycling of household solid wastes

Table 1. The sample size based on the population of each district

| District | District population based on the SIB system | Sample size |
|----------|---|-------------|
| 1 | 139.845 | 93 |
| 2 | 194.879 | 130 |
| 3 | 197.577 | 132 |
| 4 | 129.487 | 89 |
| Total | 661.788 | 444 |

stratified sampling method was used and the questionnaires were randomly completed by the household heads based on the residents' data registered in the SIB system in Kerman.

Materials and Methods

The data were collected using questionnaires, consisting of two parts: The first part included demographic data (age, gender, mean income, and household head's educational level) and the second part contained questionnaires related to the individuals' behavioral patterns in Kerman as follows:

1. Knowledge and awareness of waste
2. Attitude towards waste
3. Citizens' waste behavior
4. Environmental factors of waste disposal site

The questionnaire used in the study by Kalantari et al was employed with modifications in some items, the validity of which was confirmed (23). The validity of awareness and knowledge, attitude, environmental factors, and waste management behavior was obtained as 0.72, 0.75, 0.70, and 0.74, respectively. Based on a preliminary study on 25 individuals, the internal reliability of waste behavioral pattern questionnaires in Kerman was calculated using Cronbach's alpha (Table 2). As the Cronbach's alpha was greater than 0.7, the internal

Table 2. The reliability of the questionnaire dimensions

| Variable | Cronbach's alpha | Number of items in each dimension |
|-----------------------|------------------|-----------------------------------|
| Knowledge awareness | 0.86 | 12 |
| Attitude | 0.90 | 21 |
| Environmental factors | 0.87 | 8 |
| Behavior | 0.79 | 4 |

reliability of all the questionnaires was confirmed. The statistics showed the questionnaires had high reliability. The questionnaires were completed by the households in Kerman using stratified sampling method.

The "knowledge and awareness" and "attitude" questionnaires consisted of 12 and 21 items, respectively. The number of items of other variables, which included 12 items in total, was examined from several aspects. The items were rated based on a five-point Likert scale, ranging from completely agree to completely disagree. The minimum and maximum scores were 1 and 5, respectively. Hair scoring scale was used for better interpretation of the mean (24) (Table 3).

Data analysis

The data were analyzed using SPSS version 25.0. In the descriptive statistics section, mean and standard deviation were used to describe the quantitative variables, and number and percentage frequency were employed to describe the qualitative variables. In the inferential statistics section, Kruskal-Wallis, Mann-Whitney, ANOVA, and multivariate regression were used. The confidence level of 95% and significance level of 0.05 were considered.

Results

Determination of Kerman citizens' demographic data

The results of the distribution of demographic variables of Kerman citizens in 2022 showed most of the respondents were male (75.5%) and aged 31-40 years (40.9%). They earned 40 million IRR or higher income (62.2%), lived in District 3 and had a bachelor's degree (Table S1, for more information, see Supplementary file 1).

Distribution of studied variables

Table 4 presents the distribution of the investigated variables among Kerman citizens in 2022. The results of data analysis showed the mean and standard deviation of "awareness and knowledge", "attitude", "behavior" and "environmental factors" were " 2.53 ± 0.28 ", " 3.77 ± 0.37 ", " 4.21 ± 1.01 " and " 3.48 ± 0.52 ", respectively. The minimum, maximum, and median are presented in Table 4.

Evaluation of Kerman residents' knowledge and awareness of waste with an emphasis on household waste management during COVID-19 period considering demographic variables

As presented in Table 5, there was a significant correlation between the mean score of knowledge and awareness and income categories and educational level ($P < 0.05$). The highest mean score of awareness and knowledge was observed among individuals who earned 40 million IRR and higher (2.55 ± 0.24) and those who had a PhD degree (2.63 ± 0.27).

Evaluation of Kerman residents' attitude towards waste with an emphasis on household waste management during COVID-19 period considering demographic variables

As presented in Table 6, there was a statistically significant correlation between the mean score of attitude and district, income, educational level and gender ($P < 0.05$). The highest mean attitude was observed in District 2 (3.84 ± 0.36) among those who earned 40 million IRR and higher (3.83 ± 0.38), those with a PhD degree (3.89 ± 0.38), and women (3.82 ± 0.34).

Table 3. Hair scoring scale

| Low | Moderate | High |
|--------|-----------|-----------|
| 1-2.33 | 2.34-3.67 | 3.68-5.00 |

Table 4. Descriptive statistics of the investigated variables among Kerman citizens in 2022

| Variables | Mean | SD | Minimum | Maximum | Median |
|-------------------------|------|------|---------|---------|--------|
| Awareness and knowledge | 2.53 | 0.28 | 1.33 | 3.00 | 2.58 |
| Attitude | 3.77 | 0.37 | 2.67 | 4.86 | 3.76 |
| Behavior | 4.21 | 1.01 | 1.00 | 5.00 | 5.00 |
| Environmental factors | 3.48 | 0.52 | 1.75 | 4.88 | 3.50 |

Evaluation of Kerman residents' behaviors with an emphasis on household waste management during COVID-19 period considering demographic variables

As presented in Table 7, there was no significant correlation between behavior and other demographic variables ($P > 0.05$).

Evaluation of environmental factors influencing household waste management during COVID-19 period considering demographic variables

As presented in Table 8, there was no significant correlation between environmental factors (enough space to segregate waste at home, distance of segregated waste collection bases from people's homes, presence of recyclable waste collection bins, etc) and demographic variables ($P < 0.05$).

Determination of the impact of awareness and knowledge, attitude and environmental factors on Kerman residents' behaviors by controlling demographic variables with an emphasis on household waste management during COVID-19 period

The analysis results using multivariate regression (Table 9) showed a significant correlation between Kerman residents' awareness and knowledge and behavior. One unit increase in awareness, attitude and environmental factors' score increased the mean behavior score by 0.72, 0.32, and 0.21, respectively, by controlling demographic variables (Table 9) (for more information, see Table S2-S4 of Supplementary file 1).

Discussion

Based on the mean obtained for each variable (Table 4) and the Hier scoring scale (Table 3), awareness, knowledge, attitude, and environmental factors were at a moderate level and behavior was at a high level. It seems holding regular and continuous educational workshops for all ages could increase general knowledge and improve public participation in the recycling program. Moreover, incentive programs should be provided in the field of recycling to improve urban waste management and public performance. This approach could be used to increase Kerman residents' awareness and knowledge, attitude and behavior.

The comparison of the results of the present study with the results of other researchers showed some agreement and negative results. Several studies have indicated no significant correlation between gender, marital status and age (25), attitude, age, educational level and gender (26), age, gender, educational level, and waste segregation behavior (27).

Despite all the cons results, there are some studies, the results of which are consistent with the results of the present study. Specifically, the levels of awareness, attitude, and performance of women of Hassanabad city in

Table 5. The correlation between Kerman citizens' knowledge and awareness of household waste management income categories and educational level

| Variable | Mean±SD | P value | |
|-------------------|------------------------|-----------|-------|
| District | 1 | 0.20±2.58 | 0.06 |
| | 2 | 2.56±0.25 | |
| | 3 | 2.51±0.27 | |
| | 4 | 2.48±0.28 | |
| Age (year old) | 20-30 | 2.52±0.27 | 0.12 |
| | 31-40 | 2.53±0.26 | |
| | 41-50 | 2.58±0.23 | |
| | 51-60 | 2.53±0.23 | |
| | 61 and older | 2.46±0.29 | |
| | Less than 10 million | 2.37±0.37 | |
| Income (IRR) | 10-20 million | 2.43±0.27 | |
| | 20-30 million | 2.49±0.22 | |
| | 30-40 million | 2.55±0.28 | |
| | 40 million and higher | 2.55±0.24 | |
| Educational level | High school, no degree | 2.49±0.20 | 0.002 |
| | Diploma | 2.49±0.29 | |
| | Bachelor's degree | 2.54±0.23 | |
| Gender | Master's degree | 2.59±0.28 | 0.05 |
| | PhD and higher | 2.63±0.27 | |
| | Female | 2.57±0.24 | |
| | Male | 2.52±0.26 | |

Table 6. The correlation between Kerman citizens' attitude towards waste management and district, income, educational level, and gender

| Variable | Mean±SD | P value | |
|-------------------|------------------------|------------|---------|
| District | 1 | 3.77±0.43 | <0.0001 |
| | 2 | 3.84±0.36 | |
| | 3 | 3.77±0.34 | |
| | 4 | 3.66±0.36 | |
| Age (y) | 20-30 | 3.76±0.34 | 0.15 |
| | 31-40 | 3.78±0.37 | |
| | 41-50 | 3.82±0.839 | |
| | 51-60 | 3.77±0.38 | |
| | 61 and older | 3.65±0.37 | |
| | Less than 10 million | 3.68±0.50 | |
| Income (IRR) | 10-20 million | 3.65±0.38 | |
| | 20-30 million | 3.63±0.26 | |
| | 30-40 million | 3.72±0.35 | |
| | 40 million and higher | 3.83±0.38 | |
| Educational level | High school, no degree | 3.67±0.34 | <0.0001 |
| | Diploma | 3.66±0.40 | |
| | Bachelor's degree | 3.82±0.35 | |
| Gender | Master's degree | 3.85±0.37 | 0.04 |
| | PhD and higher | 3.89±0.38 | |
| | Female | 3.82±0.34 | |
| | Male | 3.75±0.38 | |

Table 7. The correlation between Kerman citizens' behaviors toward waste management and demographic variables

| Variable | Mean±SD | P value | |
|-------------------|------------------------|-----------|------|
| District | 1 | 4.22±0.88 | 0.16 |
| | 2 | 4.26±0.92 | |
| | 3 | 4.07±1.02 | |
| | 4 | 3.92±1.1 | |
| Age (year old) | 20-30 | 4.05±1.02 | 0.75 |
| | 31-40 | 4.1±1.04 | |
| | 41-50 | 4.2±0.91 | |
| | 51-60 | 4.2±0.90 | |
| | 61 and older | 3.9±1.1 | |
| | Less than 10 million | 4.21±1.1 | |
| Income (IRR) | 10-20 million | 4.4±0.99 | |
| | 20-30 million | 4.05±1.06 | |
| | 30-40 million | 4.15±0.95 | |
| | 40 million and higher | 4.1±1.00 | |
| Educational level | High school, no degree | 4.24±1.01 | 0.57 |
| | Diploma | 4.06±1.05 | |
| | Bachelor's degree | 4.08±1.03 | |
| Gender | Master's degree | 4.22±0.74 | 0.51 |
| | PhD and higher | 4.38±0.86 | |
| | Female | 4.11±0.95 | |
| | Male | 4.14±1.01 | |

Table 8. The correlation between environmental factors influencing waste management during COVID-19 period in 2022 and demographic variables

| Variable | Mean±SD | P value | |
|-------------------|------------------------|------------|------|
| District | 1 | 3.40±0.53 | 0.05 |
| | 2 | 3.49±0.50 | |
| | 3 | 3.58±0.51 | |
| | 4 | 3.42±0.55 | |
| Age (year old) | 20-30 | 3.41±0.57 | 0.26 |
| | 31-40 | 3.54±0.53 | |
| | 41-50 | 3.44±0.53 | |
| | 51-60 | 3.50±0.47 | |
| | 61 and older | 3.42±0.451 | |
| | Less than 10 million | 3.39±0.43 | |
| Income (IRR) | 10-20 million | 3.32±0.56 | |
| | 20-30 million | 3.55±0.56 | |
| | 30-40 million | 3.42±0.55 | |
| | 40 million and higher | 3.51±0.51 | |
| Educational level | High school, no degree | 3.32±0.63 | 0.21 |
| | Diploma | 3.49±0.51 | |
| | Bachelor's degree | 3.52±0.53 | |
| Gender | Master's degree | 3.52±0.45 | 0.37 |
| | PhD and higher | 3.38±0.45 | |
| | Female | 3.45±0.52 | |
| | Male | 3.49±0.52 | |

Table 9. Impact of awareness and knowledge, attitude, and environmental factors on Kerman residents' behaviors with an emphasis on household waste management

| Variable | Regression coefficient | 95% Confidence interval | P value |
|-------------------------|------------------------|-------------------------|---------|
| Awareness and knowledge | 0.72 | 0.37-1.07 | <0.0001 |
| Attitude | 0.32 | 0.07-0.56 | 0.01 |
| Environmental factors | 0.21 | 0.04-0.38 | 0.01 |

Isfahan province showed a significant correlation between socio-demographic factors such as age, educational level and household size and individuals' awareness, attitude and performance (8), a significant correlation between residents' knowledge and awareness and gender, educational level and occupation of Tabriz residents (28), between individuals' awareness and age and educational level in Qom (26), between age and awareness of waste segregation and recycling in Iskandar, Malaysia, so that performance was better at older ages (29).

Vicente and Reis examined factors influencing household participation in recycling in Northern European countries and investigated people's participation and awareness of segregation at the source in waste management. The results showed that the people's knowledge of waste management was unfavorable. People received training at a poor or very poor level. Moreover, income level, educational level, age, and getting information about waste segregation plans at the source had a significant effect on the people's participation in waste collection (30).

It seems the reasons for the failure and success of waste separation can be awareness, knowledge and educational level (26,27,31,32), teaching (31), identification of the importance of waste separation through public media (33), and economic aspect of recycling and proximity of recycling centers to the citizens (26), which has a direct and positive correlation between waste segregation education and knowledge and waste separation behavior (Table 9). In general, the results empirically confirmed the effect of education on citizens' waste segregation behavior and highlighted the necessity of paying attention to other sociocultural factors. Education, especially at low levels, could complement the awareness process and inform citizens. Determining some spots as recycling stations in urban areas and installing recycling containers with suitable distances and desirable appearance could maximize public participation.

Also, the lack of awareness and knowledge can be the most important barriers to citizens' behaviors in waste management (33-35).

No study has ever identified the environmental factors of waste disposal sites with an emphasis on household waste management during COVID-19 period considering demographic variables (Table 8). The results showed the citizens' individual characteristics were effective in their participation in the waste management process. Education

is among the important factors increasing the public awareness level. Environmental education is considered important for reducing waste generation as well as waste segregation and proper recycling. The most important reasons for citizen participation were the appropriate quality of recycled products as a result of source segregation, environmental protection, promoting health, and helping municipalities. The important reasons for the failure of this program from the citizens' viewpoints were failure to implement or irregularly implementing the programs by the municipality, insufficient training of citizens, and poor cooperation of people due to sociocultural issues or lack of economic justification. A high percentage of citizens were familiar with the source urban waste segregation plan and its benefits, so that corrections by the municipal authorities could favorably increase citizen participation and cooperation in this plan (5).

Padilla and Trujillo conducted a study, entitled "waste disposal and household heterogeneity: identifying factors shaping attitudes towards source-separated recycling in Bogotá", and showed the households' attitude towards waste segregation was a vital component in waste management. Moreover, households with a higher socioeconomic level had a greater desire to separate solid waste. In households with a low socioeconomic level, the attitude towards waste segregation was influenced by the access to the Internet, the household head's educational level, residential house ownership and membership in environmental protection organizations (36).

No study has ever examined the effect of environmental factors on Kerman residents' behaviors by controlling demographic variables with an emphasis on household waste management during COVID-19 period. The obtained results showed citizens had a critical role in the success of the urban waste management approach. In general, three factors, including individual characteristics, participation intention, and possibility of participation could contribute, and factors such as responsibility, training and citizens' motivation, advertising, conditions and facilities, and laws and regulations could influence public participation. Economic incentives such as buying recycled materials or waiving waste fees for households that recycle regularly could play a significant role in motivating citizens to participate.

The obtained results highlighted the correlation between education, employment, gender, and age of respondents with KAP levels on MSWM ($P < 0.05$). The training was found to be an important tool to enhance residents' awareness and attitude, but strict MSW legislation must also be implemented to restart appropriate separation, recycling, and composting programs during the pandemic (7).

Nowadays, most of the urban management experts believe centralized urban management has failed and is unsuccessful without citizen participation. Therefore,

attracting citizen participation is among the main concerns of modern urban management. Cost reduction, project sustainability, project design improvement, ensuring the success of programs, increasing project acceptability, obtaining necessary information on the spot, properly evaluating causes and needs, choosing suitable options considering people's conditions and needs as well as increasing efficiency and productivity are among the other positive consequences of citizen participation (37). Evidence has shown people, as waste producers, play the main role in implementing waste segregation plans at the source, so that this procedure is not successful without their participation. Given that public participation in urban management is influenced by several factors including individual (age, gender, and marital status), contextual (education, place of birth, history of residence and ownership), and social (satisfaction, trust, awareness, attitude, environmental performance, etc).

Conclusion

It seems that there are no written laws for the optimal implementation of waste management programs at the source for Kerman residents during COVID-19 period. Other barriers include problems in the waste collection system, failure to inform and educate the citizens sufficiently, lack of an integrated urban management system, weakness in developing waste segregation policies at the source, low social participation of citizens, unbalanced resources, and weak private sector performance. Education and improving knowledge alone could not lead to waste segregation and should be investigated along with other factors affecting waste segregation behavior.

Therefore, it is expected that our results could improve Kerman residents' behavioral patterns with an emphasis on household waste management during COVID-19 period in 2022. Planners should explain environmental issues of waste to households and how to correctly separate recyclable waste, provide correct information regarding the current (COVID-19 period) and future planning and policies of waste management organizations, and create suitable motivational mechanisms in households to increase waste segregation. The media and necessary facilities should be used to educate and motivate Kerman residents to participate in waste segregation and improve household waste management during COVID-19.

Acknowledgments

This paper was taken from a Master's thesis and supported by the Vice-Chancellor for Research and Technology of Kerman University of Medical Sciences as a research project with No. 400001163. The authors would like to thank the Vice-Chancellor for Research and Technology

for their support and cooperation.

Authors' contribution

Conceptualization: Ramin Moradi.

Data curation: Ramin Moradi.

Formal analysis: Moghadameh Mirzaei.

Funding acquisition: No funding.

Investigation: Ramin Moradi, Hoda Amiri, Majid Hashemi.

Methodology: Ramin Moradi, Abedin Iranpour.

Project administration: Hoda Amiri.

Resources: Hoda Amiri, Majid Hashemi.

Software: Moghadameh Mirzaei.

Supervision: Hoda Amiri.

Validation: Ramin Moradi.

Visualization: Ramin Moradi.

Writing—original draft: Ramin Moradi.

Writing—review & editing: Hoda Amiri, Majid Hashemi, Moghadameh Mirzaei, Abedin Iranpour, Ramin Moradi.

Competing interests

The authors declare that they have no competing interests.

Ethical issues

The authors certify that all data collected during the study are presented in this manuscript (Ethical code: IR.KMU.REC.1400.713), and no data from the study has been or will be published elsewhere separately

Supplementary files

Supplementary file contains Table S1-S4.

References

1. Hamzeh Kalkenari H, Ghorbani M, Alipouryan F, Kaseb A, Hatiteh S. Investigating the behavioral patterns of households regarding waste separation at source: a case study in Mashhad. *J Nat Environ*. 2015;68(1):31-44. doi: [10.22059/jne.2015.53940](https://doi.org/10.22059/jne.2015.53940). [Persian].
2. Naddafi K, Nabizadeh R, Silva-Martínez S, Shahtaheri SJ, Yaghmaeian K, Badiei A, et al. Modeling of chlorpyrifos degradation by TiO₂ photo catalysis under visible light using response surface methodology. *Desalin Water Treat*. 2018;106:220-5. doi: [10.5004/dwt.2018.22063](https://doi.org/10.5004/dwt.2018.22063).
3. Naddafi K, Silva-Martínez S, Nabizadeh R, Yaghmaeian K, Shahtaheri SJ, Amiri H. Chlorpyrifos remediation in agriculture runoff with homogeneous solar photo-Fenton reaction at near neutral pH: phytotoxicity assessment. *Water Sci Technol*. 2021;83(1):212-22. doi: [10.2166/wst.2020.556](https://doi.org/10.2166/wst.2020.556).
4. Karimi J, Sadeghi M, Fadaie E, Mehdinejad MH. The effect of intervention through both face to face training and educational pamphlets on separation and recycling of solid waste in the Kalaleh city. *Iran J Health Environ*. 2015;8(3):275-84. [Persian].
5. Fahiminia M, Farzadkia M, Nazari S, Arsang Jang S, Alizadeh Matboo S, Ibrahim A, et al. Evaluation of the status of citizen participation in municipal waste source separation plan and offering corrective strategies. *J Qom*

- Univ Med Sci. 2013;7(5):66-72. [Persian].
6. Qureshi M. The comprehensive plan of paper waste management. *Environmental Studies, Natural Resources And Sustainable Development*. 2019;10:47-56.
 7. Daryabeigi Zand A, Vaezi Heir A, Khodaei H. A survey of Knowledge, attitudes, and practices of Tehran residents regarding solid waste management in the COVID-19 era. *J Hazard Mater Adv*. 2022;8:100203. doi: [10.1016/j.hazadv.2022.100203](https://doi.org/10.1016/j.hazadv.2022.100203).
 8. Hajizadeh Y, Kiani Feizabadi G, Rezaee A, Sadeghi Hasanabadi A, Fadaei S, Darvish Motavali M, et al. Knowledge, attitude, and performance of contributors to the waste recycling program in Hassanabad city, Iran in 2017. *J Health Syst Res*. 2019;15(1):8-16. doi: [10.48305/hsr.2019.15.1.109](https://doi.org/10.48305/hsr.2019.15.1.109). [Persian].
 9. Firouzi M, Ehteshamzadeh M, Saba F, Khayati GR. Effect of mineral nanoparticles obtained from thermal spring water on COVID-19. *Environ Health Eng Manag*. 2023;10(1):33-9. doi: [10.34172/ehem.2023.04](https://doi.org/10.34172/ehem.2023.04).
 10. Samandari M, Movahedian Attar H, Ebrahimpour K, Mohammadi F, Ghodsi S. Measurement of ampicillin and penicillin G antibiotics in wastewater treatment plants during the COVID-19 pandemic: a case study in Isfahan. *Environ Health Eng Manag*. 2022;9(3):201-11. doi: [10.34172/ehem.2022.21](https://doi.org/10.34172/ehem.2022.21).
 11. Hosseini SH, Ebrahimi AA, Dehghani Tafti A, Morowati Sharifabad MA. Citizen participation in urban waste separation from origin and its barriers (case study: city of Babol). *Toloee Behdasht*. 2021;19(6):15-32. [Persian].
 12. Babazadeh T, Mosaferi M. Optimizing the Household Solid Wastes Separation Plan at Source in Tabriz: An Advocacy-based Intervention [dissertation]. Tabriz University of Medical Sciences; 2018.
 13. Mosaferi M, Gilani N, Delfi S, Ahmadpour R, Kumar Chattu V. Psychometric development and practical use of questionnaires designed to assess knowledge, attitude, and practice of women regarding the use of sanitizer at home to control coronavirus disease. *Environ Health Eng Manag*. 2022;9(1):55-64. doi: [10.34172/ehem.2022.07](https://doi.org/10.34172/ehem.2022.07).
 14. Khaje Shahkoochi DA, Khosh Far G, Negari A. Evaluation of citizen participation scale in household waste management, (case study: city of Mashhad). *Geography and Territorial Spatial Arrangement*. 2015;5(15):215-32. [Persian].
 15. Gaiani S, Caldeira S, Adorno V, Segrè A, Vittuari M. Food wasters: profiling consumers' attitude to waste food in Italy. *Waste Manag*. 2018;72:17-24. doi: [10.1016/j.wasman.2017.11.012](https://doi.org/10.1016/j.wasman.2017.11.012).
 16. Vaezi Heir A, Daryabeigi Zand A. Investigating the Awareness, Attitude and Performance of Citizens Towards Segregation at the Source of Household Waste (Case Study: District 5 of Tehran Municipality). Tehran: The 10th National Conference on Environment, Energy and Sustainable Natural Resources; 2020.
 17. Gravand A, Zamani-Alavijeh F, Hassanzadeh A, Pourzamani H. The survey of knowledge, attitude, and performance among housewives of Kouhdasht city, Iran, about solid waste recycling in 2019. *J Health Syst Res*. 2020;16(3):187-92. doi: [10.22122/jhsr.v16i3.3811](https://doi.org/10.22122/jhsr.v16i3.3811). [Persian].
 18. Bahrami M, Karami M, Shorgashti S, Tahmasbizadeh M. The knowledge and performance of Rafsanjan residents toward municipal solid wastes management in 2017: a short report. *J Rafsanjan Univ Med Sci*. 2017;16(6):571-80. [Persian].
 19. Ebrahimi A, Ehrampoosh MH, Samaei MR, Shahsavani E, Afra Y, Abotorabi M. Survey of knowledge and practice of Yazd people regarding municipal solid waste management in 2008. *Toloee Behdasht*. 2011;9(4):80-9. [Persian].
 20. Malakootian M, Yaghmaean K. Evaluation of the knowledge, attitude and practice of residents of the city of Kerman to the municipal solid wastes management. *Journal of School of Public Health and Institute of Public Health Research*. 2004;2(4):27-38. [Persian].
 21. <https://bazyaft.kerman.ir>
 22. Zare B, Nosrati F, Karimi R. Socio-cultural determinants of citizenship participation: the case of wastes separation in Tehran city. *Sociology of Social Institutions*. 2018;5(11):39-61. [Persian].
 23. Kalantari A, Salehi S, Aghaei AB. Study of the effects of environmental values on household's waste behavior (case study of Tehran). *Quarterly Journal of Social Studies and Research in Iran*. 2016; 22;5(3):369-85. doi: [10.22059/jjsr.2016.60084](https://doi.org/10.22059/jjsr.2016.60084).
 24. Hair JF Jr, Black WC, Babin BJ, Anderson RE. *Multivariate Data Analysis*. New Jersey: Prentice Hall; 2009.
 25. Gharajelou F, Khosravi Y, Pari Zanganeh A, Zamani A. A survey on the status of municipal waste source separation in Zanjan city. *Human & Environment*. 2022;20(1):77-92. [Persian].
 26. Ghafouri Y, Tabraei Y. Investigating the Level of Awareness and Attitude of Qom Urban Households to Increase Participation in Recycling from the Source of Urban Waste in the Plan to Investigate the Model of Urban Waste Recycling in Qom. The 8th National Environmental Health Conference; 2005. [Persian].
 27. Salehi S, Bokharaei A, Ahmadi J. The role of training citizens in domestic waste management (case study: the region 8 of Tehran municipality). *Environ Sci*. 2016;13(4):43-52. [Persian].
 28. Shaker khatibi M, Khalili Naji F, Safaeian A, Azari A. Investigating the State of Segregation in the Origin of Household Waste and its Relationship with the Awareness, Attitude and Performance of the Residents of Tabriz City. Tabriz, Iran: The 16th National Environmental Health Conference; 2013. [Persian].
 29. Akil AM, Foziah J, Ho CS. The effects of socio-economic influences on households recycling behaviour in Iskandar Malaysia. *Procedia Soc Behav Sci*. 2015;202:124-34. doi: [10.1016/j.sbspro.2015.08.215](https://doi.org/10.1016/j.sbspro.2015.08.215).
 30. Vicente P, Reis E. Factors influencing households' participation in recycling. *Waste Manag Res*. 2008;26(2):140-6. doi: [10.1177/0734242x07077371](https://doi.org/10.1177/0734242x07077371).
 31. Haider A, Amber A, Ammara S, Mahrukh KS, Aisha B. Knowledge, perception and attitude of common people towards solid waste management-a case study of Lahore, Pakistan. *Int Res J Environ Sci*. 2015;4(3):100-7.
 32. Jones N, Halvadakis CP, Sophoulis CM. Social capital and household solid waste management policies: a case study in Mytilene, Greece. *Env Polit*. 2011;20(2):264-83. doi: [10.1080/09644016.2011.551032](https://doi.org/10.1080/09644016.2011.551032).

33. Zeng C, Li H, Xia F, Niu D, Zhao Y. Source-separated collection of rural solid waste in China. In: Maletz R, Dornack C, Ziyang L, eds. *Source Separation and Recycling: Implementation and Benefits for a Circular Economy*. Cham: Springer; 2018. p. 151-74. doi: [10.1007/698_2017_30](https://doi.org/10.1007/698_2017_30).
34. Adogu PO, Uwakwe KA, Egenti NB, Okwuoha AP, Nkwocha IB. Assessment of waste management practices among residents of Owerri Municipal Imo State Nigeria. *J Environ Prot*. 2015;6(5):446-56. doi: [10.4236/jep.2015.65043](https://doi.org/10.4236/jep.2015.65043).
35. Strydom WF. Barriers to household waste recycling: empirical evidence from South Africa. *Recycling*. 2018;3(3):41. doi: [10.3390/recycling3030041](https://doi.org/10.3390/recycling3030041).
36. Padilla AJ, Trujillo JC. Waste disposal and households' heterogeneity. Identifying factors shaping attitudes towards source-separated recycling in Bogotá, Colombia. *Waste Manag*. 2018;74:16-33. doi: [10.1016/j.wasman.2017.11.052](https://doi.org/10.1016/j.wasman.2017.11.052).
37. Ballesteros E. Compromise programming: a utility-based linear-quadratic composite metric from the trade-off between achievement and balanced (non-corner) solutions. *Eur J Oper Res*. 2007;182(3):1369-82. doi: [10.1016/j.ejor.2006.09.049](https://doi.org/10.1016/j.ejor.2006.09.049).