

Perceptions towards environmental and human health risks associated with feeding urban pigeons

Ali Alshehri¹, Hatim Matoon Badri¹, Wahaj A. Khan² and Mohamed Elamin³

¹*Department of Environmental Health, College of Public Health and Health Informatics, Umm Al-Qura University, Makkah, Saudi Arabia*

²*Department of Occupational Health, College of Public Health and Health Informatics, Umm Al-Qura University, Saudi Arabia*

³*Department of Health Education and Promotion, College of Public Health and Health Informatics, Umm Al-Qura University, Saudi Arabia*

(Received 22 February, 2023; Accepted 8 April, 2023)

ABSTRACT

The presence of urban pigeons around human populations can have negative impacts on the environment and human health. Their presence in urban areas is exacerbated by people who provide them with food, water, and shelter. This study aimed to examine people's perceptions towards the environmental and human health risks associated with feeding urban pigeons in an attempt to understand actions related to increasing the number of pigeons in urban areas. People's perceptions were examined in responses to a Twitter feed that trended recently and was related to the topic under study. Six different themes were identified in the responses and used to classify the data under the umbrellas of agreement or disagreement which are; health, environment, religious/humane aspects, financial/materialistic benefits and/or drawbacks, nuisance and/or comfort, and recommendations and/or solutions. It was found that the responses of the majority (49 %) of those who agreed were found to be themed around nuisance. Other responses were found to be themed around financial/materialistic damage (26 %), recommendations/solutions (25 %) environmental damage (18 %), human health risks (17 %), and religious/humane points of view (14 %). The responses of the majority (69 %) of those who disagreed were found to be themed around religious/humane points of view. Other responses were found to be themed around recommendations/solutions (16 %), environmental benefits (8 %), comfort (2 %), human health benefits (2 %), and financial/materialistic benefits (1 %). More work is required to quantify the extent of negative effects caused by the presence of urban pigeons. The results show the complexity of human perceptions; people perceived things and interpreted things differently. Nevertheless, even if urban pigeons had a positive impact on human health and the environment, the scientific literature shows that their impacts are far worse. Therefore, action is needed to minimise the effects currently present.

Key words: Environmental health, Health, Urban pigeons, Public health

Introduction

The Rock Dove (*Columba Livia*), also known now as urban/feral pigeons, was not originally present

around human populations but mainly present in coastal and inland cliffs of central and western Palearctic and in the northern Ethiopian regions, as well as in those of the Indian subcontinent (Brand *et al.*,

¹Assistant Prof. (PhD), ²Assistant Prof. (PhD), ³Assistant Prof. (PhD)

2003; Goodwin, 1977). Their presence around human populations was a result of extensive genetic selection that led to a change in their characteristics that was guided by their use by humans (Giunchi *et al.*, 2012; Daniel Haag-Wackernagel, 1995). They became the first birds to be domesticated by humans. Post-domestication, they became feral like any other domesticated animal has done so in the past. It has been previously reported that the availability of food and habitat are the main reasons that attract feral pigeons to towns and cities across the world (Daniel Haag-Wackernagel, 1995). Their presence in urban environments and daily interactions with humans can be perceived differently depending on factors like a person's cultural background and level of education for example. Some might consider them harmless and have positive effects on the environment and human health while others consider them as harmful pests (Jerolmack, 2008; Johnston and Janiga, 1995). The latter point of view does seem more likely as feral pigeons have certain characteristics that allow for their classification as pests. They are granivores, they have a high mortality and reproductive rate, and they have colonial habits and group foraging (Giunchi *et al.*, 2012; Johnston and Janiga, 1995). Current evidence suggests that the presence of pigeons in urban areas causes negative effects on the environment and human health. This includes disturbing the natural environmental balance, public nuisance, the transmission of infectious diseases, and infrastructural damage and financial losses amongst others (Brand Phillips *et al.*, 2003; Giunchi *et al.*, 2012; HaagWackernagel, 2005; Johnston and Janiga, 1995; Nghiem *et al.*, 2013; Senar *et al.*, 2017). Therefore, action is needed to reduce their numbers in urban areas. Unfortunately, certain individuals contribute to exacerbating the issue by providing food, water, and shelter to pigeons. Of course, their actions are based on their perception of the benefits of the presence of urban pigeons.

Given the importance of the issue, this study aimed to examine people's perceptions towards the environmental and health risks associated with feeding urban pigeons in Saudi Arabia. The topic trended on Twitter, which is a popular platform for sharing opinions in the kingdom, with people arguing about the negative and positive impacts of feeding urban pigeons and their presence around human populations. The analysis of people's responses will enhance our understanding of their perceptions and how to change them in order to mitigate the nega-

tive impacts associated with the presence of urban pigeons.

Methods

Data on people's perceptions towards the environmental and health risks of feeding urban pigeons was collected via Twitter. Some social media sites, such as Twitter, allow users to share a less restricted view of their insights, ideas, experiences, beliefs, and opinions about any subjects, events, or issues (Almosa, 2021; Chen *et al.*, 2014). Therefore, unlike traditional collection methods (i.e. questionnaires and interviews), which could have an effect and/or might influence participants' responses, this enabled capturing raw, unfiltered, and uninfluenced thoughts regarding the topic under study.

Data collection

The data were collected manually when the issue under study started appearing on Twitter. As found in several Twitter accounts by searching certain keywords and hashtags, the topic received more than 3000 interactions, including 1000 re-tweets, 500 replies, and over 1500 likes. Data were also manually cleaned to avoid bots, spam, and ads and only meaningful tweets were used for the analysis.

Data analysis

A qualitative (content and thematic) analysis was necessary for closely examining the user-generated content. Upon examining the content, users were found to be either in agreement or disagreement over the environmental and health risks associated with feeding urban pigeons. Also, six different themes were identified in the responses and used to classify the data under the umbrellas of agreement or disagreement which are; health, environment, religious/humane aspects, financial/materialistic benefits and/or drawbacks, nuisance and/or comfort, and recommendations and/or solutions. Some user responses were found to revolve around one theme while others were around two or more. The data were also analysed quantitatively in terms of quantifying basic information like the number of users, based on their response, that either agreed or disagreed on the environmental and health risks associated with feeding urban pigeons in general or under one or of the aforementioned themes in particular.

Results and Discussion

In general, peoples' responses towards the environmental and human health issues associated with feeding urban pigeons have received more than 1,500 likes, which can be interpreted as an agreement with the content of the main tweets. With regard to the replays under the main tweets, 299 individuals replayed with written text expressing their perspectives on the subject. The analysis of data showed that 210 (70%) of replays agreed that feeding urban pigeons is considered to be associated with negative outcomes for human health and/or the environment while 89 (30 %) of replays disagreed and they do not consider feeding urban pigeons as an environmental and human health issue (Figure 1).

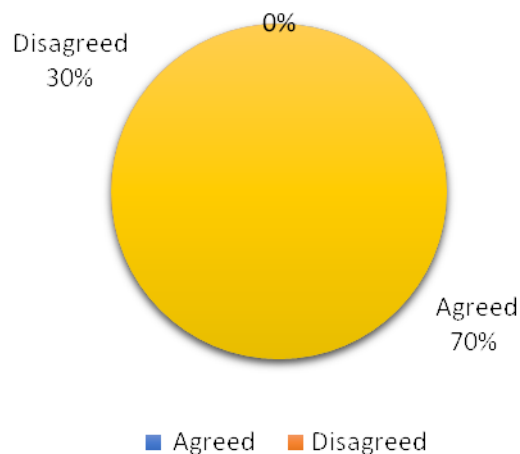


Fig. 1. Total replays (agreement and disagreement) on the subject that feeding urban pigeons is associated with negative impacts on human health and/or the environment.

The responses of the majority (103) of those who agreed were found to be themed around nuisance. Other responses were found to be themed around financial/materialistic damage (55), recommendations/solutions (53) environmental damage (38), human health risks (35), and religious/humane points of view (30).

The responses of the majority (61) of those who disagreed were found to be themed around religious/humane points of view. Other responses were found to be themed around recommendations/solutions (14), environmental benefits (8), comfort (4), humanhealth benefits (2), and financial/materialistic benefits (1).

Health

With regards to the presence of human health risks associated with feeding urban pigeons, 17 % of users agreed and expressed concern over the issue. Many of the responses revolved around the spread of bugs and flies that are associated with feeding urban pigeons and how that might harm human health.

"In Makkah, it's becoming extremely harmful. It ruined homes and is essentially associated with the spread of bugs. What's extremely annoying and frustrating is that some people consider what they are doing as good deeds. If you want to do good deeds, do that in your own home!"

"Honestly, they (pigeons) are becoming extremely annoying, and they bring these little flies with them which as I heard live in their feather".

"Annoyance – disgusting bird droppings and what results from their presence from bugs and lice".

"The issue lies in the uncivilised view of feeding them on the sidewalk and what that causes from diseases and the spread of insects".

Moreover, some users described their presence as endemic. They mentioned their possible harmful effect on those who suffer from allergies and asthma. One more felt that urban pigeons could be a source of bird flu (H5N1 virus).

"I believe that it became an endemic, and it needs to be dealt with as any other endemic".

"Other than being a nuisance, they might cause harm to those with allergies and asthma".

"Pigeons are probably a source for bird flu".

Around 2 % of users disagreed over the presence of human health risks associated with feeding urban pigeons and argued that there are human health benefits that could result from their presence. One user argued that they could be a source of food; that eating them is beneficial, especially for those over 40 years of age. Another user mentioned their ability to kill harmful insects.

"A meal that is rich with great benefits, especially for those over 40".

"Protect your house without harming the pigeons, they are very beneficial in killing harmful insects".

Environment

Around 18 % of users agreed that feeding urban pigeons could have a negative impact on the environment. The responses revolved around disrupting the natural balance of pigeons' lives by making them

more reliant on humans for food rather than on their own. Also, feeding urban pigeons led to a massive increase in their populations.

"They shouldn't be fed, let them be and they'll depend on themselves and hence, their number will decrease".

"Correct, feeding birds was exaggerated and became harmful. Birds don't need this; they can provide for themselves".

Around 8 % of users disagreed that urban pigeons could have a negative impact on the environment. On the contrary, they felt their presence is beneficial for the environment. Some users felt their presence brings environmental balance in general.

"Pigeons are a blessing and an environmental balance. Even the presence of dogs and cats in the streets brings environmental balance".

Other users mentioned how the presence of urban pigeons is good in terms of recycling (i.e. giving leftover food to pigeons instead of disposing it) and in terms of its droppings being a very rich natural fertiliser.

"We always place leftover bread and rice for the pigeons and birds to eat instead of throwing that in the trash".

"Pigeons clean and eat leftover food and bugs. It is beneficial and not harmful".

"Their droppings are considered to be some of the best fertilisers".

"On the contrary, our palm trees bore fruit after they were surrounded with pigeon droppings. What people don't know is that their droppings are a natural fertiliser".

Religious/humane aspects

With regards to religious and/or humane points of view towards feeding urban pigeons, 14 % of users agreed that feeding urban pigeons brings harm by causing negative human and environmental outcomes and is hence religiously impermissible in Islam.

"The problem lies in misunderstanding what a good deed is, some think that he is being kind to these birds and that he is religiously rewarded for it while in fact, he is actually harming his fellow brothers in Islam with his act".

"They are exhausting (i.e. people who place food for pigeons), Saudis and non-Saudis all place food on the sidewalk. They are stubborn and don't appreciate advice from others. I always tell them, if they want religious reward, place the food in some place far from others. Their

good deeds are not accepted due to them harming their neighbours".

The majority (69 %) of those who disagreed over the environmental and health risks associated with feeding urban pigeons had religious and/or humane points of view. Some considered it inhumane to let them starve without food, water, and/or shelter while others considered it to be religiously rewarding to feed them.

"This country has no trees and no place for those fragile creators to nest in".

"There is a reward for serving any animate, temperatures are close to 50 degrees (Celsius)... I ask Allah not to curse me for being heartless".

"All important issues in society were left undiscussed, and they talk about pigeons while our Prophet in Islam says There is a reward for serving any animate".

"It is weird how some people think, so should let these animals die out of hunger. This is extremely provocative; they want to deny us rewarding deeds".

"These people are amazing, Allah commands us to be merciful towards animals and you people want to get rid of them".

Financial/materialistic benefits and/or drawbacks

Around 26 % of users expressed their frustration from the financial losses and/or materialistic damages that they've experienced because of the presence of urban pigeons due to feeding them. Users reported being financially affected by high bills and regular repairs needed due to pigeons' nests, feathers, and/or droppings blocking things like air-conditioning systems, drainage pipes, and windows. Also, users complained about pigeon droppings regularly damaging the paint in homes and cars.

"The presence of pigeons leads to the waste of time, water, electricity, and money. They damage homes and block drainage pipes with droppings and feathers which along with dust makes it a very hard mixture to clean. If left uncleaned, it ends up causing leaks and damaging the building".

"Pigeons cause air-conditioning issues whether due to its droppings or feathers that block the system and result in increases in electricity consumption".

"Their droppings ruined the paint job in my car, the droppings are hard to clean and if cleaned they still leave marks on the car. I ended up selling my car and buying another just for that reason".

Only 1 % of users disagreed on pigeons cause financial losses and/or materialistic damages. A user described having pigeons could result in being a source of income for people selling their food.

“What about those that benefit from selling their food? What should they do when they have no other source of income? If we deny them their only source of income, this could result in an increase in the crime rate”.

Nuisance and/or comfort

The majority (49 %) of those who agreed over the environmental and human health issues associated with feeding urban pigeons focused on nuisance. Users described the presence of pigeons as annoying, disturbing, and disgusting for many reasons including their sounds, increased numbers, and vile smell.

“It’s really causing great harm; the sidewalk is unbearable due to the smells it is becoming utterly disgusting”.

“I swear to god this is absolutely true, it is becoming an agony. Anywhere they are fed they settle down and increase in number and the result is a bad odour in the house, the entrance, and inside the car”.

“Continuous agony and suffering with this issue!”.

“I swear to god they are extremely annoying!”.

“Their increased numbers are becoming disturbing for pedestrians”.

Only 2 % of users reported that the presence of pigeons brings joy and comfort.

“I intentionally place food and water for them so that come more often to the house; their presence is nice, and it brings me joy”.

“As a visitor to Makkah, I feel joy when I see pigeons”.

Recommendations and/or solutions

Around 25 % of users who agreed that feeding urban pigeons could be associated with negative environmental and/or human health effects provided recommendations and/or solutions on how to deal with the issue. Also, 16 % of users who disagreed that feeding urban pigeons could be associated with negative environmental and/or human health effects provided recommendations and/or solutions on how to deal with the issue as well.

“The best solution is to penalise those who own/ feeds pigeons within neighbourhoods financially”.

“For those who can; install spiked fences on top walls and inside windows. For those who can’t, clap your hands and whistle and they’ll fly away...”.

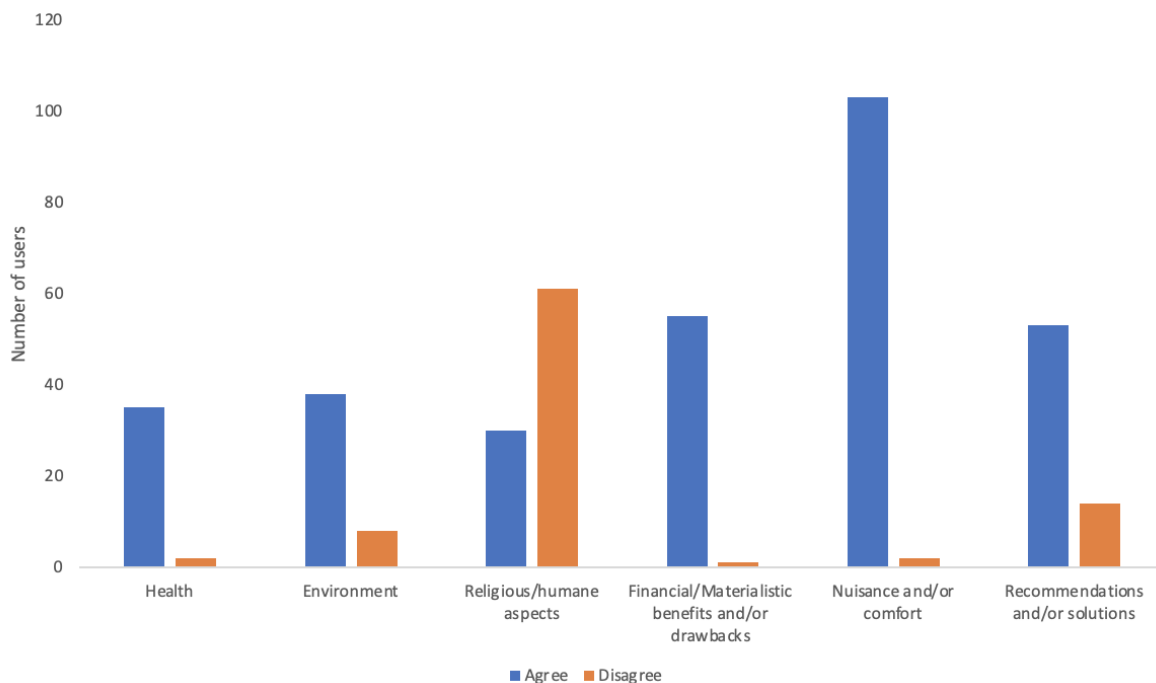


Fig. 2. Agreement and disagreement classified under six themes among users over the environmental and health risk associated with feeding urban pigeons

“The best solution is to hunt them and eat them”.

“I believe that the solution is in rehabilitating parks and public spaces with trees so that these birds have a place to live”.

“Create specific places for feeding pigeons”.

This study explored people’s perceptions towards the environmental and health risks associated with feeding urban pigeons by examining responses to several tweets related to the topic. It was found that perceptions were affected on cognitive, affective, and behavioural levels. Most people (70.3 %) viewed feeding urban pigeons as harmful; the majority believed that it is a source of nuisance, followed by those who believed that it causes financial losses, environmental harm, and negative health outcomes, and those who found it to be religiously unacceptable and sinful. On the other hand, some people (29.7 %) viewed feeding urban pigeons as being beneficial; the majority thought that it is religiously acceptable and rewarding, followed by those who thought of it as having a positive impact on the environment, as being a source of joy and comfort, improving human health, and as having financial benefits. Also, there were people from both sides of the argument that provided recommendations and solutions.

Urban pigeons are a major health concern since they are potential reservoirs and vectors of zoonotic microorganisms that can cause infections and allergic diseases (Giunchi *et al.*, 2012; Haag-Wackernagel, 2006; Daniel Haag-Wackernagel and Bircher, 2010; Daniel Haag-Wackernagel and Moch, 2004; Magnino *et al.*, 2009; Rosický, 1978). Our results found that only 17 % of people perceived that the presence of urban pigeons poses risks to human health with most citing the spread of disease through bugs and flies. Although that percentage is low, it still shows a good level of knowledge regarding the health risks associated with the presence of urban pigeons. It has been previously reported that pigeon breeding sites could be a potential host for a variety of arthropods that could end up infecting humans as bugs, flies, ticks, and mites (Giunchi *et al.*, 2012; Daniel Haag-Wackernagel and Bircher, 2010; Daniel Haag-Wackernagel and Moch, 2004; Mumcuoglu *et al.*, 2005). Also, pigeon-related pathogens can be transmitted to humans through excreta, secretions, and/or dust from feathers spread in the environment (Curtis *et al.*, 2002; Giunchi *et al.*, 2012; Daniel Haag-Wackernagel and Moch, 2004). Around 2 % of responses were found to be in dis-

agreement over the presence of human health risks associated with feeding urban pigeons. They argued that their presence is beneficial for human health citing urban pigeons as being a source of food and their ability in killing harmful insects. It has been previously reported that consuming urban pigeons could actually be harmful to human health (Brand Phillips *et al.*, 2003). Urban pigeons can contain concentrated amounts of toxic metals such as lead, cadmium and zinc in their tissues (Brand Phillips *et al.*, 2003; Cai and Calisi, 2016; García *et al.*, 1988; Hutton, 1980; Hutton and Goodman, 1980). There have been cases where urban pigeons were considered monitors of manganese pollution in urban environments (Brand Phillips *et al.*, 2003; Cai and Calisi, 2016; Loranger *et al.*, 1994). As for pigeons’ ability to kill harmful insects, that has not been scientifically proven. It could also be a false perception as they mainly depend on humans for food and do not have to go and hunt for insects and/or bugs.

Urban pigeons have invaded and adapted to the urban environment even though it is significantly different from its original natural habitat (Luniak, 2004; Møller, 2009; Ryan, 2011). Around 18 % of responses in this study agreed that urban pigeons have a negative impact on the environment. People believed that pigeons’ high capacity to procreate disturbs the natural environmental balance. The current body of knowledge does support that urban pigeons negatively impact the environment. They are known for raiding food crops, causing environmental noise, fouling urban environments with faecal droppings, and competing with native species for food and nesting sites (Nghiem *et al.*, 2013; Sodhi and Sharp, 2006; Yap and Sodhi, 2004). Only 8 % of responses were found to be in favour of having pigeons in the urban environment. They have cited things like their droppings being good fertilisers and their ability to eat leftover food is somehow similar to recycling as well as bringing overall environmental balance. It is believed that this is a false perception as their negative impacts outweigh their benefits.

Religious and humane points of view differ significantly from person to person. People tend to interpret things in a way that fits them based on their understanding. With regards to religious and/or humane point of view towards feeding urban pigeons and their presence in general, our results show that 14 % of responses were in agreement over its negative impacts. People believed that feeding

urban pigeons brings harm by causing negative human and environmental outcomes and hence religiously impermissible in Islam and cited hadiths (the words of the Prophet of Islam, Mohammed peace be upon him, memorised and written by his followers) that support their claim. Surprisingly, when compared to the other five categories of the environmental and human health risks associated with feeding urban pigeons (Figure 2), the results of this category (religious and humane) show that the disagreement rate is higher than the agreement rate. The majority (69 %) of those who disagreed over the environmental and human health risks associated with feeding urban pigeons and their presence, did so from a religious/humane point of view. Some considered it inhumane to let them starve without food, water, and/or shelter. The issue with this point of view is that it contradicts pigeons' nature. Pigeons are supposed to travel and look for food, water, and shelter and not exploit the abundant resources provided to them in the urban environment (Ryan, 2011; Shochat *et al.*, 2006). Others considered it to be religiously rewarding to feed them and have also cited hadiths that support their claim. Luckily, increasing religious awareness and correcting certain misconceptions has increased significantly lately. This has been observed in some religious Islamic sermons such as the Friday sermon. The clerics' (Imams) message emphasizes the value of safeguarding people's health and avoiding harm rather than feeding urban pigeons.

Financial losses, in general, and infrastructural damages, in particular, from urban pigeons, are of major concern. As reported previously, 26 % of responses revolved around peoples' frustration from the financial losses and/or materialistic damages that they've experienced as a result of the presence of urban pigeons due to feeding them. Issues of concern were high bills and regular repairs due to pigeons' nests, feathers, and/or droppings blocking things (i.e. air-conditioning systems, drainage pipes, and windows) and damaging the paint job of homes and cars. It has been reported in previous research that nests, feathers, and/or droppings cause structural and aesthetic damages to man-made structures leading to their deterioration and hence, increased cost and maintenance (Gómez-Heras *et al.*, 2004; Daniel Haag-Wackernagel, 1995; Johnston and Janiga, 1995; Pimentel *et al.*, 2000). A very small percentage (1 %) of users disagreed on pigeons causing financial losses and/or materialistic damages. On

the contrary, they believed that they could be a source of income for people selling their food. Although that could be possible, it doesn't seem to be true as the majority of responses described people getting rid of excess food to feed pigeons and not buying anything. Moreover, if bird food (mainly grains) was the one being used to feed the pigeons, foul smells and dirty pavements from already cooked foods wouldn't have been an issue.

The term 'nuisance' encompasses a wide range of issues; any activity or condition that is harmful and/or offensive and could affect people's morale, safety, and health could be referred to as a nuisance. As reported previously, nuisance is how the majority perceived the presence of pigeons in urban areas due to feeding them. People expressed their annoyance, disturbance, and disgust from pigeons; this perception towards pigeons has long been suggested as their tendency to search for food in flocks around human populations leads to their presence in excessive numbers which causes vile smells and unpleasant scenes (Johnston and Janiga, 1995; Ryan, 2011). Only a small minority found that feeding urban pigeons and their presence brings joy and comfort. This could be attributed to human nature and its desire to seek interactions with others including animals. People who enjoy feeding pigeons and do so on a regular basis, form associations with the pigeons that result in an elevated level of trust between the animal and the feeder. This eventually brings feelings of joy and satisfaction (Jerolmack, 2009).

The findings above show that the majority of people (70 %) are against feeding urban pigeons due to its association with causing negative environmental and human health impacts. Also, the findings highlight the complexity of human perceptions; even though people who were in favour of feeding urban pigeons and those who were against it were presenting their arguments on similar grounds, their interpretation of the issue differed significantly. However, even if the presence of urban pigeons in the urban environment has some benefits as some have claimed, current scientific evidence shows that its impacts are far worse. Hence, certain monitoring and control methods are required to minimise the effects currently present. As per the findings above, both sides of the argument provided recommendations and solutions on how to deal with excessive urban pigeon populations. Other than recommendations provided by people, it is thought that increas-

ing awareness of the issue via social media and other forms of communication in general, and through religious figures in different religious sermons, in particular, is extremely important. Although most of what was mentioned previously is valid, a more methodical approach is required to deal with the issue. It is important to consider that any approach used must be well thought out in a way that is accepted by the inhabitants of the urban area to increase its chances of success. In general, methods to control pigeon populations could be clustered into three main categories; (i) culling; (ii) decrease of reproductive success; and (iii) reduction of habitat carrying capacity (Giunchi *et al.*, 2012). Of course, some methods could be more efficient than others. Culling has been found to be less effective in species with high mortality rates and high productivity, such as urban pigeons, as a control method (Barlow, Kean, and Briggs, 1997; Dolbeer, 1998; Giunchi *et al.*, 2012). Even though it has been applied in the past and might still be used to this day, previous reports indicated that after culling, pigeons from surrounding areas quickly refill the emptied area and in a few days the population recovers (Senar *et al.*, 2017). Decreasing reproductive success which includes egg removal and/or puncturing, the use of chemo-sterilant drugs, and reproductive inhibitors also have their limitations (Giunchi *et al.*, 2012). The most reliable method present currently is thought to be carrying capacity reduction via habitat modification. Capacity reduction methods act mainly on two things, nests/roost sites and food with the latter found to be more efficient than the former. Of course, certain factors such as the characteristics of the pigeon populations (e.g. size), the features of the urban habitat (e.g. number and age of buildings), and the characteristics of the surrounding landscape (e.g. distribution of food resources) eventually determine the best method/s to apply (Giunchi *et al.*, 2012; Senar *et al.*, 2017).

Conclusion

People's perceptions towards the environmental and health risks associated with feeding urban pigeons were found to be different, however, stemming from similar themes. Nuisance was the major issue for those who agreed on the presence of negative impacts on the environment and human health while religion was the main excuse for those who disagreed on the presence of negative impacts. Fur-

ther work is needed to quantify the extent of negative effects caused by the presence of urban pigeons. Moreover, more needs to be done with regard to exploring the appropriate methods of monitoring and control.

Acknowledgement

The authors would like to thank Umm Al-Qura university for providing the required permissions to conduct the study.

Conflict of interest

The authors declare no conflict of interest.

References

- Almosa, S. Y. 2021. University students' perspectives toward learning and assessment during COVID-19. *Education and Information Technologies*. 26(6): 7163-7181.
- Barlow, N., Kean, J. and Briggs, C. 1997. Modelling the relative efficacy of culling and sterilisation for controlling populations. *Wildlife Research*. 24(2): 129-141.
- Brand Phillips, R., Snell, H. L. and Vargas, H. 2003. Feral rock doves in the Galápagos Islands: Biological and economic threats.
- Cai, F. and Calisi, R. M. 2016. Seasons and neighborhoods of high lead toxicity in New York City: the feral pigeon as a bioindicator. *Chemosphere*. 161: 274-279.
- Chen, X., Vorvoreanu, M. and Madhavan, K. 2014. Mining social media data for understanding students' learning experiences. *IEEE Transactions on Learning Technologies*. 7(3): 246-259.
- Curtis, L., Lee, B. S., Cai, D., Morozova, I., Fan, J. L., Scheff, P. and Diblee, S. 2002. Pigeon allergens in indoor environments: a preliminary study. *Allergy*. 57(7): 627-631.
- Dolbeer, R. A. 1998. *Population dynamics: the foundation of wildlife damage management for the 21st century*. Paper presented at the *Proceedings of the Vertebrate Pest Conference*.
- García, M. A., Martínez-Conde, E. and Vazquez, I. C. 1988. Lead levels of feral pigeons (*Columba livia*) from Madrid (Spain). *Environmental Pollution*. 54(2): 89-96.
- Giunchi, D., Albores-Barajas, Y. V., Baldaccini, N. E., Vanni, L. and Soldatini, C. 2012. Feral pigeons: problems, dynamics and control methods. *Integrated pest management and pest control. Current and future tactics, London, In Tech Open*. 215-240.
- Gómez-Heras, M., Benavente, D., de Buergo, M. Á. and Fort, R. 2004. Soluble salt minerals from pigeon droppings as potential contributors to the decay of stone based Cultural Heritage. *European Journal of Mineralogy*. 16(3): 505-509.

- Goodwin, D. H. 1977. *Pigeons and Doves of the World*: Comstock Pub. Associates.
- Haag-Wackernagel, D. 1995. Regulation of the street pigeon in Basel. *Wildlife Society Bulletin*. 256-260.
- Haag-Wackernagel, D. 2006. Human diseases caused by feral pigeons. In: *Advances in Vertebrate Pest Management*. (Eds CJ Feare and DP Cowan.) pp. 31-58. In: Finlander Verlag: Fürth.
- Haag-Wackernagel, D. and Bircher, A. J. 2010. Ectoparasites from feral pigeons affecting humans. *Dermatology*. 220(1): 82-92.
- Haag-Wackernagel, D. and Moch, H. 2004. Health hazards posed by feral pigeons. *Journal of Infection*. 48(4): 307-313.
- Haag Wackernagel, D. 2005. Parasites from feral pigeons as a health hazard for humans. *Annals of Applied Biology*. 147(2): 203-210.
- Hutton, M. 1980. Metal contamination of feral pigeons *Columba livia* from the London area: part 2—biological effects of lead exposure. *Environmental Pollution Series A, Ecological and Biological*. 22(4): 281-293.
- Hutton, M. and Goodman, G. 1980. Metal contamination of feral pigeons *Columba livia* from the London area: part 1—tissue accumulation of lead, cadmium and zinc. *Environmental Pollution Series A, Ecological and Biological*. 22(3): 207-217.
- Jerolmack, C. 2008. How pigeons became rats: The cultural-spatial logic of problem animals. *Social Problems*. 55(1): 72-94.
- Jerolmack, C. 2009. Humans, animals, and play: Theorizing interaction when intersubjectivity is problematic. *Sociological Theory*. 27(4): 371-389.
- Johnston, R. F. and Janiga, M. 1995. *Feral Pigeons* (Vol. 4): Oxford University Press on Demand.
- Loranger, S., Demers, G., Kennedy, G., Forget, E. and Zayed, J. 1994. The pigeon (*Columbia livia*) as a monitor for manganese contamination from motor vehicles. *Archives of Environmental Contamination and Toxicology*. 27(3): 311-317.
- Luniak, M. 2004. *Synurbanization—adaptation of animal wildlife to urban development*. 50-55. Paper presented at the *Proceedings of the Fourth International Symposium on Urban Wildlife Conservation* Shaw, WW, LK Harris, and L. Vandruff, editors. Tuscon, Arizona.
- Magnino, S., Haag-Wackernagel, D., Geigenfeind, I., Helmecke, S., Dovè, A., Prukner-Radovèia, E. and Donati, M. 2009. Chlamydial infections in feral pigeons in Europe: Review of data and focus on public health implications. *Veterinary Microbiology*. 135(1-2): 54-67.
- Møller, A. P. 2009. Successful city dwellers: a comparative study of the ecological characteristics of urban birds in the Western Palearctic. *Oecologia*. 159(4): 849-858.
- Mumcuoglu, K. Y., Banet-Noach, C., Malkinson, M., Shalom, U. and Galun, R. 2005. Argasid ticks as possible vectors of West Nile virus in Israel. *Vector-Borne & Zoonotic Diseases*. 5(1): 65-71.
- Nghiem, L. T., Soliman, T., Yeo, D. C., Tan, H. T., Evans, T. A., Mumford, J. D. and Carrasco, L. R. 2013. Economic and environmental impacts of harmful non-indigenous species in Southeast Asia. *PLoS One*. 8(8): e71255.
- Pimentel, D., Lach, L., Zuniga, R. and Morrison, D. 2000. Environmental and economic costs of nonindigenous species in the United States. *BioScience*. 50(1): 53-65.
- Rosický, B. 1978. Health risks associated with animals in different types of urban areas: present status and new ecological conditions due to urbanization. *Annali dell'Istituto Superiore di Sanità*. 14(2): 273-286.
- Ryan, A. C. 2011. The distribution, density and movements of feral pigeons *Columba livia* and their relationship with people.
- Senar, J. C., Montalvo, T., Pascual, J. and Peracho, V. 2017. Reducing the availability of food to control feral pigeons: changes in population size and composition. *Pest Management Science*. 73(2): 313-317.
- Shochat, E., Warren, P. S., Faeth, S. H., McIntyre, N. E. and Hope, D. 2006. From patterns to emerging processes in mechanistic urban ecology. *Trends in Ecology & Evolution*. 21(4): 186-191.
- Sodhi, N. S. and Sharp, I. 2006. *Winged invaders: pest birds of the Asia Pacific with information on bird flu and other diseases*: SNP Reference.
- Yap, C. A. and Sodhi, N. S. 2004. Southeast Asian invasive birds: ecology, impact and management. *Ornithological Science*. 3(1): 57-67.