ESRI
SURVEY AND
STATISTICAL
REPORT SERIES
NUMBER 120
OCTOBER 2023

CLEAN AIR TOGETHER DUBLIN:

IMPACT ON AIR QUALITY AWARENESS, ATTITUDES AND BEHAVIOUR

ANNE NOLAN AND AISLINN HOY

AN INSTITIÚID
UM THAIGHDE
EACNAMAÍOCHTA
AGUS SÓISIALTA
ESRI ECONOMIC & SOCIAL
RESEARCH INSTITUTE

CLEAN AIR TOGETHER DUBLIN:

IMPACT ON AIR QUALITY AWARENESS, ATTITUDES AND BEHAVIOUR

Anne Nolan

Aislinn Hoy

October 2023

ESRI SURVEY AND STATISTICAL REPORT SERIES

NUMBER 120

Available to download from www.esri.ie

https://doi.org/10.26504/sustat120

ABOUT THE ESRI

The Economic and Social Research Institute is an independent research institute working towards a vision of **'Informed policy for a better Ireland'**. The ESRI seeks to support sustainable economic growth and social progress in Ireland by providing a robust knowledge base capable of providing effective solutions to public policy challenges.

The Institute was founded in 1960 by a group of senior civil servants, led by Dr T.K. Whitaker, who identified the need for independent and in-depth research to support the policymaking process in Ireland. Since then, the Institute has remained committed to independent research and its work is free of any expressed ideology or political position. The Institute publishes all research reaching the appropriate academic standard, irrespective of its findings or who funds the research.

The ESRI brings together leading experts from a variety of disciplines who work together to break new ground across a number of research initiatives. The expertise of its researchers is recognised in public life and researchers are represented on the boards and advisory committees of several national and international organisations.

ESRI researchers uphold the highest academic standards. The quality of the Institute's research output is guaranteed by a rigorous peer review process. Research is published only when it meets the required standards and practices. Research quality has also been assessed as part of three peer reviews of the Institute, in 2010,2016 and 2022.

ESRI research findings are disseminated widely in books, journal articles and reports. Reports published by the ESRI are available to download, free of charge, from its website. ESRI staff members communicate research findings at regular conferences and seminars, which provide a platform for representatives from government, civil society and academia to discuss key findings from recently published studies and ongoing research.

The ESRI is a company limited by guarantee, answerable to its members and governed by a Council, comprising a minimum of 11 members and a maximum of 14 members, who represent a cross-section of ESRI members: academia, civil service, state agencies, businesses and civil society.

THE AUTHORS

Aislinn Hoy is a Research Assistant at the Economic and Social Research Institute (ESRI). Anne Nolan is a Research Professor at the ESRI and an Adjunct Professor at Trinity College Dublin (TCD).

ACKNOWLEDGEMENTS

The research was funded by the Environmental Protection Agency (EPA) under a programme of research on environmental economics carried out at the ESRI. The authors thank in particular Sabrina Moore from An Taisce's Environmental Education Unit and Leo McKittrick from the EPA for providing us with access to the survey data, and for helpful guidance and discussions throughout the project. All views, errors and omissions remain the sole responsibility of the authors.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS AND KEY TERMS

CAT	Clean Air Together
EEU	Environmental Education Unit
EPA	Environmental Protection Agency
ESRI	Economic and Social Research Institute
NO_2	Nitrogen dioxide
TCD	Trinity College Dublin

Selected participants:	CAT participants who participated in the surveys and took NO_2 measurements.
Non-selected participants:	CAT participants who participated in the surveys but were not chosen to take NO_2 measurements.

EXECUTIVE SUMMARY

Clean Air Together (CAT) is a citizen science project where people voluntarily sign up to measure levels of nitrogen dioxide (NO_2) pollution in their local area. In this study, we assessed the impact of CAT on awareness, attitudes and behaviours of participants in relation to air quality. Selected participants (and those who signed up for the study but who were ultimately not selected to engage in NO_2 measurement, referred to in this report as non-selected participants) were invited to complete three surveys at various points in 2021 and 2022. It is these survey responses that are used to evaluate the impact of CAT participation on awareness, attitudes and behaviour in relation to air quality.

While the analysis was hindered by small samples, the research identified a number of key findings:

- Compared to the general Dublin population aged 18+, CAT participants were more concentrated in the middle age groups (aged 35-64), and nearly half had postgraduate-level educational qualifications.
- The baseline survey was conducted in September 2021, at the start of the CAT project and before participants participated in NO_2 measurement or received infographics and further information on NO_2. It revealed that CAT participants were more aware of NO_2 (and other environmental risks) than the general Dublin population aged 18+, and more likely to correctly identify the main source of NO_2 pollution. However, nearly one-quarter of CAT participants did not know the most significant source of NO_2 pollution, and a further quarter answered this question incorrectly.
- In terms of attitudes, CAT participants were, in general, more supportive of various policy measures to reduce air pollution than the overall Dublin population aged 18+.
- Analysis of CAT participants who responded to the first (September 2021) and second (March 2022) surveys showed that awareness of NO_2-related issues improved. For example, the proportion who correctly identified the most significant source of NO_2 increased from just over 50 per cent to nearly 70 per cent, with an additional large decline in the proportion of participants who reported that they did not know the most significant source of NO_2 pollution.

In terms of lessons for future environmental citizen science projects, a number of key points can be made:

- The socioeconomic profile of CAT participants highlights a real challenge for those designing environmental citizen science projects and who seek to ensure greater diversity in participation. The broader literature on effective strategies to encourage greater diversity in the profile of environmental citizen scientists

suggests that practical actions such as the use of alternative recruitment strategies, recognition of the barriers to participation for certain groups (e.g., time commitments on the part of individuals with paid work and caring responsibilities), and co-design of citizen science projects can be effective tools for widening participation.

- A strength of this study was the retention of non-selected participants in the study via participation in the three surveys (although levels of drop-out were very high). In terms of maximising response rates in future CAT surveys, consideration could be given to sending dedicated reminders to those who have not yet completed surveys. Insights from behavioural science interventions to increase survey response rates (e.g., using personalised communications) may be useful in future CAT projects.
- The survey collected information on individual behaviours (focusing on transport mode choice and working from home), but there was limited evidence of significant changes in behaviour as a result of participation in CAT. Previous research has also shown that while attitudes towards pro-environmental individual behaviours can be very positive, there is a considerable gap between attitudes and behaviours.
- Ultimately, in order to achieve lower levels of air pollution, individual-level behaviour change will need to be accompanied by targeted public policies. Overall, survey participants exhibited high levels of agreement with various policy options designed to reduce air pollution. However, policy options that required increased investment on the part of the State (e.g., increased investment in public transport) were favoured over those options that involved restrictions or curbs on individual behaviour (e.g., implementing congestion charges in cities).

CHAPTER 1

Introduction

Clean Air Together (CAT) is a citizen science project where people voluntarily sign up to measure levels of nitrogen dioxide (NO_2) pollution in their local area. The main source of NO_2 is road transport, which emits NO_2 close to the ground, mostly in densely populated areas (European Environment Agency, 2022). NO_2 leads to respiratory disease and mortality, and there is evidence that children and older people are at increased risk (WHO, 2021). In the first phase of CAT, conducted in 2021 and 2022, approximately 1,000 participants in Dublin recorded NO2 levels in their local area. The second phase involved a similar number of participants measuring NO_2 levels in Cork, while the third phase will begin in Galway in August 2023. The project is led by the Environmental Protection Agency (EPA) and the Environmental Education Unit (EEU) of An Taisce.

In addition to developing and delivering a methodology for large-scale citizen-based monitoring of air quality (and specifically NO_2), and for providing data that will input into the validation of national air quality models,[1] it was envisaged that CAT would increase public knowledge of and engagement with the topic of air quality. In this context, the current study seeks to assess the impact of CAT on awareness, attitudes and behaviours in relation to air quality. The research was carried out under the programme of research on environmental economics at the Economic and Social Research Institute (ESRI), funded by the EPA. Both selected and non-selected CAT participants were invited to complete three surveys at various points in 2021 and 2022,[2] and it is these survey responses that are used to evaluate the impact of CAT participation on awareness, attitudes and behaviour in relation to air quality.[3] In particular, the following research questions are addressed in this paper:

- How do CAT participants differ from the general Dublin population aged 18+ in terms of their demographic and socioeconomic characteristics (i.e., age, gender, highest level of education)?
- How do CAT participants differ from the general Dublin population aged 18+ in terms of their awareness, attitudes and behaviours in relation to air quality?
- How did awareness, attitudes and behaviours in relation to air quality of CAT participants change over the period of their participation in the study?

1 At present, NO_2 is monitored in 30 stations across the country (EPA, 2022).

2 'Non-selected participants' refers to those who signed up for the study but who were not selected to participate in nitrogen dioxide (NO_2) measuring.

3 As explained in Chapters 3, 4 and 5, the extent to which causal inferences about CAT participation can be made is hampered by the sample recruitment method, survey response rates and attrition rates over time.

- What are the key learnings based on the analysis of the surveys and a review of the communication that can inform future CAT projects?

In Chapter 2, we provide a brief overview of the literature on environmental citizen science projects, with a particular focus on studies that have assessed the impacts of participation on awareness, attitudes and behaviours. Chapter 3 describes the data and methods used to evaluate the impact of CAT on air quality awareness, attitudes and behaviour, while Chapter 4 provides an overview of the main results. Chapter 5 discusses the findings and draws out implications for future environmental citizen science projects.

CHAPTER 2

Literature review

Citizen science is the practice whereby members of the public assist local institutions or government agencies by monitoring or tracking a common concern in the community (Conrad and Hilchey, 2011). It is increasingly being employed across the 'science, technology, engineering, maths' (STEM) disciplines, facilitating a rapid generation of data at previously unachievable spatial and temporal scales (Dickinson et al., 2012). This has proven to be instrumental for environmental science, as much of the current understanding of nature and biodiversity has been derived from data collected via citizen science (Bela et al., 2016). In addition to the pronounced benefits to science, citizen science has been credited with acting as a causal pathway to increasing public awareness and understanding of environmental concerns (Walker et al., 2021). This promise of societal transformation, coupled with scientific advances, explains the recent increase in environmental citizen science projects (Bela et al., 2016). For example, human behaviour is a primary contributor to today's climate crisis. The potential of citizen science to impact awareness of and behaviour regarding this issue at the level of the individual, while also enabling the collection of important environmental data, makes it a particularly valuable tool (Walker et al., 2021). The literature regarding the positive impacts of citizen science on science and data collection is extensive. However, only limited literature exists regarding the impact of citizen science on participants' awareness levels, behaviour and attitudes.

It is widely accepted that exposure to information can impact an individual's awareness of an issue and, consequently, shape their attitudes and behaviours (Rizzi et al., 2020). Given this, and the level of exposure to specific information in a citizen science project, it is logical to assume that participants' awareness of, and attitudes and behaviour towards, the environment should improve through participating in an environmental citizen science project. This assumption underpins the use of citizen science to monitor five of the United Nations' (UN) Sustainable Development Goals indicators (Fraisl et al., 2020), numerous conservation studies (Bela et al., 2016; Dickinson et al., 2012; Jordan et al., 2011) and countless other environmental studies (Ewing et al., 2004; Walker et al., 2021). Despite this consensus, and the extensive recent adoption of citizen science across the field of environmental science, there is little empirical evidence of this transformative capacity (Bela et al., 2016). Changes to participants' awareness (and ultimately their behaviour) are thought to be achieved through interaction with scientists, direct participation in a scientific study, and access to high-quality educational materials throughout the study (Jordan et al., 2011). However, quantitatively evaluating changes in participants' attitudes, awareness and behaviours is difficult to due to high attrition levels. Further, if they do occur, it is

difficult to quantify whether such changes are due specifically to participation in the specific environmental citizen science project. This is because environmental citizen science projects are ultimately designed with data collection and science progression as their primary goal, and increased awareness and behavioural changes as their secondary goal (Burgess et al., 2017). Various difficulties are thus encountered in assessing awareness and behavioural change across participation groups, including lack of a suitable control group, significant attrition levels, and bias in the profile of participants compared with the general population (Birkin et al., 2021; Burgess et al., 2017; Walker et al., 2021).

When analysing participants' awareness and behavioural changes, it is essential to consider who the participants in environmental citizen science projects are, and whether they represent the general population. Since most citizen science projects are voluntary, participants must be willing to dedicate some of their leisure time to the project. The literature regarding motivation for citizen scientists suggests that citizens sign up either to learn new skills and knowledge or because the project is directly linked with personal values (Maund et al., 2020). This shows that citizen science projects require ample leisure time, which may be difficult for individuals in certain life stages or socioeconomic groups. This is further demonstrated through the high attrition levels observed in citizen science projects; there is a much higher initial interest in projects than there is continuous participation. Some studies have attributed this to time requirements (Maund et al., 2020) and others to motivations changing over time (Rotman et al., 2012).

Nonetheless, the growing reliance on technology in the recruitment and participation of citizen science projects can play a role in diversifying participants' profiles. In theory, smartphones and the internet facilitate a more diverse network and media platform to inform the public of such projects, allowing for a more diverse age and regional makeup of citizen scientists (Walker et al., 2021). However, in practice, most of the peer-reviewed scholarly literature concerning citizen science shows a base of more socio-economically advantaged, older and well-educated participants (Birkin et al., 2021; Mac Domhnaill et al., 2020; Sauermann et al., 2020). In fact, most participants tend to have a third-level education, higher-than-average salary, and a pre-existing interest in environmental science (Burgess et al., 2017).

This participant profile leads to various problems when analysing awareness, attitudes and behaviour. Firstly, in many citizen science projects, participants help identify issues and set research agendas; when representation is lacking, agendas and future projects will reflect the preferences and concerns of those who participate, instead of the larger population (Burgess et al., 2017). Secondly, a core aspect of augmenting behaviour through citizen science is the diffusion of knowledge to those who do not participate in citizen science projects. When

participants are not diverse or representative, large chunks of society (non-participants) are still not privy to crucial environmental information (Sauermann et al., 2020). Thirdly, there is strength in diversity, and more representative projects may carry greater weight in political processes associated with the problem. Voices from different backgrounds increase the chances of generating valuable knowledge and solutions, giving everyday citizens the power to contribute to science and ultimately impact policy (Sauermann et al., 2020). Finally, it is challenging to attribute changes in awareness or behaviour of this category of people to participate in citizen science. It is noted in the literature that those with disproportionate levels of leisure time and higher education levels may have a predisposition to scientific knowledge or the ability to change behaviours easily (Curtis, 2015).

CHAPTER 3

Data and methods

3.1 SAMPLE RECRUITMENT

In July 2021, the Environmental Protection Agency (EPA) and An Taisce's Environmental Education Unit (EEU) started a media campaign to publicise Clean Air Together (CAT) and requested those interested in participating to register on the dedicated website for CAT Dublin (cleanairtogether.ie). Participation was restricted to those aged 18+. Registration for CAT closed on Wednesday 22 September 2021, with a total of 2,250 participants registered. The next stage in recruitment involved dividing those who registered into separate groups of selected participants and non-selected participants. This was necessary because there were only 1,200 measurement tubes available. In essence, the allocation aimed to ensure that there was an even distribution of applicants across postcodes and, within each postcode area, a distribution of one-third in likely low risk zones and two-thirds in higher risk zones.[4] Selected participants were sent the NO_2 measurement pack and instructions on how to collect NO_2 measurements at their residence. Non-selected participants were not selected to participate in the nitrogen dioxide (NO_2) measurement process but were retained in the study. Like selected participants, they were invited to participate in three surveys (described in Section 3.2.1 below).

The assessment of whether applicants were located in a low- or high-risk zone was based on an analysis of the total (baseline) population, daytime population and distance from a road. For example, a high scoring location would have a relatively high baseline population and daytime population for its postcode, and it would be within 20m of a main road. The analysis then identified postcode areas that had more than 46 participants registered and flagged them as 'over-subscribed'. Within these over-subscribed areas, the 31 highest-risk-scoring applicants and 15 lowest-risk-scoring applicants were allocated a measurement tube. The remaining applicants were excluded from the NO_2 measuring component of the project (and are referred to as 'non-selected participants').

Postcode areas where there were fewer than 46 registered locations were flagged as 'under-subscribed'. In these cases, all applicants were allocated an NO_2 measurement tube (referred to as 'selected participants'). Applicants were

[4] Of the 35 postcode (eircode) areas in Dublin city and county, the number of applicants for CAT ranged from 1 to 161 (personal communication, An Taisce's EEU, 11 April 2023).

informed on 29 September 2021 whether or not they had been selected to participate (i.e., measure NO_2).[5]

This selection process resulted in a baseline sample of 1,186 selected participants and 1,064 non-selected participants. While not a focus of this study, 940 of the 1,186 selected participants installed NO_2 measurement tubes and received a value for NO_2 exposure at their registered address.[6]

3.2 SURVEY DATA

3.21 CAT surveys

All applicants were advised of the results of the selection process on 29 September 2021, and were invited to take part in the first CAT survey. Table A1 in Appendix A details the various communications received by participants in the subsequent year. Selected participants took their NO_2 measurements between 8 October and 5 November 2021, and were advised of their results on 10 March 2022. Both selected participants and non-selected participants were invited to attend a webinar on 11 March, at which the overall results were presented. Both selected and non-selected participants were invited to take part in the second survey on 28 March 2022, and the third and final survey on 26 September 2022. All surveys were conducted online and kept open for approximately four to six weeks. As illustrated in Table 3.1, the response rate to the first survey was 60.8 per cent among selected participants and 17.0 per cent among non-selected participants. There was considerable attrition over time in responses to the second and third surveys, with 196 selected participants responding to the third survey and just 84 non-selected participants responding to the third survey. Table 3.2 presents the data in a slightly different way; analysing patterns of response across all three surveys. The impact of attrition is particularly noticeable in this context, with very small numbers of selected and non-selected participants responding to all three surveys (n=48 and n=9 respectively).[7] Note that these figures exclude the small number of participants with duplicate responses,[8] as well as participants who did not provide information on age, gender or education.

---

5 Non-selected participants were not informed of the reason for their non-selection (i.e., that they were resident in an 'over-subscribed' area).

6 In Section 4.4, we examine selected participants' NO_2 measurement results and how they correlate with selected participants' expected measurement results and perceptions of air quality and health risks in their area.

7 In Appendix B we present the results of a probit model to test if education, age, gender or being a selected participant are predictors of attrition between Survey 1 and Survey 2; of the included characteristics, being female and a non-selected participant is associated with attrition, albeit only at the 10 per cent level of statistical significance.

8 In a small number of cases, respondents filled out the relevant survey more than once. For example, for the first survey of selected participants, three respondents filled out the survey twice. In these cases, we retain only the first recorded set of responses.

TABLE 3.1 NUMBER OF PARTICIPANTS AND RESPONSE RATES (%)

	Selected participants	Non-selected participants
Baseline sample	1,186	1,064
Survey 1 (6 October 2021)	721 (60.8%)	181 (17.0%)
Survey 2 (28 March 2022)	371 (31.3%)	162 (15.2%)
Survey 3 (26 September 2022)	196 (16.5%)	84 (7.9%)

Note: Response rate (% of baseline sample) is presented in parentheses.

TABLE 3.2 SAMPLE SIZES BY SURVEY PARTICIPATION PATTERN

	Survey 1 only	Survey 2 only	Survey 3 only	Survey 1 and 2 only	Survey 1 and 3 only	Survey 2 and 3 only	All waves
Selected participants	537	199	94	103	33	21	48
Non-selected participants	141	117	48	20	11	16	9

The three surveys contained sections relating to demographics, awareness, attitudes and behaviours (in relation to air quality). Most questions were repeated across all three surveys, although some questions were changed slightly in the second and third surveys, some additional questions were asked in the second and third surveys, and there were slight differences in the questions asked of selected participants and non-selected participants. To illustrate the type of questions asked, Appendix C reproduces the first survey that was fielded to selected participants.

3.2.2 Baseline RED C survey

As the recruitment of CAT participants was not random, there is no obvious control group that can be used to evaluate the impact of CAT participation on awareness, attitudes and behaviour in relation to air quality. However, in July 2021, as part of the EPA Life Emerald project,[9] RED C carried out a nationally representative survey of 1,005 individuals aged 18+ to gauge their awareness, attitudes and behaviours in relation to various environmental risks (including air pollution). Many of the questions fielded in the RED C survey were subsequently asked as part of the three CAT surveys. Where relevant, we use the data from the Dublin participants of the RED C survey to compare the responses of CAT participants to the first CAT survey with those of the wider Dublin population.

9 See https://www.epa.ie/environment-and-you/air/life-emerald/.

3.3 METHODS

As the recruitment of CAT participants was not random, and the sample sizes were too small, policy evaluation methods such as difference-in-difference analysis cannot be used to test the impact of CAT participation on awareness, attitudes or behaviours in relation to air quality. The analysis is therefore descriptive and answers the following detailed research questions:[10]

- How do CAT participants differ from the general Dublin population aged 18+ in terms of their demographic and socioeconomic characteristics (i.e., age, gender, highest level of education)?
- How do CAT participants differ from the general Dublin population aged 18+ in terms of their awareness, attitudes and behaviours in relation to air quality?
- Using data from the first two surveys (carried out over the period September 2021–April 2022), how did awareness, attitudes and behaviours in relation to air quality of CAT participants change over the period September 2021–April 2022?[11]

[10] For the analyses of changes in attitudes, awareness and behaviours in relation to air quality, statistical tests are used to test for statistically significant differences in responses over time (see Section 4.3 for further details).

[11] As explained in Section 4.3, the attrition rate was too high to enable analysis of the responses from the third survey (conducted in September 2022).

CHAPTER 4

Results

4.1 PROFILE OF CAT DUBLIN PARTICIPANTS (FIRST SURVEY)

In this chapter, we describe how selected and non-selected participants of Clean Air Together (CAT) differ from the general Dublin population aged 18+ in terms of their demographic and socioeconomic characteristics, i.e., age, gender and level of education. Data from the first CAT Dublin surveys of selected and non-selected participants in September 2021 are compared with the 18+ Dublin population using data from the 2016 Census of Population.[12]

In Figure 4.1, we show how the age (panel A), gender (panel B) and education (panel C) of CAT respondents (selected and non-selected participants) of the first surveys differ from the age, gender and education of the general Dublin population aged 18+.[13] While the data on the general Dublin population aged 18+ are from the 2016 Census of Population (i.e., five years prior to the CAT Dublin data collection), the data provide an assessment of how CAT Dublin participants differ from the general Dublin population aged 18+. As is evident from the data, higher proportions of CAT Dublin participants are in the middle age groups in comparison with the general Dublin population aged 18+. For example, just under 50 per cent of the Dublin population aged 18+ are aged between 35 and 64 years of age, compared to nearly 72 per cent of CAT Dublin selected participants. The age distribution is even more marked for the CAT Dublin non-selected participants, although the CAT Dublin non-selected participant data are based on a small number of observations overall (n=181). The gender profile of CAT Dublin participants is similar to that of the general Dublin population aged 18+ (although relatively more females than males who were CAT Dublin non-selected participants completed the first CAT survey).

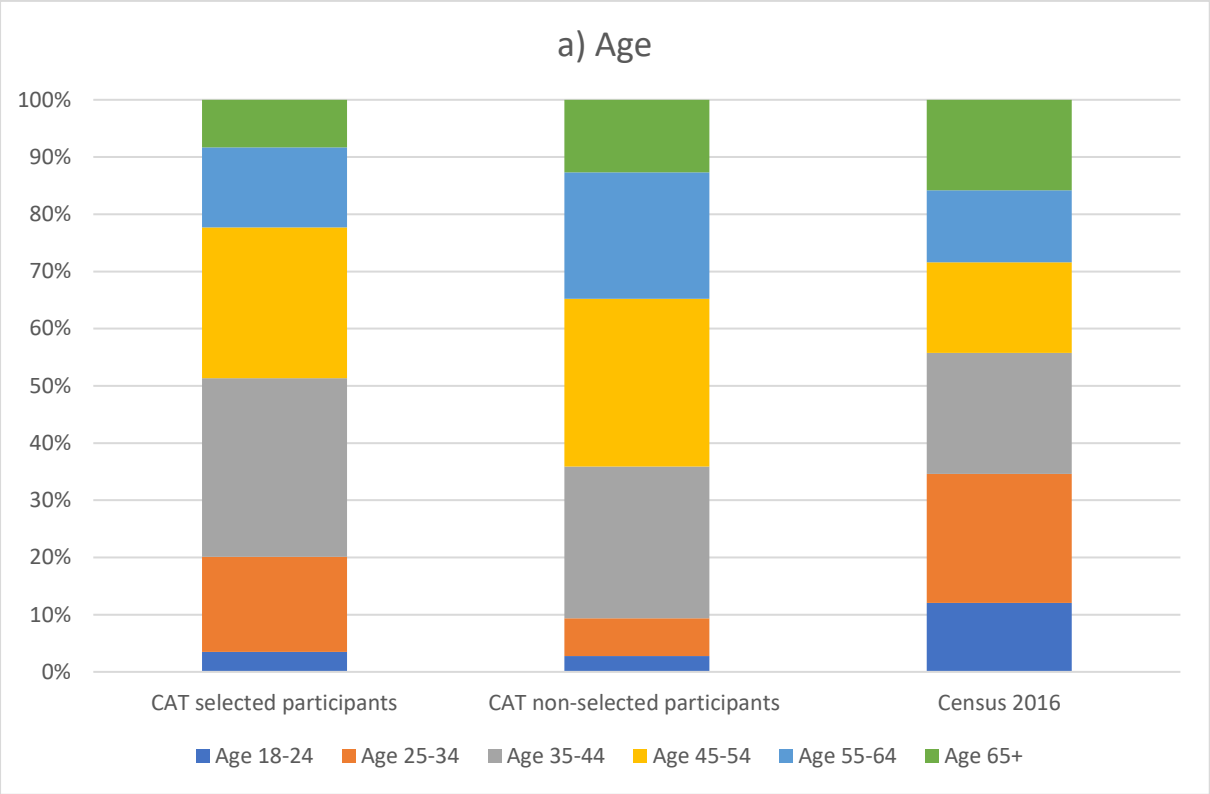
What is most striking about CAT Dublin participants is their high levels of education; nearly half of CAT Dublin selected participants have a postgraduate qualification, compared to less than 10 per cent of the general Dublin population aged 15+. While educational attainment is likely to have continued to increase for the general Dublin population since the last Census in 2016, and nearly 20 per cent of Census 2016 Dublin population did not state their highest level of education (or

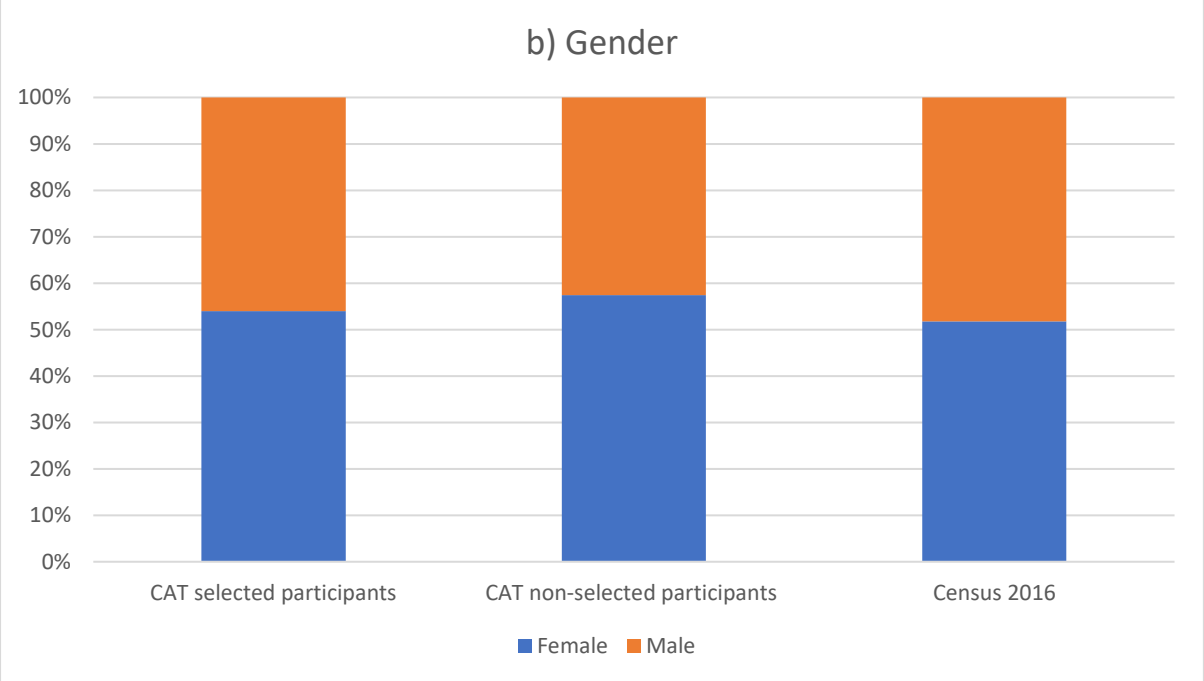
12 At time of writing, data from Census 2022 were not yet available.

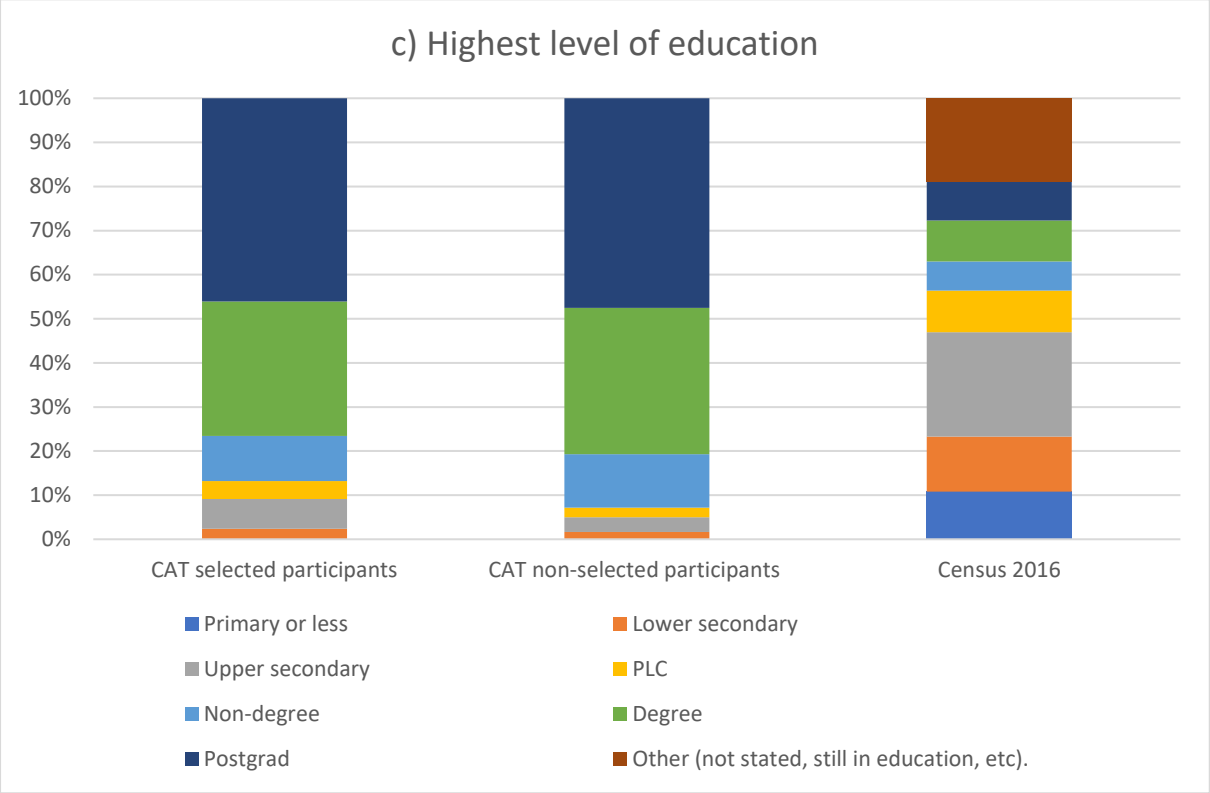
13 See Figure D1 in Appendix D for a comparison with the Dublin 18+ respondents in the July 2021 national RED C survey.

were still in education), it is clear that CAT Dublin participants are a highly educated group in comparison with the wider Dublin adult population.

FIGURE 4.1 DEMOGRAPHIC AND SOCIOECONOMIC PROFILE OF CAT DUBLIN SURVEY RESPONDENTS AND DUBLIN POPULATION 18+ FROM CENSUS 2016





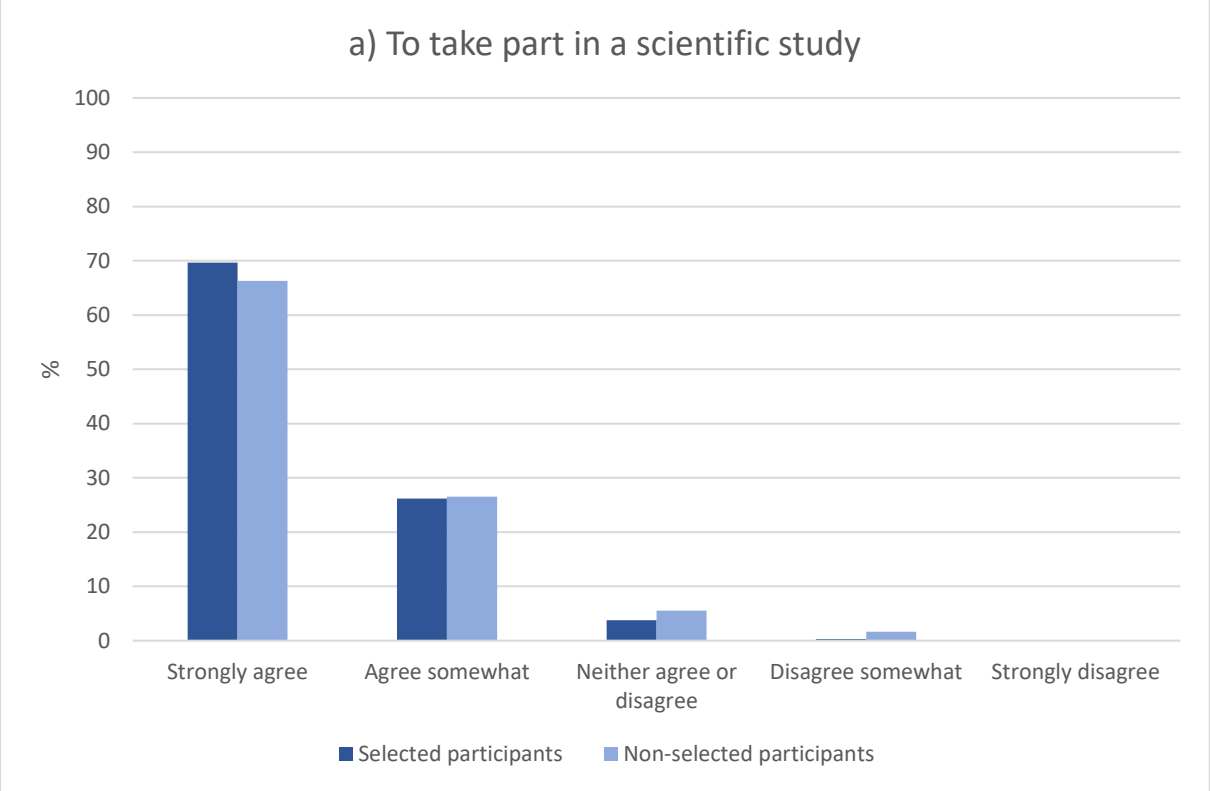


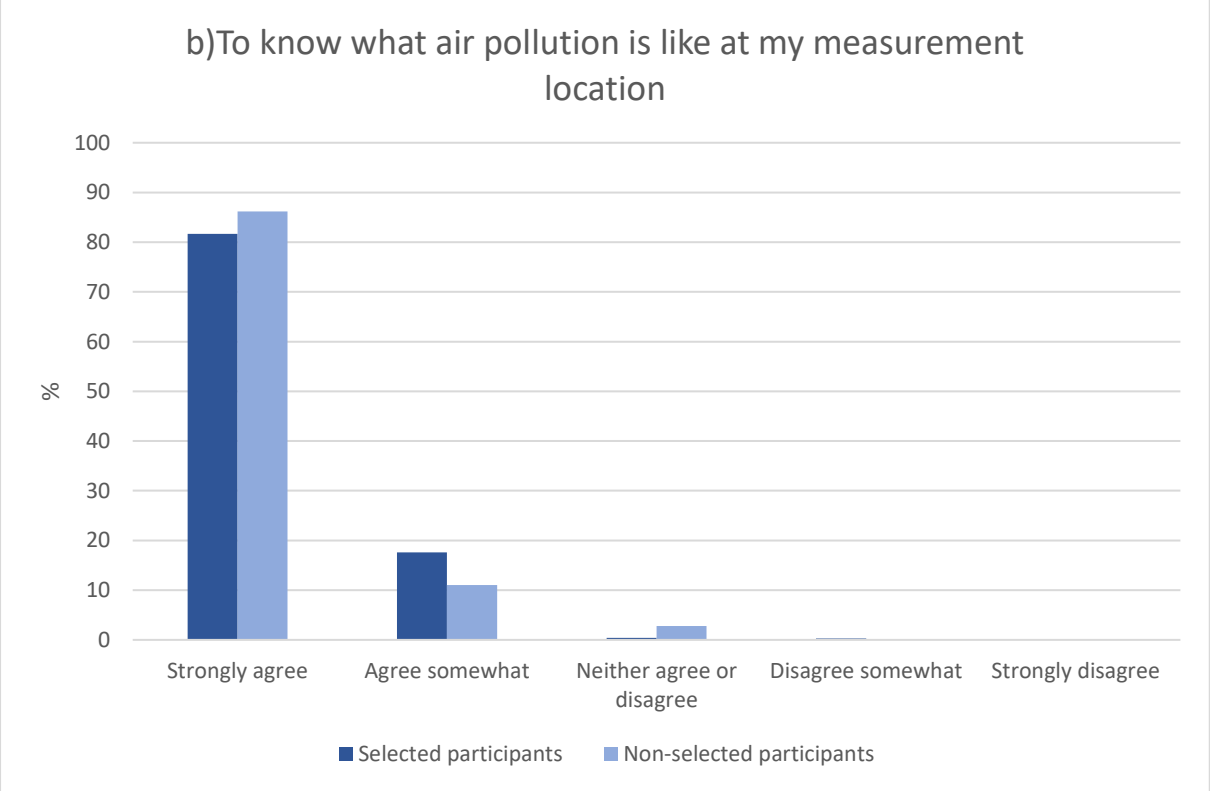
Notes: Data for CAT selected participants are from the first survey of 721 respondents, while data for CAT non-selected participants are from the first survey of 181 respondents (see also Table 3.1).
Data for the general 18+ Dublin population are from the 2016 Census of Population as follows: Age: https://data.cso.ie/table/E3004; Gender: https://data.cso.ie/table/E3004; Education: https://data.cso.ie/table/EA019. The Census of Population education tabulations include a number of additional categories (e.g., still in education) that are aggregated to a single 'other' category here.

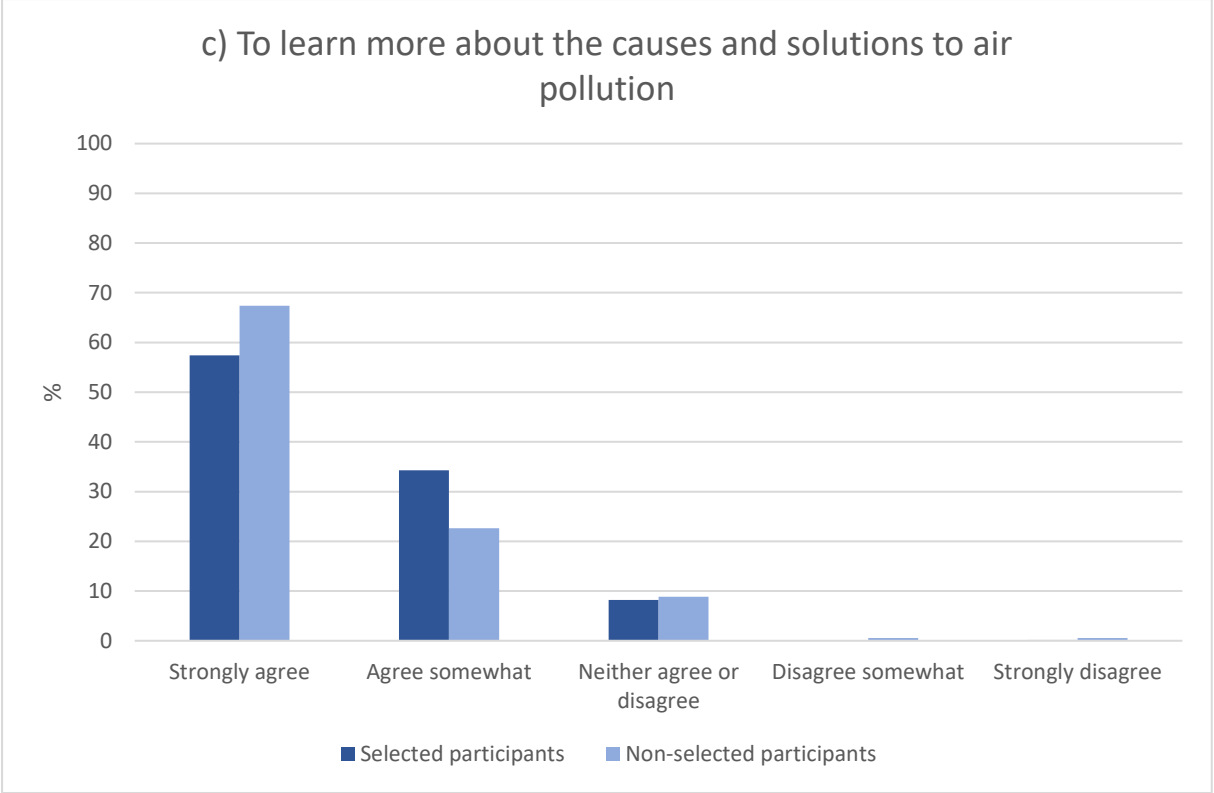
The CAT Dublin surveys also include some questions on the reasons why respondents participated in CAT. Both selected and non-selected participants were asked '*Why are you participating in Clean Air Together?*' with five statements listed (and possible responses ranging from 'strongly agree' to 'strongly disagree'). As illustrated in Figure 4.2, panels A to E, CAT participants expressed high levels of agreement with all statements, reflecting their high level of engagement with the study. Overall, the greatest motivation for participation was the desire to know about air pollution levels at their measurement location, with 82 per cent of selected participants 'strongly agreeing' with the statement 'I want to know what air pollution is like at my measurement location'.[14]

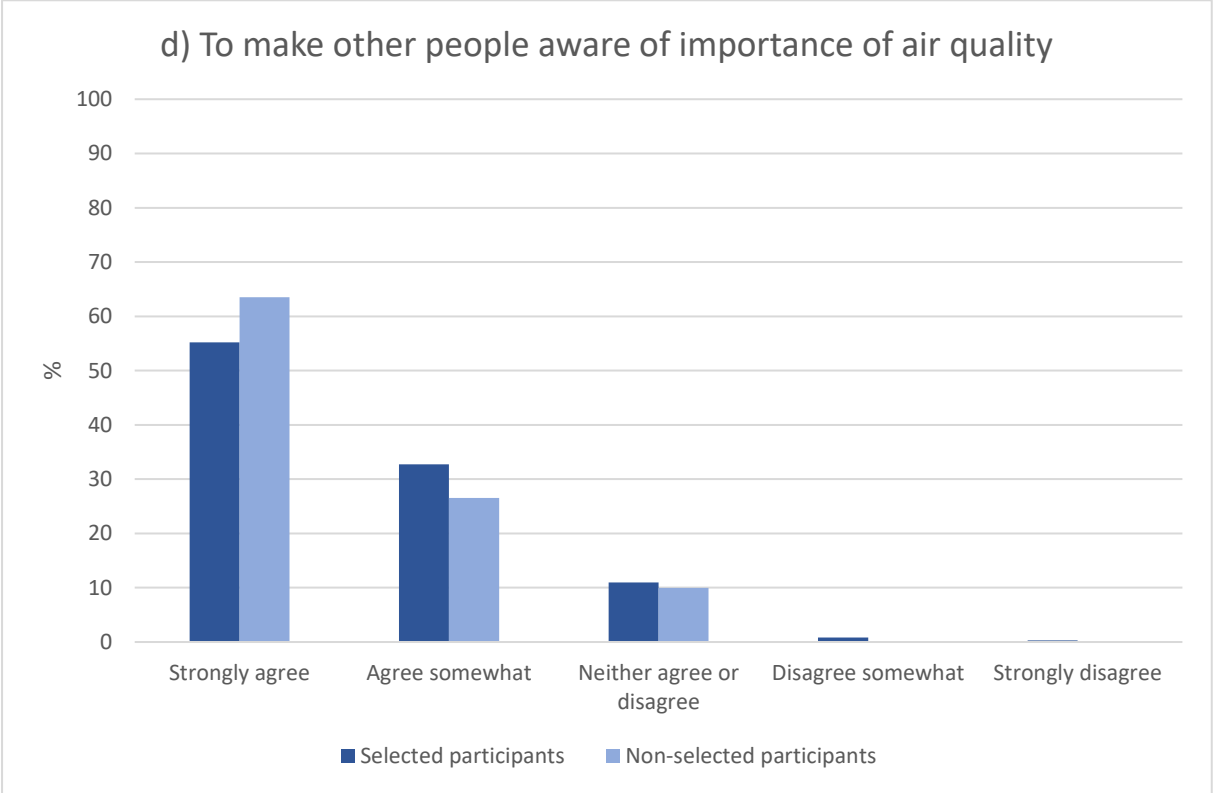
[14] The proportion of non-selected participants (i.e., those who did not get selected to receive a measurement tube) who completed the first survey and who responded 'strongly agree' was even higher, at 86 per cent.

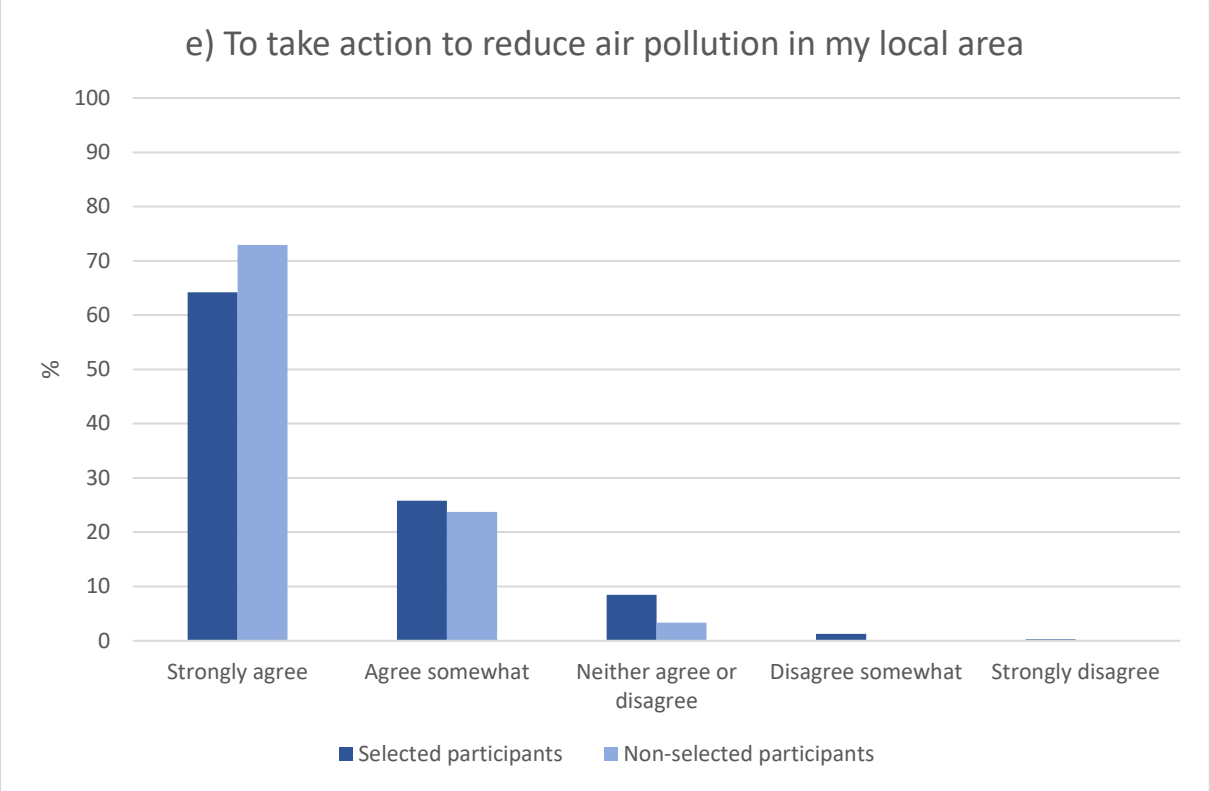
FIGURE 4.2 REASONS FOR PARTICIPATING IN CAT DUBLIN






c) To learn more about the causes and solutions to air pollution
100
90
80
70
60
50
40
30
20
10
0
%
Strongly agree
Agree somewhat
Neither agree or disagree
Disagree somewhat
Strongly disagree
Selected participants
Non-selected participants


d) To make other people aware of importance of air quality
100
90
80
70
60
50
40
30
20
10
0
%
Strongly agree
Agree somewhat
Neither agree or disagree
Disagree somewhat
Strongly disagree
Selected participants
Non-selected participants



4.2 AWARENESS, ATTITUDES AND BEHAVIOURS OF CAT SURVEY RESPONDENTS (FIRST SURVEY)

In this section, we use data from the first survey of CAT participants in September 2021 to document their awareness, attitudes and behaviours in relation to air quality. Where possible, we benchmark these responses against similar questions asked in the national RED C survey in July 2021.

4.2.1 Awareness and attitudes

Focusing on attitudinal and awareness questions where responses can be benchmarked against the national RED C survey in July 2021, CAT respondents were first asked:

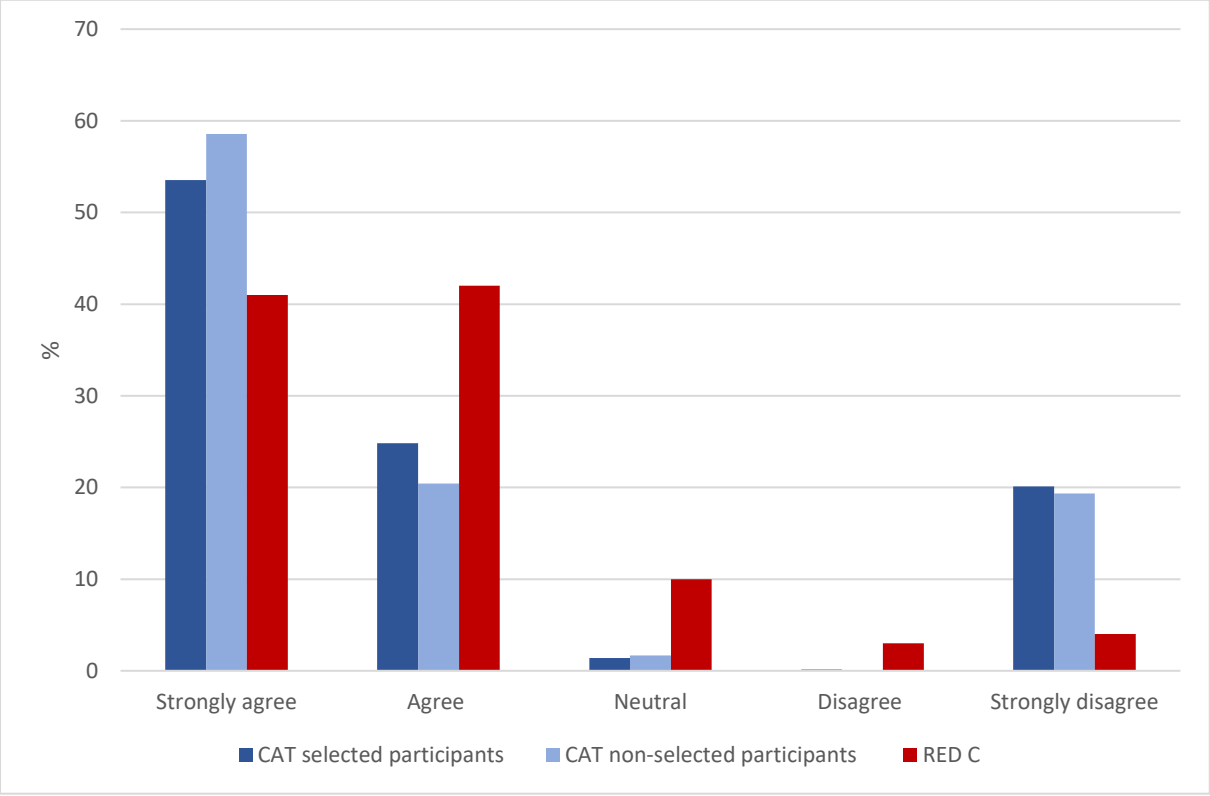
How strongly do you agree or disagree with the following statement? Air pollution poses a serious health risk to the public.

The format of the question in the RED C survey was somewhat different in that respondents were asked, *'How strongly do you agree or disagree with each of the following statements about air quality?'* Eight statements were given, one of which was the same statement fielded to CAT respondents (*'Air quality poses a serious*

health risk to the public'). Response categories were also slightly different.[15] Figure 4.3 illustrates the responses to the question for CAT Dublin participants, compared with responses provided by Dublin residents in the national RED C survey in July 2021.

In general, CAT participants expressed similar levels of agreement with the statement that air pollution poses a serious health risk to the public. Nearly 80 per cent of CAT participants (both selected and non-selected) strongly agreed or agreed with the statement, while the corresponding proportion for RED C respondents was 83 per cent. While the overall level of agreement was similar, the strength of the agreement was stronger among CAT participants, who were more likely to 'strongly agree' with the statement. While none of the RED C respondents 'strongly disagreed' with the statement, approximately 20 per cent of CAT participants did so. In Section 4.3, we return to this question to assess whether responses of CAT selected participants changed after they had participated in NO_2 measurement and received their measurement results, and had received information about NO_2 via infographics and the results webinar.

FIGURE 4.3 'AIR POLLUTION POSES A SERIOUS HEALTH RISK TO THE PUBLIC'



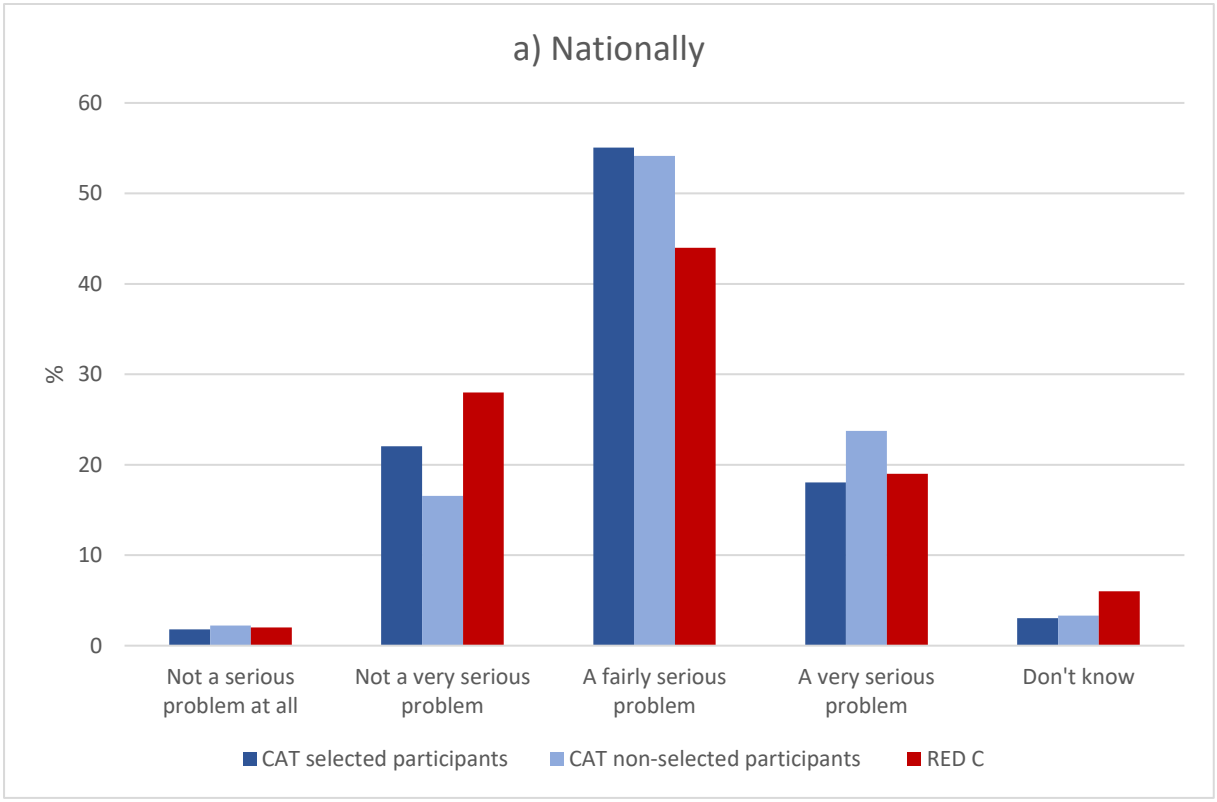
[15] In CAT, the available response categories were: strongly disagree, disagree, neutral, agree and strongly agree. In RED C, the available response categories were: strongly agree, agree somewhat, neither agree nor disagree, disagree somewhat, strongly disagree and don't know.

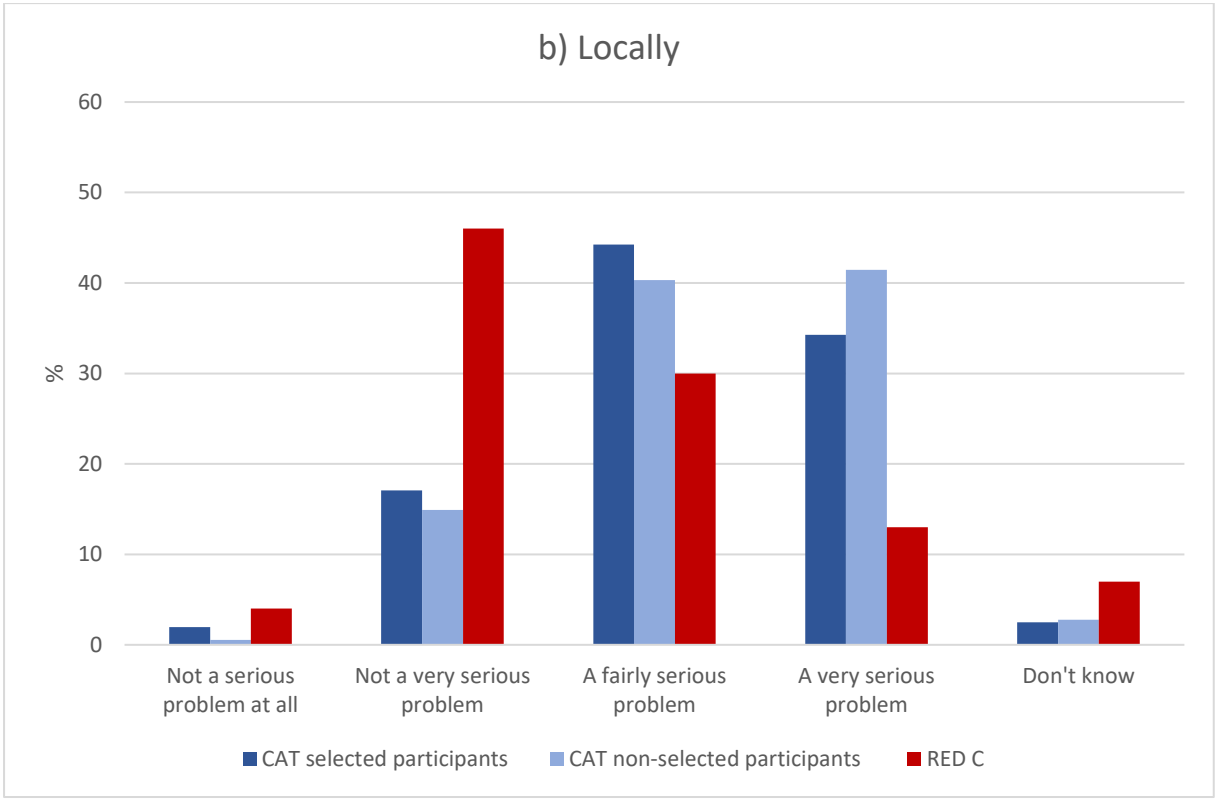
CAT respondents were then asked, '*How much of a problem do you believe air pollution is?*' Respondents were asked to consider responses 'nationally', 'in your local area' and 'Dublin' (RED C respondents were asked to consider responses 'nationally' and 'in your local area' only).[16] Figure 4.4 illustrates the responses to the question, compared with responses provided by Dublin residents in the national RED C survey in July 2021.

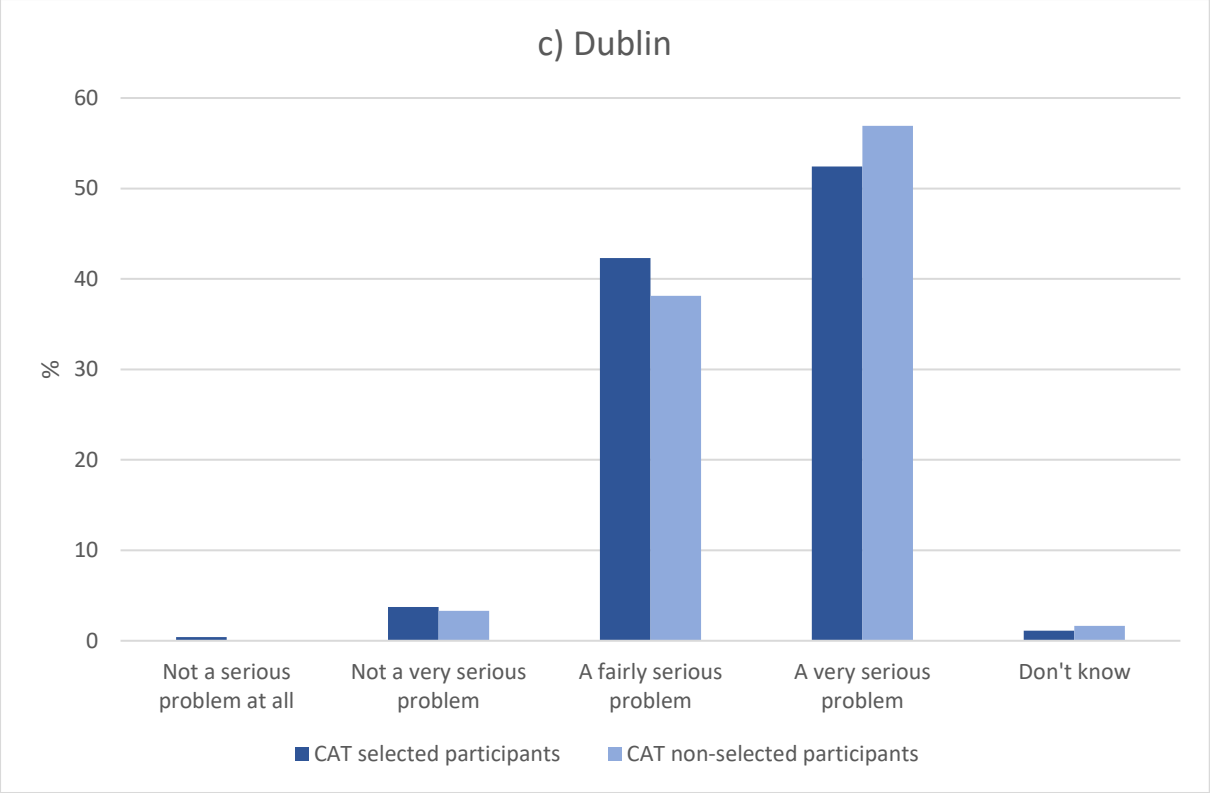
Looking first at the response to the question concerning air pollution on a national level, in general, higher proportions of CAT respondents rated air pollution as a very serious or fairly serious problem than RED C Dublin respondents (73 per cent and 78 per cent for CAT selected and non-selected participants respectively vs. 63 per cent for RED C respondents). Regarding responses to the 'local area', differences between CAT respondents and RED C respondents are more striking; 43 per cent of RED C respondents felt that air pollution was a very or fairly serious problem in their local area, compared to 79 per cent of CAT selected participants (the corresponding proportion for CAT non-selected participants was slightly higher again, at 82 per cent). Overall, CAT participants rated air pollution a very serious or fairly serious problem both nationally and in their local area, with more variation in the assessment of the seriousness of the problem among RED C respondents, depending on the area considered (national or local).

16 The RED C question wording was also slightly different: '*How much of a problem, if at all, do you believe poor air quality / air pollution is?*'

FIGURE 4.4 'HOW MUCH OF A PROBLEM DO YOU BELIEVE AIR POLLUTION IS?'



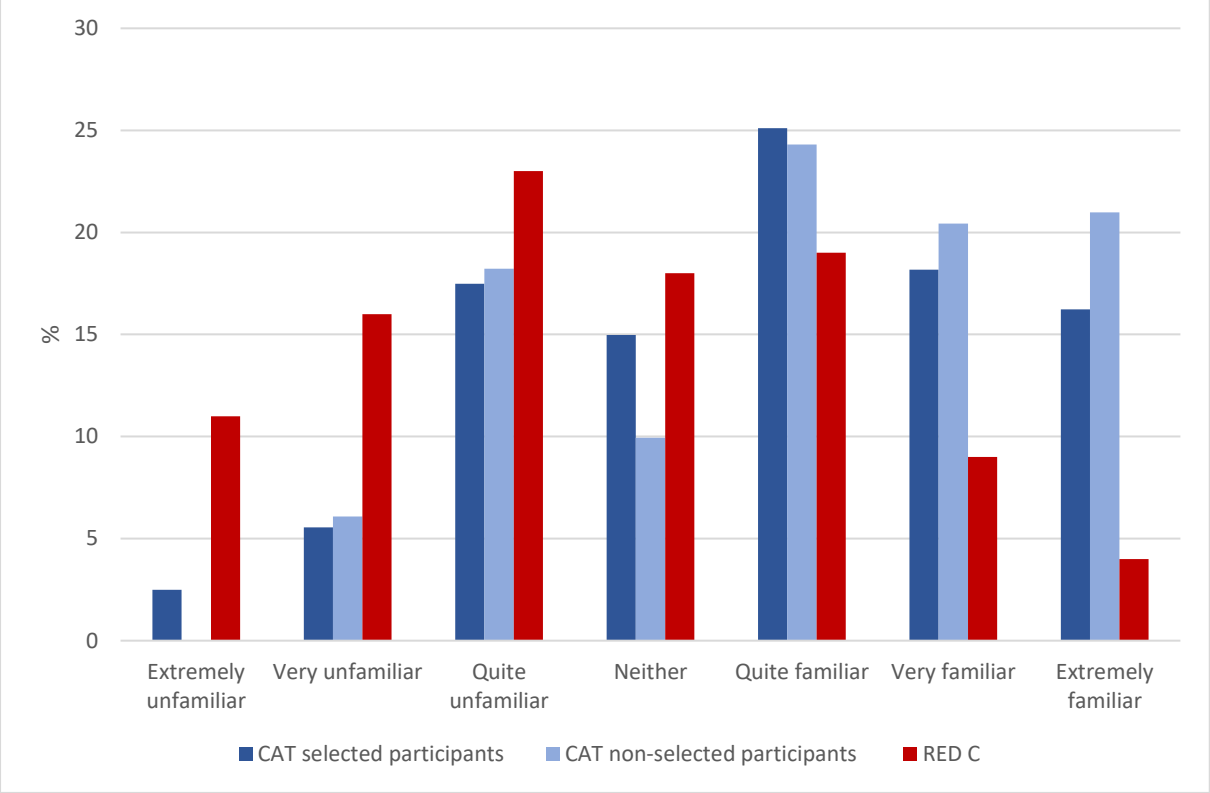




Finally, while a comparison with the RED C sample cannot be made, CAT respondents were also very concerned with air pollution in Dublin, with approximately 95 per cent responding that air pollution was a very or fairly serious problem in Dublin.

Respondents to both the CAT Dublin surveys and the RED C survey were asked to rate their familiarity with a list of environmental risks, including NO_2 (see Figure 4.5). CAT participants were much more familiar with NO_2 as an environmental risk than the Dublin respondents to the RED C survey; while 13 per cent of RED C respondents were extremely or very familiar with NO_2, the corresponding proportion among CAT selected participants was 34 per cent (and was higher again among CAT non-selected participants, at 41 per cent). Figure E1 in Appendix E presents corresponding data for the other five environmental risks considered: carbon monoxide (CO), E. coli, lead in drinking water, radon and particulate matter.

FIGURE 4.5 FAMILIARITY WITH NO_2

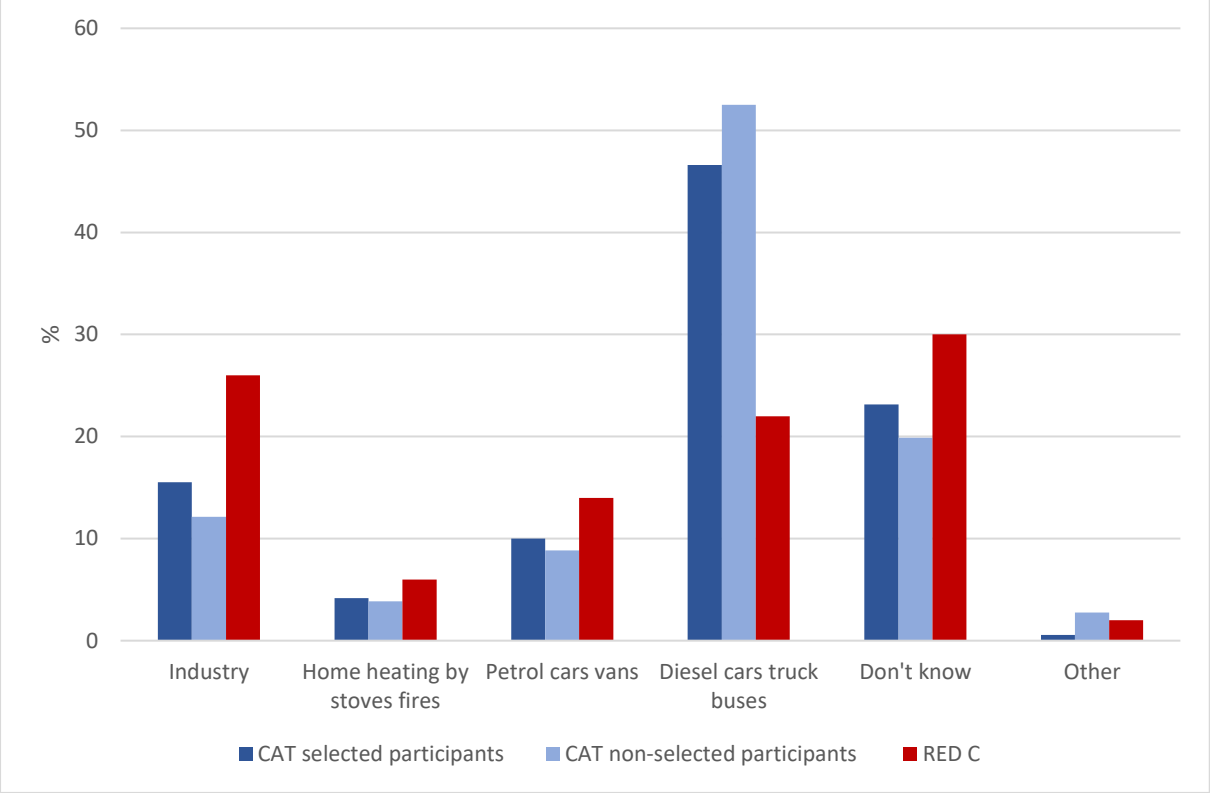


CAT respondents were then asked, '*Which of the following do you think is the most significant source of emissions of nitrogen dioxide (NO_2) in Ireland*?' Six response options were provided: industry, home heating by stoves/fires, petrol cars/vans, diesel cars/trucks/buses, don't know and other.[17] Figure E2 in Appendix E provides the corresponding data for the most significant source of particulate matter.

As is evident from Figure 4.6, higher proportions of CAT Dublin participants identified correctly that diesel cars/trucks/buses comprise the most significant source of NO_2 emissions in Ireland. However, across all three sets of respondents, a sizeable minority reported that they did not know the most significant source of NO_2 emissions in Ireland (between 20 and 30 per cent).

17 In the RED C survey, other was replaced with 'something else'.

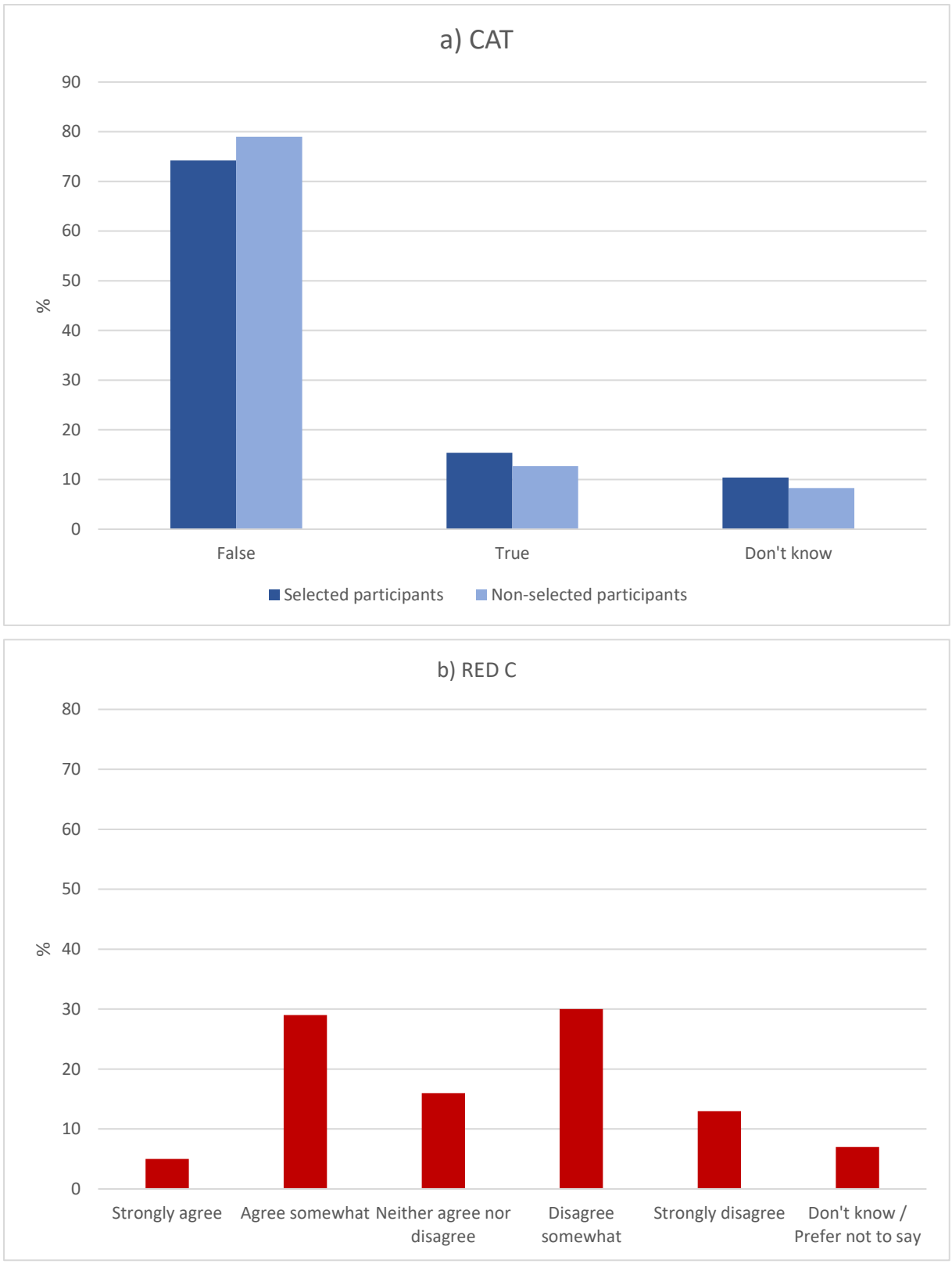
FIGURE 4.6 MOST SIGNIFICANT SOURCE OF EMISSIONS OF NO_2 IN IRELAND



Next, we examine responses to similar attitudinal and awareness questions that were asked of CAT and RED C respondents, but which are not directly comparable due to differences in question wording/framing and response categories. CAT respondents were asked, '*For each of the statements below, tell us if you think it is 'true', 'false' or whether you 'don't know*". The first statement – '*Poor air quality is only a problem in and around cities*' – was also asked of RED C respondents, but there the reference was to air pollution rather than poor air quality, and the response categories were very different.[18] Figure 4.7 (panels A and B) present the results for the two surveys separately. CAT participants, illustrated in panel A, (correctly) reject overwhelmingly the statement that 'poor air quality is only a problem in and around cities' with over three-quarters of participants regarding this statement as 'false'. While not directly comparable due to differences in question context and response categories, the responses to the RED C survey suggest a lower level of awareness of the risks of air pollution, with 43 per cent of respondents reporting that they 'somewhat disagree' or 'disagree strongly' that 'air pollution is only a problem in and around cities'.

[18] The response categories in the RED C survey were 'strongly agree', 'somewhat agree', 'neither agree nor disagree', 'somewhat disagree', 'strongly disagree' and 'don't know'. In CAT, respondents were asked whether the statements were 'true', 'false' or 'don't know'.

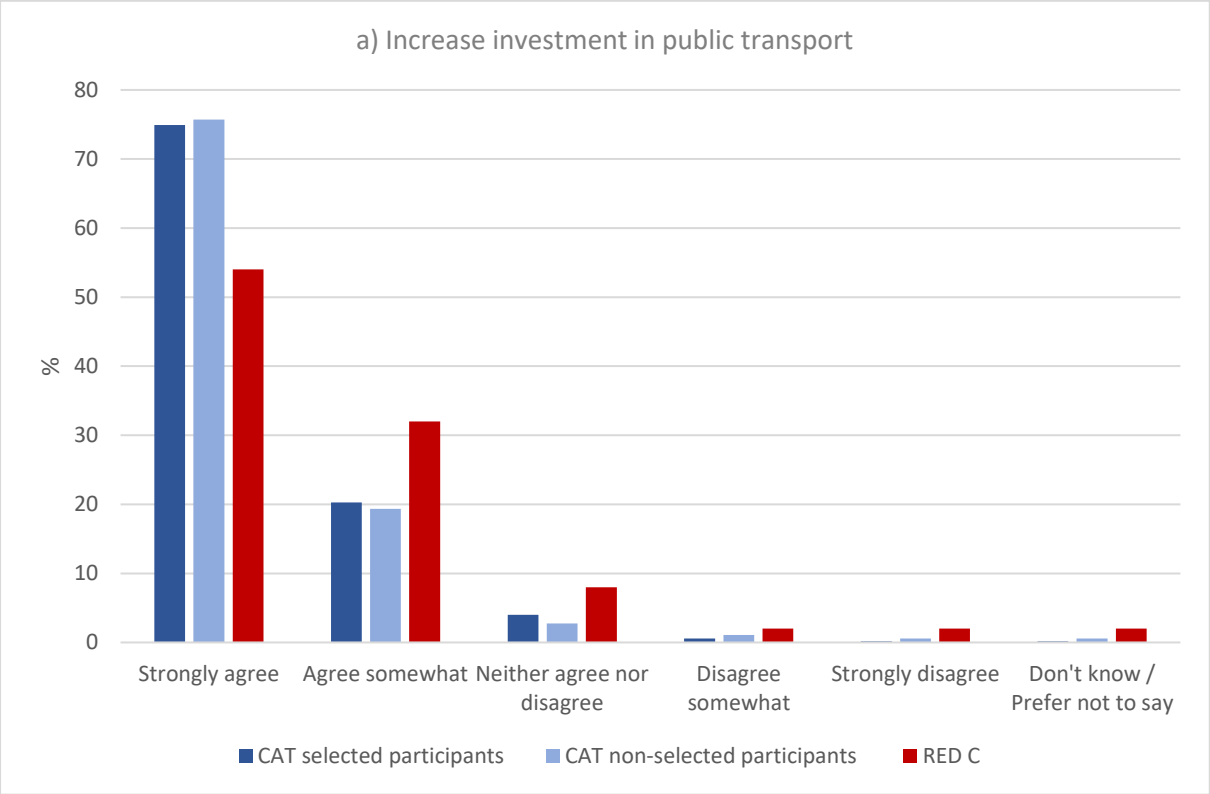
FIGURE 4.7 'POOR AIR QUALITY IS ONLY A PROBLEM IN AND AROUND CITIES'

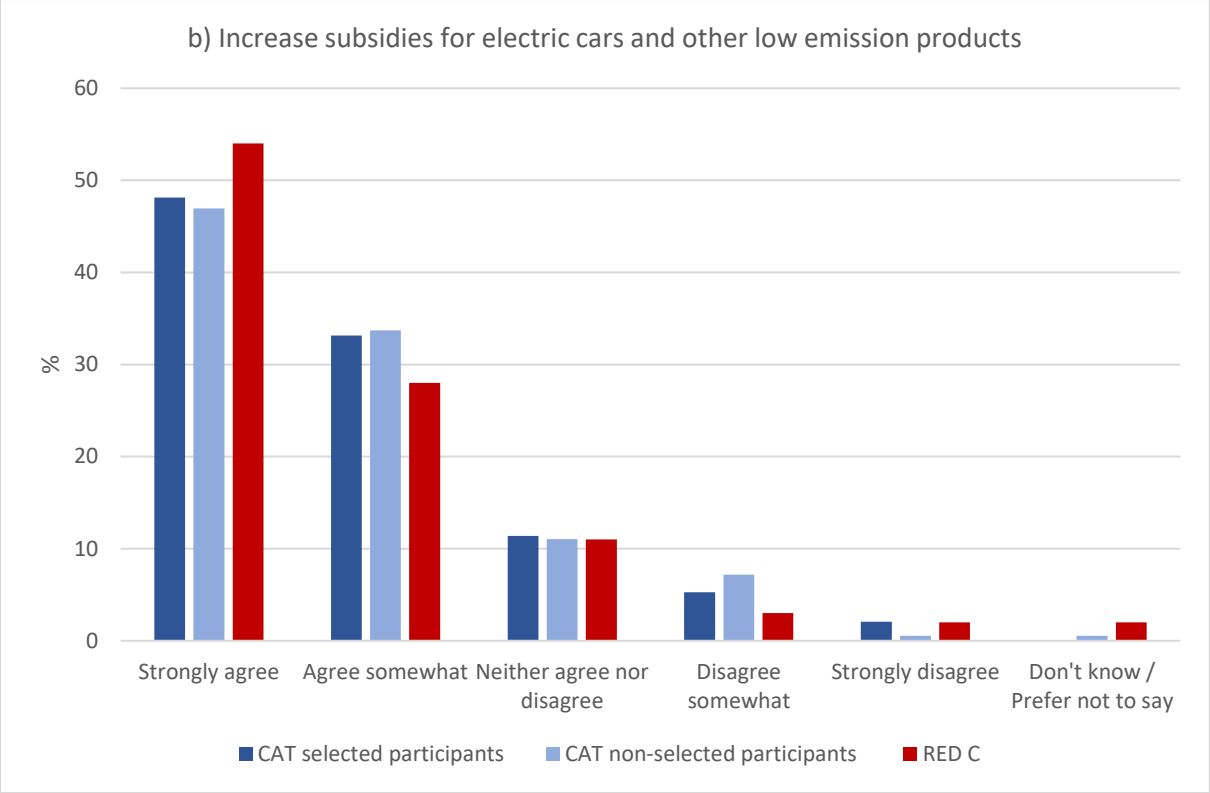


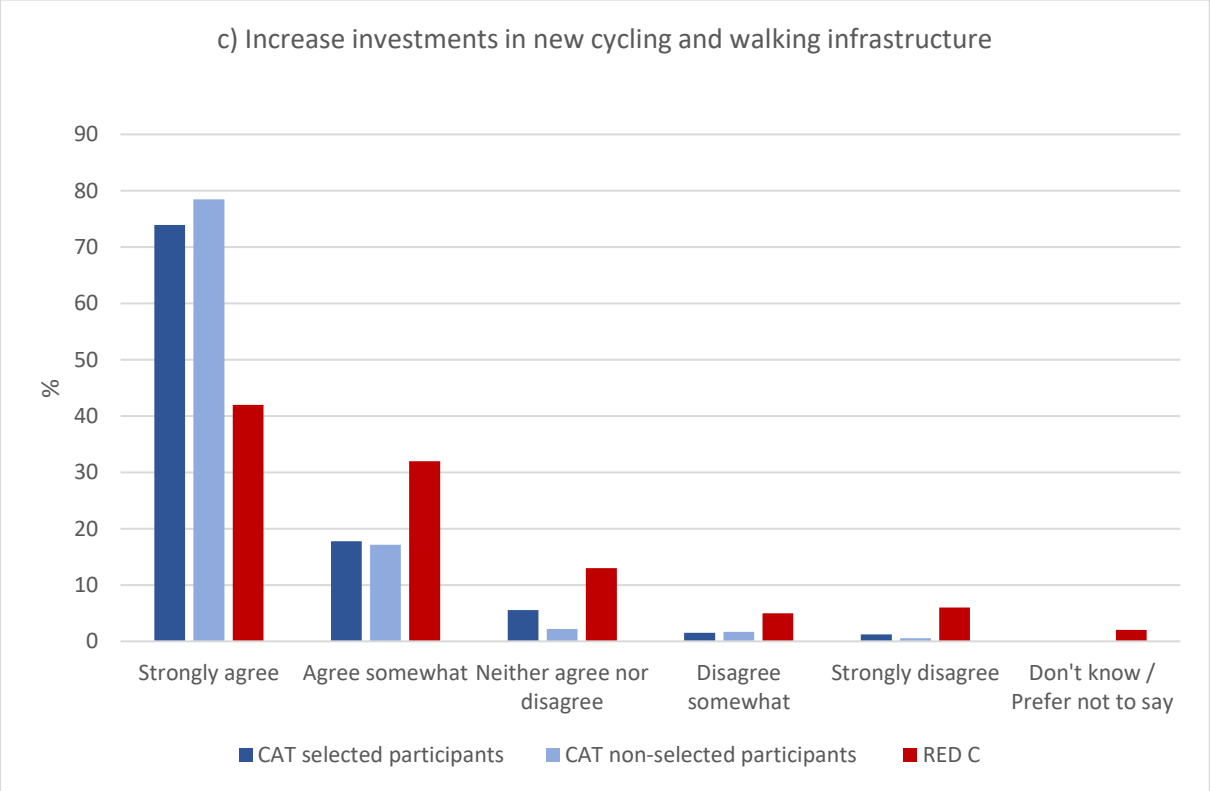
Finally, respondents to CAT and RED C were asked similar questions about potential policy options for reducing air pollution levels. CAT respondents were asked, '*What*

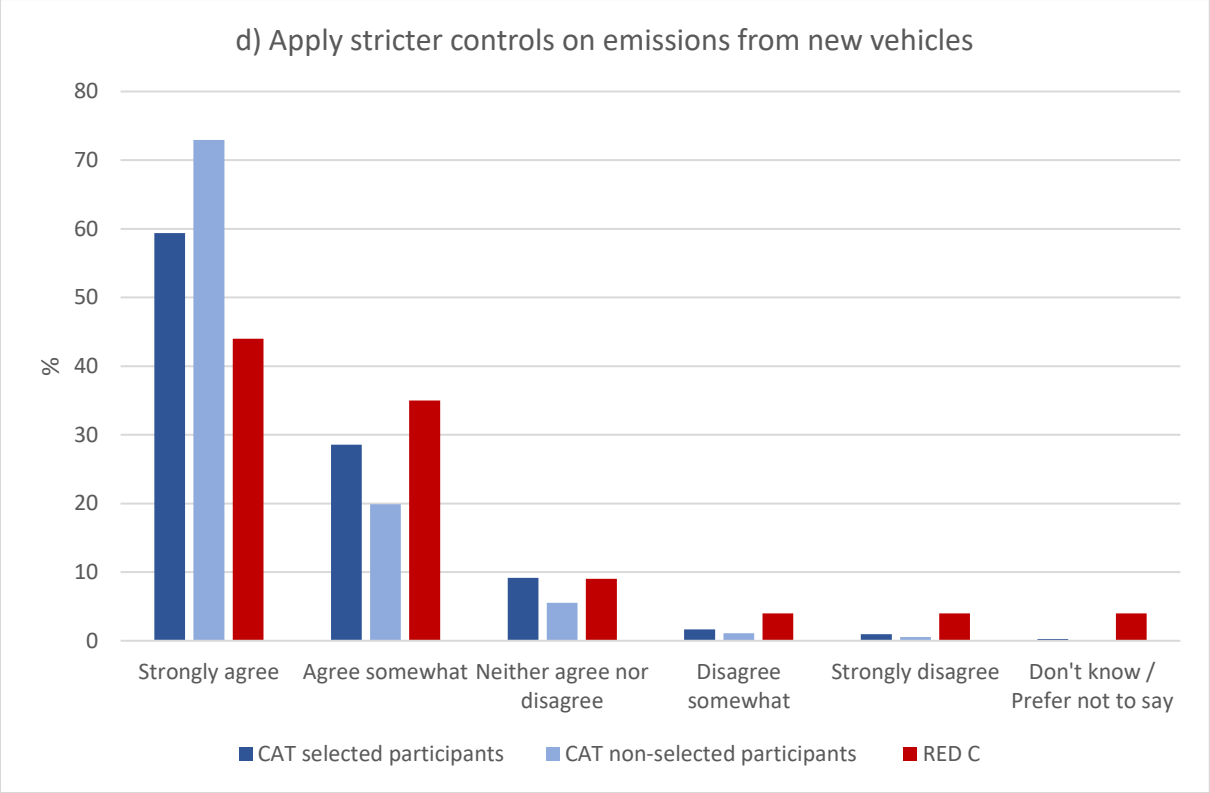
changes would you like to see happen at policy level to reduce air pollution levels in Dublin?' Six policy options were put forward, and respondents were asked to indicate their level of agreement (from 'strongly agree' to 'strongly disagree') for each option. In RED C, respondents were asked '*How strongly do you agree or disagree with each of the following possible policy options relating to transport impacting on air quality?*', with seven policy options put forward. Figure 4.8 shows that CAT Dublin participants are in general much more supportive of all policy measures than the general Dublin population. The exception was the policy to 'increase subsidies for electric cars and low emission products', where a similar proportion (around 81–82 per cent) of respondents from the two surveys 'strongly agreed' or 'agreed' with the policy option. Across all options common to both the CAT and RED C surveys, the policy options that involved increased investment by the State (options A to C) were more favoured than those that involved potential curbs on individual choice and behaviour (e.g., via congestion charging or banning the sale of new petrol and diesel vehicles from 2030).

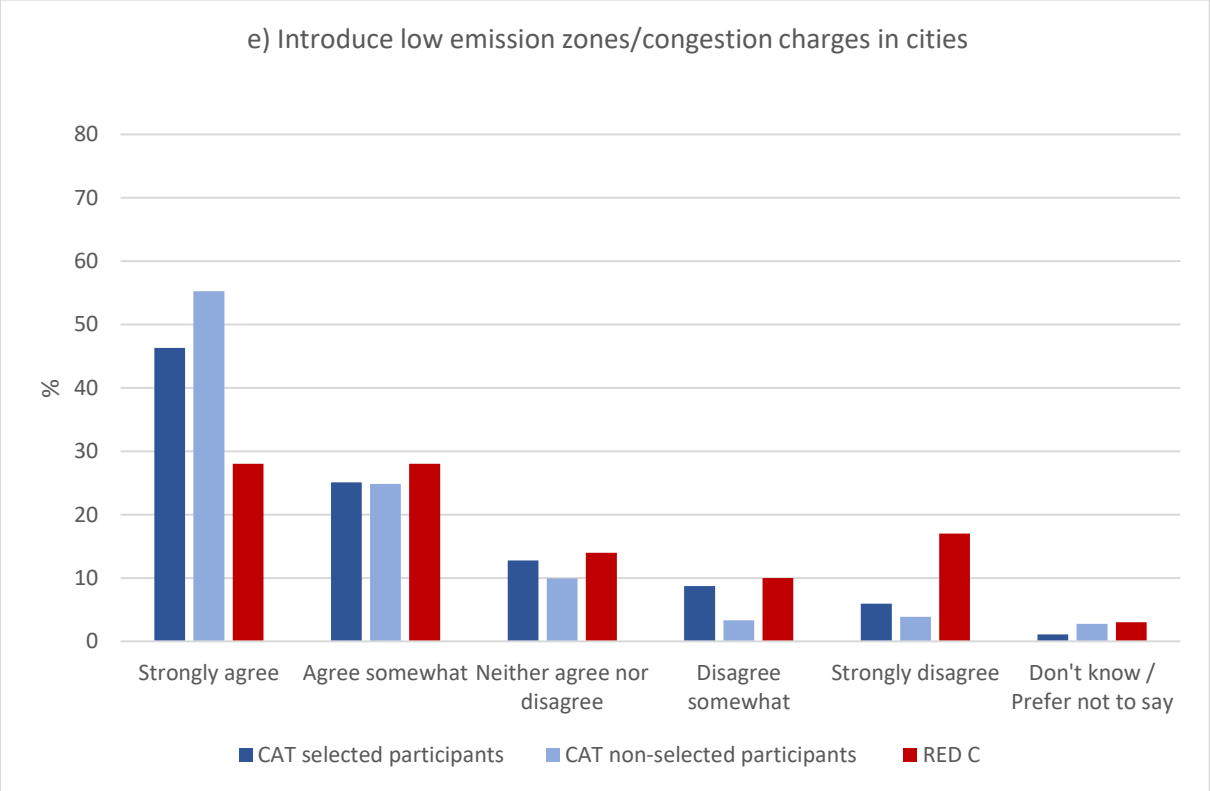
FIGURE 4.8 POLICY OPTIONS TO REDUCE AIR POLLUTION

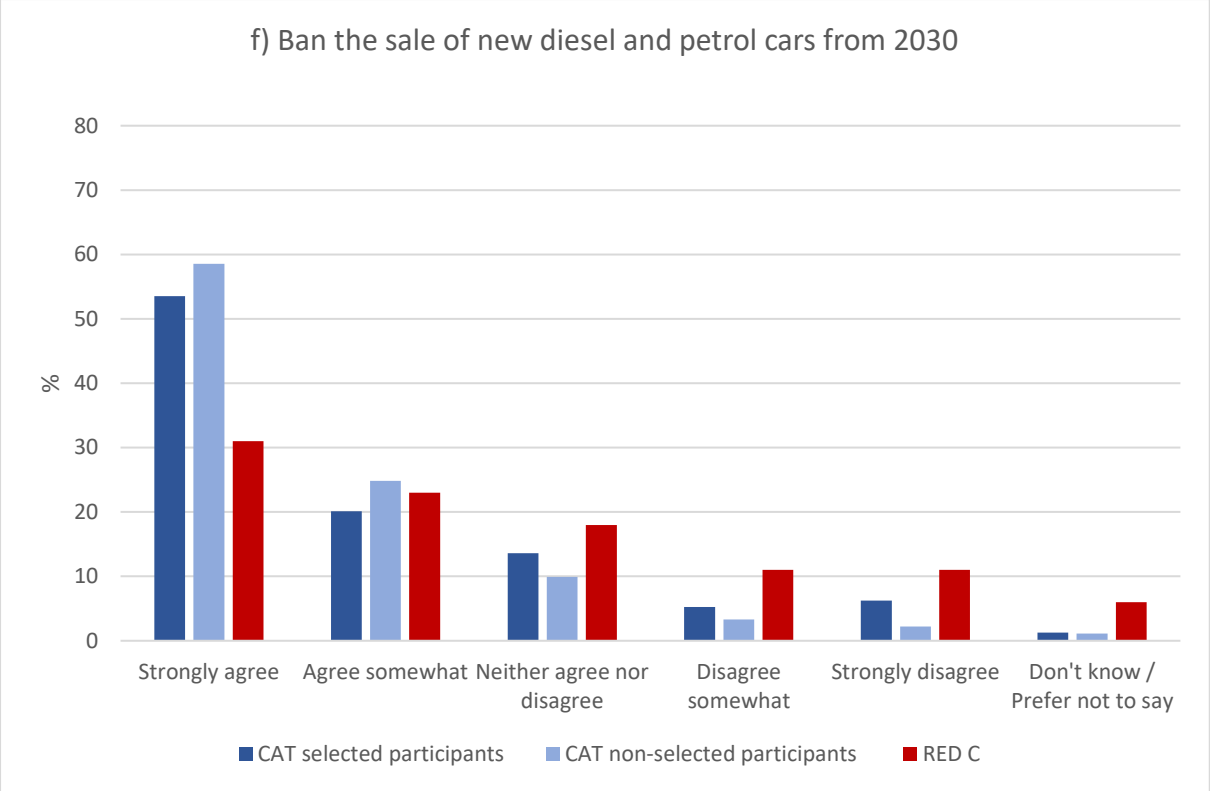



b) Increase subsidies for electric cars and other low emission products
60
50
40
30
20
10
0
%
Strongly agree
Agree somewhat
Neither agree nor disagree
Disagree somewhat
Strongly disagree
Don't know / Prefer not to say
CAT selected participants
CAT non-selected participants
RED C


c) Increase investments in new cycling and walking infrastructure
90
80
70
60
50
40
30
20
10
0
%
Strongly agree
Agree somewhat
Neither agree nor disagree
Disagree somewhat
Strongly disagree
Don't know / Prefer not to say
CAT selected participants
CAT non-selected participants
RED C


d) Apply stricter controls on emissions from new vehicles
80
70
60
50
40
30
20
10
0
%
Strongly agree
Agree somewhat
Neither agree nor disagree
Disagree somewhat
Strongly disagree
Don't know / Prefer not to say
CAT selected participants
CAT non-selected participants
RED C


e) Introduce low emission zones/congestion charges in cities
80
70
60
50
40
30
20
10
0
%
Strongly agree
Agree somewhat
Neither agree nor disagree
Disagree somewhat
Strongly disagree
Don't know / Prefer not to say
CAT selected participants
CAT non-selected participants
RED C



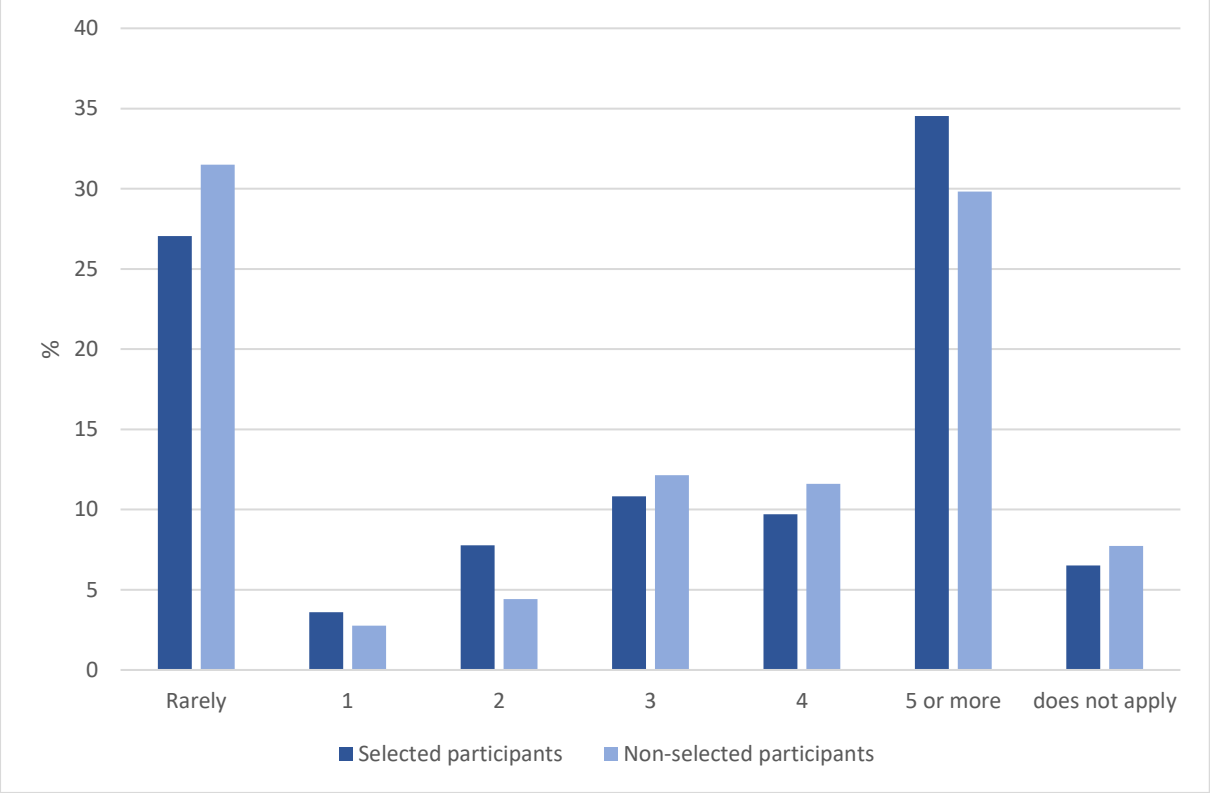
4.2.2 Behaviours

CAT participants were asked a number of questions about behaviours (either current or planned), covering issues such as working from home, usual modes of transport and planned changes to mobility (these questions were not asked of RED C respondents).[19] In the first instance, CAT participants were asked, 'on average, how many days per week do you work from home?' At that time (September 2021), over one-third of participants worked from home for five or more days per week (Figure 4.9). This reflects public health advice at the time, in which work from home guidance was still in place, except for specific business requirements.[20]

[19] We do not analyse responses to the question in which respondents were asked about changes to their mobility they were considering over the next 12 months due to the multiple combinations of options available (i.e., respondents could tick as many of the eight options as they wished).

[20] See https://www.gov.ie/en/speech/eef37-speech-by-the-taoiseach-micheal-martin-covid-19-reframing-the-challenge-continuing-our-recovery-reconnecting/.

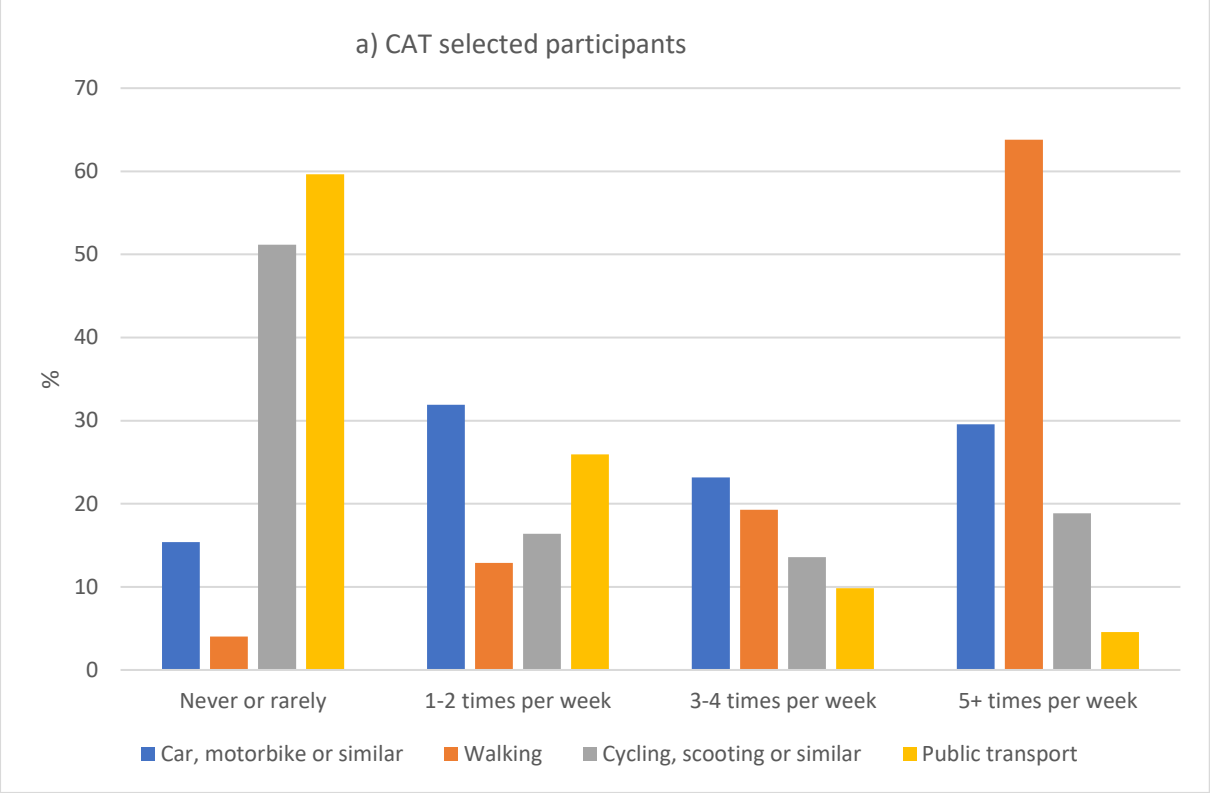
FIGURE 4.9 WORKING FROM HOME (NUMBER OF DAYS PER WEEK)

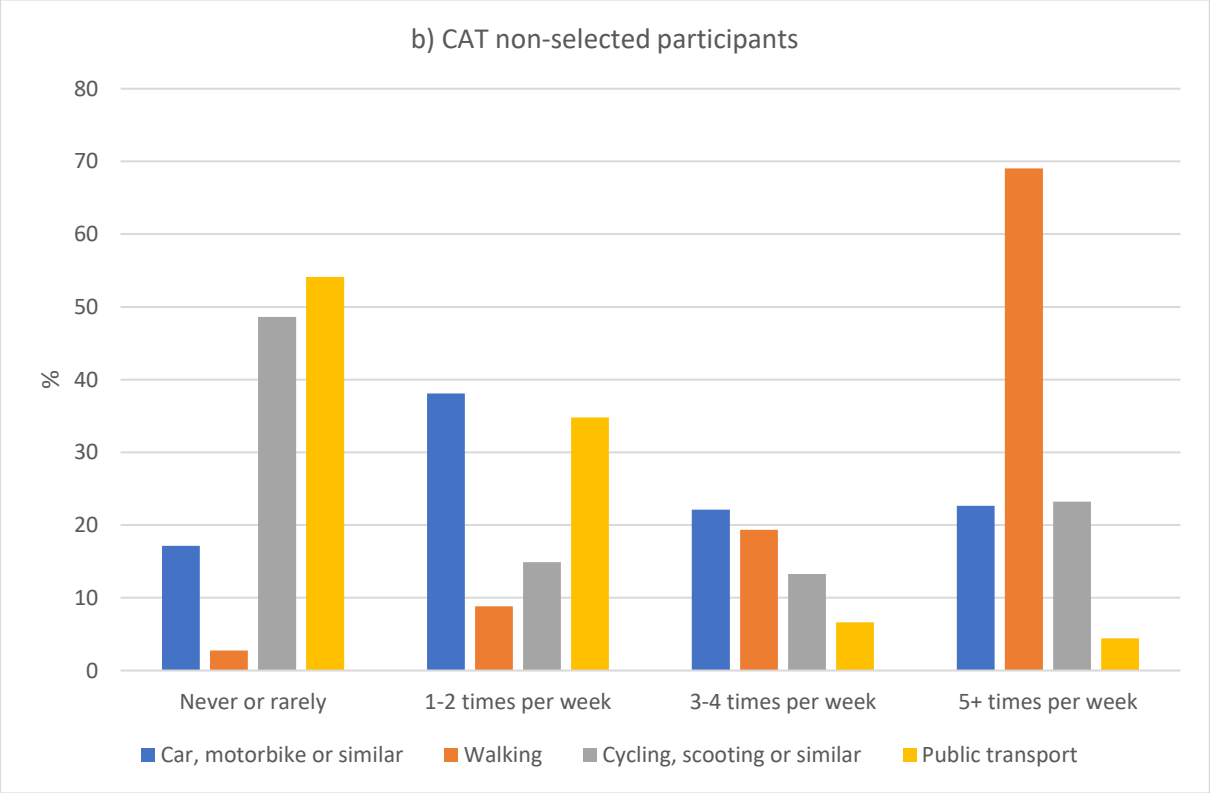


Next, respondents were asked 'How often do you use the following modes of transport on a typical week?', with five transport options listed (car, motorbike or similar; walking; cycling, scooting or similar; public transport).[21] Figure 4.10, panel A, illustrates that while most selected participants (nearly two-thirds) walked five times or more in a typical week, and nearly 20 per cent of respondents cycled five or more times in a typical week, the proportions using public transport five times or more in a typical week were much lower (at just 5 per cent). Similar patterns were evident for CAT non-selected participants (panel B).

[21] Response categories were 'never or rarely', '1 to 2 times a week', '3 to 4 times a week', '5 times a week or more'.

FIGURE 4.10 MODES OF TRANSPORT





4.3 CHANGES IN AWARENESS, ATTITUDES AND BEHAVIOUR OF CAT DUBLIN PARTICPANTS

In this section, ideally we would use data from all three surveys (carried out over the period September 2021–September 2022) to analyse how awareness, attitudes and behaviours in relation to air quality changed for participants as the CAT project progressed. However, attrition over time means that the numbers of CAT selected and non-selected participants who responded to all three surveys is extremely small (n=48 and n=9 respectively) (see also Table 3.2). For this reason, we focus the analysis in this section on CAT Dublin selected participants who responded to the first and second surveys (n=151).[22] As shown in Appendix B, selected participants received a number of communications from the CAT team in the period between the first (September 2021) and second (March 2022) surveys, including the results of their NO_2 measurement, an invitation to an information webinar and various infographics about NO_2.[23] Due to the limited sample size, the analysis is essentially descriptive, with statistical tests used to test for statistically significant differences in responses between the first and second survey.[24] Apart from concerns over attrition, it is also worth noting that CAT participants (both selected and non-selected) did not comprise a random sample of the Dublin population to begin with (see also Section 4.1).

In the first instance, we assess how attitudes and awareness of selected participants changed between the first and second surveys. In Figure 4.11, we show how responses to the question, '*Air pollution poses a serious health risk to the public*', changed between the first and second surveys, although in the second survey the question wording was changed to refer to NO_2 rather than air pollution. The data indicate that there was a statistically significant increase in the proportion of selected participants who 'strongly agreed' or 'agreed' with the statement, from 82.1 per cent in the first survey to 87.4 per cent in the second survey.[25]

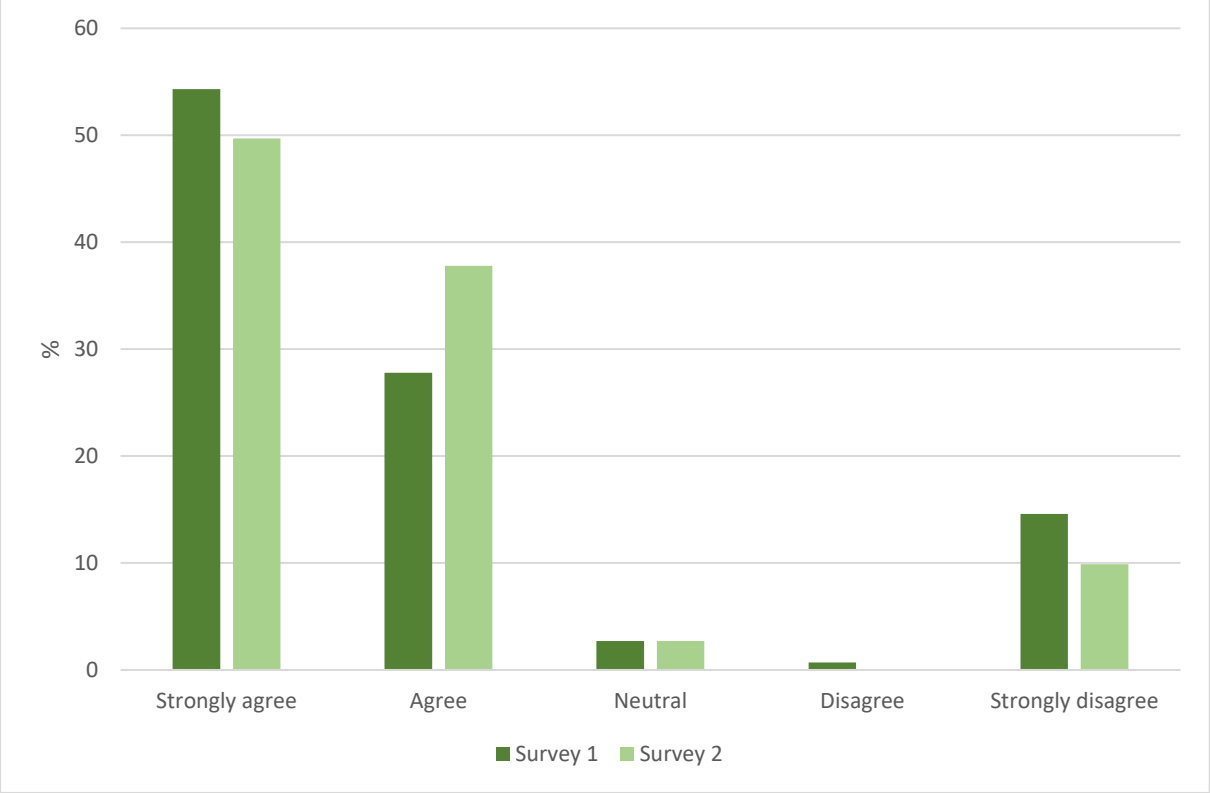
[22] As just 29 non-selected participants responded to the first and second surveys, we do not analyse their responses in this section.

[23] See Figure A1 in the appendix for an example of an infographic sent to participants.

[24] As most variables are categorical, and due to small sample size, we use Fisher's exact test to test for statistically significant differences in the distribution of question responses between the first and second surveys.

[25] Fisher's exact test p-value = 0.048.

FIGURE 4.11 'AIR POLLUTION/NO_2 POSES A SERIOUS HEALTH RISK TO THE PUBLIC'

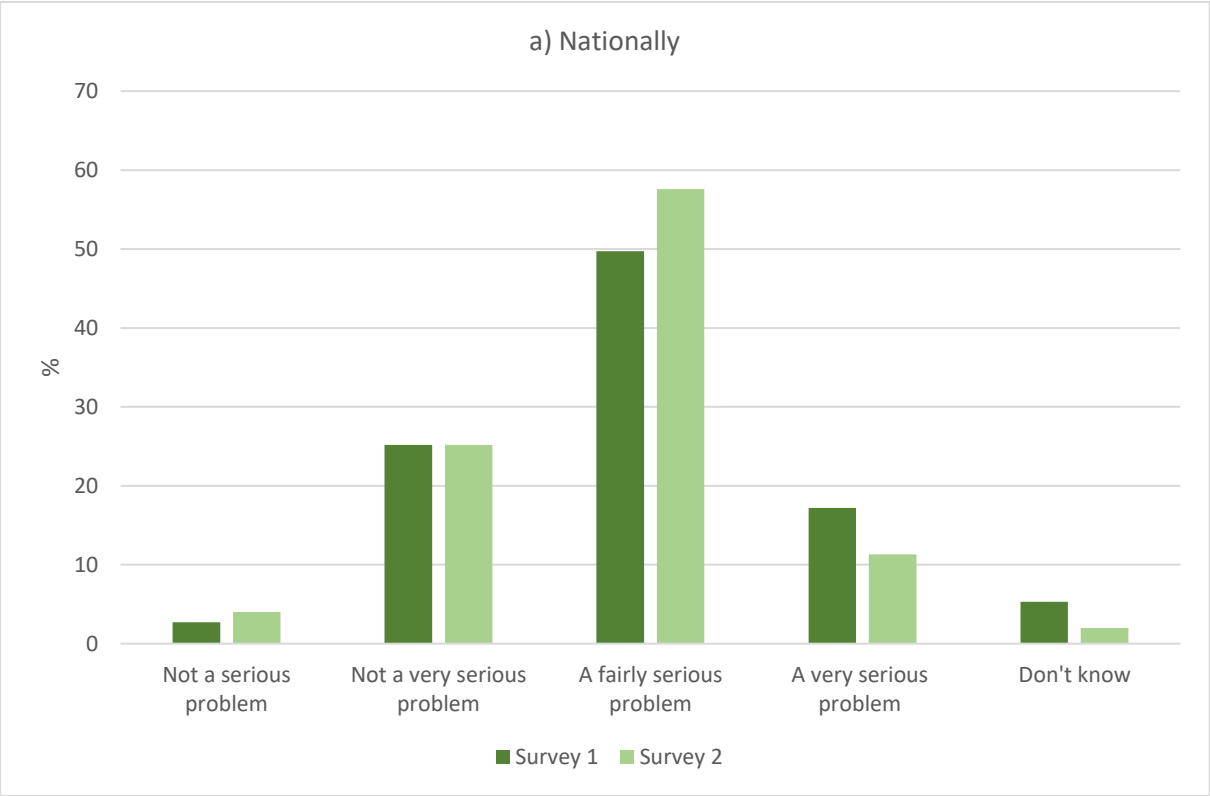


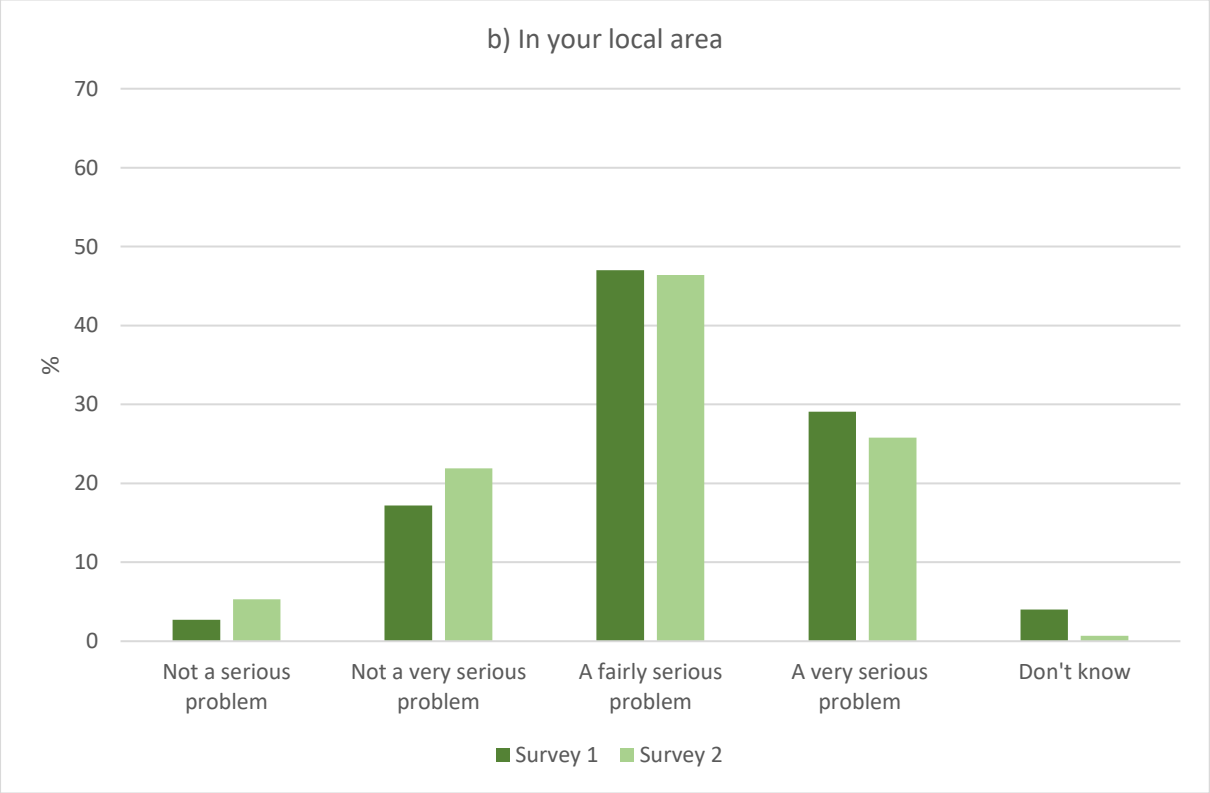
Note: Based on the sample of CAT Dublin selected participants who participated in the first and second surveys (n=151).

In Figure 4.12, we show how responses to the question, '*How much of a problem do you think air pollution is?*',[26] changed between Survey 1 and Survey 2. While there was an increase in the proportion of respondents who regarded air pollution/NO_2 as a 'very serious problem' or 'a fairly serious problem' nationally (from 66.9 per cent to 68.8 per cent),[27] there was essentially no change in the high levels of concern over air pollution/NO_2 levels in Dublin (with approximately 93-95 per cent of respondents regarding it as a 'very serious problem' or a 'fairly serious problem').[28] Interestingly, the proportion who regarded it as a 'very serious problem' or a 'fairly serious problem' in their local area declined slightly (from 76.2 per cent to 72.2 per cent),[29] although levels of concern remain high overall. A possible explanation for this finding is that respondents may have updated their assessment of the extent of the problem associated with air pollution/NO_2 in their local areas (as opposed to nationally or in Dublin) based on their NO_2 measurement result.[30]

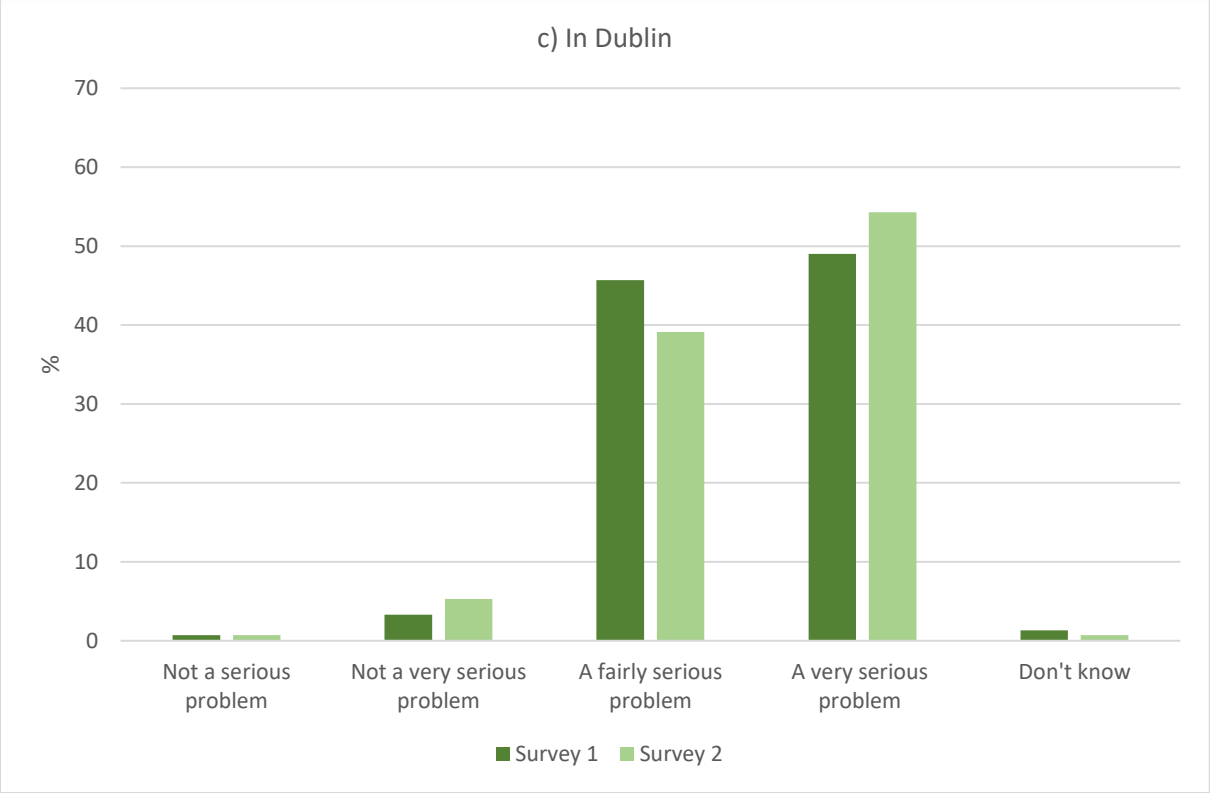
26 In Survey 2, the reference to air pollution was replaced by NO_2.
27 Fisher's exact test p-value=0.000.
28 Fisher's exact test p-value=0.089.
29 Fisher's exact test p-value=0.000.
30 While the sample sizes are too small for disaggregated analyses (just n=26 observations in the 'high' NO_2 measurement locations answered this question in Survey 1 and Survey 2), the proportion of those in the 'low' NO_2 measurement

FIGURE 4.12 'HOW MUCH OF A PROBLEM DO YOU BELIEVE AIR POLLUTION/NO_2 IS?'





locations (n=101 in total) who regarded air pollution/NO_2 as a 'very serious problem' or a 'fairly serious problem' declined from 71.3 per cent in Survey 1 to 66.3 per cent in Survey 2.

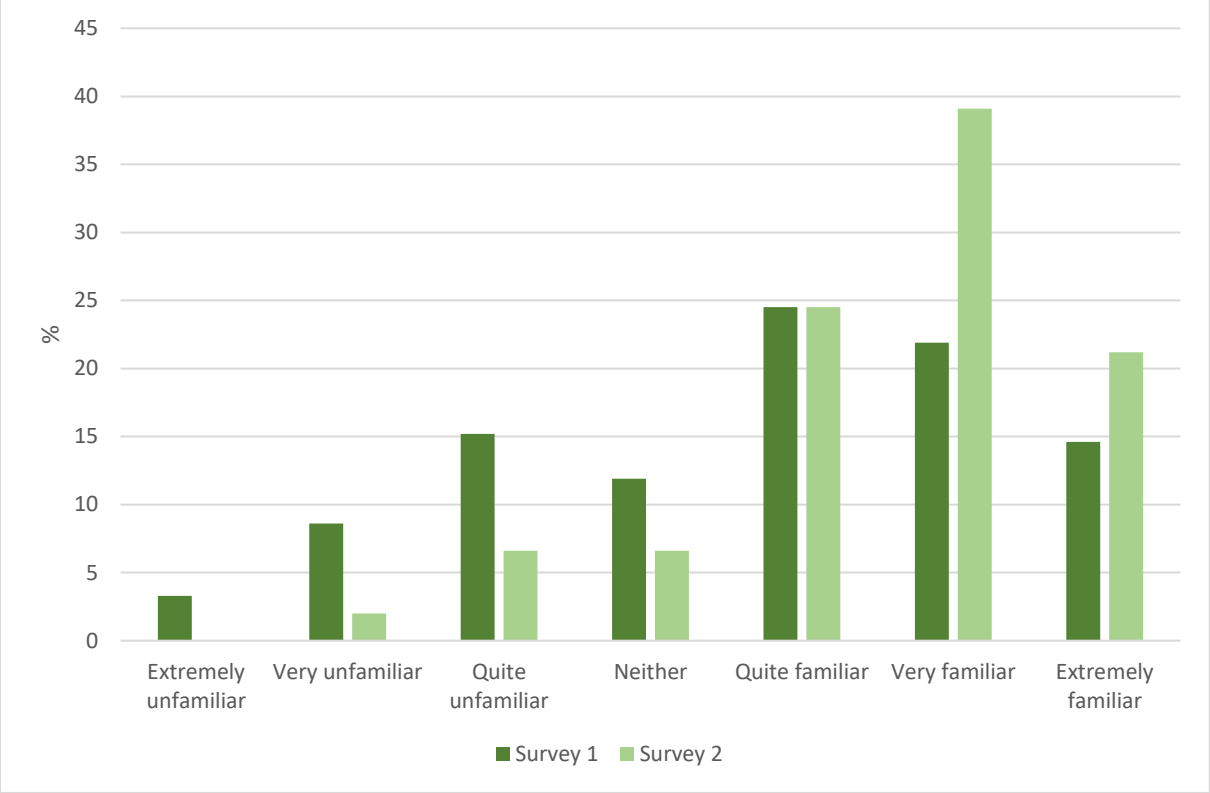


Note: Based on the sample of CAT Dublin selected participants who responded to the first and second surveys (n=151).

In terms of awareness of environmental health risks, the proportion who responded that they were 'extremely familiar', 'very familiar' or 'quite familiar' with NO_2 increased as expected (from 60.9 per cent in Survey 1 to 84.8 per cent in Survey 2), and this difference was statistically significant.[31] For changes in familiarity with other environmental health risks, see Appendix F.

[31] Fisher's exact test p-value = 0.000.

FIGURE 4.13 FAMILIARITY WITH ENVIRONMENTAL HEALTH RISK NO_2

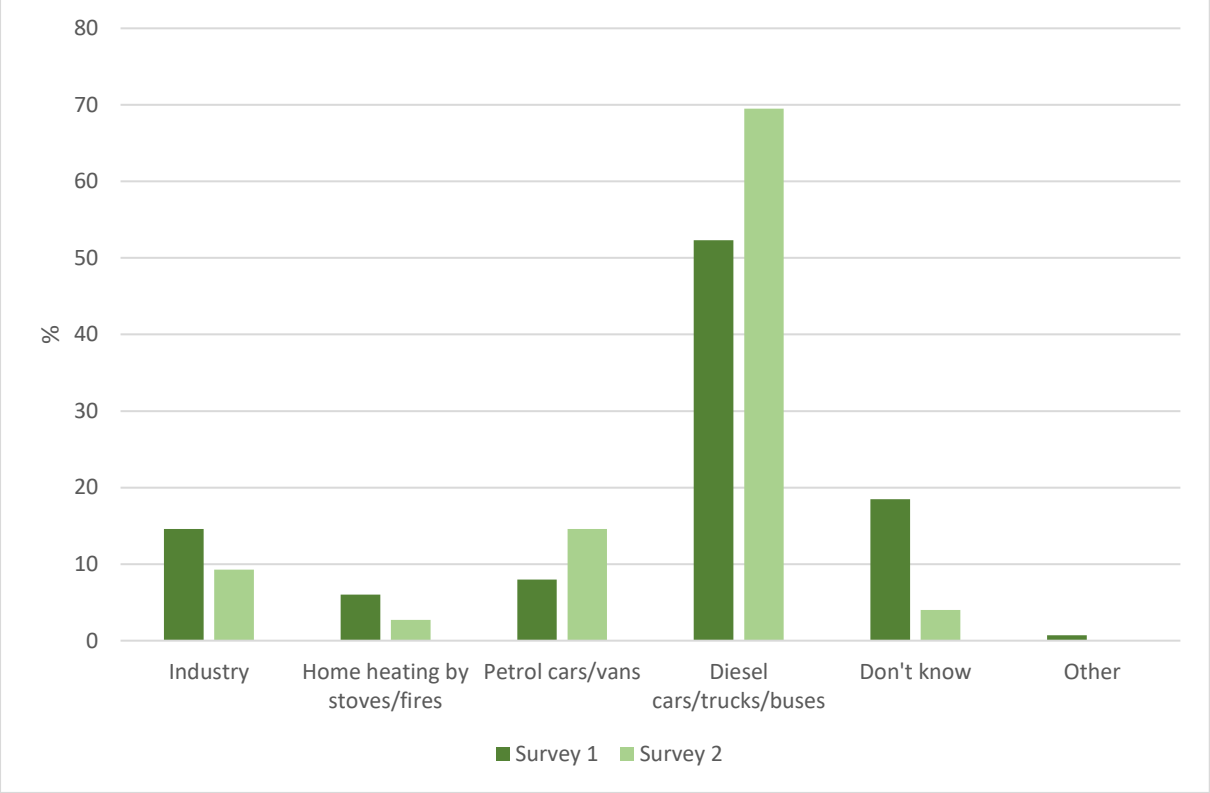


Note: Based on the sample of CAT Dublin selected participants who participated in the first and second surveys (n=151).

Consistent with the increased familiarity with NO_2 as an environmental health risk, respondents were also significantly more likely in the second survey to correctly identify that 'diesel cars/trucks/buses' were the main source of NO_2 in Ireland (increasing from just over half of respondents in Survey 1 to nearly 70 per cent of respondents in Survey 2).[32] The proportion who reported that they did not know the main source also declined sharply, from 18.5 per cent to 4 per cent (Figure 4.14). See Figure F2 in Appendix F for results of the question about the main source of particulate matter, where again there was a large decline, between Survey 1 and Survey 2, in the proportion who reported that they did not know the main source.

[32] Fisher's exact test p-value = 0.005.

FIGURE 4.14 MAIN SOURCE OF NO_2 IN IRELAND

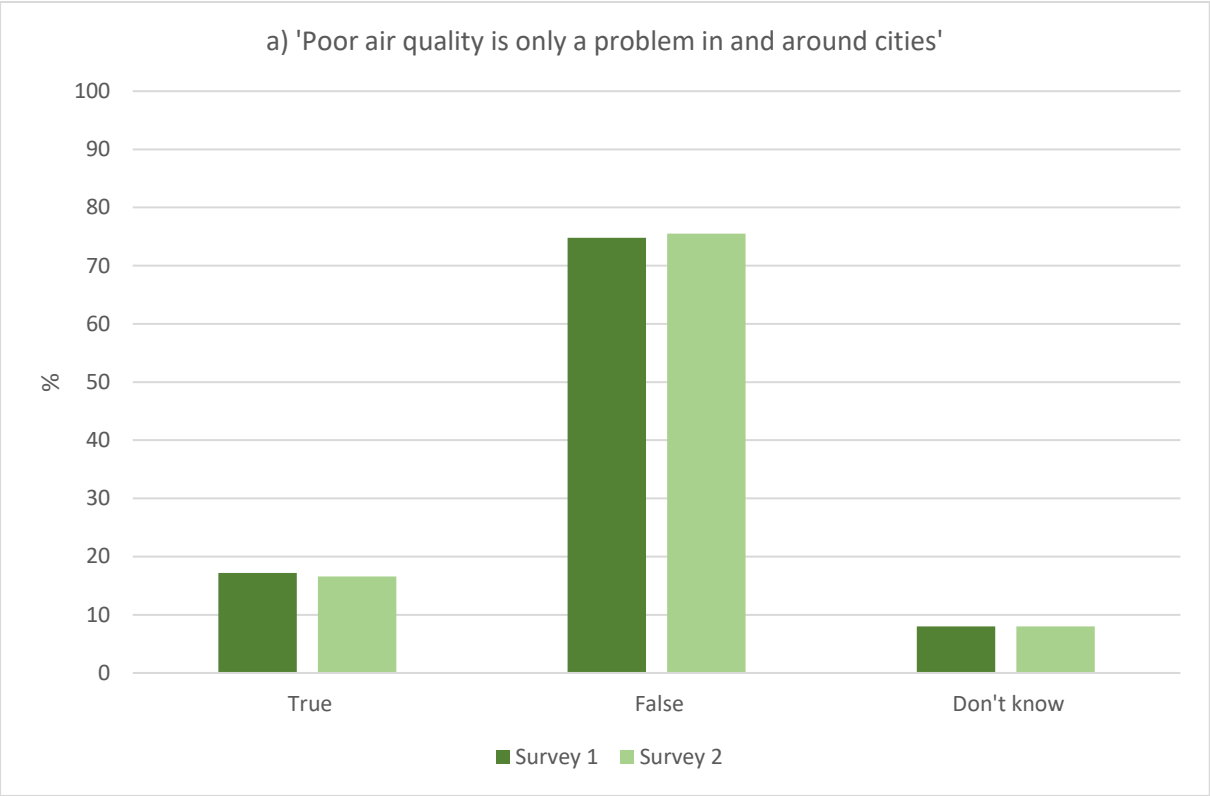


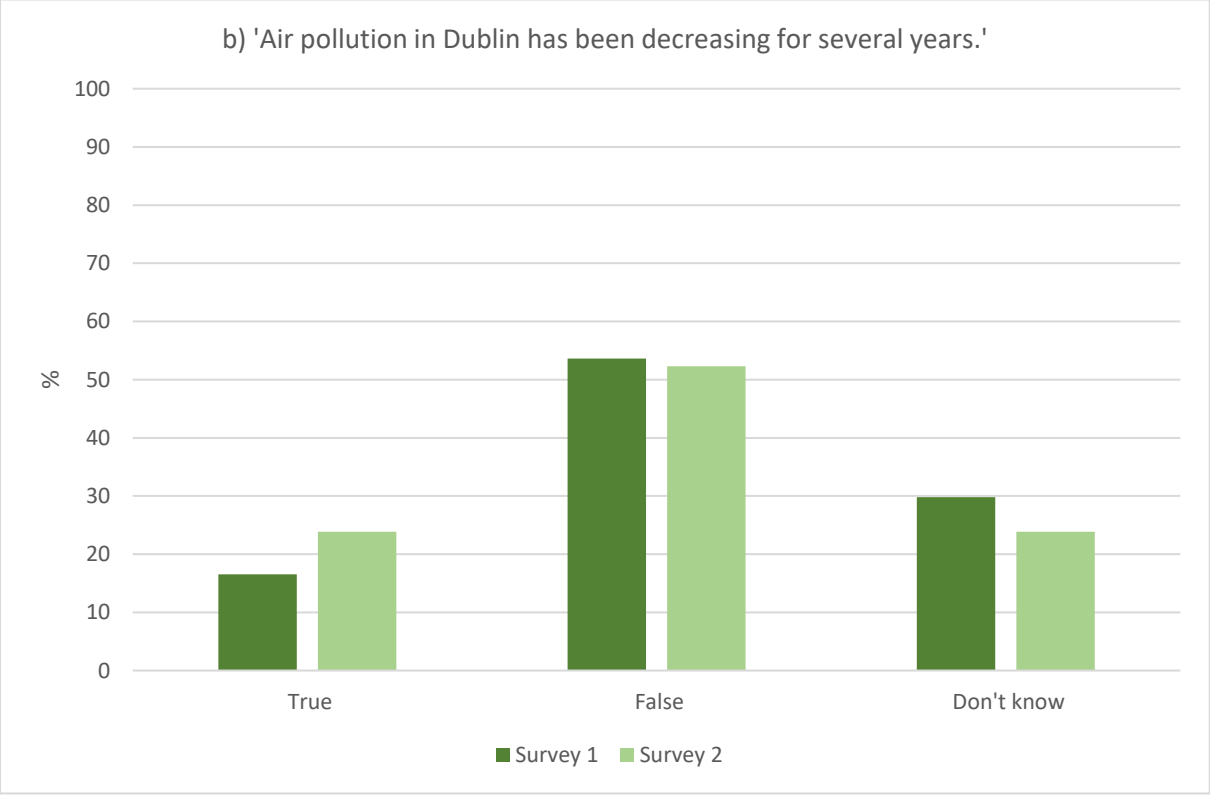
Note: Based on the sample of CAT Dublin selected participants who participated in the first and second surveys (n=151).

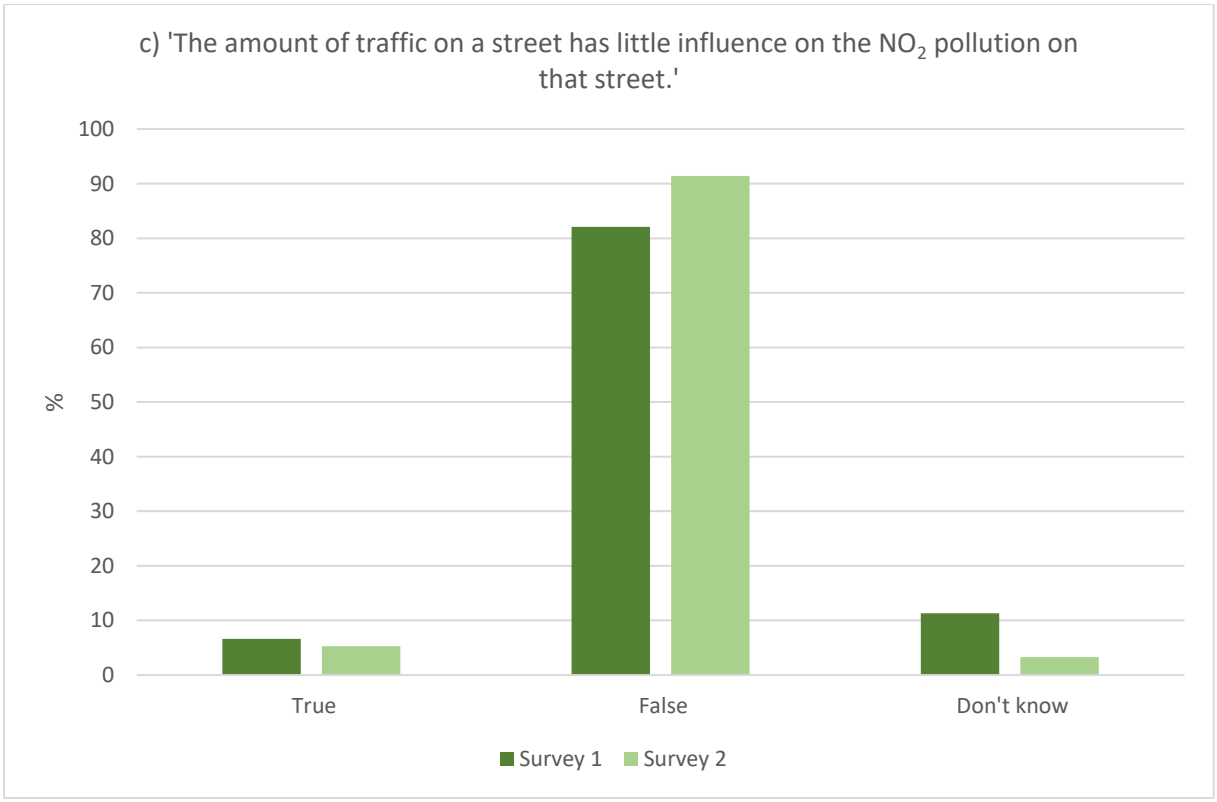
The final set of questions in relation to attitudes and awareness – the true/false statements – revealed little change overall in responses across the six statements posed to respondents (Figure 4.15). However, in general, an increase in the proportion of respondents answering correctly between the two surveys was higher for statements that related specifically to NO_2 than for more general air pollution statements. For example, the proportion of respondents who answered 'false' to the statement, 'poor air quality is only a problem in and around cities', was largely unchanged from Survey 1 to Survey 2, at around 75 per cent (with 8 per cent at both time points responding that they 'don't know'). In contrast, the proportion who responded 'true' to the statement that 'NO_2 can vary greatly between nearby streets' increased from 70.9 per cent in Survey 1 to 90.1 per cent in Survey 2 (the proportion who responded 'don't know' also fell sharply, from 23.8 per cent to 4.6 per cent).[33]

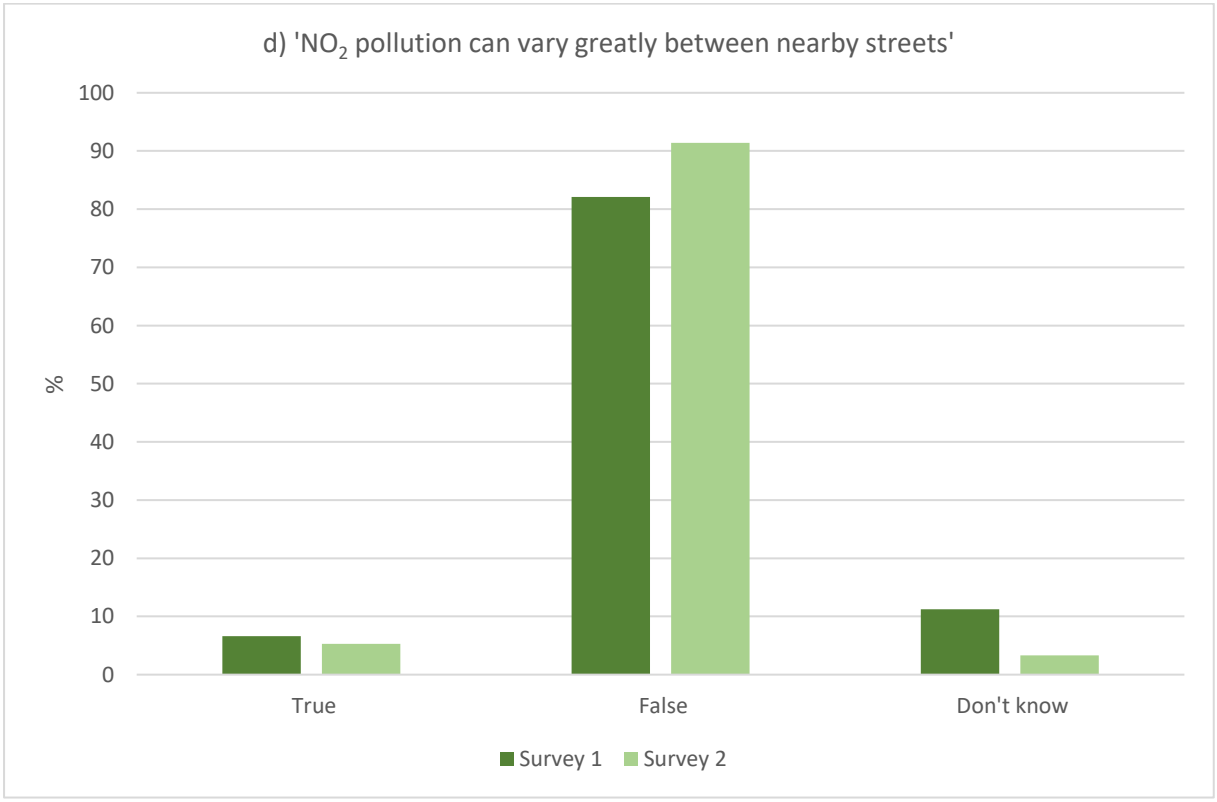
[33] Fisher's exact test results:
a) Poor air quality is only a problem in and around cities: p-value = 0.000.
b) Air pollution in Dublin has been decreasing for several years: p-value = 0.000.
c) The amount of traffic on a street has little influence on the NO_2 pollution on that street: p-value = 0.023.
d) NO_2 pollution can vary greatly between nearby streets: p-value = 0.026.
e) Higher NO_2 concentrations in the air increase the risk of asthma: p-value = 0.000.
f) On average, diesel cars emit more NO_2 than petrol cars: p-value = 0.000.

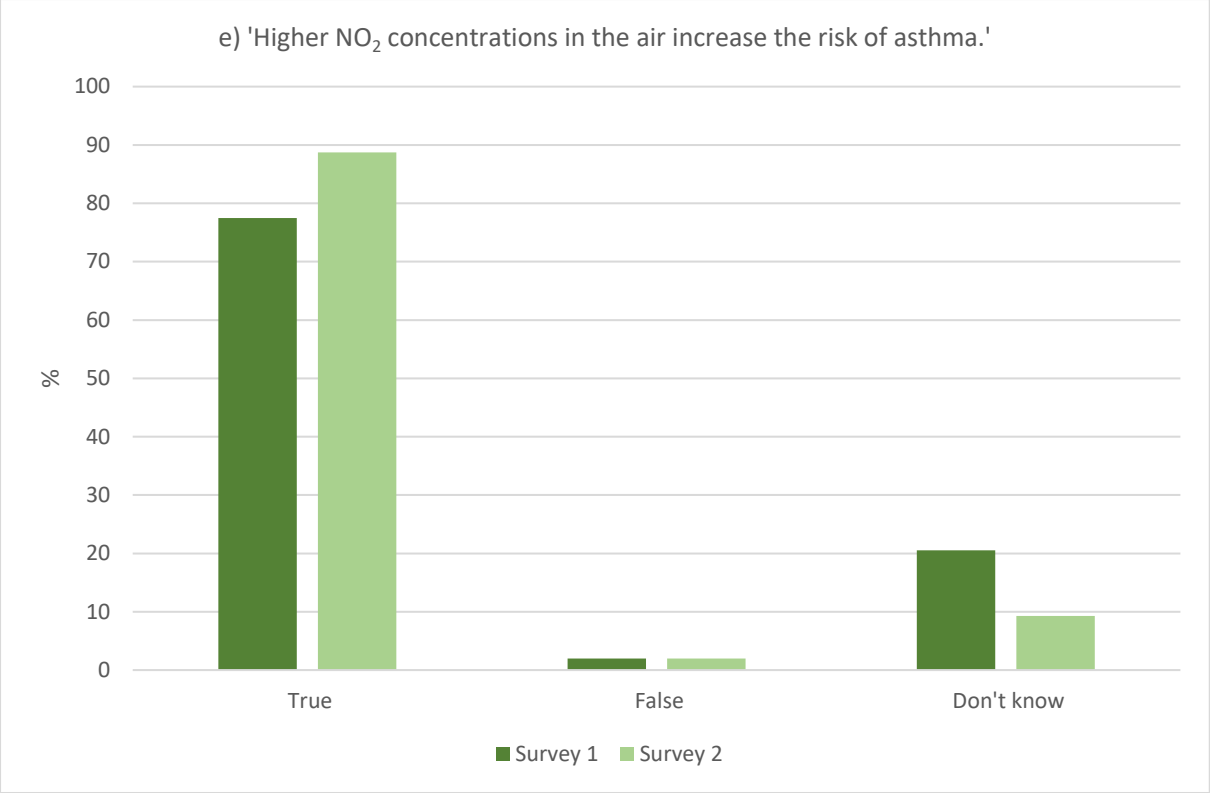
FIGURE 4.15 AWARENESS OF AIR QUALITY ISSUES (TRUE/FALSE)

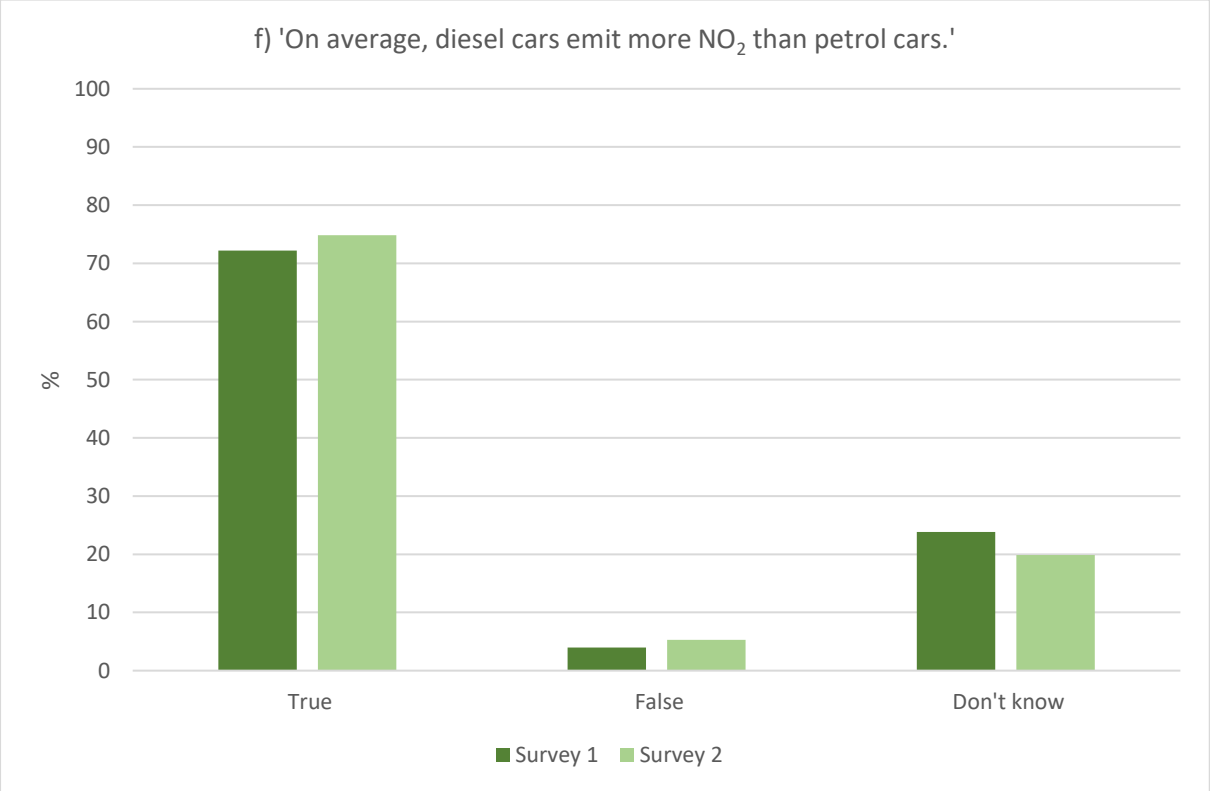





c) 'The amount of traffic on a street has little influence on the NO_2 pollution on that street.'
100
90
80
70
60
50
40
30
20
10
0
%
True
False
Don't know
Survey 1
Survey 2


d) 'NO_2 pollution can vary greatly between nearby streets'
100
90
80
70
60
50
40
30
20
10
0
%
True
False
Don't know
Survey 1
Survey 2



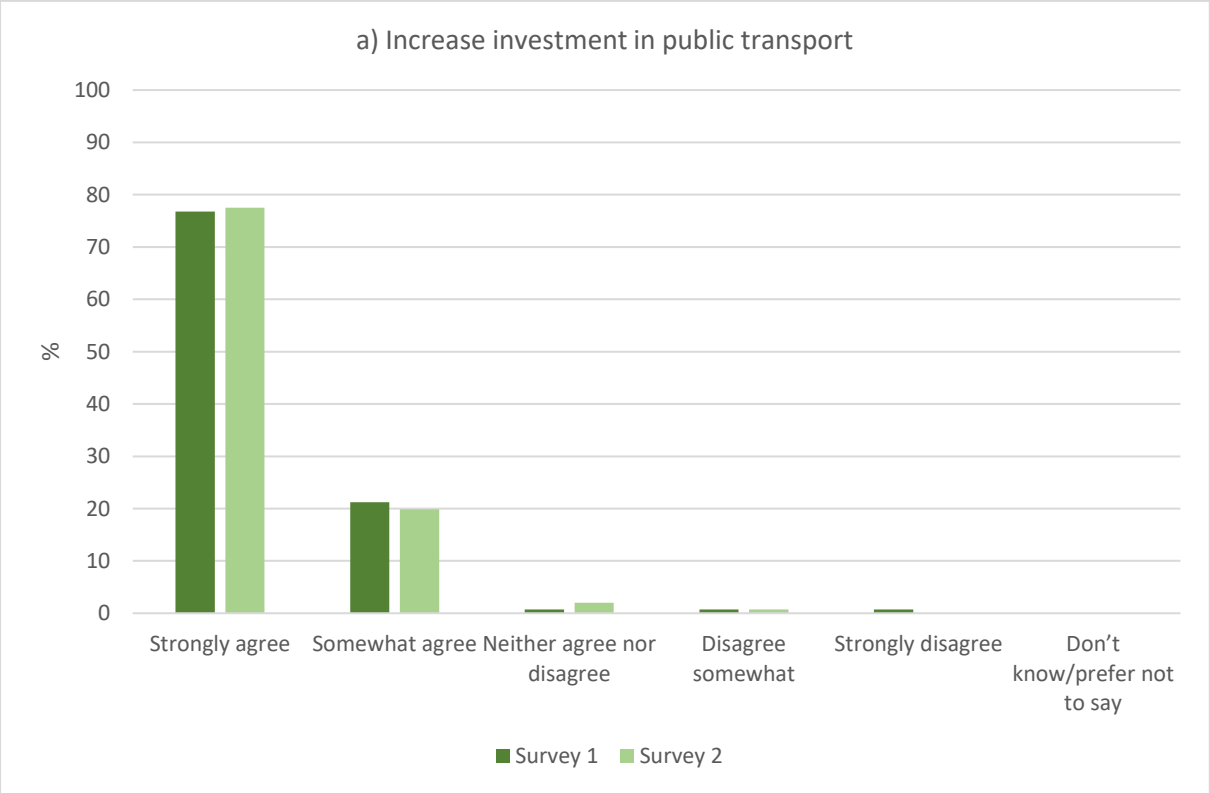


Note: Based on the sample of CAT Dublin selected participants who responded to the first and second surveys (n=151).

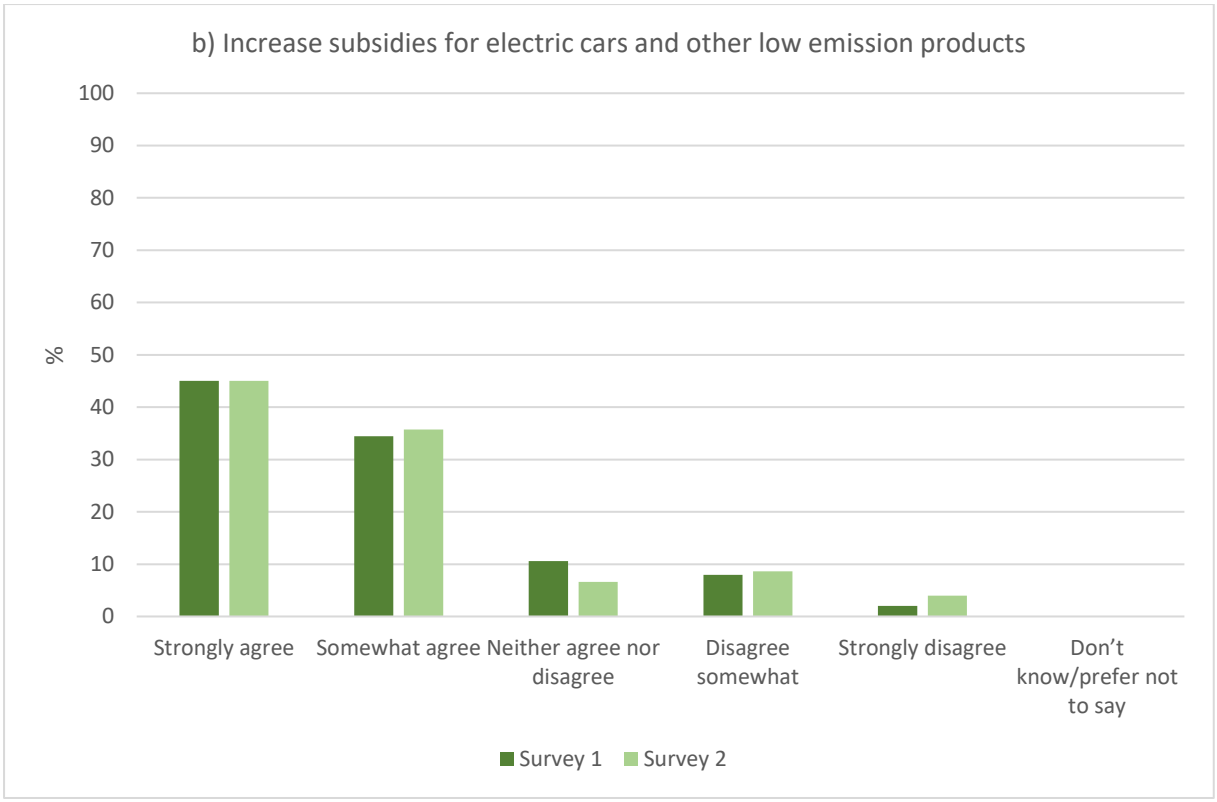
Finally, in relation to the policy options that respondents would like to see implemented in Dublin to reduce air pollution, Figure 4.16 shows that there was

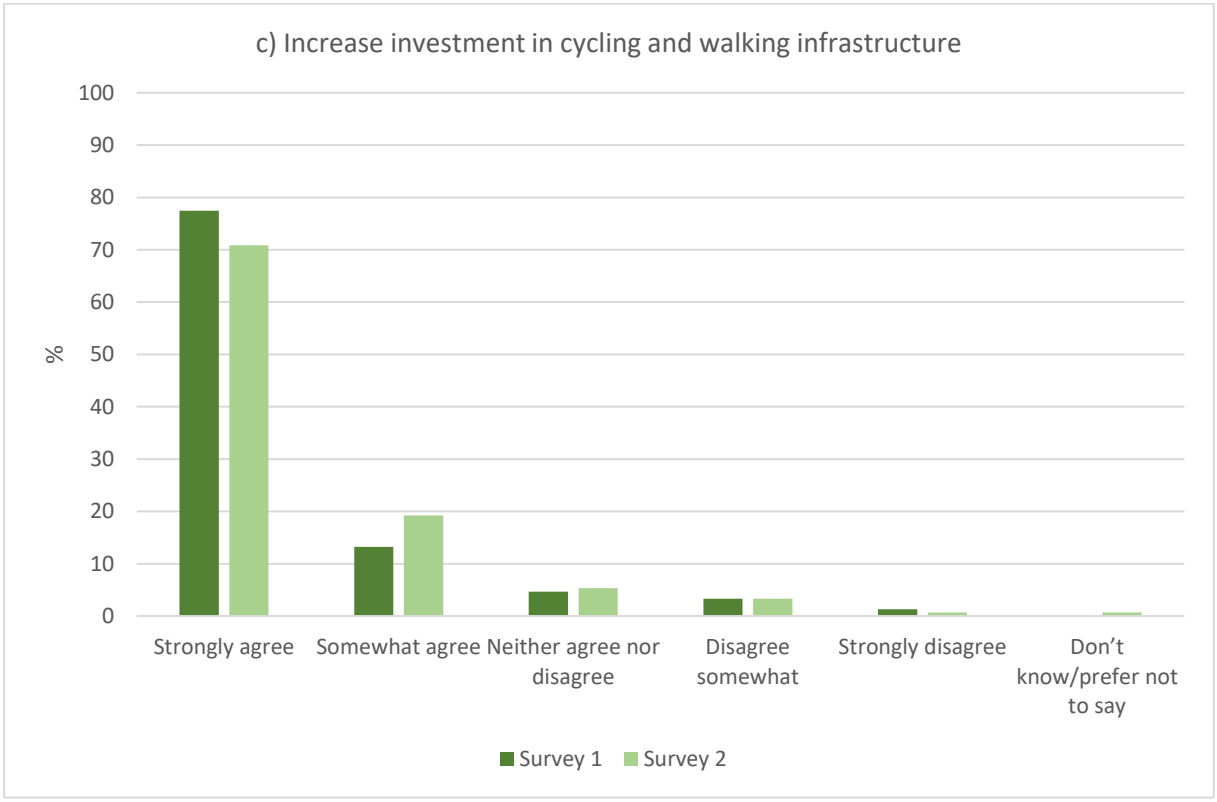
relatively little change in responses between Surveys 1 and 2.[34] While the proportion who 'strongly agree' or 'agree somewhat' with applying stricter controls on emissions from new vehicles declined over time (from 92.1 per cent in Survey 1 to 88.1 per cent in Survey 2), the proportion who 'strongly agree' or 'agree somewhat' with banning the sale of new diesel and petrol cars after 2030 increased from 80.8 per cent to 84.1 per cent. Overall, the responses indicate a high level of agreement with all policy options, with the least popular option (introducing low emission zones/congestion charges entering city centre areas) still favoured by approximately three-quarters of respondents.

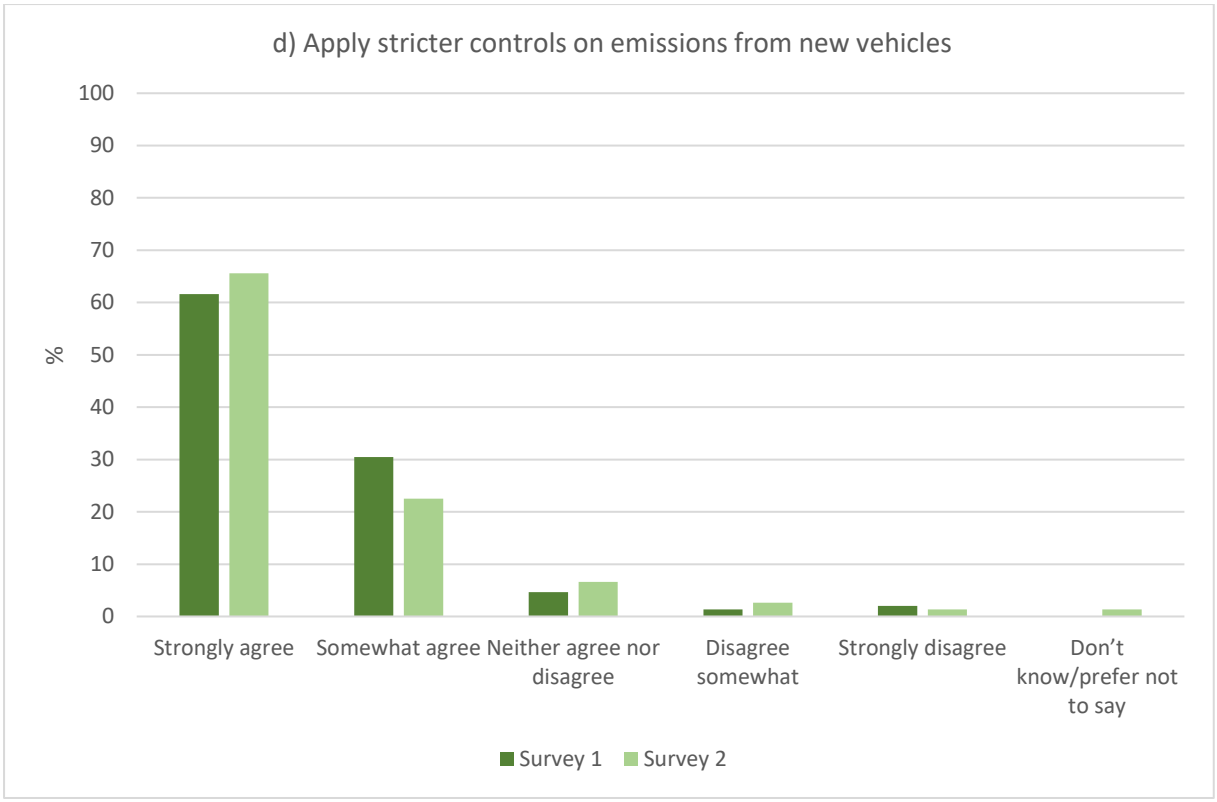
FIGURE 4.16 POLICY OPTIONS TO REDUCE AIR POLLUTION LEVELS IN DUBLIN

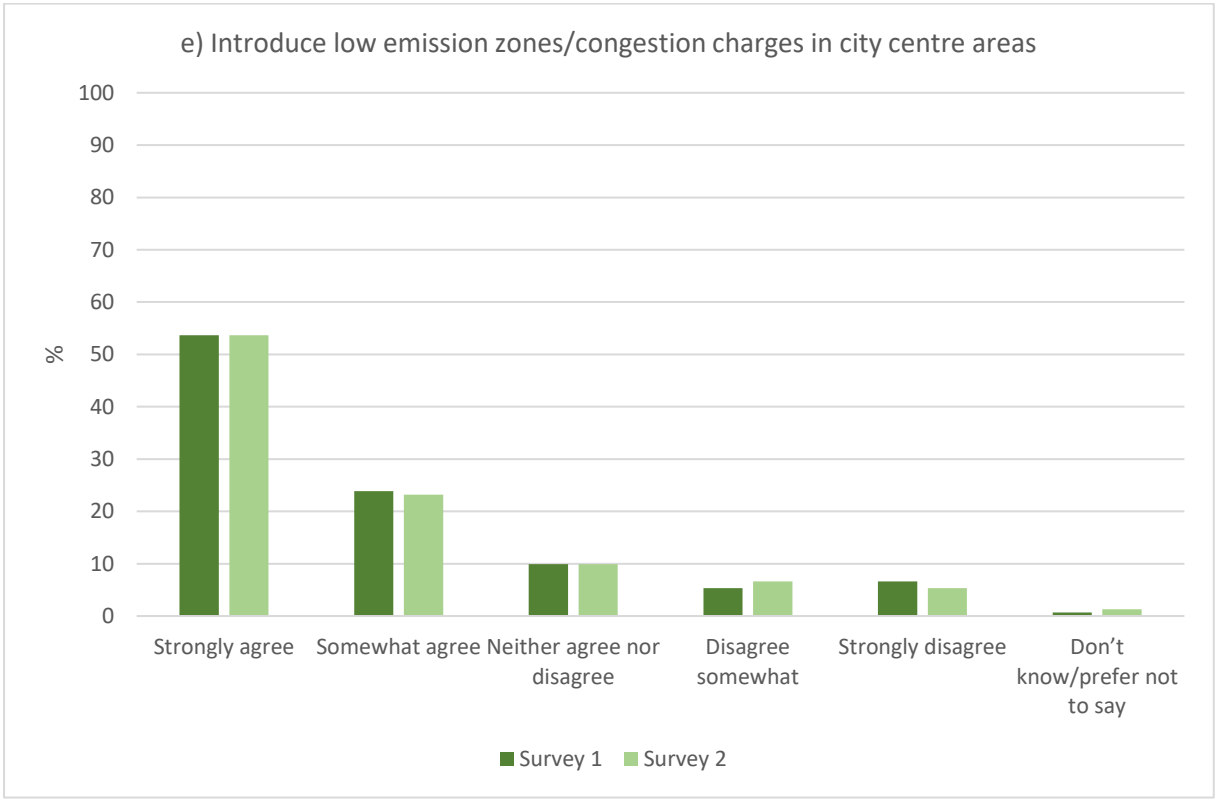


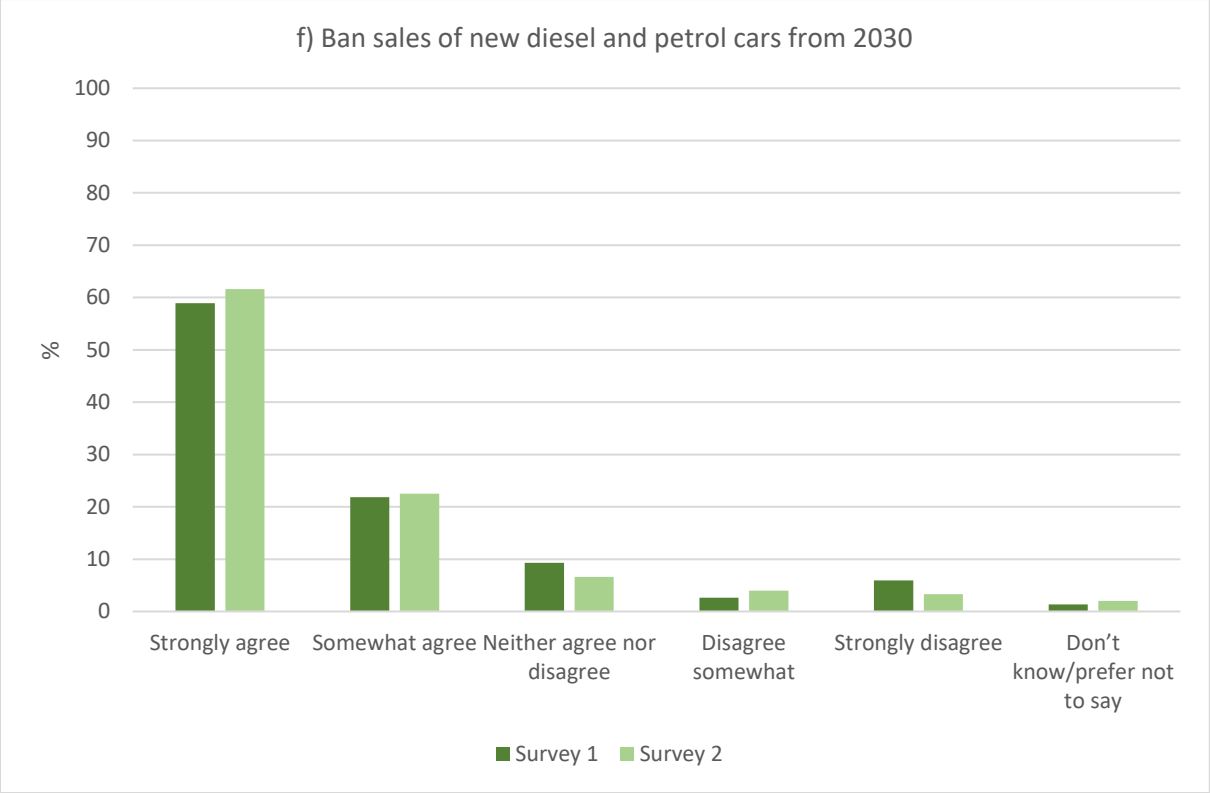
[34] Fisher's exact test results:
a) Increase investment in public transport: p-value = 0.078.
b) Increase subsidies for electric cars and other low emission products: p-value = 0.000.
c) Increase investment in cycling and walking infrastructure: p-value = 0.000.
d) Apply stricter controls on emissions from new vehicles: p-value = 0.000.
e) Introduce low emission zones/congestion charges in city centre areas: p-value = 0.000.
f) Ban sales of new diesel and petrol cars from 2030: p-value = 0.000.


b) Increase subsidies for electric cars and other low emission products
100
90
80
70
60
50
40
30
20
10
0
%
Strongly agree
Somewhat agree
Neither agree nor disagree
Disagree somewhat
Strongly disagree
Don't know/prefer not to say
Survey 1
Survey 2


c) Increase investment in cycling and walking infrastructure
100
90
80
70
60
50
40
30
20
10
0
%
Strongly agree
Somewhat agree
Neither agree nor disagree
Disagree somewhat
Strongly disagree
Don't know/prefer not to say
Survey 1
Survey 2


d) Apply stricter controls on emissions from new vehicles
100
90
80
70
60
50
40
30
20
10
0
%
Strongly agree
Somewhat agree
Neither agree nor disagree
Disagree somewhat
Strongly disagree
Don't know/prefer not to say
Survey 1
Survey 2


e) Introduce low emission zones/congestion charges in city centre areas
100
90
80
70
60
50
40
30
20
10
0
%
Strongly agree
Somewhat agree
Neither agree nor disagree
Disagree somewhat
Strongly disagree
Don't know/prefer not to say
Survey 1
Survey 2



Note: Based on the sample of CAT Dublin selected participants who responded to the first and second surveys (n=151).

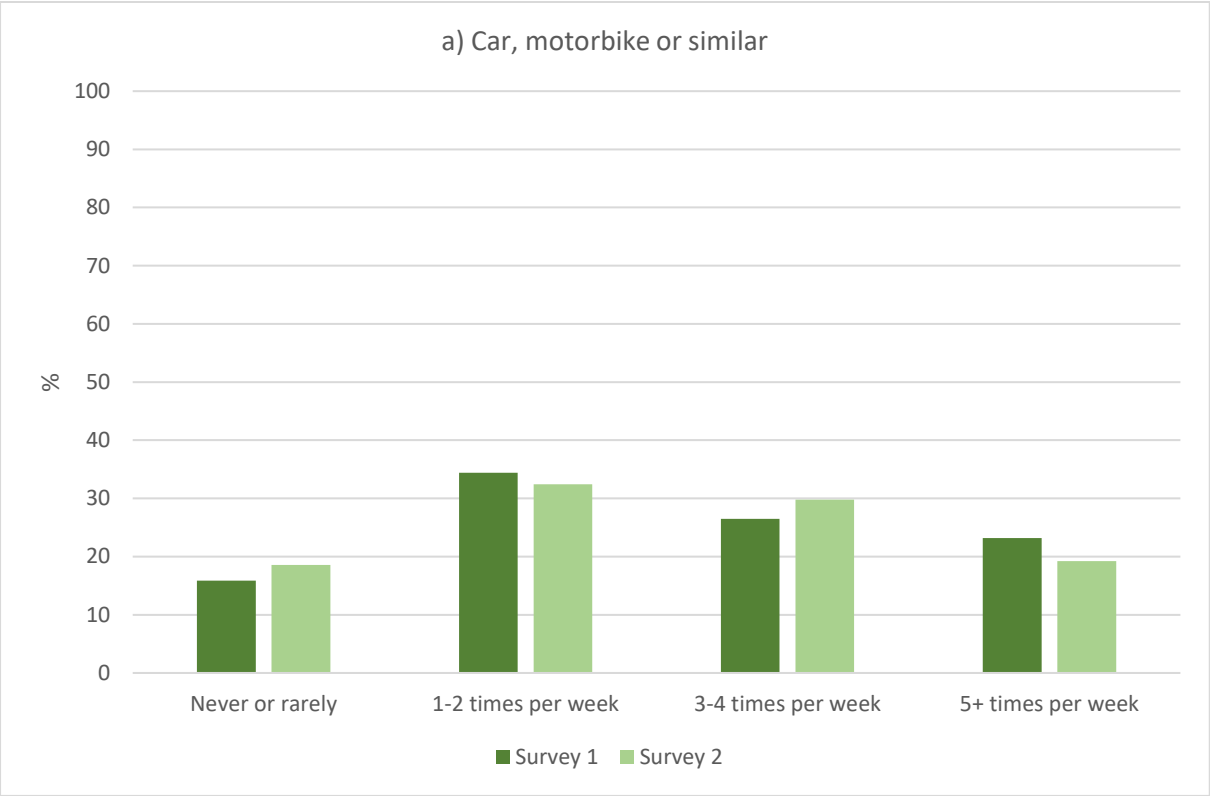
In terms of behaviour change, respondents were once again asked to state how often they used various forms of transport in a typical week.[35] Figure 4.17 shows that, in general, any change observed was slight.[36] While the proportion who drove five times or more per week declined somewhat (from 23.2 per cent to 19.2 per cent), there were also declines in those who walked, cycled or used public transport five or more times per week.[37]

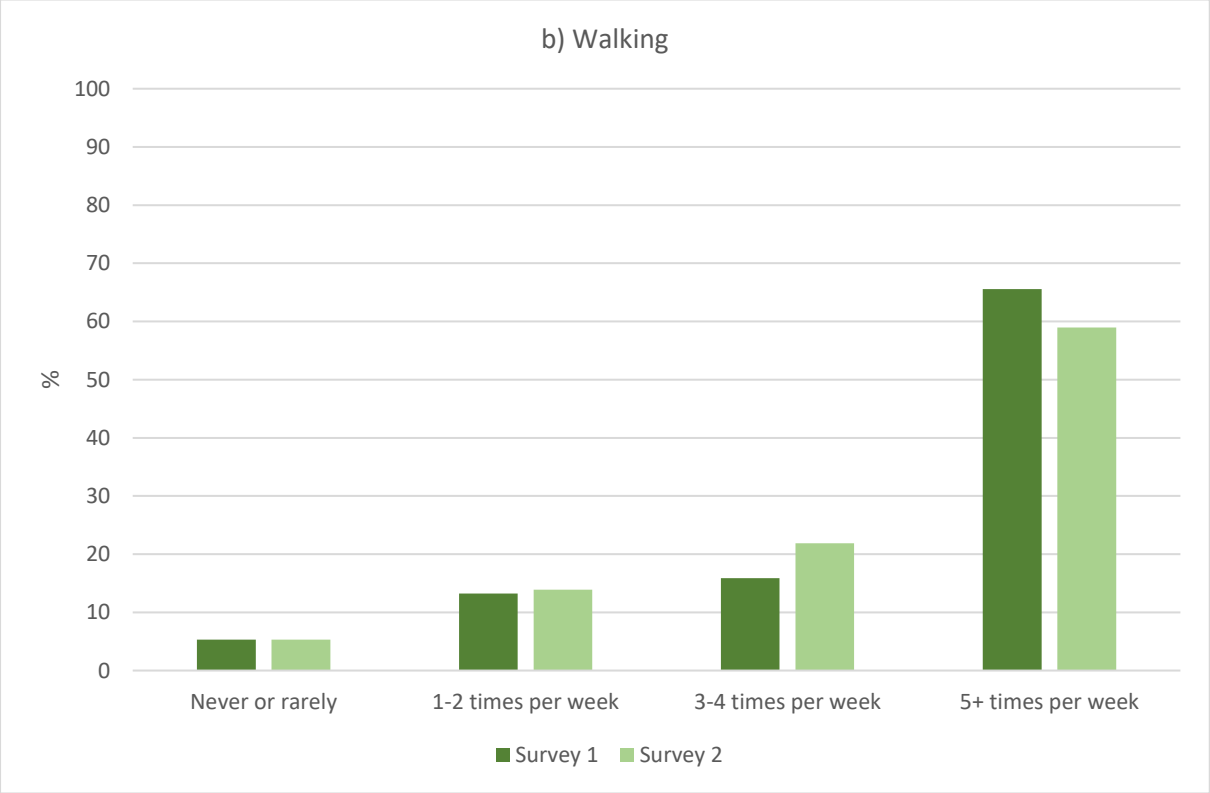
35 As noted in Section 4.2, respondents were also asked what changes to their mobility they were considering over the next 6 months (12 months in Survey 1), but due to the multiple combinations of options available (i.e., respondents could tick as many of the seven options as they wished), we do not analyse the results here.

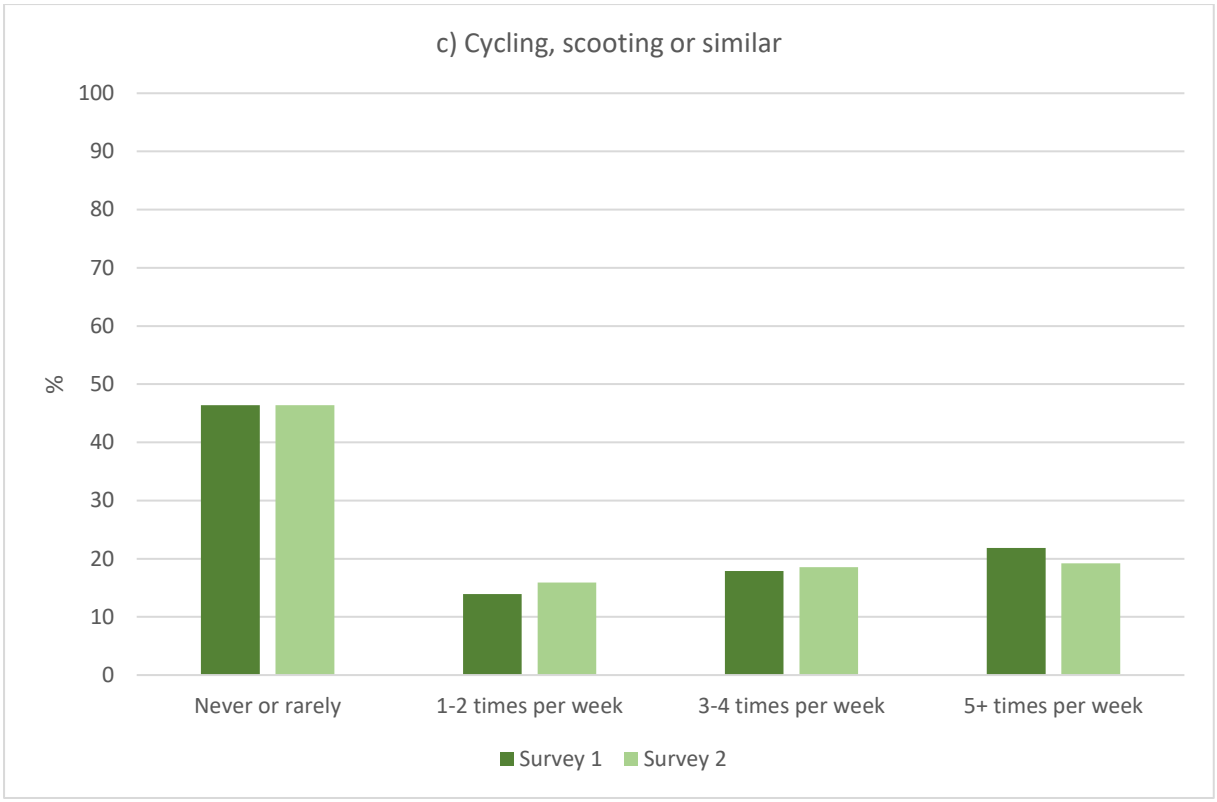
36 Fisher's exact test results:
a) Car, motorbike or similar: p-value = 0.000.
b) Walking: p-value = 0.000.
c) Cycling, scooting or similar: p-value = 0.000.
d) Public transport: p-value = 0.029.

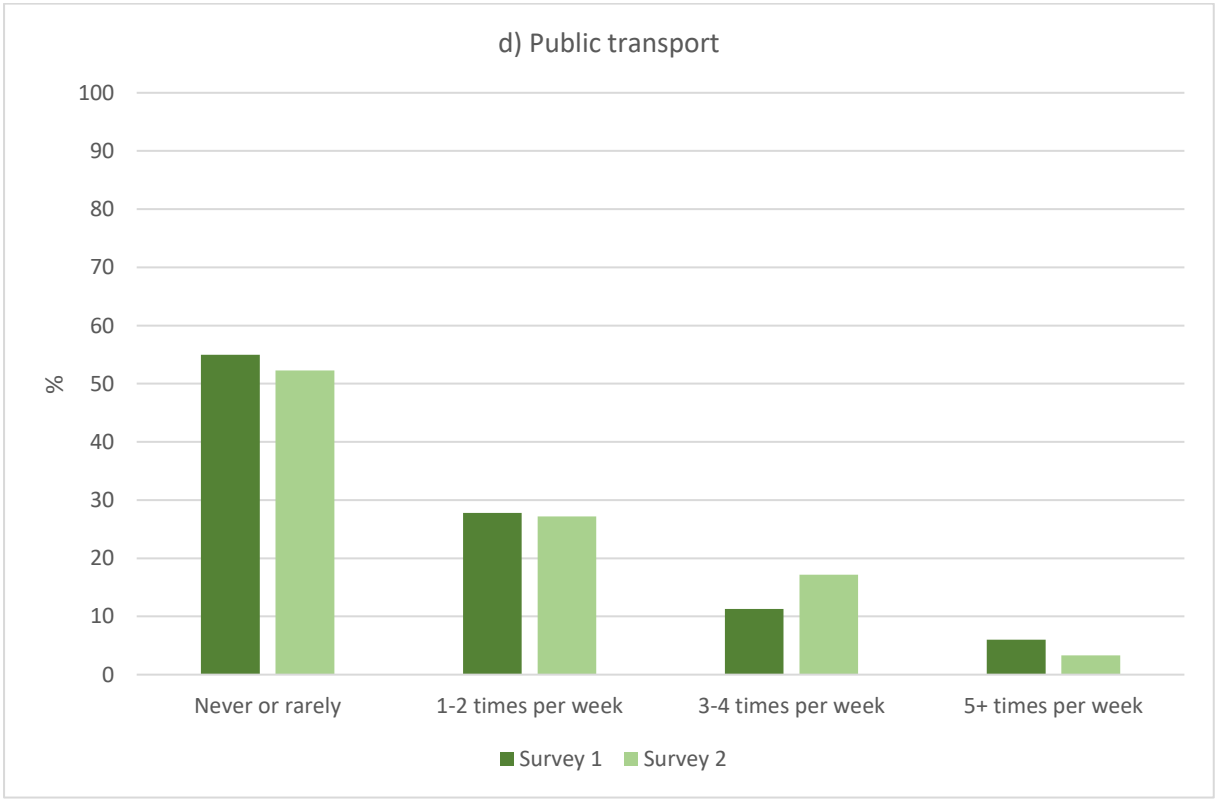
37 As in Survey 1, respondents were also asked how frequently they worked from home. While a similar proportion of respondents never worked from home (or the question did not apply to them) in Surveys 1 and 2, there was a statistically significant decline in the proportion of respondents working from home five or more days per week (from 33.1 per cent to 21.2 per cent). This is likely due to the timing of the two surveys; while work from home public health guidance was still in place in September 2021, by March 2022 all restrictions on workplaces had been lifted.

FIGURE 4.17 CHANGES IN FREQUENCY OF MODES OF TRANSPORT







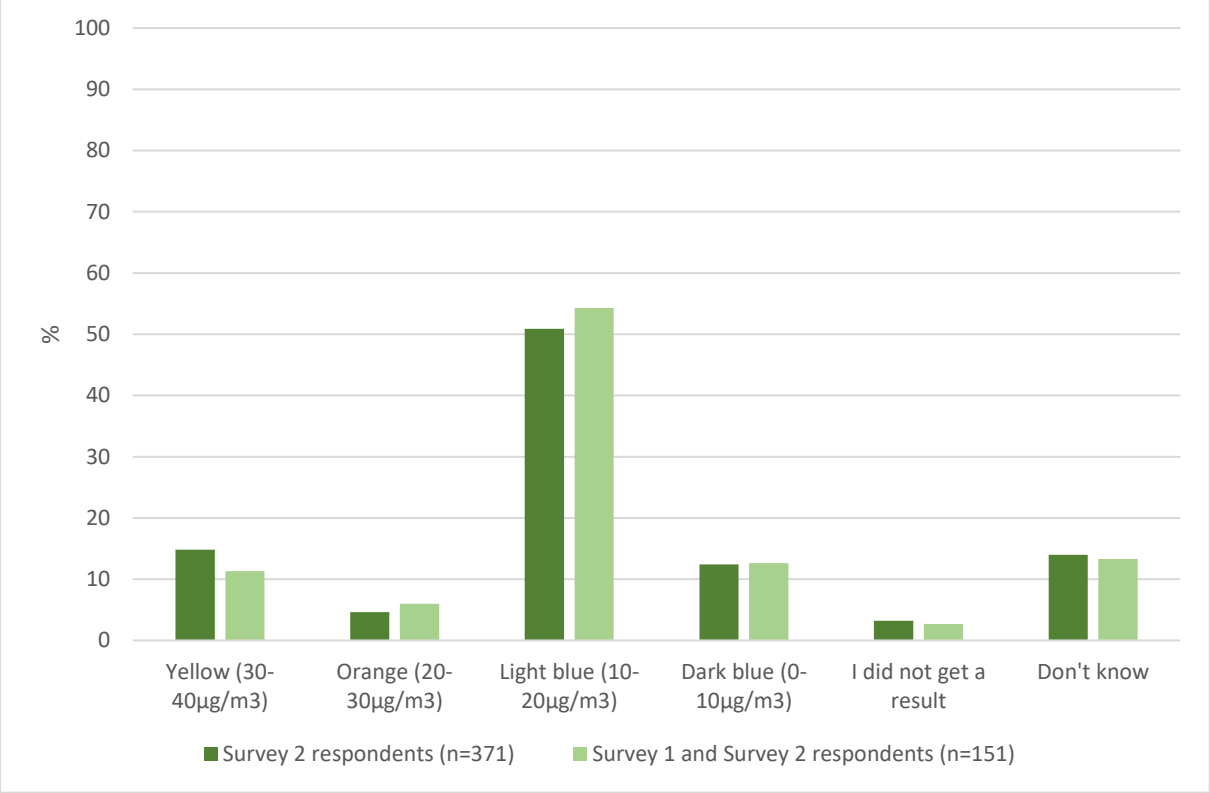


Note: Based on the sample of CAT Dublin selected participants who responded to the first and second surveys (n=151).

4.4 NO_2 MEASUREMENT RESULTS AND IMPACTS

By the time of the second survey, CAT selected participants had received their NO_2 measurement result. Figure 4.18 shows the distribution of NO_2 measurements across the sample (of those who participated in Survey 2 (n=371) and those who participated in both Survey 1 and Survey 2 (n=151)).[38] Of those of participated in Survey 2 (n=371), just under 20 per cent lived in a residence where the measured NO_2 level over the four-week period in October/November 2021 was 20µg/m^3 or greater. A further 51 per cent of the sample lived in residences where the measured NO_2 level was between 10 and 20 µg/m^3, while 12 per cent lived in residences with levels below 10 µg/m^3. The most recent WHO guidelines for NO_2 state that NO_2 should not exceed an average of 10µg/m^3 (on an annual basis) and 25µg/m^3 (on a daily basis) (WHO, 2021).

FIGURE 4.18 NO_2 MEASUREMENT RESULTS

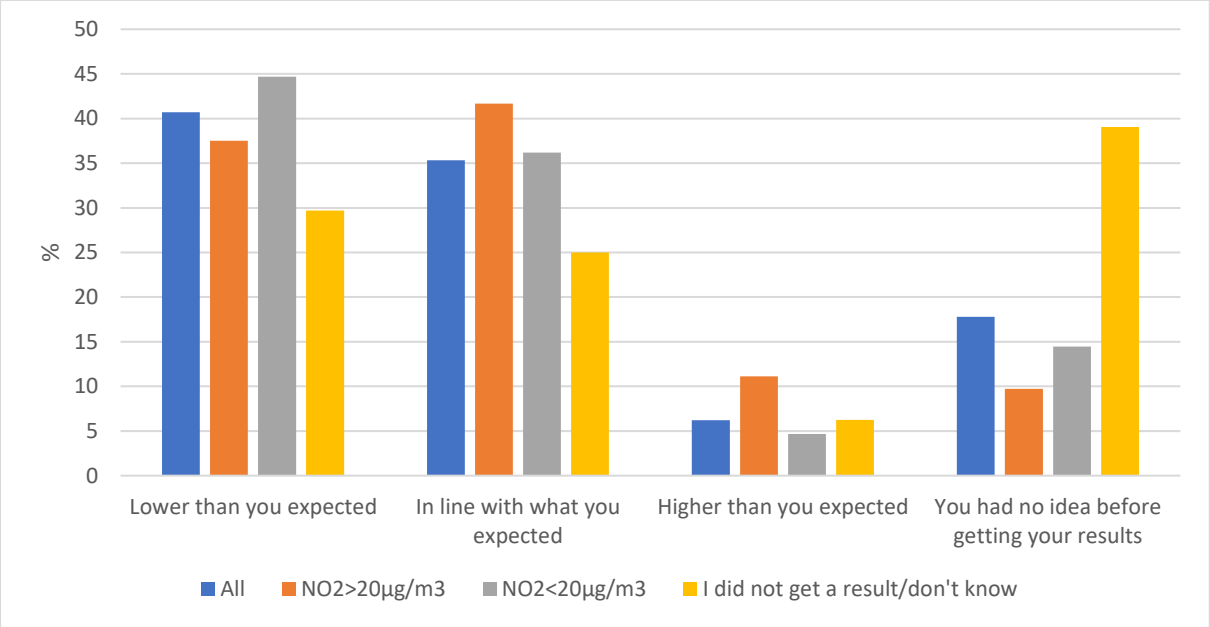


Respondents were then asked if the NO_2 level at their measurement location was in line with what they had expected. Figure 4.19 shows that for the full sample of Survey 2 respondents (n=371), 35.3 per cent responded that their measurement was in line with their expectations, while a further 40.7 per cent noted that the measurement was lower than they expected. Examining the distribution of

[38] Data were presented to the project team in categorical form, corresponding to the coloured 'dots' also received by respondents. Red represents the highest measurement levels (i.e., >40µg/m^3), while dark blue represents the lowest (i.e., 0-10µg/m^3).

expectations by actual NO_2 measurements shows a relationship between expectations and actual measurements (although only statistically significant at the 10 per cent level).[39] For example, the proportion of respondents who had measurements that were lower than they expected was higher in the low measurement areas (<20µg/m^3) (44.7 per cent) than in the high measurement areas (>20µg/m^3) (37.5 per cent).

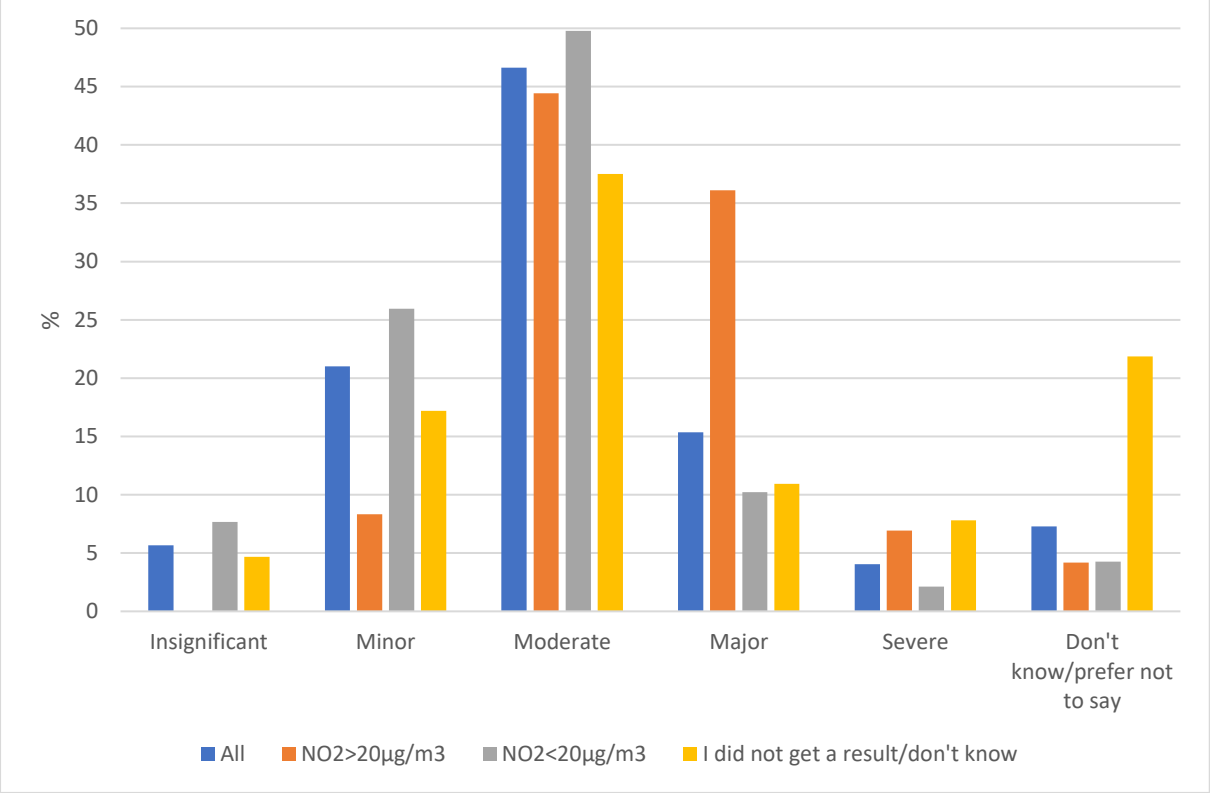
FIGURE 4.19 EXPECTATIONS AND MEASURED NO_2



Respondents were then asked to rate the risk of the NO_2 level measured outside their residence to people's health, with seven responses ranging from 'insignificant' to 'severe' (as well as 'don't know;/'prefer not to say' options). Overall, just under 20 per cent of respondents considered the threat to health at their measurement level to be 'major' or 'severe', and this proportion ranged from 43.1 per cent of those whose NO_2 measurement was >20µg/m^3 to 12.3 per cent among those whose NO_2 measurement was <20µg/m^3.[40]

39 Fisher's exact test p-value=0.083.
40 Fisher's exact test p-value = 0.000.

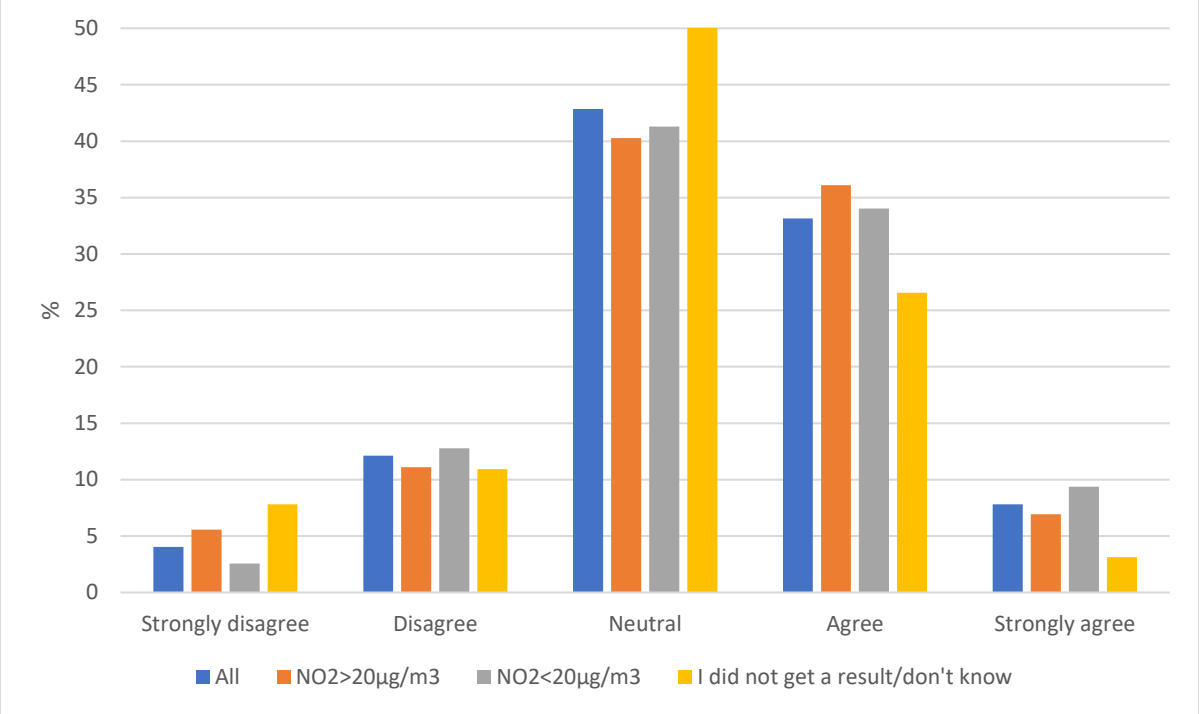
FIGURE 4.20 RISK TO HEALTH



Finally, respondents were asked whether participation in CAT had motivated them to drive less. Figure 4.21 shows that overall just over 40 per cent of respondents 'strongly agreed' or 'agreed' with the statement. However, this proportion did not vary by level of actual NO_2 measurement, with similar proportions of those in the low and high measurements responding that they 'strongly agreed' or 'agreed' (approximately 43 per cent).[41]

[41] Fisher's exact test p-value = 0.133.

FIGURE 4.21 'HAS PARTICIPATION IN CLEAN AIR TOGETHER MOTIVATED YOU TO DRIVE LESS?'



CHAPTER 5

Summary and policy implications

5.1 KEY FINDINGS

Clean Air Together (CAT) is a citizen science project where people voluntarily sign up to measure levels of nitrogen dioxide (NO_2) pollution in their local area. In the first phase of CAT, conducted in 2021 and 2022, approximately 1,000 selected participants in Dublin recorded NO_2 levels in their local area. In this study, we assessed the impact of CAT on awareness, attitudes and behaviours of participants in relation to air quality. CAT selected participants (and those who signed up for the study but who were ultimately not selected to engage in NO_2 measurement, i.e., non-selected participants) were invited to complete three surveys at various points in 2021 and 2022, and it is these survey responses that are used to evaluate the impact of CAT participation on awareness, attitudes and behaviour in relation to air quality.

While the analysis was hindered by small samples (particularly for non-selected participants, and for analysing changes over time), the research identified a number of key findings:

- Compared to the general Dublin population aged 18+, CAT participants differed significantly in their age and socioeconomic profile. CAT participants were more concentrated in the middle age groups (aged 35-64), and nearly half had postgraduate-level educational qualifications.
- The baseline survey was conducted in September 2021, at the start of the CAT project and before participants participated in NO_2 measurement or received infographics and further information on NO_2. It revealed that CAT participants were more aware of NO_2 (and other environmental risks) than the general Dublin population aged 18+, and more likely to correctly identify the main source of NO_2 pollution. However, nearly one-quarter of CAT participants did not know the most significant source of NO_2 pollution, and a further quarter answered this question incorrectly.
- In terms of attitudes, CAT participants were, in general, more supportive of various policy measures to reduce air pollution than the overall Dublin population aged 18+. However, policy options that required increased investment on the part of the State (e.g., increased investment in public transport) were favoured over those options that involved restrictions or curbs on individual behaviour (e.g., implementing congestion charges in cities). A similar distinction in support was evident for the general Dublin population aged 18+.

- While the analysis of changes in attitudes, awareness and behaviours was hampered severely by large amounts of attrition in survey responses, the analysis of CAT selected participants who responded to the first (September 2021) and second (March 2022) surveys showed that awareness of NO_2-related issues improved, as expected. For example, the proportion who correctly identified the most significant source of NO_2 increased from just over 50 per cent to nearly 70 per cent, with an additional large decline in the proportion of participants who reported that they did not know the most significant source of NO_2 pollution.

5.2 STRENGTHS AND LIMITATIONS

Before drawing out the main implications for policy and future environmental citizen science projects in Ireland, it is worth highlighting the strengths and limitations of the current study. One of the main strengths of this study is the availability of similar survey data from a sample of the Dublin population aged 18+, carried out by RED C for another Environmenal Protection Agenct (EPA) funded project (Life Emerald) in July 2021. This allowed us to assess how CAT selected participants and non-selected participants differed, if at all, from the general Dublin population in terms of their attitudes and awareness to air quality at the start of the CAT project.[42] The availability of repeated survey data for CAT participants allowed for an exploratory analysis of changes in attitudes, awareness and behaviours as the CAT project progressed. A unique feature of this study was the availability (albeit on a very limited sample) of CAT non-selected participants, i.e., those who signed up to participate in CAT but who were not selected to participate in the measurement of NO_2 levels at their location. With a larger sample size, further research could have assessed the extent to which active participation in CAT (i.e., measuring NO_2) impacted awareness, attitudes and behaviours of participants over time.

However, while the collection of repeated survey data is to be welcomed, the response rates to the surveys were poor, with just 16.5 per cent of selected participants, and 7.9 per cent of non-selected participants, responding to the third survey in September 2022. In addition, slight changes to question wording in the second and third surveys limited the extent to which reliable comparisons across time could be made.

[42] No data were available against which behaviours (e.g., mode of transport, working from home) could be benchmarked.

5.3 POLICY IMPLICATIONS

In terms of lessons for future environmental citizen science projects, a number of key points can be made:

- Even allowing for the fact that sample recruitment was not designed to generate a sample that was representative of the adult Dublin population in terms of socioeconomic status (see Section 4.1), the extent of educational advantage among those who responded to the first survey is striking.[43] This finding, of a highly engaged and advantaged group of citizen scientists, is consistent with other literature on environmental citizen science (Burgess et al., 2017; Mac Domhnaill et al., 2020; Sauermann et al., 2020), but it highlights a real challenge for those designing environmental citizen science projects and who seek to ensure greater diversity in participation. The broader literature on effective strategies to encourage greater diversity in the profile of environmental citizen scientists suggests that practical actions such as the use of alternative recruitment strategies, recognition of the barriers to participation for certain groups (e.g., time commitments on the part of individuals with paid work and caring responsibilities), and co-design of citizen science projects can be effective tools for widening participation (Pateman et al., 2021).
- With a project of this kind, for which resources were limited (there were only 1,200 NO_2 measurement tubes available), ensuring a high initial response rate to the survey, and continued participation in subsequent surveys, is key. As noted, a strength of this study was the retention of non-selected participants in the study via participation in the three surveys (although levels of attrition were very high). In terms of maximising response rates in future CAT surveys, consideration could be given to sending dedicated reminders to those who have not yet completed surveys. With CAT Dublin, the three surveys were very similar in terms of the ordering of questions, with demographic and socioeconomic information asked at the beginning of each survey. This may have confused some participants who may have thought (incorrectly) that there was no need to respond a second or third time if they had done so already. Highlighting the value of completing the second and third surveys in communications with selected and non-selected participants could be considered in this regard. Insights from behavioural science interventions to increase survey response rates (e.g., using personalised communications) may be useful in future CAT projects (Lunn et al., 2018; Purcell, 2016).
- In addition, a number of amendments to the surveys for participants could be considered for future CAT projects. As a key aim of CAT Dublin was to assess changes in awareness, attitudes and behaviours of participants over time,

[43] It would be useful also to have demographic and socioeconomic characteristics (age, gender and education) of those who signed up but did not complete the first survey. For example, as per Table 1, approximately 40 per cent of participants and 83 per cent of non-participants did not complete the first survey.

ensuring that the wording and response categories of questions are identical across surveys would allow for greater certainty in the assessment of such changes. For example, while there were increases in awareness of the importance of good air quality between the first and second surveys, the wording of questions in the second survey referred specifically to NO_2, while the wording in the first survey referred to air pollution or air quality more generally. Even slight changes in wording can affect responses, and hinder the extent to which changes can be attributed to participation in the CAT project. Lessons from the broader literature on survey design, which discusses how ways in which questions are asked (ordering, framing, mode of administration, etc.) can affect survey responses, may be useful for future CAT survey design (Schaeffer and Dykema, 2020; Timmons et al., 2021).

- The survey collected limited information on individual behaviours (focusing on transport mode choice and working from home), and it was impossible to benchmark these behaviours with the general population. However, there was limited evidence of significant changes in behaviours as a result of participation in CAT. Previous research has also shown that while attitudes towards pro-environmental individual behaviours can be very positive, there is a considerable gap between attitudes and behaviours (Andersson et al., 2022).
- One reason can be a lack of information about the most effective behaviours. This study found high levels of concern about poor air quality, and an increased awareness of NO_2 over time. Despite this, even after receiving NO_2 measurement results, alongside infographics and a webinar about NO_2, knowledge of the most significant source of NO_2 was still relatively low (with approximately 30 per cent of respondents still unable to correctly identify the main source of NO_2 air pollution). However, simply providing enhanced information is often not enough to motivate individual behaviour change, with limited evidence in the literature on the most effective interventions to encourage long-term pro-environmental behaviour change (Rau et al., 2022).
- Ultimately, in order to achieve lower levels of air pollution, individual-level behaviour change will need to be accompanied by targeted public policies. Overall, the research shows that survey participants exhibited high levels of agreement with various policy options designed to reduce air pollution. However, policy options that required increased investment on the part of the State (e.g., increased investment in public transport) were favoured over those options that involved restrictions or curbs on individual behaviour (e.g., implementing congestion charges in cities). Previous research (in Ireland and elsewhere) has also shown that while individuals can profess high levels of support for policies to improve environmental outcomes when asked in surveys, they tend to favour policy options that require action on the part of Government (rather than individuals), and that involve incentives (rather than disincentives) for pro-environmental behaviour (Andersson et al., 2022; Swim and Geiger, 2021).

REFERENCES

Andersson, Y., S. Timmons and P. Lunn (2022). *Youth knowledge and perceptions of climate mitigation,* Dublin: Economic and Social Research Institute.

Bela, G., T. Peltola, J.C., Young, B. Balázs, I. Arpin, G. Pataki, J. Hauck, E. Kelemen, L. Kopperoinen, A. Van Herzele, H. Keune, S. Hecker, M. Suškevičs, H.E. Roy, H.E., P. Itkonen, M. Külvik, M. László, C. Basnou, J. Pino, A. Bonn (2016). 'Learning and the transformative potential of citizen science: Lessons from the study of nature', *Conservation Biology*, Vol. 30, pp, 990–999, https://doi.org/10.1111/cobi.12762.

Birkin, L., E. Vasileiou, H. Stagg (2021). *Citizen science in the time of COVID-19*, Thorax. https://doi.org/10.1136/thoraxjnl-2020-216673.

Burgess, H.K., L.B. DeBey, H.E. Froehlich, N. Schmidt, E.J. Theobald, A.K. Ettinger, J. HilleRisLambers, J. Tewksbury, J.K. Parrish (2017). 'The science of citizen science: Exploring barriers to use as a primary research tool', *Biological Conservation*, Vol. 208, pp. 113–120, https://doi.org/10.1016/j.biocon.2016.05.014.

Conrad, C.C., K.G. Hilchey (2011). 'A review of citizen science and community-based environmental monitoring: Issues and opportunities', *Environ Monit Assess*, Vol. 176, pp. 273–291, https://doi.org/10.1007/s10661-010-1582-5.

Curtis, V. (2015). *Online citizen science projects: An exploration of motivation, contribution and participation*, PhD thesis, the Open University, https://doi.org/10.21954/ou.ro.0000a4ff.

Dickinson, J.L., J. Shirk, D. Bonter, R. Bonney, R.L. Crain, J. Martin, T. Phillips, K. Purcell (2012). 'The current state of citizen science as a tool for ecological research and public engagement', *Frontiers in Ecology and the Environment*, Vol. 10, pp. 291–297, https://doi.org/10.1890/110236.

EPA (2022). *Air quality in Ireland 2021*, Wexford: Environmental Protection Agency.

European Environment Agency (2022). *Air quality in Europe 2022*, Copenhagen: European Environment Agency.

Ewing, R., W. Schroeer, W. Greene (2004). 'School location and student travel: Analysis of factors affecting mode choice', *Transportation Research Record*, Vol. 1885, pp. 55–53.

Fraisl, D., J. Campbell, L. See, U. Wehn, J. Wardlaw, M. Gold, I. Moorthy, R. Arias, J. Piera, J.L. Oliver, J. Masó, M. Penker, S. Fritz (2020). 'Mapping citizen science contributions to the UN sustainable development goals', *Sustain Sci*, Vol. 15, pp. 1735–1751, https://doi.org/10.1007/s11625-020-00833-7.

Lunn, P., D. Robertson, D. (2018). *Using behavioural experiments to pre-test policy*, Dublin: Economic and Social Research Institute, https://doi.org/10.26504/bp201902.

Mac Domhnaill, C., S. Lyons, A. Nolan (2020). 'The citizens in citizen science: Demographic, socioeconomic, and health characteristics of biodiversity recorders in Ireland', *Citizen Science: Theory and Practice*, Vol. 5, No. 16, https://doi.org/10.5334/cstp.283.

Pateman, R., A. Dyke, S. West (2021). 'The diversity of participants in environmental citizen science', *Citizen Science Theory and Practice*, Vol. 6, No. 9, https://doi.org/10.5334/cstp.369.

Purcell, K. (2016). *Applying behavioural economics in Irish policy*, October 2016, Irish Government Economic and Evaluation Service.

Rizzi, F., E. Annunziata, M. Contini, M. Frey (2020). 'On the effect of exposure to information and self-benefit appeals on consumer's intention to perform pro-environmental behaviours: A focus on energy conservation behaviours', *Journal of Cleaner Production*, Vol. 270, 122039. https://doi.org/10.1016/j.jclepro.2020.122039.

Rotman, D., J. Preece, J. Hammock, K. Procita, D. Hansen, C. Parr, D. Lewis, D. Jacobs (2012). 'Dynamic changes in motivation in collaborative citizen-science projects', in *Proceedings of the ACM 2012 Conference on Computer Supported Cooperative Work*. ACM, Seattle Washington USA, pp. 217–226. https://doi.org/10.1145/2145204.2145238.

Sauermann, H., K. Vohland, V. Antoniou, B. Balázs, C. Göbel, K. Karatzas, P. Mooney, J. Perelló, M. Ponti, R. Samson, S. Winter (2020). 'Citizen science and sustainability transitions', *Research Policy*, Vol. 49, 103978, https://doi.org/10.1016/j.respol.2020.103978.

Schaeffer, N.C., J. Dykema (2020). 'Advances in the science of asking questions', *Annu. Rev. Sociol.*, Vol. 46, pp. 37–60, https://doi.org/10.1146/annurev-soc-121919-054544.

Swim, J.K., N. Geiger, N. (2021). 'Policy attributes, perceived impacts, and climate change policy preferences', *Journal of Environmental Psychology*, Vol. 77, 101673, https://doi.org/10.1016/j.jenvp.2021.101673.

Timmons, S., F. McGinnity, C. Belton, M. Barjaková, P. Lunn (2021). 'It depends on how you ask: Measuring bias in population surveys of compliance with COVID-19 public health guidance', *J Epidemiol Community Health*, Vol. 75, pp. 387–389, https://doi.org/10.1136/jech-2020-215256.

Walker, D.W., M. Smigaj, M. Tani (2021). *The benefits and negative impacts of citizen science applications to water as experienced by participants and communities*, WIREs Water 8, https://doi.org/10.1002/wat2.1488.

WHO (2021). *WHO global air quality guidelines: Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulphur dioxide and carbon monoxide*, Geneva: World Health Organization.

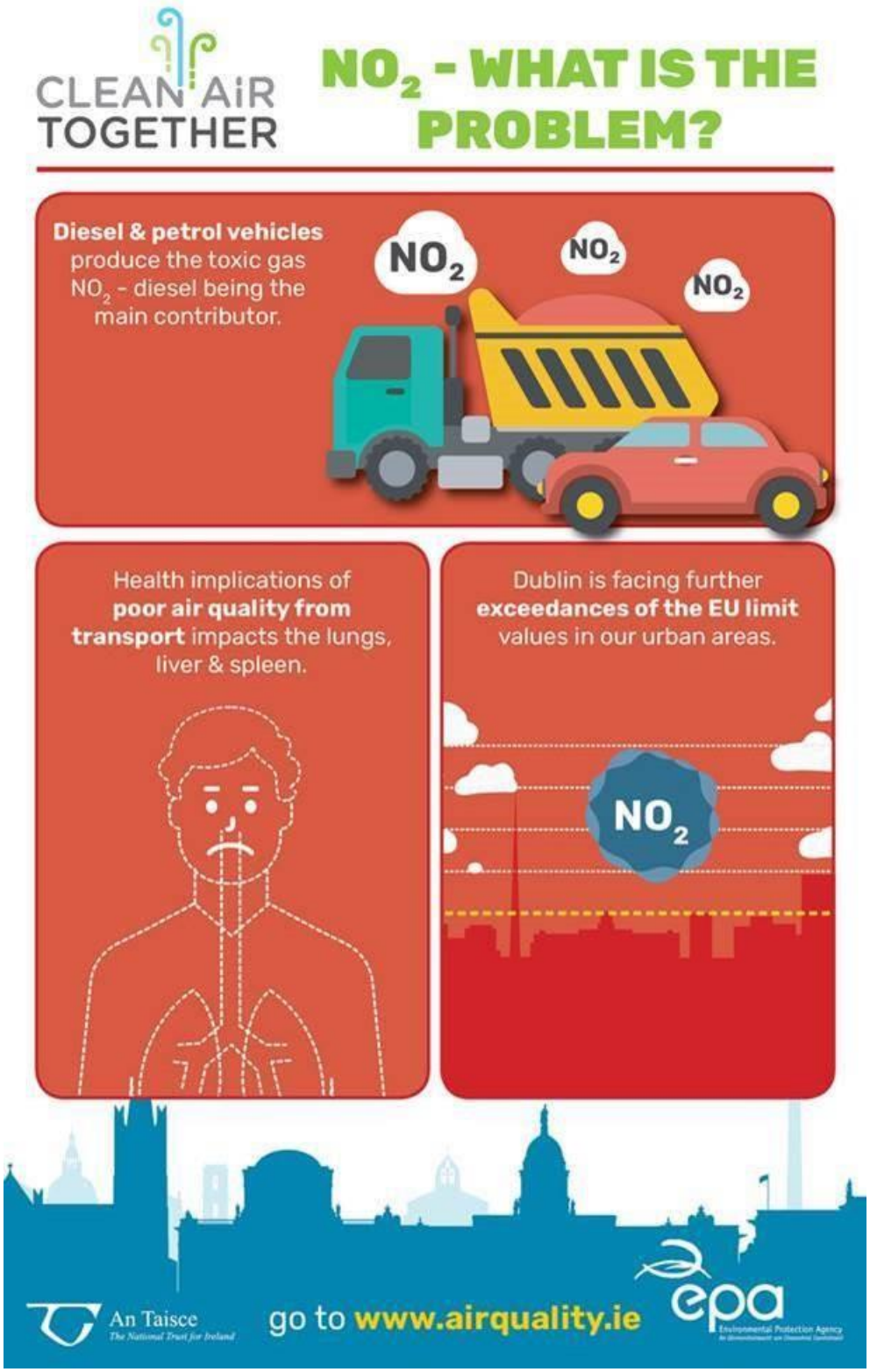
APPENDIX A

Communication

TABLE A1 COMMUNICATIONS WITH PARTICIPANTS AND NON-PARTICIPANTS

Date	Subject of email communication	Did non-participants receive an email?
29 September 2021	Congratulations, you have been selected + link to the 1st survey	Information that they were not selected but will continue to receive emails to keep engaged with the project
6 October 2021	Measurement tube installation and a reminder to complete the 1st survey	No
7 October 2021	Social media post	No
11 October 2021	Tube installation reminder	No
15 October 2021	Week 1 complete	Yes
22 October 2021	What is nitrogen dioxide (NO_2)?	Yes
3 November 2021	Sending your tube for analysis	No
4 Novemeber 2021	Social media post	No
5 November 2021	Collect and post your tube today!	No
11 November 2021	Help us reach our targeted measurements by returning your tube today	No
9 December 2021	Results due in Q1 2022	Yes
3 March 2022	Project Results	Yes
7–9 March 2022	Webinar invitation	Yes
9 March 2022	Your Clean Air Together results and an information sheet to 'understand your results!'	Yes
11 March 2022	Social media post	Yes
28 March 2022	'We need your insight!' link to second survey	Yes
8 April 2022	Latest updates and reminder to complete second survey	Yes
26 September 2022	Whats your knowledge of air pollution like now? Link to 3rd survey.	Yes

FIGURE A1 EXAMPLE OF NO_2 INFOGRAPHIC



APPENDIX B

Predictors of sample attrition

TABLE B1 PROBIT REGRESSION MODEL OF ATTRITION BETWEEN SURVEY ONE AND SURVEY TWO

Characteristic	Marginal effect
Age 18-24	Ref
Age 25-34	-0.014 (0.082)
Age 35-44	-0.11 (0.078)
Age 45-54	0.031 (0.076)
Age 55-64	-0.128 (0.083)
Age 65+	-0.109 (0.091)
Male	-0.046 (0.032)*
Female	Ref
Junior Certificate	0.066 (0.073)
Leaving Certificate	-0.000 (0.061)
Post-Leaving Certificate	0.037 (0.068)
Third level non-degree	0.018 (0.046)
Third level degree	Ref
Postgraduate degree	-0.045 (0.028)*
Selected participant	Ref
Non-selected participant	0.061 (0.032)*
N	858

Notes: Results of a probit regression model explaining attrition between Survey 1 and Survey 2 (0/1 with 0 indicating those who completed both surveys, and 1 those who completed Survey 1 only).
Standard errors are reported in parentheses.
*significant at 10% level; ** significant at 5% level; *** significant at 1% level.

APPENDIX C

Survey 1 for participants

A key objective of Clean Air Together is to better understand the perception of air pollution by members of the public, as well as to raise awareness and increase knowledge of air pollution. Over the course of the project, we will send three surveys to assess the impacts that participation in Clean Air Together may have. It is extremely valuable to us if you can fill in the three surveys. Note that participation in our surveys is at your discretion. The surveys are anonymous, and we won't have any means to identify you. To protect your anonymity and be able to compare responses over time, we will be using a unique identifier. This unique identifier will be based on your responses to a set of three questions: your mother's initials, your day and month of birth and the last two digits of your mobile phone number. As an example, my responses to these questions generate the identifier: NB280311 This survey takes around 10 minutes to complete. Thank you!

1. Age Range 0

- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ 45-54
- ◯ 55-64
- ◯ 65+

2. Gender 0

- ◯ Female
- ◯ Male
- ◯ Prefer Not To Say
- ◯ Other

3. Highest level of education to date 0

- ◯ Junior Cert or less
- ◯ Leaving Cert
- ◯ Post Leaving Cert
- ◯ Non-Degree
- ◯ Degree
- ◯ Postgraduate Degree
- ◯ Other

4. Rate the importance of each value as guiding principle in your life 0

	Extremely Important	Very Important	Moderately Important	Slightly Important	Not Important At All
Respecting the Earth	◯	◯	◯	◯	◯
Preventing Pollution	◯	◯	◯	◯	◯
Social Justice	◯	◯	◯	◯	◯
Being Helpful	◯	◯	◯	◯	◯
Wealth	◯	◯	◯	◯	◯
Ambition	◯	◯	◯	◯	◯
Enjoying Life	◯	◯	◯	◯	◯

5. Rate the importance of each value as guiding principle in your life 0

	Strongly Agree	Somewhat Agree	Neither Agree or Disagree	Disagree Somewhat	Strongly Disagree
I want to take part in a scientific project	○	○	○	○	○
I want to know what air pollution is like at my measurement location.	○	○	○	○	○
I want to learn more about the causes of and solutions to air pollution.	○	○	○	○	○
I want to make other people aware of the importance of air quality	○	○	○	○	○
I want to take action to reduce air pollution in my local area.	○	○	○	○	○

6. Your Mothers Initials 0

7. Your day of birth 0

8. Your month of birth 0

9. Second last digit 0

10. last digit 0

11. Air pollution poses a serious health risk to the public 0

- ◯ Somewhat Disagree
- ◯ Disagree
- ◯ Neutral
- ◯ Agree
- ◯ Somewhat Agree

12. How much do you believe air pollution is...? 0

	Not a serious problem at all	Not a very serious problem	A fairly serious problem	A very serious problem	Don't Know
Nationally	◯	◯	◯	◯	◯
In Your Local Area	◯	◯	◯	◯	◯
In Dublin	◯	◯	◯	◯	◯

13. How strongly do you agree or disagree with the following statements? 0

	Not a serious problem at all	Not a very serious problem	A fairly serious problem	A very serious problem	Don't Know
I feel concerned about air pollution levels in Dublin	◯	◯	◯	◯	◯
I feel curious about air pollution levels in Dublin	◯	◯	◯	◯	◯
I want air quality to improve in Dublin	◯	◯	◯	◯	◯

14. Which do you think is the most significant source of nitrogen dioxide (NO_2) in Ireland? 0

- ◯ Industry
- ◯ Home heating by stoves/ fires
- ◯ Petrol cars/vans
- ◯ Diesel cars/truck/buses
- ◯ Don't know
- ◯ Other

15. Which do you think is the most significant source of particulate matter (PM) in Ireland? 0

- ◯ Industry
- ◯ Home heating by stoves/fires
- ◯ Petrol cars/vans
- ◯ Diesel cars/trucks/buses
- ◯ Don't Know
- ◯ Other

16. Where would you go to (agencies, groups, organisations, websites etc) if you were looking for information about air quality in Ireland? 0

17. For each of the statement below, tell us if you think it is "true", "false" or whether you "don't know": 0

	True	False	Don't Know
Poor air quality is only a problem in and around cities	◯	◯	◯
Air pollution in Dublin has been decreasing for several years	◯	◯	◯
The amount of traffic on a street has little impact on the pollution on the street	◯	◯	◯
NO2 pollution can vary greatly between nearby streets	◯	◯	◯
Higher NO2 concentrations in the air increase the risk of asthma	◯	◯	◯
On average, diesel cars emit more NO2 than petrol cars	◯	◯	◯

18. How often do you use the following modes of transport on a typical week? 0

	Never or rarely	1 to 2 times a week	3 to 4 times a week	5 times a week or more	
Car, motorbike or similar	◯	◯	◯	◯	◯
Walking	◯	◯	◯	◯	◯
Cycling, scooting or similar	◯	◯	◯	◯	◯
Public transport	◯	◯	◯	◯	◯

19. On average, how many days per week do you work from home? 0

- ◯ 1
- ◯ 3
- ◯ 4
- ◯ 5 or more
- ◯ Rarely
- ◯ Never/does not apply

20. What changes to your mobility, if any, are you considering in the next 12 months? 0

- ◯ Walking, cycling or scooting more
- ◯ Using public transport more
- ◯ Working from home more often
- ◯ Driving less
- ◯ Upgrading my car to a model with lower or zero emission
- ◯ I am already doing as much as I can
- ◯ I have no intention to change my mobility
- ◯ Other

21. What changes would you like to see happen at policy level to reduce air pollution levels in Dublin?
0

	Strongly Agree	Agree Somewhat	Neither Agree or Disagree	Disagree Somewhat	Strongly Disagree	Don't know/prefer not to say
Increase investment in public transport	○	○	○	○	○	○
Increase subsidies for electric cars and other low emission products	○	○	○	○	○	○
Increase investments in new cycling and walking infrastructure	○	○	○	○	○	○
Apply stricter controls on emissions from new vehicles	○	○	○	○	○	○
Introduce low emission zones/congestion charges in cities	○	○	○	○	○	○
Ban the sale of new diesel and petrol cars from 2030	○	○	○	○	○	○

22. Below is a list of different environmental health risks, some of them you may have heard of before and some of them you may not have 0

	Extremely Familiar	Very Familiar	Quite Familiar	Neither	Quite Unfamiliar	Very Unfamiliar	Extremely Familiar
Carbon monoxide (CO)	○	○	○	○	○	○	○
E. Coli	○	○	○	○	○	○	○
Lead in drinking water	○	○	○	○	○	○	○
Radon	○	○	○	○	○	○	○
Nitrogen Dioxide (NO2)	○	○	○	○	○	○	○
Particulate Matter (PM)	○	○	○	○	○	○	○

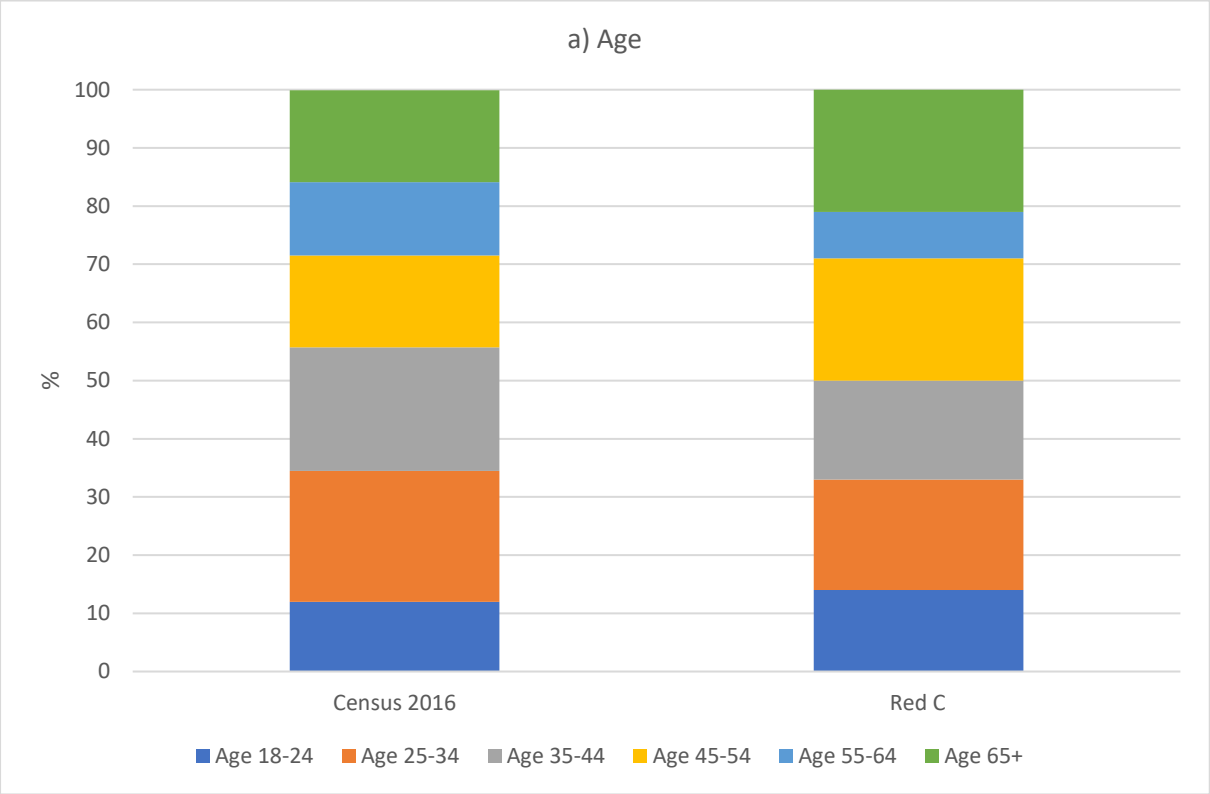
23. Why are you participating in Clean Air Together? 0

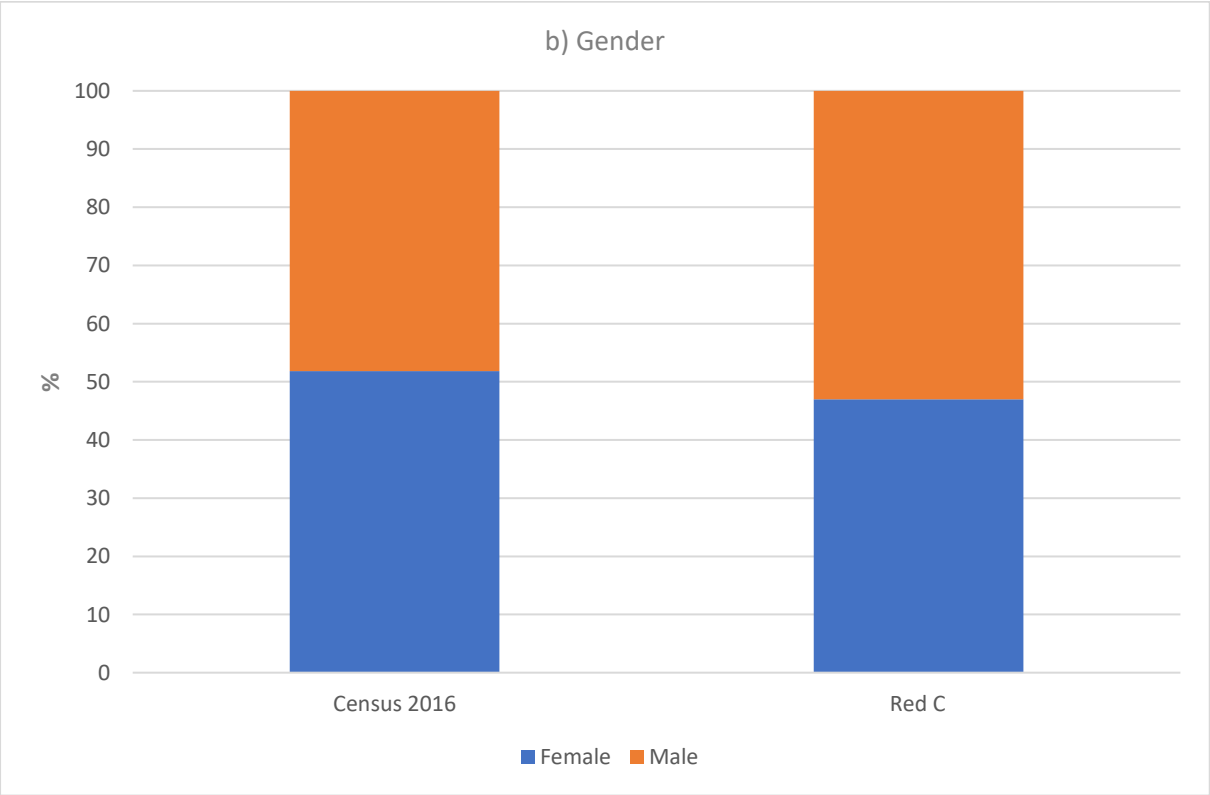
	Strongly Agree	Agree Somewhat	Neither Agree or Disagree	Disagree Somewhat	Strongly Disagree
I want to take part in a scientific study	○	○	○	○	○
I want to know what air pollution is like at my measurement location	○	○	○	○	○
I want to learn more about the causes of and solutions to air pollution	○	○	○	○	○
I want to make other people aware of the importance of air quality	○	○	○	○	○
I want to take action to reduce air pollution in my local area	○	○	○	○	○

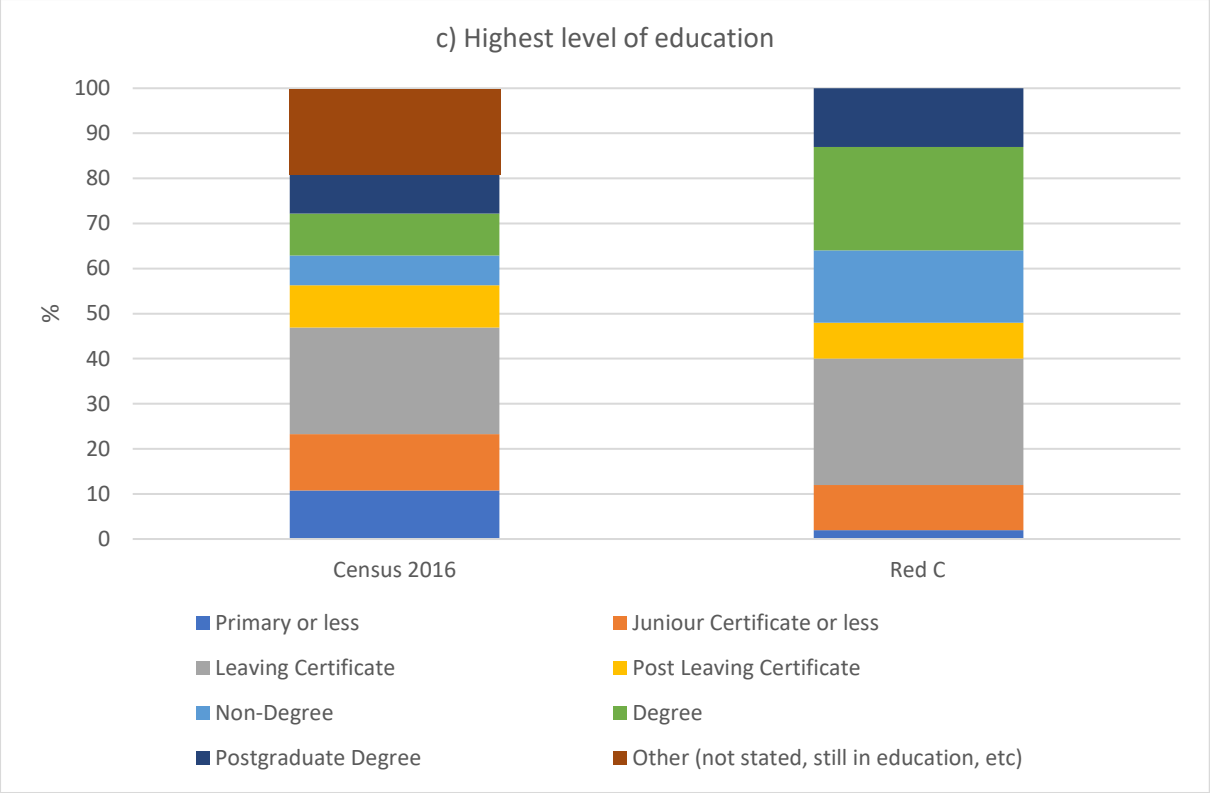
APPENDIX D

Dublin aged 18+ (Census vs. RED C)

FIGURE D1 DEMOGRAPHIC AND SOCIOECONOMIC PROFILE OF DUBLIN POPULATION 18+ FROM CENSUS 2016 AND RED C SURVEY



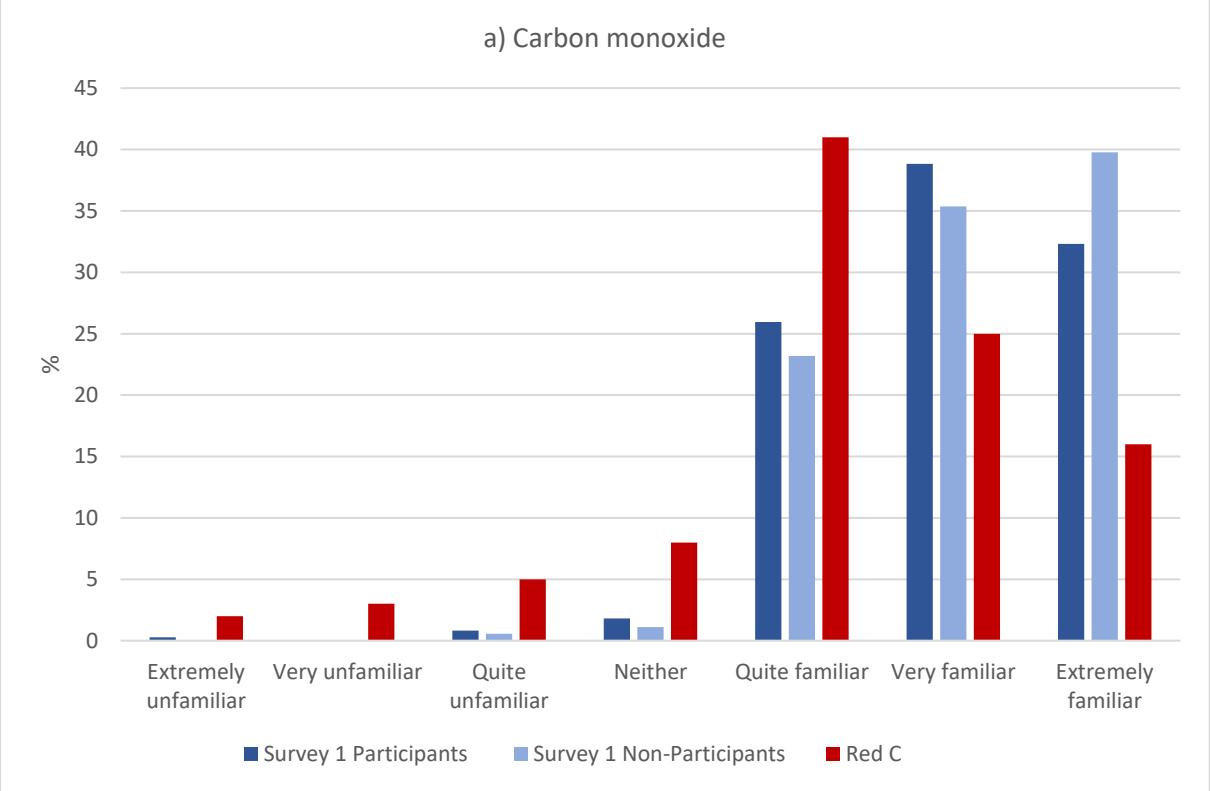


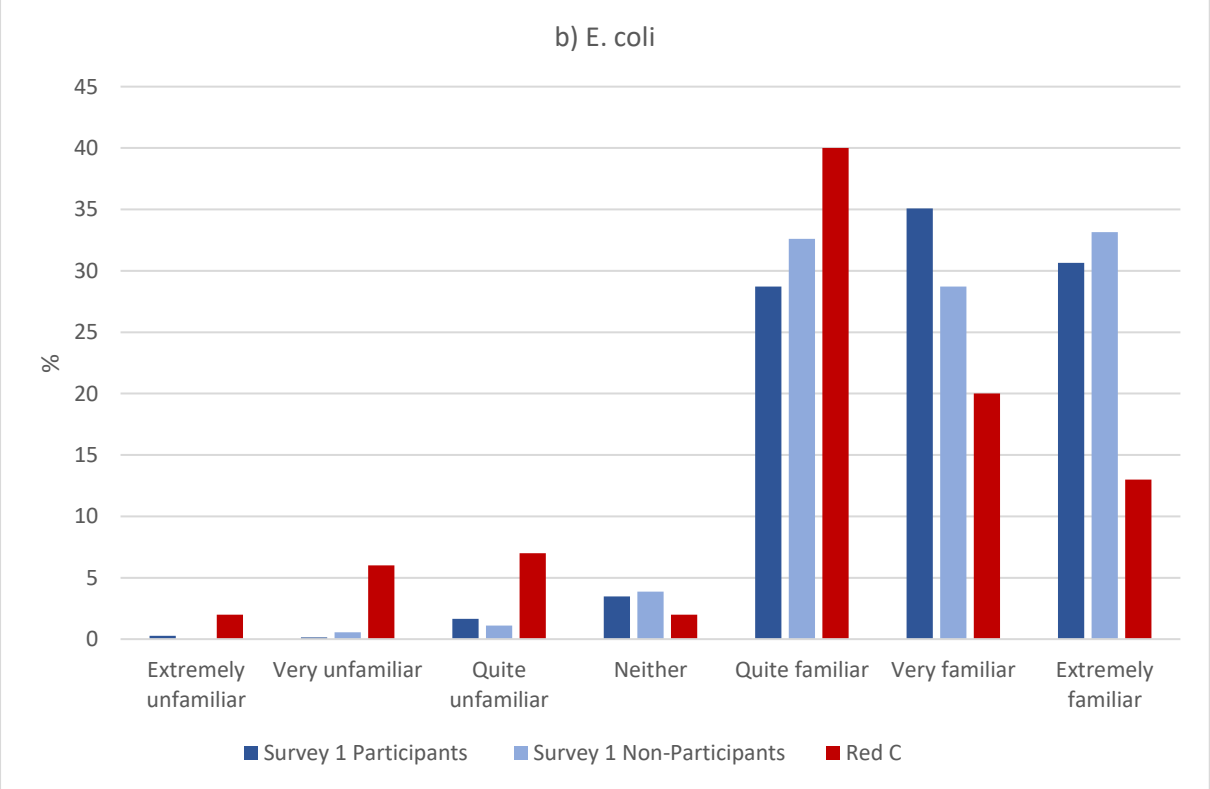

c) Highest level of education
100
90
80
70
60
50
40
30
20
10
0
%
Census 2016
Red C
Primary or less
Juniour Certificate or less
Leaving Certificate
Post Leaving Certificate
Non-Degree
Degree
Postgraduate Degree
Other (not stated, still in education, etc)

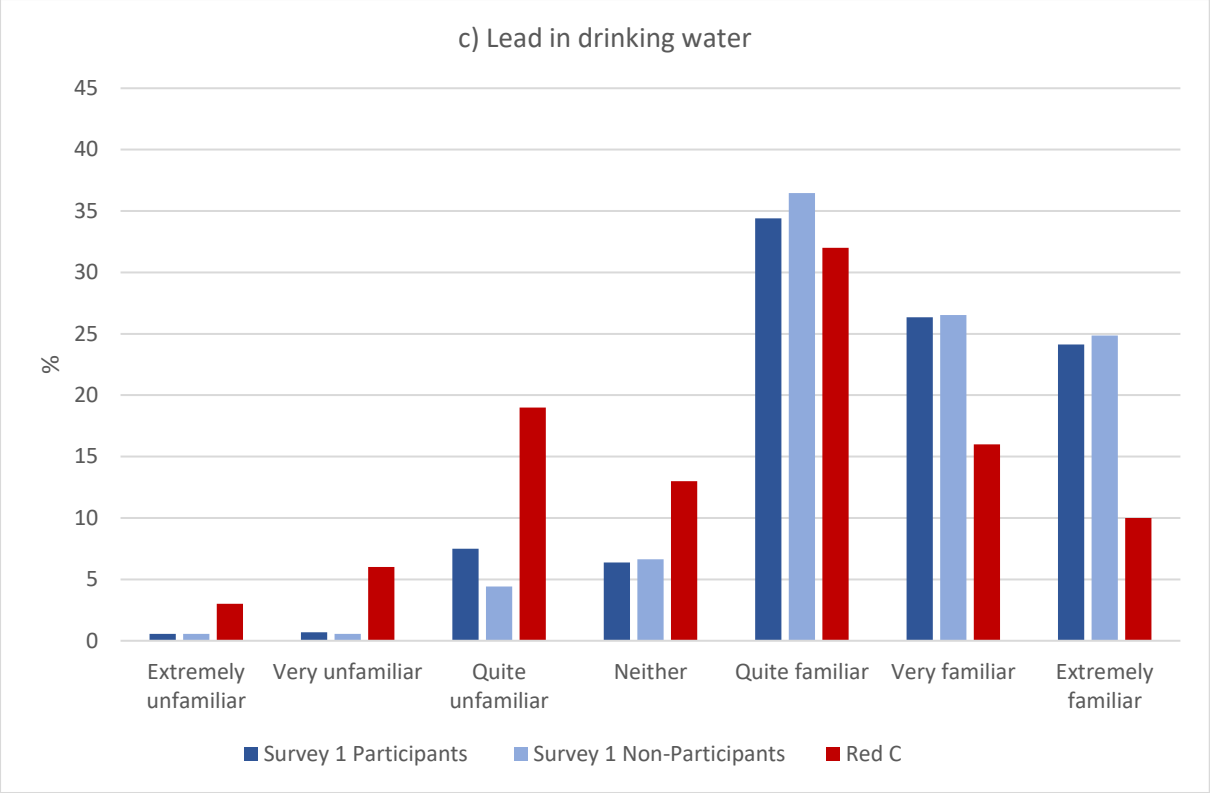
APPENDIX E

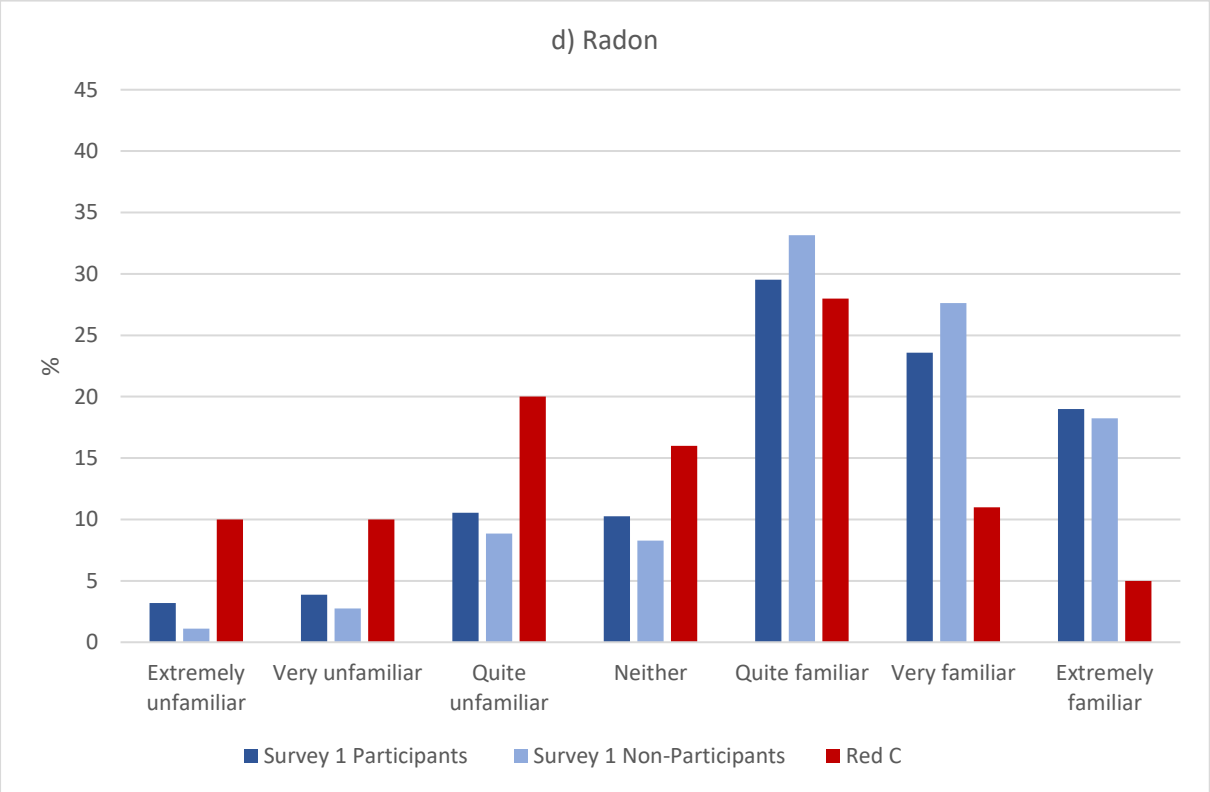
Familiarity with other environmental health risks

FIGURE E1 FAMILIARITY WITH ENVIRONMENTAL HEALTH RISKS






c) Lead in drinking water
45
40
35
30
25
20
15
10
5
0
%
Extremely unfamiliar
Very unfamiliar
Quite unfamiliar
Neither
Quite familiar
Very familiar
Extremely familiar
Survey 1 Participants
Survey 1 Non-Participants
Red C


d) Radon
45
40
35
30
25
20
15
10
5
0
%
Extremely unfamiliar
Very unfamiliar
Quite unfamiliar
Neither
Quite familiar
Very familiar
Extremely familiar
Survey 1 Participants
Survey 1 Non-Participants
Red C

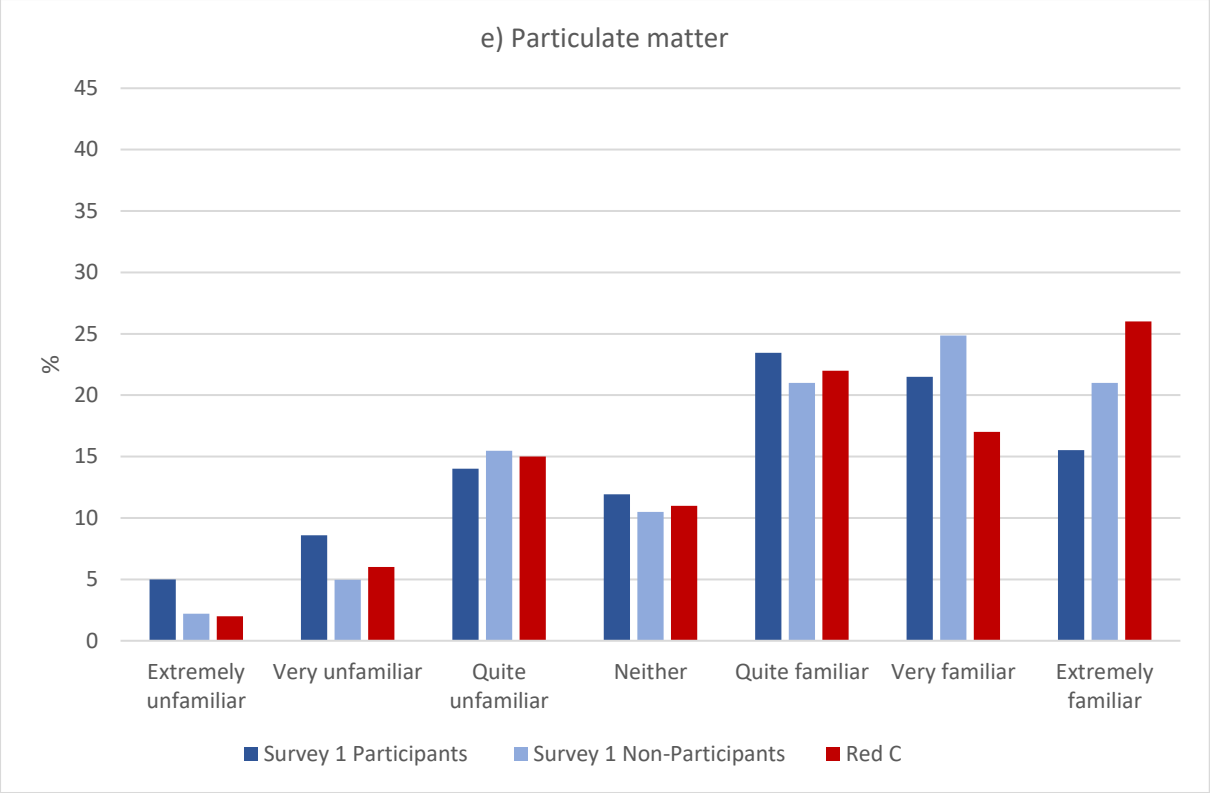
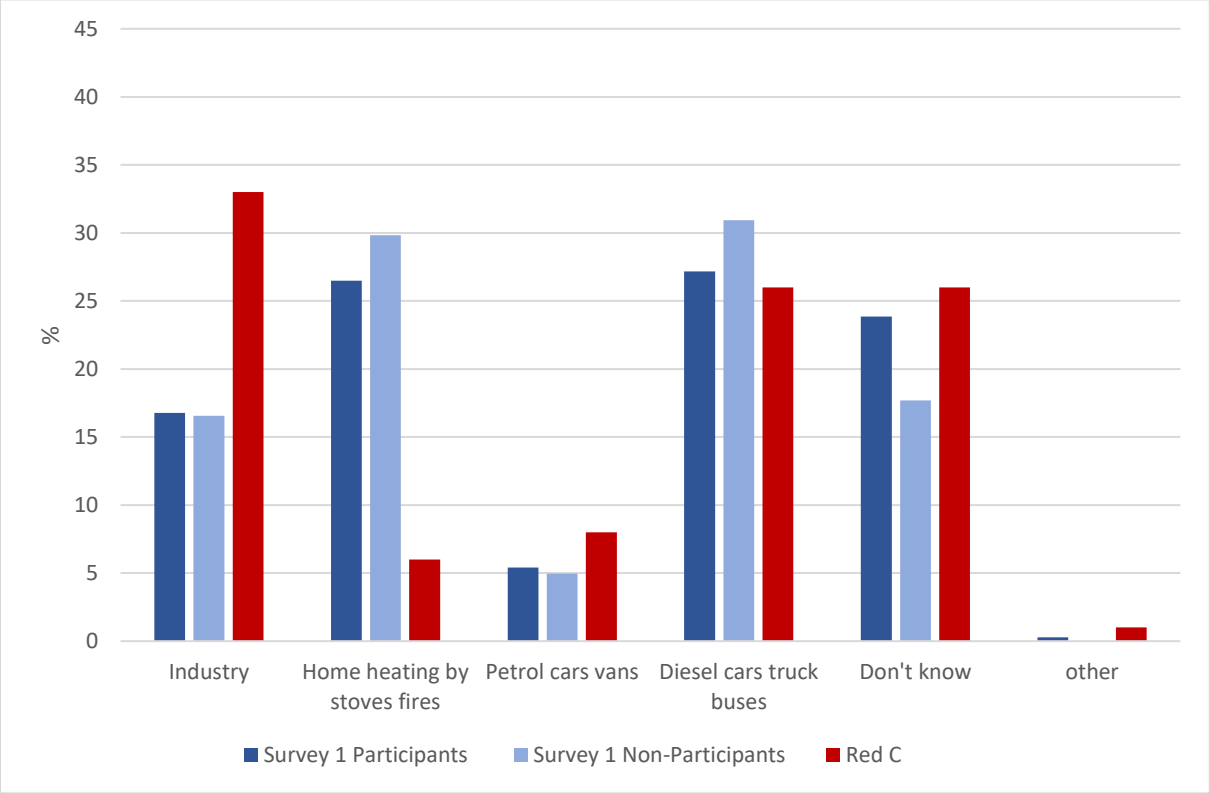


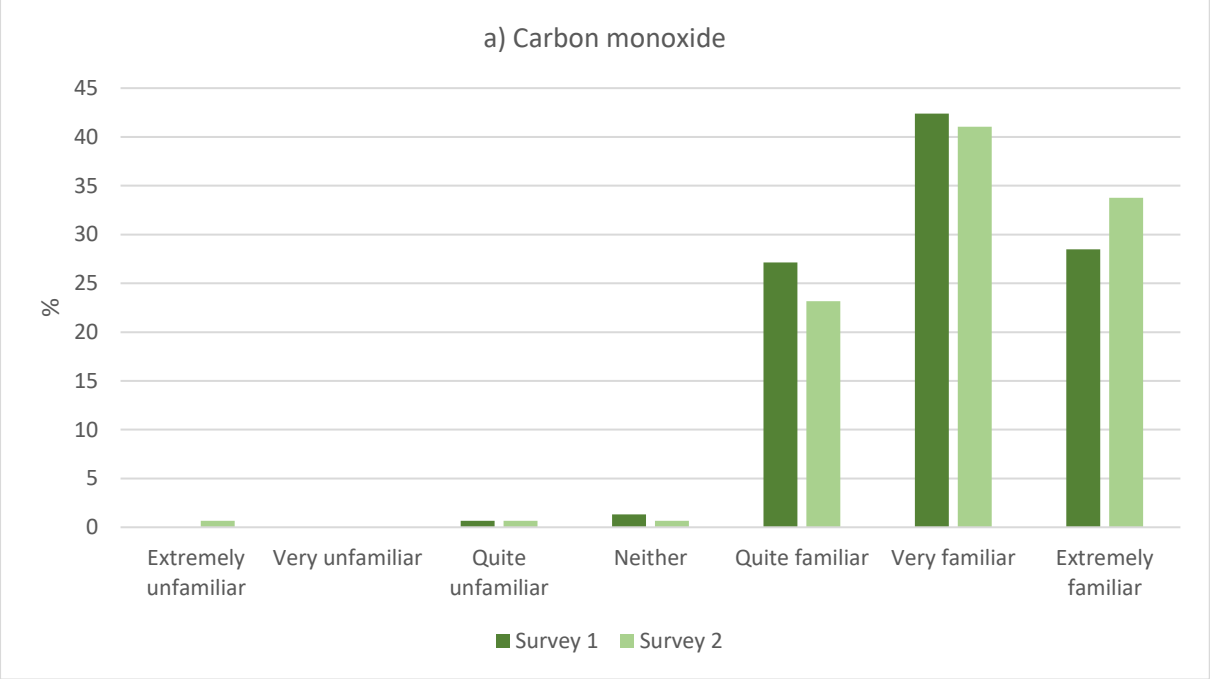
FIGURE E2 MOST SIGNIFICANT SOURCE OF PARTICULATE MATTER

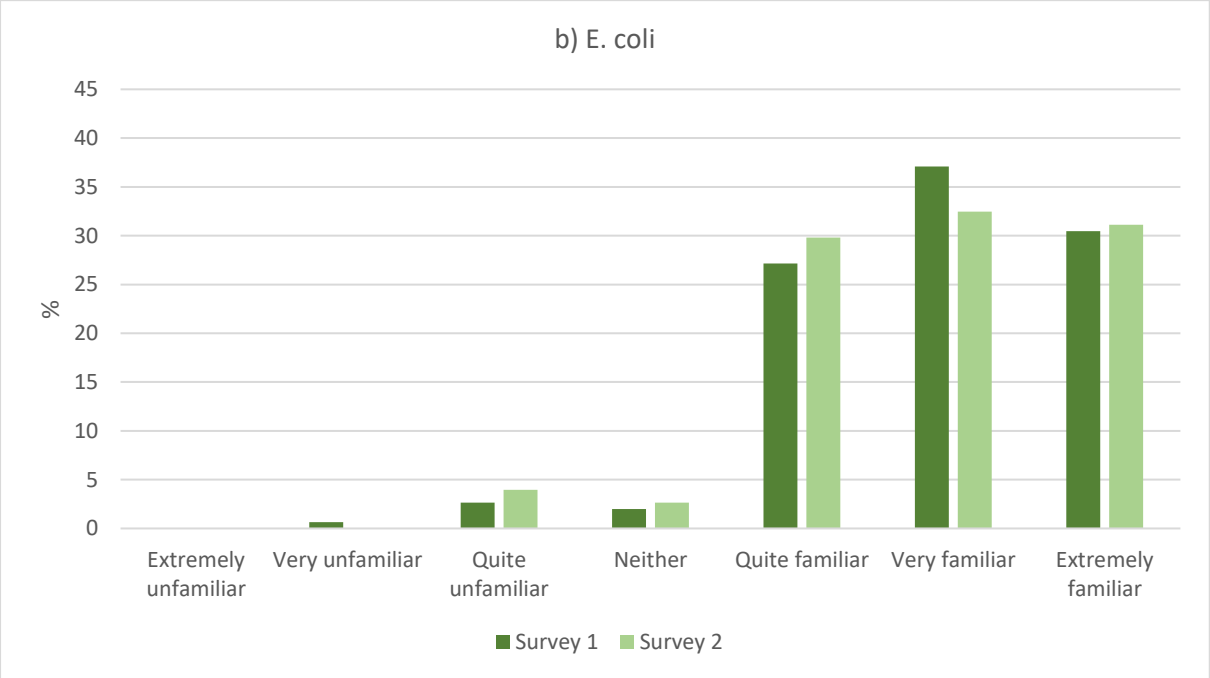


APPENDIX F

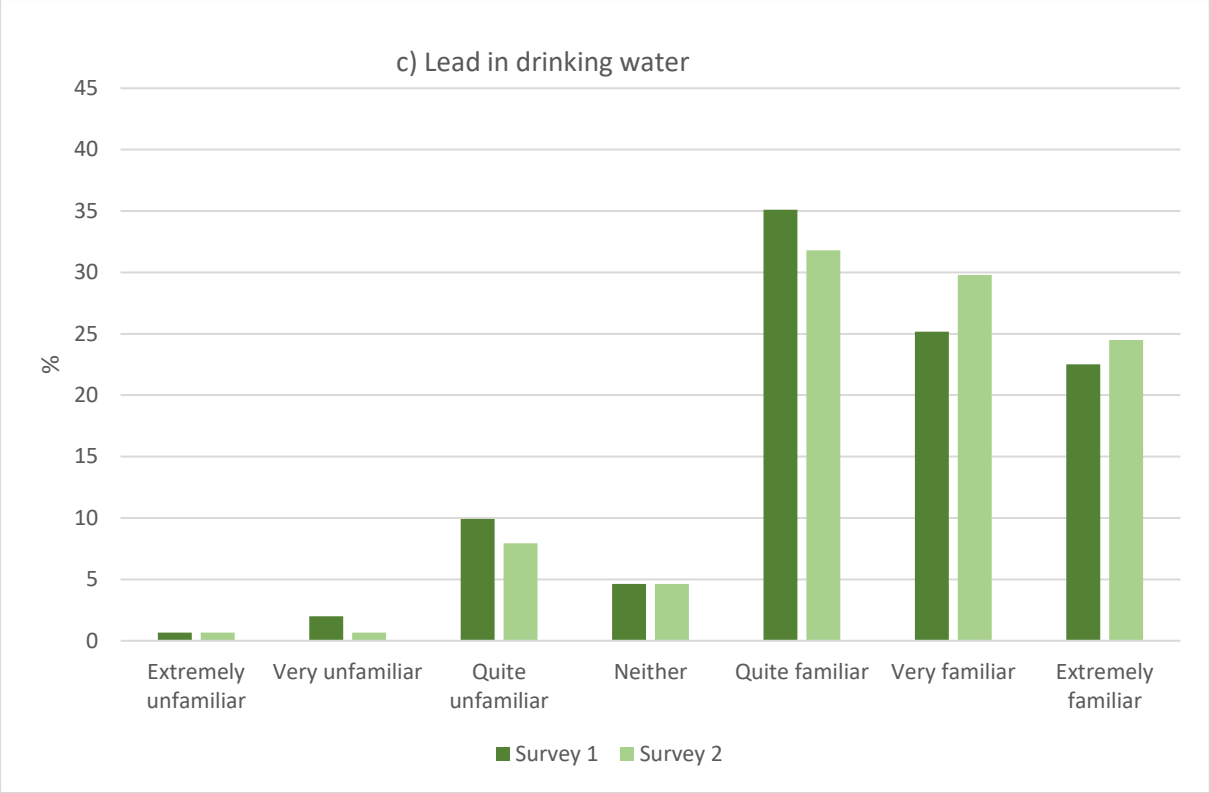
Changes in familiarity with other environmental health risks

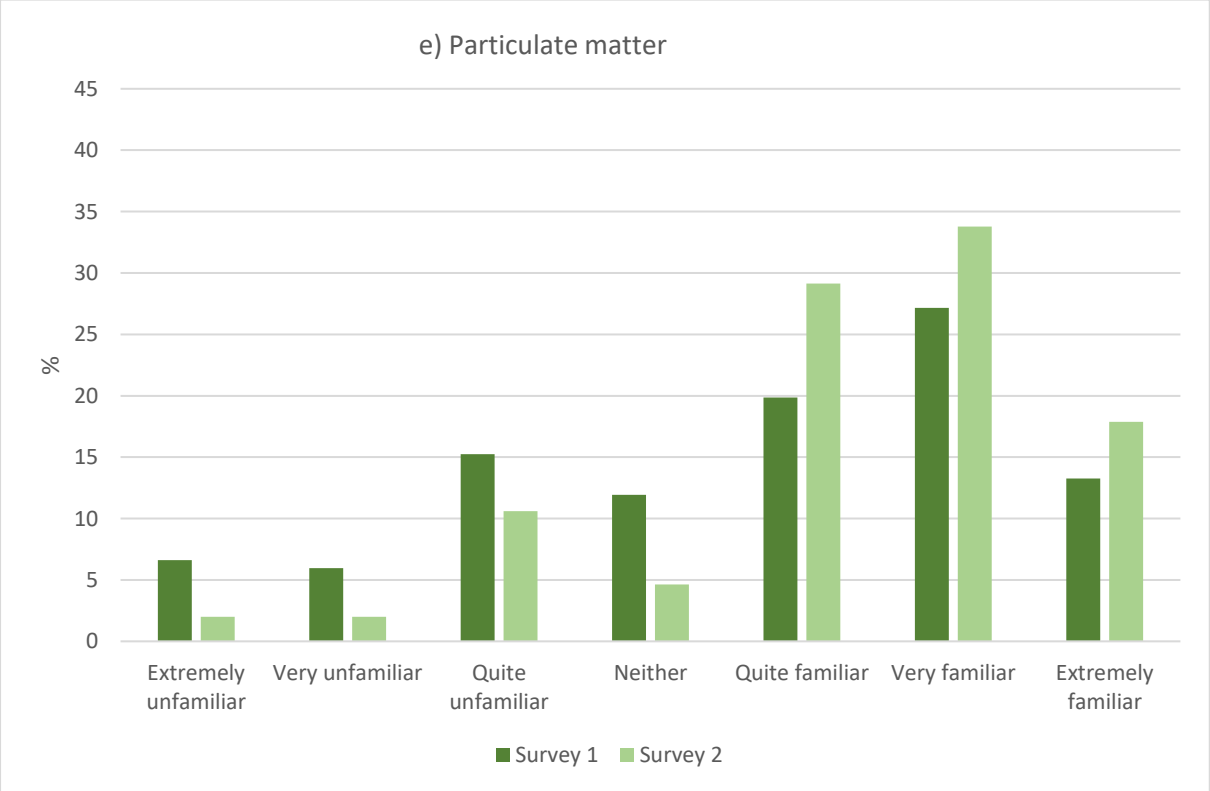
FIGURE F1 FAMILIARITY WITH ENVIRONMENTAL HEALTH RISKS[44]





[44] Fisher's exact test results:
- a) Carbon Monoxide (CO): p-value = 1.00
- b) E. Coli: p-value = 0.089
- c) Lead in Drinking Water: p-value= 0.000
- d) Radon: p-value = 0.000
- e) Particulate matter = 0.000.


c) Lead in drinking water
45
40
35
30
25
20
15
10
5
0
%
Extremely unfamiliar
Very unfamiliar
Quite unfamiliar
Neither
Quite familiar
Very familiar
Extremely familiar
Survey 1
Survey 2


e) Particulate matter
45
40
35
30
25
20
15
10
5
0
%
Extremely unfamiliar
Very unfamiliar
Quite unfamiliar
Neither
Quite familiar
Very familiar
Extremely familiar
Survey 1
Survey 2

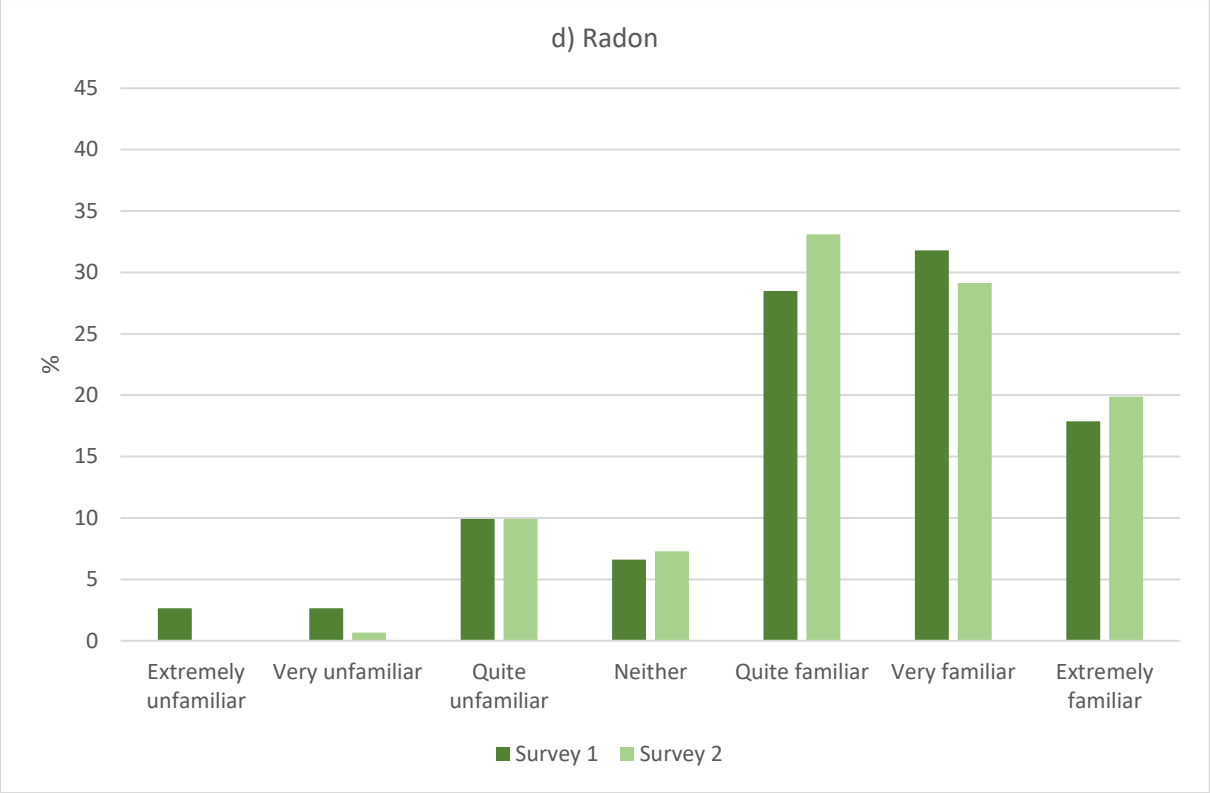
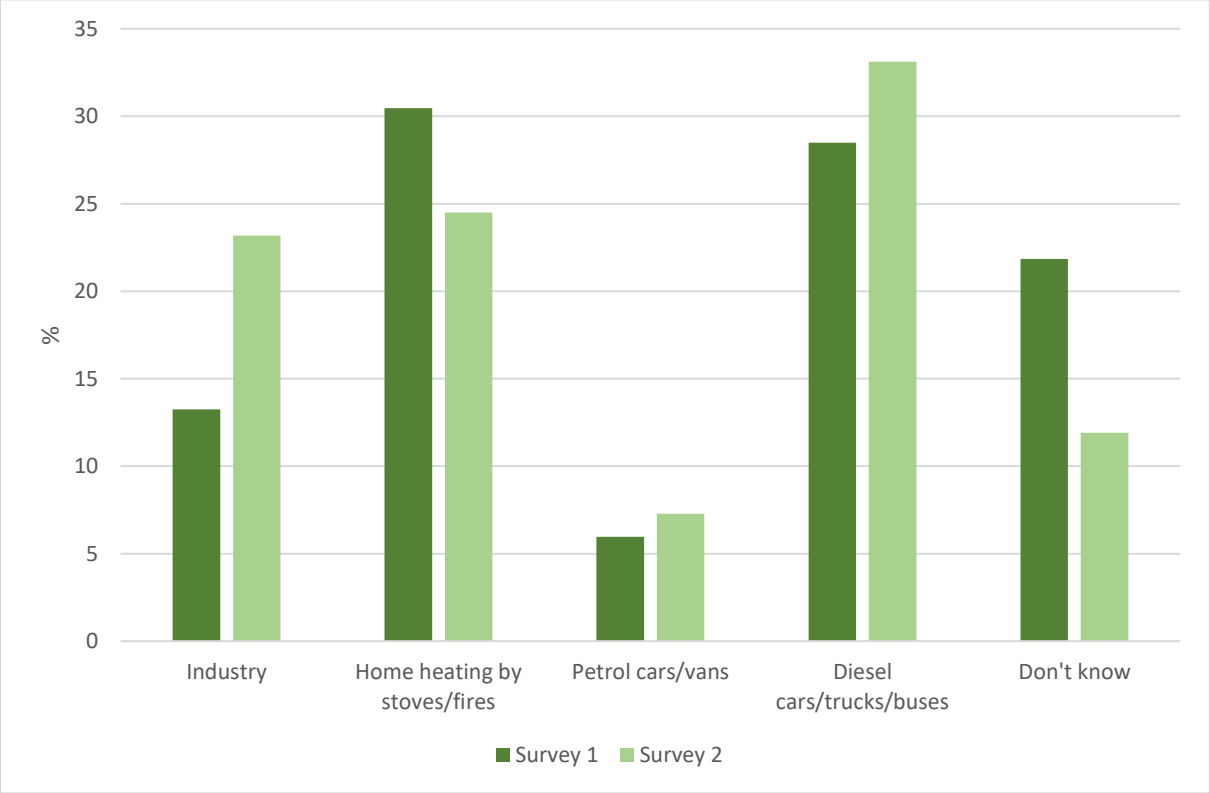


FIGURE F2 CHANGE IN MOST SIGNIFICANT SOURCE OF PARTICULATE MATTER[45]



[45] Fisher's exact test p-value = 0.000

Whitaker Square,
Sir John Rogerson's Quay,
Dublin 2
Telephone **+353 1 863 2000**
Email **admin@esri.ie**
Web **www.esri.ie**
Twitter **@ESRIDublin**

AN INSTITIÚID UM THAIGHDE EACNAMAÍOCHTA AGUS SÓISIALTA
ESRI ECONOMIC & SOCIAL RESEARCH INSTITUTE