

Research report:

The connection between people, nature and wellbeing in Wellington, Part 1

Author:

Dr Danielle Shanahan

The ZEALANDIA Centre for People and Nature

31 Waiapu Road

Karori, 6012

In collaboration with

Wellington City Council

Date:

26 February 2020

© Karori Sanctuary Trust, 31 Waiapu Road, Karori 6012, Wellington, New Zealand.



**Absolutely Positively
Wellington City Council**

Me Heke Ki Pōneke

Summary

Living in a city environment can be stressful; but experiences of nature can provide an antidote by delivering a suite of mental, physical and social wellbeing benefits. Yet most of us struggle to find time for nature, with an 'extinction of experience' of nature being reported across the globe.

In this research we aim to investigate what role experiences of nature have for the health and wellbeing of Wellington, New Zealand, residents. Wellington offers a particularly unique place to carry out this study, as it is one of the few places in the world where native forest bird biodiversity is improving, rather than declining. We also aim to take this a step further, investigating what added benefits becoming involved in predator trapping communities might provide.

We have replicated a tried and tested Brisbane study that established methods to explore the association between mental, physical and social wellbeing outcomes and nature experiences at a population level. This is Part 1 of a two-part study; we will also explore how nature experiences and the benefits people receive change over time to extend our understanding.

From our survey of 1200 Wellington residents, we found that levels of depression, anxiety and stress are lower in respondents who spent more time in public green spaces, and this relationship remained after accounting for a range of other influential factors such as age, or work status.

We found benefits over and above those for standalone nature experiences for those who participated in predator trapping. Around 30% of those surveyed participate in this activity, and it was associated with lower levels of depression, stress and greater feelings of social cohesion.

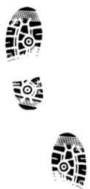
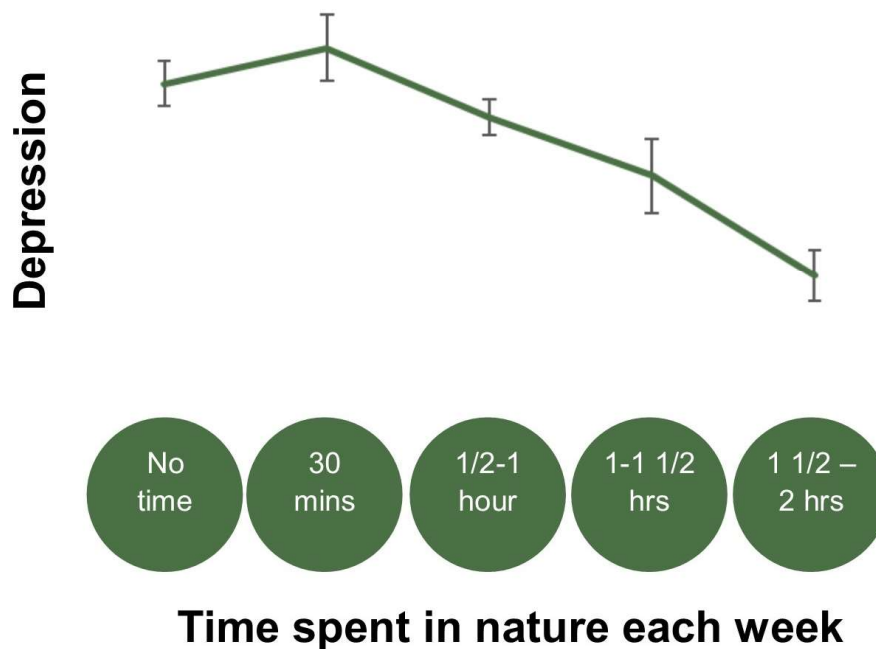
Several other interesting findings emerged from this work. For example, we found that around 40% of respondents noted they currently have more experiences of nature than they did 10 years ago. While such results need to be interpreted with care, it provides some suggestion that the 'extinction of experience' of nature may be reversing. Certainly, we have strong evidence that the children of Wellington city in 2020 experience a much greater diversity of native birdlife than the children of 2000.

Ultimately, these results suggest that nature is playing a key role in promoting the health and wellbeing of Wellingtonians. Further, becoming involved in an environmental volunteering group can offer benefits above and beyond nature experiences, and these outcomes are likely contributing to a more resilient population.

Part 2 of this work will extend these results and provide added insights into what happens to nature experiences and wellbeing over time.

ZEALANDIA CENTRE FOR PEOPLE AND NATURE

Our natural spaces promote the mental wellbeing of Wellingtonians. People who spend more time in nature show lower levels of depression, anxiety and stress.



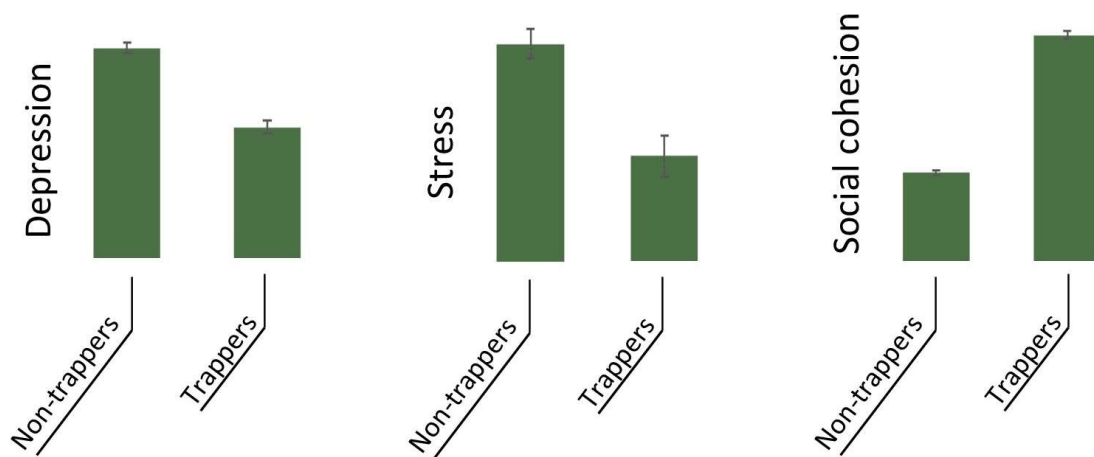
We love our natural spaces.

Around 85% of Wellington respondents spent at least some time in the city's parks, bushland and beaches during the survey week.



ZEALANDIA CENTRE FOR PEOPLE AND NATURE

We love to help. 30% of Wellingtonians trap introduced predators of native wildlife, and this also gives our wellbeing a further boost.



A community that has greater levels of social cohesion will be more resilient in tougher times.

Meet your neighbours, and create a nature-rich future by becoming part of your local Predator Free group.



ZEALANDIA CENTRE FOR PEOPLE AND NATURE

In most cities people are having fewer, and poorer experiences of nature. But we are bucking the trend in Wellington.

Around half of all Wellingtonians participate in some form of environmental volunteering.



61% of Wellingtonians encounter tūi almost every day.

36% of Wellingtonians spot the previously locally extinct kākā around their home at least occasionally.

Our children are growing up with richer experiences of nature because of Zealandia and community and council trapping efforts.



Photo: Chris Helliwell

Introduction

Urbanisation leads to wholesale change of the natural environment through a process of habitat loss and degradation [1]. These changes, coupled with the busy modern lifestyle, are leading to a widespread ‘extinction of experience’ of nature—that is, where people are having fewer, poorer quality experiences of nature. [2, 3]. This extinction of experience of nature is occurring despite powerful new evidence which highlights the critical role that urban nature and green infrastructure can play in shaping healthy cities.

How can nature improve our wellbeing?

Experiences of nature are unique in that they affect people in many different ways, and because of this there are multiple pathways to health and wellbeing benefits [4]. For example, nature is thought to improve wellbeing through ‘attention restoration’; that is, looking at the forest or a garden requires unfocussed effort, providing a much needed break from the constant focus that is required in every-day modern life [5]. Supporting this, even glimpses of nature through a window have been linked to feelings of restoration [6], and it is thought to be a key pathway to improved mental and physical wellbeing [7-9]. Some studies have shown that experiences of nature have led to lower rates of high blood pressure in populations, and this is likely linked to the attention restoration pathway.

People’s behaviour is also affected by the presence of nature in their neighbourhood. Physical activity has repeatedly been found to be higher in greener neighbourhoods even after accounting for a range of potentially confounding socio-economic and demographic variables [10, 11]; they provide free, accessible locations for active pastimes [12]. Coupled with this, exercising in nature can provide wellbeing benefits above and beyond what might be experienced in an indoor environment [13-15], with one highly controlled study showing that natural scenes combined with exercise can boost the benefits for blood pressure, self-esteem and mood [14].

There is increasingly clear evidence that the presence of nature also has a significant impact on the prevalence of allergies and respiratory illnesses in a population. For example, one key study in Finland found that a wider diversity of plant species in an adolescent’s backyard was linked to the diversity of microbiota in the soil, and subsequently on the individual’s skin [16]. This diversity of microbiota is thought to be very important in the development of a healthy immune system, and ultimately atopic individuals in the study tended to have a lower diversity of plants in their backyard [16]. The presence of nature around the home has also been linked to lower levels of asthma in New Zealand [17]. Vegetation is known to filter particulates and pollution from the air, which is another potential contributor to these types of outcomes.

This provides just a glimpse into the many ways that nature can influence wellbeing. As a consequence, there are a myriad of opportunities for nature to be incorporated into individual health care and neighbourhood planning to improve wellbeing outcomes [18]. This includes green prescriptions where people are prescribed a minimum amount of time to spend in nature each week, through to local council efforts to green neighbourhoods to improve the baseline levels of nature that people are exposed to every day. Many of these strategies are now in frequent use across the globe.

Nature and wellbeing in Wellington city

We have some evidence that Wellington city, New Zealand, may be one of the only cities in the world where the diversity of some groups of native birds are improving; for example, we have experienced significant regional improvements in the distributions of species such as tūi and kākā

(Figure 1). As a result, anecdotally nature is becoming central to the identity of Wellingtonians. These changes offer a remarkable opportunity to understand how improving biodiversity can influence the human experience of nature, and also to explore whether wellbeing outcomes improve as a result. This type of information is lacking globally. Most studies on the link between experiences of nature and wellbeing are either single time point (e.g. [8]) or occur in places where nature is declining across all groups of species; thus, we have a very poor understanding about what happens when elements of nature improve.

The improvements in distribution of some bird species is likely occurring for a number of interlinked reasons. Zealandia sanctuary (a fenced ecosanctuary) has provided a source of native bird biodiversity, much of which was previously extinct or effectively extinct from the region (e.g. kākā, kererū). Coupled with this, 'top down' approaches including the enhancement and management of public green and blue spaces (blue spaces include, for example, natural spaces centred around the harbour or coast), combined with 'bottom up' initiatives (e.g. local green space care groups, and community introduced predator trapping groups ('Predator Free') may have had a positive effect on reducing threats facing native birds within the city environment.

Wellington, similar to many other cities, still has many opportunities to further enhance biodiversity across all groups of species by reducing ongoing threats and improving habitat for lizards, plants, invertebrates, freshwater ecosystems, as well as birds. This study will help provide a base line against which we can explore how our society changes as a result of transformation in the natural world over time.

The purpose of this research

This research aims to address two globally important questions. 1) Can the extinction of experience of nature be reversed for urban residents by improving the biodiversity around them? 2) What is the impact of engaging with nature on population health and wellbeing? 3) What are the added benefits of engaging in environmental volunteering? This information, along with key mechanisms for improving biodiversity, will be crucial to support business cases for biodiversity improvement in cities. Further, it will support councils and other organisations that seek to enhance wellbeing of city residents across multiple dimensions.

This report is part 1 of this research. It is a snapshot in time, with a second follow up survey planned in 2021 to examine changes over time. This will allow us to determine changes in health and wellbeing as they relate to nature experiences, but it will also provide a better sense of how experiences of nature themselves are changing rather than relying on people's recollections.

Part 1 has three goals:

- Gain a 2019 snapshot of engagement with nature by Wellington residents.
- Examine the correlations between key health and wellbeing outcomes and nature exposure for Wellington residents.
- Identify key wellbeing outcomes arising from the Predator Free initiatives in the region.

Part 2 (to be completed in 2021) will additionally examine how these elements change over time, including:

- evidence for causal links between health and wellbeing outcomes and nature exposure.
- whether nature experiences are improving in Wellington over time.

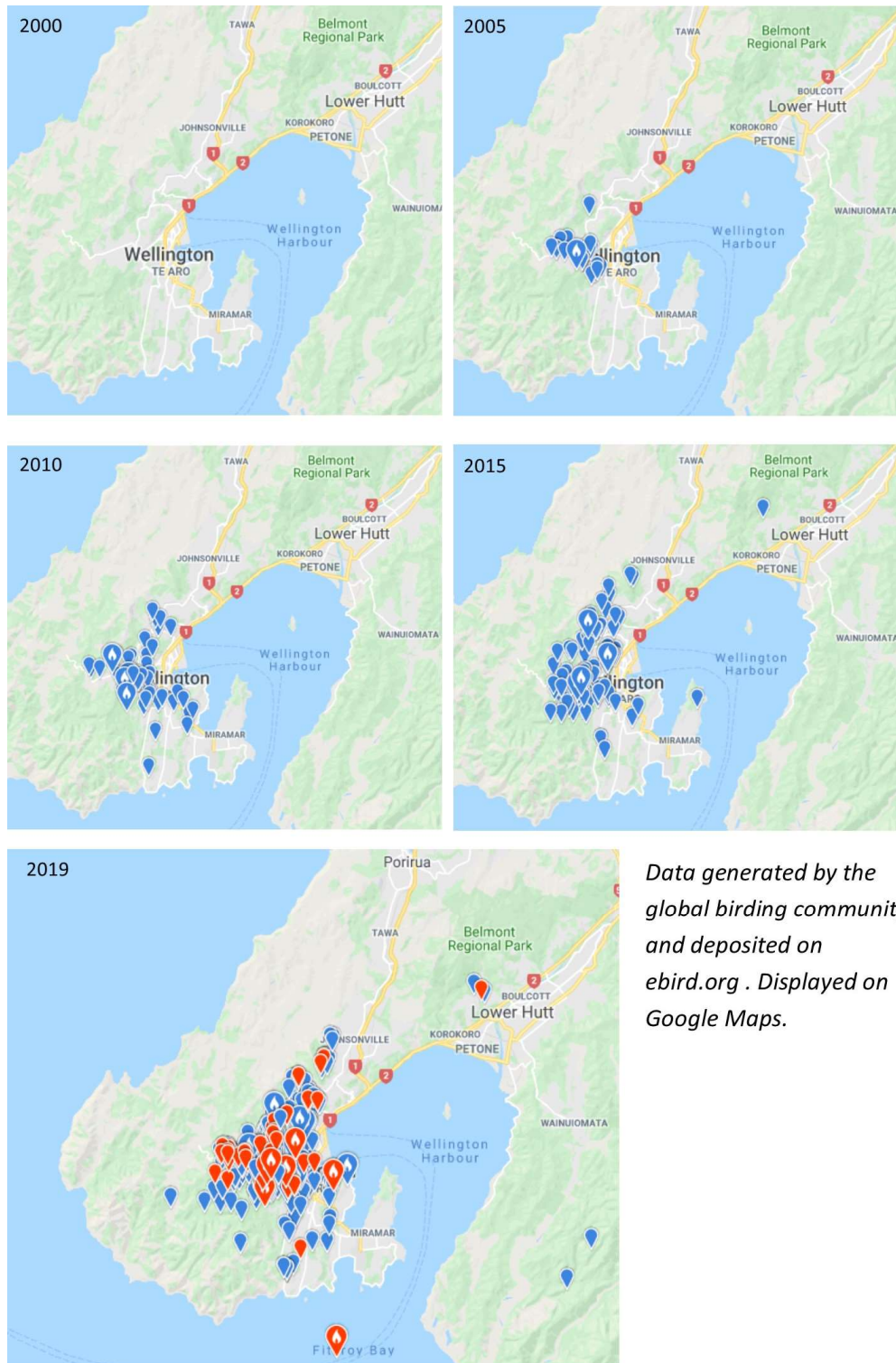


Figure 1. The spread of North Island kākā (*Nestor meridionalis*), as reported by the birding community on the citizen science platform ebird.org. Blue marks indicate sightings, and red marks indicate hotspots. Larger marks indicate a higher number of sightings.

Methods

This research replicates survey-based studies which have now been undertaken in Brisbane (2012, published in 2016 [8]), the UK [7] and most recently Singapore (unpublished). Thus, there will be added opportunities for comparative analysis between countries and cities at a later date to examine differences in nature experiences and wellbeing for people living in different city contexts.

Online survey deployment and content

An online survey was conducted through the Wellington City Council market research panel *Capital Views* between March and June 2019, targeting Wellington city, New Zealand, residents. This panel is representative of Wellington city in terms of age, gender and council ward based on 2013 New Zealand census data.

A total of 1261 survey responses were submitted, and 1200 of these were completed by residents within the Wellington city study area. Respondents were 18+ years, and the survey was completed in accordance with a Victoria University of Wellington Human ethics approval reference number 0000027314.

The Wellington survey replicated and expanded that first conducted in Brisbane, Australia, to determine the relationship between health outcomes and exposure to nature [8]. This involved collecting information on a number of known covariates that are known to influence health and wellbeing outcomes for individuals including age, gender, personal annual income, highest formal qualification, presence of children under 16 in the home, the number of days the respondent normally spends at work per week, the number of days the respondent exercised continuously for 10 minutes or more, and Body Mass Index (BMI). The location of the person's home (street name or as a minimum suburb or postcode) was also given, and from this the New Zealand census-derived index of deprivation [19] was determined as a measure of the level of socio-economic disadvantage in the respondent's neighborhood. Respondent's feelings of connection to nature were measured using the Nature Relatedness scale [20].

Finally, to extend the Brisbane survey and address additional longitudinal research questions respondents were asked to indicate how frequently they encountered five bird species (native species: tūi, North Island kākā, tauhou/silvereye and pīwakawaka/fantail, non-native: blackbird); to indicate whether they spend more or less time in nature than they did 10 years ago and as a child; and whether they participate in trapping or other environmental volunteering activities. The responses to these questions will provide the foundations for a time series analysis following replication of the survey in 2021.

Wellbeing responses to experiences of nature

Respondents provided information on three dimensions of wellbeing that have been shown in previous studies to be linked to experiences of nature. A subset of these used in previous Brisbane studies were selected as response variables in analyses. These include:

Mental health. A measure of depression, anxiety and stress was generated based on the relevant components of the Depression, Anxiety and Stress (DAS) scale [21]. Total scores for each area of mental health were used in the analyses, where a higher score indicates better health.

Physical health. Respondents reported whether they were currently receiving treatment for high blood pressure, coded as a binary measure where 0 indicates no treatment and 1 indicates treatment.

Social health. Respondents' perceptions of social cohesion were estimated based on three previously developed scales that measure trust, reciprocal exchange within communities, and general community cohesion [22-24]. The average score across the questions was calculated, resulting in a continuous score from highest (4) to the lowest (0) perceived social cohesion.

Measurements of experiences of nature

Duration of nature experiences: Multiple measures of exposure to nature were collected within the survey based on the nature dose framework [9]; that is, the duration, frequency and type (e.g. bushland vs manicured garden) of nature experiences. Previous studies have found these various measures of experience are highly correlated, and that the duration of time spent in public spaces provides a reasonable proxy [25]. As such, duration of experiences in public nature spaces was used as a predictor variable in the Wellington study.

Total duration of visits to natural spaces was estimated for each individual based on self-reported time spent during visits to reported locations across the survey week. Duration was selected from a time category (no time, 1-29 minutes; 30 minutes to one hour; one to two hours; two to three hours; three to four hours; four or more hours), and the mid-point of each selected category was summed (where four or more hours was treated as 'four'), and this value was summed across all visits.

Participation in community trapping networks: Respondents were also asked whether they participated in introduced predator trapping in their backyard or in public green space. This activity has increased significantly in the region, and there is wide interest in the benefits of engaging in the activity. This was converted into a binary predictor variable (yes or no).

Correlation between wellbeing responses and predictor variables

All analyses outlined here were conducted in the software package R [26], and replicate those carried out by Shanahan et al. 2016.

Generalised linear models (GLM, Poisson family) were used for the depression, anxiety, stress and social cohesion response variables, and binomial family GLMs for high blood pressure response variable. All predictor variables including age, gender, personal annual income, highest formal qualification, BMI (log transformed to meet assumptions of normality), presence of children under 16 in the home, the number of days the respondent normally spends at work per week, the number of days the respondent exercised continuously for 10 minutes or more were included in all the models as predictor variables, given the strong *a priori* expected influence of each on the health outcomes. Social cohesion was included as an added predictor where it was not treated as the wellbeing outcome. The variance inflation factor was checked to ensure it was <2 for all variables to avoid issue of multicollinearity.

Results

Characteristics of the surveyed group

A total of 1200 survey respondents reported living in Wellington city area and were included in the analyses. A further 61 respondents did not live within the city area and were excluded for the purposes of this study. Survey respondents covered all age classes 18 years and older, with a bias toward people in the over 70 years respondent pool (Appendix Figure A1).

Sixty-five percent of respondents identified as female, 33% as male, and 2% as gender diverse, other, or preferred not to say. Approximately 56% of respondents were in the top quartile income bracket for the region, and only 5.5% in the lowest quartile (Appendix Figure A2), indicating a sample bias.

Recollections of experiences of nature

Nearly 60% of respondents indicated they spent less time in nature in 2019 than they did as a child (Figure 2), a trend that was apparent across all age groups (Figure 3). While on first glance this pattern could be indicative of a wide-spread ‘extinction of experience’ of nature in Wellington, these results must be used with caution as recollections of experiences of nature may be significantly overestimated. In contrast over 40% of respondents indicated that their time spent in nature had increased over the past 10 years and 31% that it was about the same (Figure 2). This results apparent across all age groups except for those <30 years (Figure 2). There is significant complexity in interpreting recollections of nature experiences, however, this may provide some suggestion that the extinction of experiences of nature may be reversing, or that the decline has halted for some Wellingtonians.

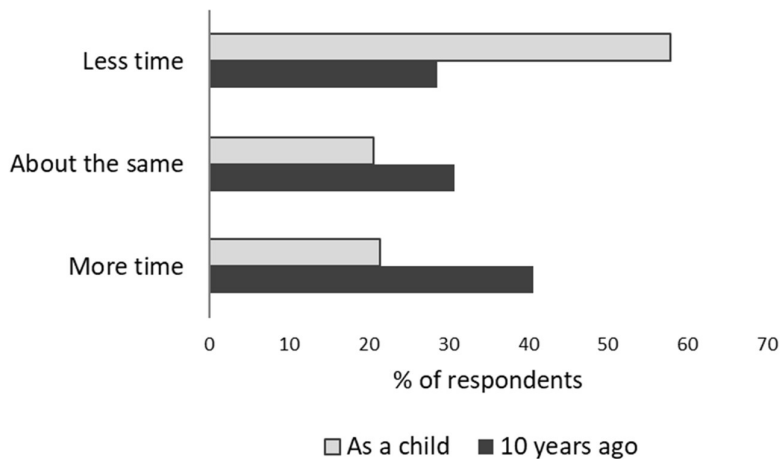


Figure 2. Percentage of Wellington survey respondents who self-reported increases, decreases or no changes in time spent in nature in 2019 compared to as a child or 10 years ago.

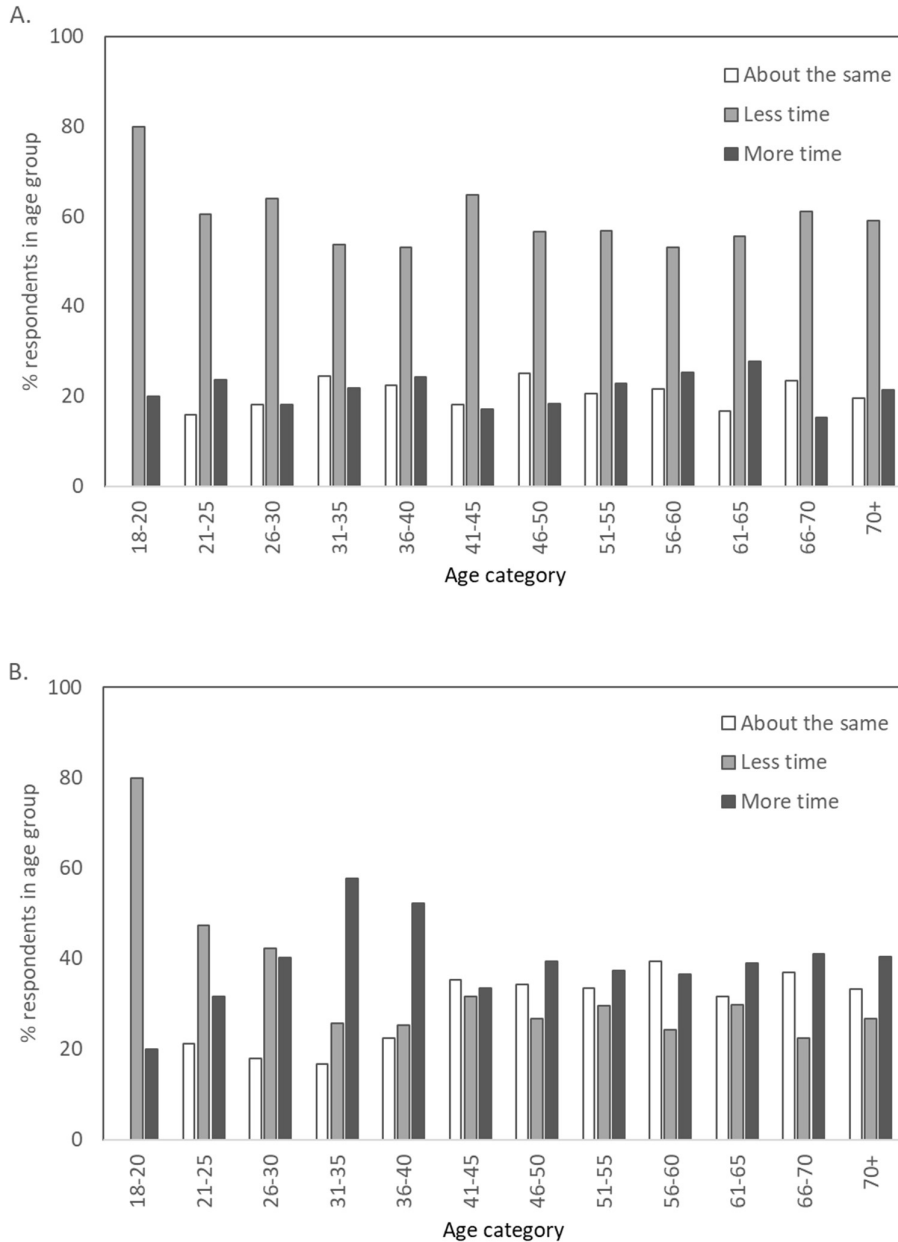


Figure 3. Percentage of Wellington respondents across the different age categories provided who self-reported increases, decreases or no changes in time spent in nature in 2019 compared to A) as a child, and B) 10 years ago.

Thirty one percent of respondents participated in trapping, and 30% in planting as a form of environmental volunteering. Fourteen percent and 10% respectively reported involvement in citizen science or other types of environmental volunteering such as beach clean ups. In total, 53% reported participation in some form of volunteering.

The surveyed residents also reported high rates of native bird sightings around the home. Ninety percent of respondents reported sighting the previously rare tūi occasionally or more often, and 35% reported sighting the previously extinct kākā at that frequency.

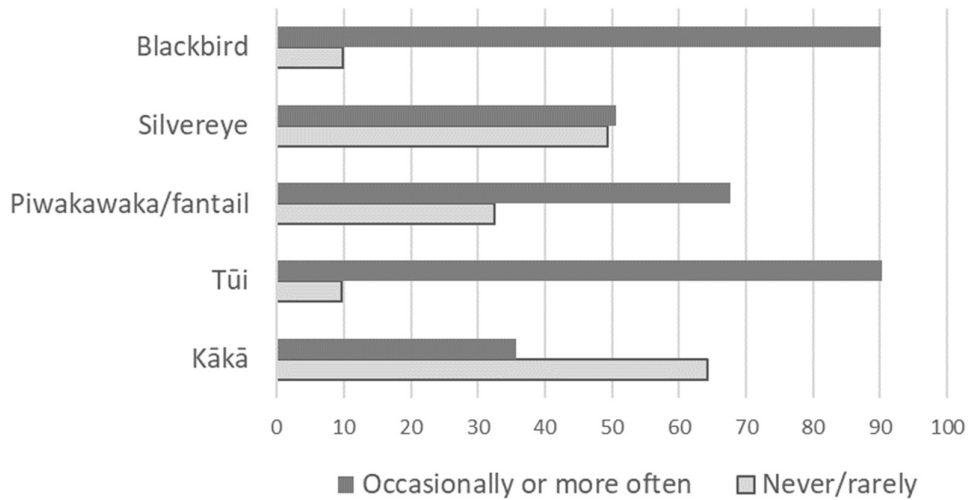


Figure 7. Self-reported frequency of encounters with five bird species around survey respondents' homes in Wellington city area, 2019.

Health and exposure to nature

Levels of depression, anxiety and stress were significantly lower in survey respondents who spent more time across their week in public nature spaces (this included, for example, parks, the harbourside, rivers and the outer green belt), and this relationship remained after accounting for a range of covariates (Table 1). Participation in trapping was additionally significantly associated with lower levels of depression, stress and greater feelings of social cohesion (Table 1). A number of other factors were important predictors of all health outcomes, such as age, income, and BMI, among others (Table 1). These relationships were as expected, though there was a negative relationship observed between nature relatedness and depression and stress. This has, however, been found in some studies where the mechanism is potentially a negative effect on mental wellbeing in relation to declining global environmental health [27].

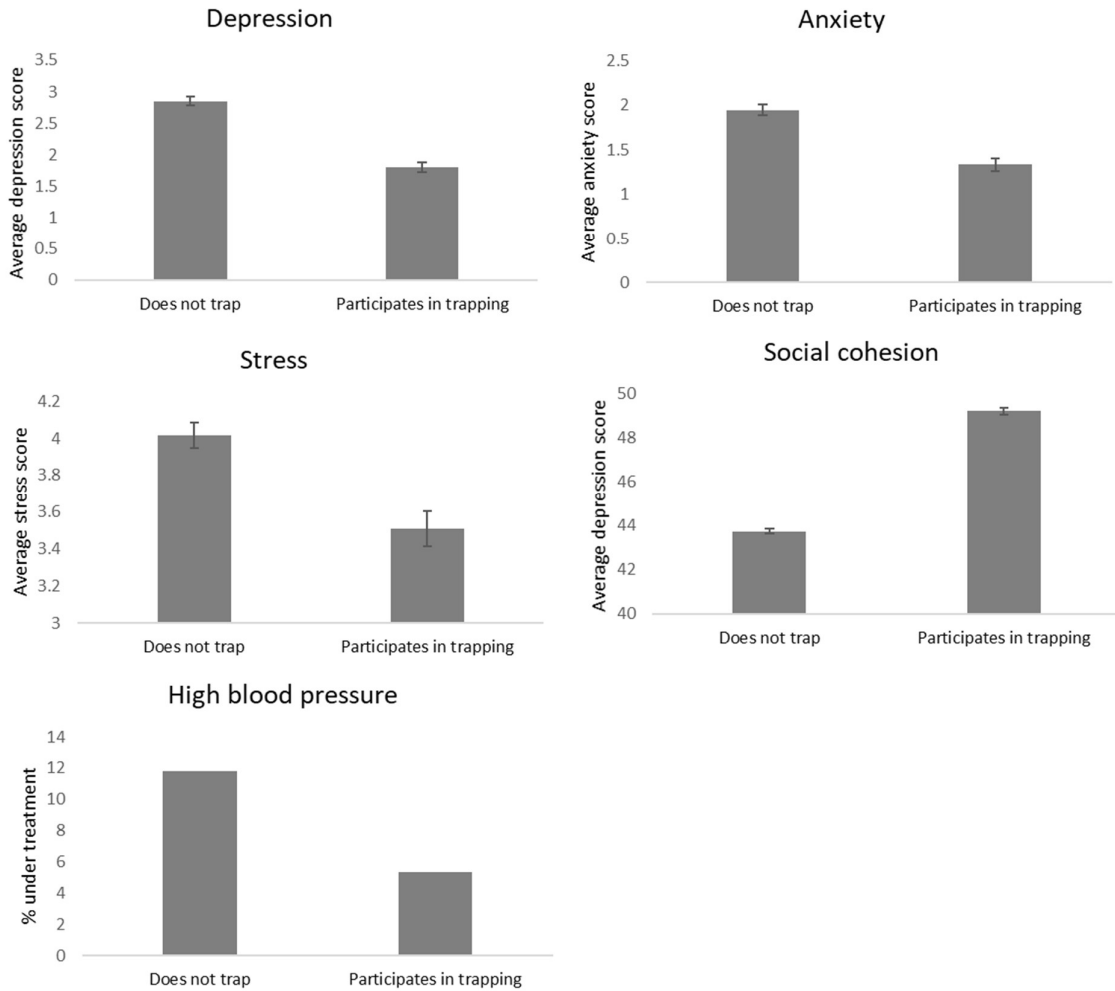


Figure 8. Average scores for depression, anxiety, stress and social cohesion, and % of people under treatment for high blood pressure, for survey respondents who participate and do not participate in predator trapping activities. The relationships for depression, stress and social cohesion were significant at $p < 0.05$ in multivariate models (Table 1), and close to that level of significance ($p < 0.1$) for anxiety and high blood pressure.

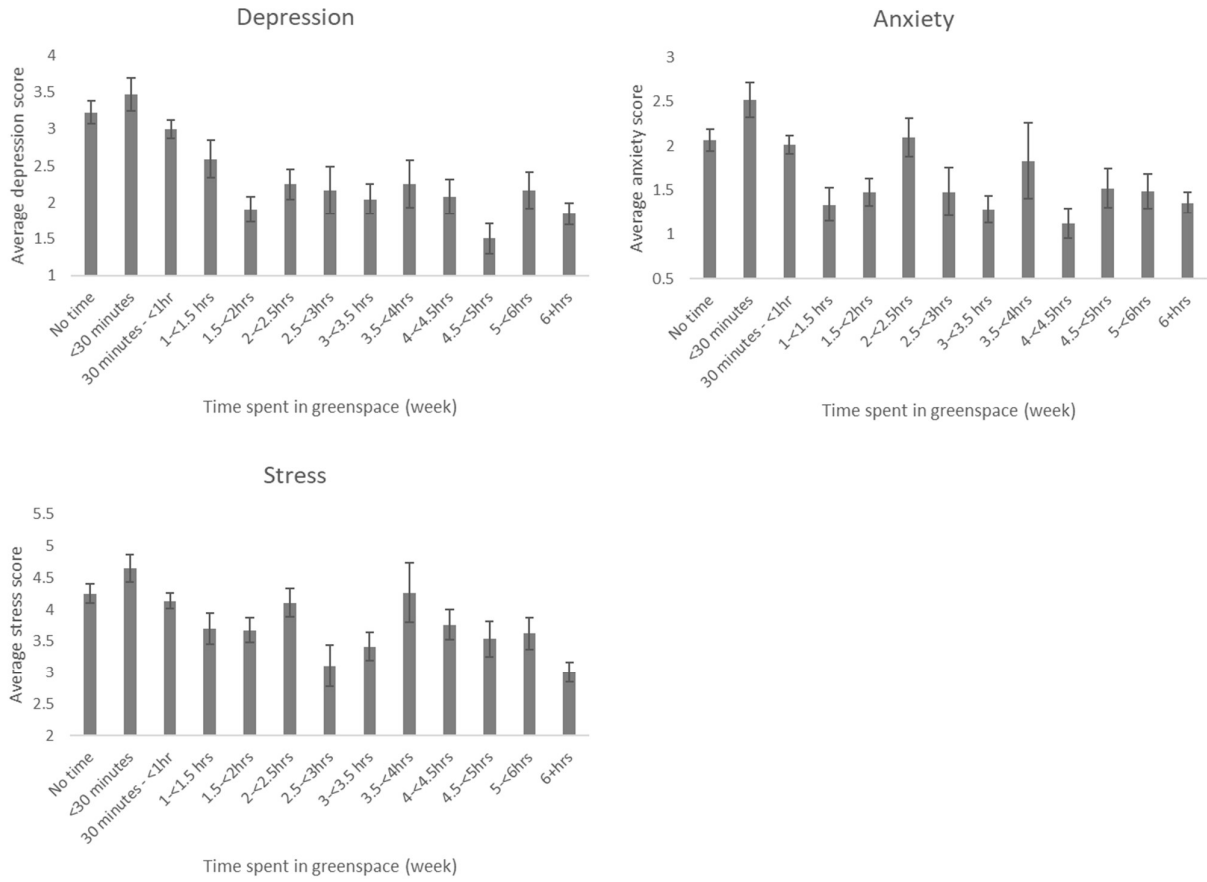


Figure 9. Average scores for depression, anxiety, stress for survey respondents who spent varying amounts of total time in green or blue spaces over the survey week. The relationships were significant at $p < 0.05$ in multivariate models (Table 1).

Table 1. The relationship between five health outcomes (the response variables), socio-demographic covariates and nature experience predictor variables from generalised linear regression models. Coefficient estimates are shown with standard error in brackets. For the first four health variables (depression, anxiety, stress and high blood pressure) a negative coefficient mean a better health outcome with lower levels of the predictor variable, but for social cohesion a negative coefficient means a poorer outcome with lower levels of the predictor. Significance: . $p < 0.1$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Predictor variables	Depression	Anxiety	Stress	High blood pressure	Social cohesion
Age	-0.1(0.01)***	-0.1(0.01)***	-0.08(0)***	0.26(0.07)***	3.38(0.19)***
Gender (cf. female)					
<i>Gender diverse</i>	-0.49(0.29).	-0.33(0.34)	-0.11(0.21)	1.52(1.27)	0.02(0)***
<i>Male</i>	0.15(0.06)*	-0.04(0.07)	0.03(0.04)	1.06(0.31)*	-0.07(0.07)
<i>Prefer not to say</i>	0.31(0.22)	0.12(0.3)	-0.17(0.24)	-13.1(935)	-0.02(0.01)
Income	-0.04(0)***	-0.03(0.01)**	0(0)	-0.03(0.05)	-0.06(0.06)
Neighbourhood disadvantage	0(0)*	0(0)*	0(0)	0(0)	0(0)
Children in home	-0.12(0.03)***	-0.15(0.04)***	-0.03(0.02)	-0.7(0.37)	0(0)***
Work days/week	0(0.01)	0.01(0.02)	0.03(0.01)*	-0.12(0.08)	0.06(0)***
Highest qualification	0.06(0.03).	0(0.03)	0.06(0.02)*	0.15(0.17)	0(0)
Nature relatedness	0.15(0.05)*	0.11(0.06)	0.2(0.04)***	-0.05(0.3)	0.01(0).
Physical activity frequency	-0.01(0.01)	0(0.01)	0(0)	-0.03(0.06)	0.07(0.01)***
BMI	0.43(0.15)**	0.4(0.19)*	0(0.12)	1.79(0.89)*	0.01(0).
Social cohesion	-0.01(0)***	0(0).	0(0)	0.02(0.01)	NA
Total time in greenspace	-0.05(0.01)***	-0.03(0.01)*	-0.02(0)**	0(0.05)	0(0)
Participation in trapping	-0.17(0.06)*	-0.13(0.08).	-0.15(0.05)**	-0.23(0.32).	0.04(0.01)**

Discussion

Here we show there is a significant relationship between experiences of nature and health and wellbeing outcomes for Wellington city residents, with mental wellbeing in particular showing a strong association with time spent in nature. The patterns remain after accounting for a number of other social and demographic factors that are also known to affect these wellbeing outcomes. While there are challenges in interpreting the results (for example, people may be more prepared to spend time in nature when they are not facing mental wellbeing challenges), they are consistent with many previous studies in other countries which are collectively starting to point to a causal relationship [e.g. 8, 27, 28, 29]. The follow up survey in 2021 (part 2 of this project) will help lend further evidence to this result.

Interestingly, participation in predator trapping (a common mode of environmental volunteering in the city) provided further predictive power for mental, physical and social health and wellbeing outcomes. This pattern suggests that significant additional wellbeing benefits are gained when people experience active stewardship of their environment alongside other nature-based activities; indeed, participation in trapping was a significant predictor of higher levels of social cohesion whereas general time in nature was not in this study. These additional benefits could be derived from the added interpersonal connections people gain when participating in a community activity, or these experiences may also encourage more considered observation of the natural environment, potentially leading to greater benefits. These results are likely less entangled by the causality issue outlined above, as the effect of mental wellbeing challenges on overall experiences of nature was also accounted for in the multivariate models; however, again, the repeat survey in 2021 will assist in unpicking this pattern. These results do highlight the need for dedicated experimental research looking at changes in mental wellbeing before and after people begin engagement in environmental volunteering.

Wellington residents were also asked about their observations of five bird species; the kākā was extinct from the region in 2000, and was reintroduced to Zealandia in 2001; the tūi was effectively extinct with very few pairs left in the city area; and the touhou/silvereye and pīwakawaka/fantail are more common native species. The European blackbird is introduced, and has remained common in the region. The proportion of residents who reported encountering the tūi and the kākā is particularly remarkable for a city environment, and these are clear indicators of a shift in experiences of nature. Coupled with the reported increase in time spent in natural environments, there is strong potential that some Wellington city residents are experiencing a reversal in the 'extinction of experience' of nature phenomenon.

This study was based on a self-report survey, which has limitations. People are known to inaccurately report behaviours for a variety of reasons, and there has been significant concern that this occurred in previous studies that asked people to compare, for example, current time spent in nature with that of their childhood (e.g. see [30]). This effect is likely observed in this study. We additionally asked a question about time spent in nature 10 years ago, and most (>70%) respondents noted that they spent more, or about the same, amount of time. While there are still likely inaccuracies in people's recollection, this may be indicative of a real shift in nature-based experiences of Wellington residents, and the longitudinal aspect of this study will endeavour to unpack this question further.

Conclusions

This study has detected a number of interesting correlations and trends, perhaps most notably that Wellington city residents not only receive wellbeing benefits when they spend time in nature, but that there are additional benefits when they also engage in predator trapping. These patterns

require further unpacking through the longitudinal element of this study. Further analyses can also be carried out to assess thresholds, and the minimum dose of nature that Wellingtonians require to gain wellbeing benefits from nature. An additional interesting trend in Wellington is the shift towards higher quality experiences of nature. Again, while analysing people's recollections of their past experiences of nature can be fraught, we have tangible evidence that native bird biodiversity in Wellington is improving, and people are noticing it. This may be one of the few, if only cities in the world where this shift is occurring.

References

1. McKinney, M.L., *Urbanization, biodiversity, and conservation*. Bioscience, 2002. **52**(10): p. 883-890.
2. Pyle, R.M., *The extinction of experience*. Horticulture 1978. **56**: p. 64-67.
3. Soga, M. and K.J. Gaston, *Extinction of experience: the loss of human–nature interactions*. Frontiers in Ecology and the Environment, 2016. **14**(2): p. 94-101.
4. Shanahan, D.F., et al., *Toward improved public health outcomes from urban nature*. American Journal of Public Health, 2015. **105**(3): p. 470-477.
5. Kaplan, S., *The restorative benefits of nature - toward and integrative framework*. Journal of Environmental Psychology, 1995. **15**(3): p. 169-182.
6. Kaplan, R., *The nature of the view from home: psychological benefits*. Environment and Behaviour, 2001. **33**: p. 507-542.
7. Cox, D.T.C., et al., *Doses of nearby nature simultaneously associated with multiple health benefits*. International Journal of Environmental Research and Public Health (accepted 22/1/2017), 2017. **14**(2): p. E172.
8. Shanahan, D.F., et al., *Health benefits from nature experiences depend on dose*. Scientific Reports, 2016. **6**: p. 28551.
9. Shanahan, D.F., et al., *The health benefits of nature: how much do we need?* BioScience, 2015. **65**(5): p. 476-485.
10. Richardson, E.A., et al., *Role of physical activity in the relationship between urban green space and health*. Public Health, 2013. **127**(4): p. 318-324.
11. Astell-Burt, T., X.Q. Feng, and G.S. Kolt, *Mental health benefits of neighbourhood green space are stronger among physically active adults in middle-to-older age: Evidence from 260,061 Australians*. Preventive Medicine, 2013. **57**(5): p. 601-606.
12. Shanahan, D.F., et al., *The benefits of natural environments for physical activity*. Sports Medicine, 2016. **46**: p. 989-995.
13. Puett, R., et al., *Physical Activity: Does Environment Make a Difference for Tension, Stress, Emotional Outlook, and Perceptions of Health Status?* Journal of Physical Activity & Health, 2014. **11**(8): p. 1503-1511.
14. Pretty, J., et al., *The mental and physical health outcomes of green exercise*. International Journal of Environmental Health Research, 2005. **15**(5): p. 319-337.
15. Focht, B.C., *Brief Walks in Outdoor and Laboratory Environments: Effects on Affective Responses, Enjoyment, and Intentions to Walk for Exercise*. Research Quarterly for Exercise and Sport, 2009. **80**(3): p. 611-620.
16. Hanski, I., et al., *Environmental biodiversity, human microbiota, and allergy are interrelated*. Proceedings of the National Academy of Sciences of the United States of America, 2012. **109**(21): p. 8334-8339.
17. Donovan, G.H., et al., *Vegetation diversity protects against childhood asthma: results from a large New Zealand birth cohort*. Nature Plants, 2018. **4**(6): p. 358+.
18. Shanahan, D.F., et al., *Nature-Based Interventions for Improving Health and Wellbeing: The Purpose, the People and the Outcomes*. Sports (Basel), 2019. **7**(6).

19. Atkinson J., Salmond C., and C. P., *NZDep2013 Index of Deprivation*, University of Otago. 2014: Dunedin.
20. Nisbet, E.K., J.M. Zelenski, and S.A. Murphy, *The nature relatedness scale: linking individuals' connection with nature to environmental concern and behavior*. *Environment and Behavior*, 2009. **41**(5): p. 715-740.
21. Lovibond, S.H. and P.F. Lovibond, *Manual for the Depression anxiety Stress Scales (second edition)* 1995, Psychology Foundation: Sydney.
22. Sampson, R.J., J.D. Morenoff, and F. Earls, *Reciprocated exchange*. 1999, Chicago Neighborhood Study Chicago.
23. Sampson, R.J., S.W. Raudenbush, and F. Earls, *Neighborhoods and violent crime: a multilevel study of collective efficacy*. *Science*, 1997. **277**(5328): p. 918-24.
24. Bullen, P. and J. Onyx, *Measuring Social Capital in Five Communities in NSW - A Practitioner's Guide*. 1998, Centre for Australian Community Organisations and Management: Coogee, New South Wales.
25. Cox, D.T.C., et al., *The rarity of direct experiences of nature in an urban population*. *Landscape and Urban Planning*, 2017. **160**: p. 79-84.
26. R Core Team, *R: A language and environment for statistical computing*. 2012, R Foundation for Statistical Computing: Vienna, Austria.
27. Dean, J.H., et al., *Is Nature Relatedness Associated with Better Mental and Physical Health?* *International Journal of Environmental Research and Public Health*, 2018. **15**(7).
28. Cox, D.T.C., et al., *Doses of Nearby Nature Simultaneously Associated with Multiple Health Benefits*. *International Journal of Environmental Research and Public Health*, 2017. **14**(2).
29. Cox, D.T.C., et al., *Doses of Neighborhood Nature: The Benefits for Mental Health of Living with Nature*. *Bioscience*, 2017. **67**(2): p. 147-155.
30. Solomon-Moore, E., et al., *"In my day..." - Parents' Views on Children's Physical Activity and Screen Viewing in Relation to Their Own Childhood*. *International journal of environmental research and public health*, 2018. **15**(11): p. 2547.

Appendix

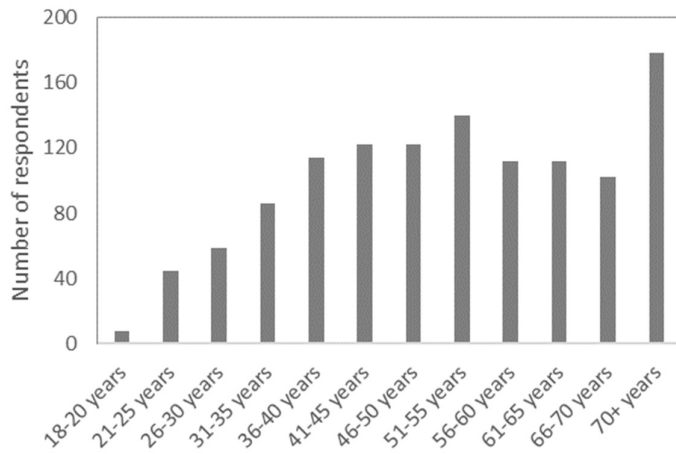


Figure A1. Number of Wellington city survey respondents in specified age classes.

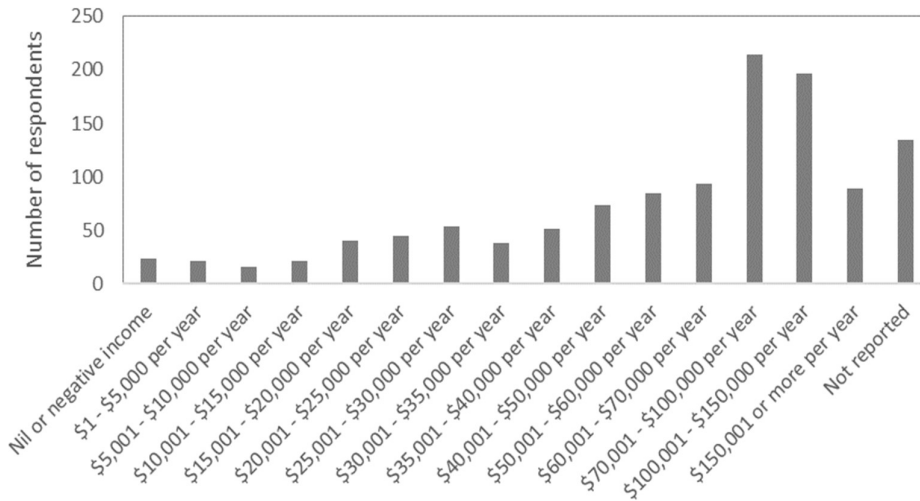


Figure A2. Number of Wellington city survey respondents in specified personal income brackets.