Public perceptions of air pollution and its health impacts in Greater Kuala Lumpur

F.J. Chang and M. J. Ashfold
1School of Environmental and Geographical Sciences, University of Nottingham Malaysia, Jalan Broga, 43500 Semenyih, Selangor, Malaysia
2Mindset Interdisciplinary Centre for Environmental Studies, University of Nottingham Malaysia, Jalan Broga, 43500 Semenyih, Selangor, Malaysia
Email: khby6cfj@nottingham.edu.my; matthew.ashfold@nottingham.edu.my (Corresponding authors)

Abstract. Air pollution is a globally pervasive health hazard but the risks it poses can be overlooked by the public. To explore the significance of this problem in Greater Kuala Lumpur (KL), Malaysia, we conducted a survey of the public (n = 165). We found (1) an appreciation for the importance of motor vehicles as a source of air pollution; (2) little reported engagement with the official Air Pollution Index (API); (3) a lack of awareness of the long-term health effects of air pollution and (4) reports of a substantial impact of air pollution on day-to-day life. While our survey sample is not representative of the population of Greater KL, our findings are broadly consistent with those of others and underscore a need for improved communication to the public of risks posed by air pollution. Tightened standards underlying the Malaysian API and improved dissemination of real-time air quality updates may be important opportunities to achieve this.

Keyword: air pollution; public perception; health risk; Malaysia, Greater Kuala Lumpur

1. Introduction
Air pollution is a globally pervasive health hazard [1]. Malaysia is not excluded from this, with rapid economic growth, urbanization and motorization contributing to air pollution problems [2]. Malaysia also faces intense transboundary air pollution, in the form of episodic “haze” events linked to regional burning of agricultural land [3]. Both local and transboundary air pollution cause serious problems in Malaysia. Air pollution causes far-reaching health issues, for example increasing throat discomfort and respiratory illnesses, particularly asthma, and especially among children and the elderly [4], and leading to headache, coughing and breathing difficulties among commuters [5]. The local economy also suffers as air pollution affects tourism and shipping activities in addition to the costs related to hospital admission, medication and loss of income opportunities [6], [7].

Despite air pollution’s negative impacts, risks can be overlooked by the public [8]. This is problematic because perceiving a threat to health would encourage people to take actions to reduce the adverse effects of air pollution [9]. Unfortunately, a gap between public understanding of air pollution and reality is often found. A recent study [10] found that publics across much of Asia have a poor understanding of chronic health impacts of air pollution, that health authorities are not a prominent source of information and that public interest is driven by seasonal variations in air quality. Evidence
from Malaysia suggests broadly positive perceptions of air quality despite widespread unhealthy air, highlighting that Malaysians may not perceive a real threat to their health [11]. Efforts to reduce health impacts in Malaysia would benefit from improved understanding of the complex relationships [12] between peoples’ knowledge, perceptions and behavioural responses related to air pollution. Accordingly, in this work we developed and deployed a survey to explore how people in Malaysia: (1) perceive air pollution at their home and work/school place and engage with Air Pollution Index (API) (2) understand health impacts and perceive a risk from of air pollution and (3) undertake self-protective and coping actions in relation to air pollution.

2. Materials and methods

2.1. Instrumentation
We developed a survey (available at https://doi.org/10.3886/E115525) containing four sections: (1) Demographics and participant descriptors; (2) Air pollution perception; (3) Health risk perception; (4) Self-protective and coping actions. Questions used were both self-created and adapted from [9]. The survey was implemented using Qualtrics (Qualtrics, Provo, Utah, USA) and designed in the form of a self-administered questionnaire, with participants expected to complete the survey by themselves without guidance. The survey language was English, which has high proficiency levels in Malaysia [13].

2.2. Participants
People from Greater Kuala Lumpur (KL) were targeted. Greater KL is a term used to describe the urban agglomeration including KL, neighbouring cities in the state of Selangor such as Petaling Jaya and Kajang, and the Federal Territory of Putrajaya. Living in Malaysia’s largest urban area, we expected residents of Greater KL to experience higher levels of air pollution [14], [15]. People who stated they were living in Greater KL, and were either Malaysian citizens or non-Malaysians who had been working or studying in Malaysia for more than a year, were eligible to participate.

2.3. Data Collection
Ethics approval for this participant contact study was obtained from the Science and Engineering Research Ethics Committee, University of Nottingham Malaysia. Online snowball sampling was used to recruit participants, with the survey distributed via an anonymous link through social media networks and personal connections. Each survey required about 5-6 minutes to complete. A total of 219 survey responses were collected over 36 days, from 14 March to 18 April 2019. This period did not include reports of “haze” pollution coming from regional fires.

To inform our interpretation of the survey responses we also collected hourly Air Pollution Index (API) data covering the same period from the Malaysian Department of Environment’s (DoE) website for public sharing of near real-time API data (http://apims.doe.gov.my/public_v2/home.html). As in other countries, the API is used by the DoE to indicate the air quality status based on the concentrations of criteria air pollutants (SO₂, NO₂, CO, O₃, PM₁₀ and PM₂.₅) measured across a national network of monitoring stations.

2.4. Data Analysis
For the survey, a final sample size of 165 participants was used for further data analysis after removal of 54 participants owing to extensive missing responses. All sorting and managing of responses and data analyses were done using Microsoft Excel (Microsoft Office 365 ProPlus, version 1903) and Statistical Package for the Social Sciences (SPSS) version 24 (IBM Corp, Armonk, NY).

Many survey questions required responses on a 4-point or 5-point Likert scale from 1 (not at all, never, very bad) to 4/5 (excellent, always, extremely). The mean scores and standard deviation of these questions were calculated using this Likert scale where necessary. For statistical analyses, Kruskal-Wallis H test, Mann-Whitney U test were used to compare between groups and responses while Spearman’s correlation was used to examine relationships.
3. Results and discussion

3.1 Sample demographics
Our sample had slightly more female participants (53.9%) than male participants (46.1%) and was largely of Chinese ethnicity (86.1%) and educated to tertiary level (79.3%). Respondents were mainly students (53.3%) or working in the private sector (31.5%). In terms of ethnicity, education level and employment status this sample is relatively homogenous and is not representative of Malaysia’s or Greater KL’s population [16]. Nevertheless, our results contain indications of the state of public perceptions of air pollution in Greater KL.

3.2. Perceptions of air pollution and sources in Greater KL
Figure 1a shows most respondents perceived air pollution to be ‘Moderate’, both at home (65.5%) and at work (52.8%). When asked to rank the main sources of air pollution, motor vehicles were most often ranked first and forest fires most often ranked last (Figure 1b). This is broadly consistent with similarly measured public perceptions [11] and the few available government statistics [17]. Further, people who think they live close to a major road were more likely than other respondents to rank motor vehicles the most important air pollution source ($\chi^2(2) = 7.55$, $p = 0.023$) (Figure 1c).

Consistent with other studies [12], [18], we found a ‘neighbourhood halo effect’. When asked to compare air pollution in their home neighbourhood with other neighbourhoods in Greater KL, using descriptors of ‘less’, ‘equal’ or ‘more’ polluted, respondents were more likely to describe their neighbourhood as ‘less’ polluted (35.3% of comparisons) than ‘more’ polluted (20.2%). This pattern applied, to varying degrees, to aggregate opinions of each home neighbourhood with sufficient responses (>5 responses per neighbourhood) and to the aggregate opinion of each other neighbourhood.

![Figure 1](image_url)

Figure 1: (a) perceptions of air pollution levels at home and at place of work or study, (b) ranking of air pollution sources and (c) ranking of motor vehicles as an air pollution source stratified by perceived distance of home from a major road.

3.3. API knowledge and engagement
Most respondents report hardly checking the API (94.5% responded “Never” or “Once or Twice a year”). This finding is broadly consistent with [9] and with [19], who found a minority of people in Malaysia check the API daily, even during haze periods. This indicates the API is underutilised by the Malaysian public and implies little awareness of day-to-day variations in air pollution in Greater KL.
Most respondents (58.2%) predicted that the API was in the Moderate (51-100) range at the time of their participation in the survey. This is generally in accordance with actual API levels in Greater KL (e.g. during the study period daily mean API averaged over seven Greater KL monitoring stations ranged between 53-88), suggesting some familiarity with the typical API category. The DoE has indicated intentions [20], [21] to tighten air quality standards for PM$_{2.5}$ and O$_3$, the pollutants normally determining the API in Greater KL. If the standards were to be tightened and air pollution levels remain unchanged, API levels will more frequently be in the ‘Unhealthy’ range. To illustrate, over our study period there was an ‘Unhealthy’ hourly API reading at one or more Greater KL site on 16 of 36 days. We estimate 22 of 36 days (i.e. 6 additional days) would have included ‘Unhealthy’ hourly API readings had the most ambitious standard for PM$_{2.5}$ in [20] been implemented at the time. Evidence on public interactions with air pollution information is mixed [22], [23], but given the apparent familiarity of respondents with the typical ‘Moderate’ API categorical descriptor we hypothesize an increased frequency of ‘Unhealthy’ days would act to improve people’s perception of health risks from air pollution in Greater KL.

3.4. Health impacts
From a list of eight examples of health-related problems that have been connected to air pollution in the scientific literature, we asked respondents to indicate which they thought were related to air pollution. Most respondents thought the first four health problems listed in Table 1 were related to air pollution, but less than 30% of respondents thought there were links between air pollution and the final four health problems. This particularly demonstrates a lack of awareness of possible long-term consequences of exposure to air pollution, also highlighted by [10]. The greater awareness among our respondents of more immediate health effects of air pollution is consistent with [24].

Table 1: Some health problems linked to air pollution, examples of literature that document these links, and the percentage of respondents believing each health problem has a link to air pollution.

| Health-related problem                  | Illustrative literature source | % of respondents |
|----------------------------------------|--------------------------------|------------------|
| Respiratory diseases                   | [4]                            | 95.2             |
| Increased fatigue                      | [25]                           | 83.0             |
| Reduction in life expectancy           | [26]                           | 69.1             |
| Reduces productivity at work           | [27]                           | 68.5             |
| Myocardial infarction (heart attack)   | [28]                           | 27.3             |
| Causes pre-term birth                  | [29]                           | 26.7             |
| Increased risk of autism               | [30]                           | 20.0             |
| Alzheimer's disease                    | [31]                           | 14.5             |

3.5. Responses towards air pollution
Recalling that our survey was conducted during a “non-haze” period of typical urban air pollution in Greater KL, Figure 2a shows that many respondents reported in the past month feeling annoyed or a deterioration of quality of life owing to air pollution (53.9% and 38.1%, respectively, responding ‘Often’ or ‘Always’). Further, Figure 2b shows most respondents reported being at least ‘Moderately’ concerned about air pollution’s impact on their health both at home (68.5%) and at work or school (71.1%). Figure 2c shows 31.5% and 49.1% of respondents, respectively, report an impact (responding ‘Often’ or ‘Always’) of air pollution on their leisure activities or on going outdoors in the last month, though fewer people report using a face mask (88.5% responding “Never” or “Hardly”). Finally, Figure 2d shows more than 50% of respondents report ‘Often’ or ‘Always’ looking for a less polluted street and feelings of anger when encountering air pollution while walking in the city. Together, these findings indicate a substantial effect of air pollution, even when it is largely considered of ‘Moderate’ levels, on people’s day-to-day lives in Greater KL.
4. Conclusion
We surveyed various aspects of public perceptions of air pollution in Greater KL. While our sample is not representative of the population of Greater KL, our findings are in many respects consistent with those of others. Respondents ranked motor vehicles as the main source of air pollution and, at a time without “haze” pollution, forest fires were ranked lowest. We identified a ‘neighbourhood halo effect’, implying an unwillingness to attribute high levels of air pollution to one’s own neighbourhood. We found the API to be underutilised by our respondents, and a lack of awareness of long-term health...
consequences of air pollution. The survey responses also indicate that air pollution in Greater KL has a substantial impact on the day-to-day life of its citizens, even when air quality levels are mainly perceived as ‘Moderate’.

The lack of engagement with the API and lack of awareness of long-term health consequences suggest a need to improve communication to the public of risks associated with air pollution in Greater KL. Accordingly, opportunities for more widespread and accessible dissemination of real-time information on air quality should be assessed. Additionally, with respondents most often describing air quality as ‘Moderate’, a tightening of Malaysian air quality standards and a resulting increase in the frequency of occurrence of the ‘Unhealthy’ API category may enhance awareness of risks to health.

Acknowledgments
We are grateful to Laura De Pretto, Alex Lechner and David Tan for their constructive suggestions for improving this study, and to the Faculty of Science and Engineering, University of Nottingham Malaysia, for funding.

References
[1] World Health Organization, 2018. ‘Air pollution’, viewed 11 November 2019, <https://www.who.int/en/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health/>.
[2] Mohamad, J. and Kiggundu, A.T., 2007. The rise of the private car in Kuala Lumpur, Malaysia. IATSS research, 31(1), p.69.
[3] Gaveau, D.L., Salim, M.A., Hergoualc’h, K., Locatelli, B., Sloan, S., Wooster, M., Marlier, M.E., Mohidena, E., Yaen, H., DeFries, R. and Verchot, L., 2014. Major atmospheric emissions from peat fires in Southeast Asia during non-drought years: evidence from the 2013 Sumatran fires. Scientific Reports, 4, p.6112.
[4] Ramakreshnan, L., Aghamohammadi, N., Fong, C.S., Bulgiba, A., Zaki, R.A., Wong, L.P. and Sulaiman, N.M., 2018. Haze and health impacts in ASEAN countries: a systematic review. Environmental Science and Pollution Research, 25(3), pp.2096-2111.
[5] Wong, L.P., Alius, H., Aghamohammadi, N., Ghadimi, A. and Sulaiman, N.M.N., 2017. Control measures and health effects of air pollution: A survey among public transportation commuters in Malaysia. Sustainability, 9(9), p.1616.
[6] Abdul Rahman, H., 2013. Haze phenomenon in Malaysia: Domestic or transboundary factor. In 3rd International Journal Conference on Chemical Engineering and its Applications (pp. 597-599).
[7] Ab Manan, N., Manaf, M.R.A. and Hod, R., 2018. The Malaysia Haze and its health economy impact: A literature review. Malaysian Journal of Public Health Medicine, 18(1), pp.38-45.
[8] Kelly, F.J. and Fussell, J.C., 2015. Air pollution and public health: emerging hazards and improved understanding of risk. Environmental geochemistry and health, 37(4), pp.631-649.
[9] Oltra, C. and Sala, R., 2018. Perception of risk from air pollution and reported behaviors: a cross-sectional survey study in four cities. Journal of Risk Research, 21(7), pp.869-884.
[10] Mehta, A. and D’souza, R., 2019. Hazy Perceptions: Public understanding of air quality and its health impact in South and Southeast Asia, 2015-2018. Vital Strategies, New York NY.
[11] Chin, Y.S.J., De Pretto, L., Thuppil, V. and Ashfold, M.J., 2019. Public awareness and support for environmental protection—A focus on air pollution in peninsular Malaysia. PloS one, 14(3), p.e0212206.
[12] Bickerstaff, K. and Walker, G., 2001. Public understandings of air pollution: the ‘localisation’ of environmental risk. Global Environmental Change, 11(2), pp.133-145.
[13] Thirusanku, J. and Yunus, M.M., 2014. Status of English in Malaysia. Asian Social Science, 10(14), p.254.
[14] Makmom Abdullah, A., Armi Abu Samah, M. and Yee Jun, T., 2012. An overview of the air pollution trend in Klang Valley, Malaysia. Open Environmental Sciences, 6(1).
[15] Marlier, M.E., Jina, A.S., Kinney, P.L. and DeFries, R.S., 2016. Extreme air pollution in global megacities. *Current Climate Change Reports*, 2(1), pp.15-27.

[16] Department of Statistics Malaysia (DoSM), 2018. *Current Population Estimates, Malaysia, 2018-2019*, viewed 17 November 2019, <https://www.dosm.gov.my/v1/index.php?r=column/cthemeByCat&cat=155&bul_id=aWJZRkJ4UEdKcUZpT2tVT090Snpydz09&menu_id=L0pheU43NWJwRWVSZklWdzQ4TlhUUT09>

[17] Afroz, R., Hassan, M.N. and Ibrahim, N.A., 2003. Review of air pollution and health impacts in Malaysia. *Environmental research*, 92(2), pp.71-77.

[18] Brody, S.D., Peck, B.M. and Highfield, W.E., 2004. Examining localized patterns of air quality perception in Texas: a spatial and statistical analysis. *Risk Analysis: An International Journal*, 24(6), pp.1561-1574.

[19] De Pretto, L., Acreman, S., Ashfold, M.J., Mohankumar, S.K. and Campos-Arceiz, A., 2015. The link between knowledge, attitudes and practices in relation to atmospheric haze pollution in Peninsular Malaysia. *PloS one*, 10(12), p.e0143655.

[20] Department of Environment, 2013. ‘New Malaysia Ambient Air Quality Standard’, viewed 11 November 2019, <http://www.doe.gov.my/portalv1/wp-content/uploads/2013/01/Air-Quality-Standard-BI.pdf>.

[21] Wu, C.F., Woodward, A., Li, Y.R., Kan, H., Balasubramanian, R., Latif, M.T., Sahani, M., Cheng, T.J., Chio, C.P., Tanepanichskul, N. and Kim, H., 2017. Regulation of fine particulate matter (PM 2.5) in the Pacific Rim: perspectives from the APRU Global Health Program. *Air Quality, Atmosphere & Health*, 10(9), pp.1039-1049.

[22] Semenza, J.C., Wilson, D.J., Parra, J., Bontempo, B.D., Hart, M., Sailor, D.J. and George, L.A., 2008. Public perception and behavior change in relation to hot weather and air pollution. *Environmental research*, 107(3), pp.401-411.

[23] Reames, T.G. and Bravo, M.A., 2019. People, place and pollution: Investigating relationships between air quality perceptions, health concerns, exposure, and individual-and area-level characteristics. *Environment International*, 122, pp.244-255.

[24] Rajper, S.A., Ullah, S. and Li, Z., 2018. Exposure to air pollution and self-reported effects on Chinese students: A case study of 13 megacities. *PloS one*, 13(3), p.e0194364.

[25] Jazani, R.K., Saremi, M., Rezapour, T., Kavousi, A. and Shirzad, H., 2015. Influence of traffic-related noise and air pollution on self-reported fatigue. *International journal of occupational safety and ergonomics*, 21(2), pp.193-200.

[26] Bennett, J.E., Tamura-Wicks, H., Parks, R.M., Burnett, R.T., Pope III, C.A., Bechle, M.J., Marshall, J.D., Danaei, G. and Ezzati, M., 2019. Particulate matter air pollution and national and county life expectancy loss in the USA: A spatiotemporal analysis. *PLoS Medicine*, 16(7), p.e1002856.

[27] He, J., Liu, H. and Salvo, A., 2019. Severe air pollution and labor productivity: Evidence from industrial towns in China. *American Economic Journal: Applied Economics*, 11(1), pp.173-201.

[28] Wang, X., Kindzierski, W. and Kaul, P., 2015. Air pollution and acute myocardial infarction hospital admission in Alberta, Canada: a three-step procedure case-crossover study. *PLoS One*, 10(7), p.e0132769.

[29] Stieb, D.M., Chen, L., Eshoul, M. and Judek, S., 2012. Ambient air pollution, birth weight and preterm birth: a systematic review and meta-analysis. *Environmental research*, 117, pp.100-111.

[30] Pagalan, L., Bickford, C., Weikum, W., Lanphear, B., Brauer, M., Lanphear, N., Hanley, G.E., Oberlander, T.F. and Winters, M., 2019. Association of prenatal exposure to air pollution with autism spectrum disorder. *JAMA pediatrics*, 173(1), pp.86-92.

[31] Calderon-Garciduenas, L., Leray, E., Heydarpour, P., Torres-Jardón, R. and Reis, J., 2016. Air pollution, a rising environmental risk factor for cognition, neuroinflammation and neurodegeneration: the clinical impact on children and beyond. *Revue Neurologique*, 172(1), pp.69-80.