City scale climate change policies: Do they matter for wellbeing?

Rosemary Hiscock [a,b,*], Arja Asikainen [c,d], Jouni Tuomisto [c], Matti Jantunen [c], Erkki Pärjälä [d], Clive E. Sabel [e]

[a] School of Geographical Sciences, University of Bristol, University Road, Bristol BS8 1SS, UK
[b] Department for Health, University of Bath, Bath BA2 7AY, UK
[c] National Institute for Health and Welfare, Neulaniementie 4, P.O. Box 95, FI-70701 Kuopio, Finland
[d] Environmental Protection Services, City of Kuopio, Suokatu 42, P.O. Box 1097, FI-70111 Kuopio, Finland
[e] Department of Environmental Science - Emission modeling & environmental geography, Frederiksborgvej 399, building 7420, K1.31, 4000 Roskilde, Denmark

A B S T R A C T

Climate change mitigation policies aim to reduce climate change through reducing greenhouse gas (GHG) emissions whereas adaption policies seek to enable humans to live in a world with increasingly variable and more extreme climatic conditions. It is increasingly realised that enacting such policies will have unintended implications for public health, but there has been less focus on their implications for wellbeing. Wellbeing can be defined as a positive mental state which is influenced by living conditions. As part of URGENCHE, an EU funded project to identify health and wellbeing outcomes of city greenhouse gas emission reduction policies, a survey designed to measure these living conditions and levels of wellbeing in Kuopio, Finland was collected in December 2013. Kuopio was the northmost among seven cities in Europe and China studied. Generalised estimating equation modelling was used to determine which living conditions were associated with subjective wellbeing (measured through the WHO-5 Scale). Local greenspace and spending time in nature were associated with higher levels of wellbeing whereas cold housing and poor quality indoor air were associated with lower levels of wellbeing. Thus adaption policies to increase greenspace might, in addition to reducing heat island effects, have the co-benefit of increasing wellbeing and improving housing insulation.

© 2017 Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

1. Introduction

It has been increasingly accepted that climate change mitigation and adaption policies, in addition to their primary goals, will have implications for human health and wellbeing (Berry et al., 2010; Haines et al., 2009). Mitigating policies aim to reduce greenhouse gas emissions to prevent or at least lessen climate change whereas adaption policies are to aid coping with climate changes as they occur (Pelling, 2011). Implications have begun to be understood regarding physical diseases (Haines et al., 2009; Sabel et al., 2016) but the focus of this paper is on consequences for wellbeing where there has been fewer studies (Hiscock et al., 2014). There are a number of definitions of wellbeing but we have previously defined wellbeing as a positive mental state influenced by living conditions (Hiscock et al., 2014).

The EU funded Urban Reduction in Greenhouse Gas Emissions in China and Europe (URGENCHE) project's incorporation of city policy makers, as well as leading academics, enabled the development of our understanding of how greenhouse gas reduction policies impact living conditions. Via expert opinion and extensive literature review, the following mitigation policies were identified: raising buildings' energy efficiency to reduce need for heating (UNEP, 2009), increased use of wood burning for domestic heating (Sjølie and Solberg, 2011) and promotion of active transport (human powered transportation such as walking or cycling (Public Health Agency of Canada, 2014)) over motorised transport (Hensher, 2008); for adaption the following policies were identified: development of green spaces and vegetation which cool city heat islands (Maimaitiyiming et al., 2014), increased resilience of the population (Keim, 2008) and reduced socioeconomic inequalities (Paavola and Adger, 2006).

These policies, if enacted, will lead to changes in living conditions which have wellbeing implications (Hiscock et al., 2014; Liu et al., 2016; Sabel et al., 2016). Increasing a building's energy efficiency and wood burning for domestic heating have implications for the following living conditions which have generally been found to associated with wellbeing: damp (Blackman et al., 2001; Butler et al., 2003; Evans et al., 2000; Hyndman, 1990; Packer et al., 1994; Shenassa et al., 2007;

WHO Regional Office for Europe, 2007), thermal comfort (Blackman et al., 2001; Butler et al., 2003; Evans et al., 2000; Hopton and Hunt, 1996; Hyndman, 1990) and indoor air quality (Guite et al., 2006) have been associated with depression and other measures of mental health.

Supporting active transport over motorised transport may also impact wellbeing related living conditions (air pollution is associated with annoyance, mental health, depression and suicide) (Amundsen et al., 2008; Klaeboe et al., 2008; Lim et al., 2012; Menz, 2011; Szyszkowicz, 2007; Szyszkowicz et al., 2009; Szyszkowicz et al., 2010; Welsch, 2006), noise is associated with mental health, depression and sleep problems (Braubach et al., 2015; Dratva et al., 2010; Li et al., 2008; Schreckenberg et al., 2010; Yoshida et al., 1997) and opportunities for building social capital (trust, participation, community building and voting) (Addy et al., 2004; Ball et al., 2010; Hanibuchi et al., 2012; Hopkins and Williamson, 2012; Leyden, 2003; Mason et al., 2011; Nguyen, 2010; Poortinga, 2006; Renalds et al., 2010; Richard et al., 2009; Rogers et al., 2011; Toit et al., 2007; Wilkerson et al., 2012; Wood et al., 2010).

Access to greenspace and nature has been linked to wellbeing in previous studies (Alcock et al., 2014; de Vries et al., 2003; White et al., 2013). Resilience of the population has been discussed as a theoretical issue of importance to cope with change after climate change incidents (Collier et al., 2013; IPCC, 2014; Pelling, 2011). Low socioeconomic status and inequalities in socioeconomic status need to be reduced in order to enhance wellbeing (Hajdu and Hajdu, 2014; Wood et al., 2012).

Although some evidence for links between policy related living conditions and wellbeing has been found, much is weak or only considers one living condition whereas the aim of URGENCHE was to compare policies (Hiscock et al., 2014). Thus as part of URGENCHE a survey was commissioned in Kuopio, Finland, to increase understanding of whether a number of living conditions might be associated with wellbeing. Kuopio (population 100,000 (Statistics Finland, 2016)) was chosen because of a lack of data on wellbeing despite Kuopio's leading comprehensive climate change policy (City of Kuopio, 2009). Kuopio's climate change policy goals include (a) identify and prepare for effects and (b) all citizens to participate (City of Kuopio, 2009). Consequently understanding more about wellbeing implications is paramount in order that the population will accept and aid climate change mitigation and adaption actions (Fritze et al., 2008).

2. Methodology

A postal survey was sent to a random sample of adults, stratified by age, from the population registry living in 2500 households in Kuopio, Finland on 5th and 6th December 2013 (n = 680, a 27% response rate). From the 6th to 20th December an online version was available (n = 102). The online version was publicised via the internet, newspapers and radio in the week following 6th December. We do not know the number of people who saw the link to the online survey so we cannot calculate a response rate. Power calculations (SurveyMonkey, n.d.) suggest this was a sufficient sample size for analysis.

2.1. Dependent variable (wellbeing)

The WHO_5 Wellbeing scale (Psychiatric Research Unit at the Medical Health Centre North Zealand, 2013) was chosen to measure wellbeing. This scale has been translated into many languages and successfully statistically validated in a variety of populations (Liu et al., 2016) and used in the European Quality of Life Survey (EQLS) (Eurofound, 2012), which made it possible to compare this study with international studies in the future. A score was derived in the standard manner (Psychiatric Research Unit at the Medical Health Centre North Zealand, 2013) with a higher score indicating higher wellbeing. A square transformation was used to reduce skew for multivariable analyses.

2.2. Independent variables (living conditions and individual characteristics)

The independent variables were chosen after extensive literature review, consultation with WHO Regional office for Europe and Kuopio City Council Departments of Environmental Protection Services and Environmental Health Care. Relevant questions from the European Quality of Life Surveys (EQLS) (Eurofound, 2012), WHO LARES study on European housing and health (WHO Regional Office for Europe, 2007) and an earlier URGENCHE wellbeing survey carried out in Suzhou, China (Liu et al., 2016) were collated and in some instances modified. In addition there were some additional questions designed especially for this survey. Questions were asked about the home, the outdoor environment, resilience and sociodemographic characteristics.

The home variables were as follows. To measure home satisfaction, respondents were asked to respond on a five point Likert scale how they would rate their home on each of the following: heating, insulation, air quality, ventilation, parking, neighbourhood, distance to green space, distance to sporting facilities, distance to a bus stop and distance to a beach. In order to explore housing conditions respondents were asked about thermal comfort and damp. To measure indoor air quality respondents were asked how often they had the following air problems in their home: too moist, dry air, dust and particles, odour, smoke (not tobacco), still air, stuffiness, draught, tobacco smoke from balcony/terrace, pollution from traffic/industry. Respondents were also asked whether anyone smoked tobacco cigarettes or a pipe in their home.

Outdoor transport, air pollution and greenspace were explored. Main transport mode was established by asking whether respondents made most of their journeys by car/motorbike/moped, public transport, bike, walk or other in winter and in summer. Opinion on air quality was established by asking whether respondents agreed or disagreed with the following statements: 'some air quality should be sacrificed for faster economic development', 'GHG should be reduced in Kuopio', 'Kuopio should promote renewable energy for heating of buildings', 'district heating is the greenest domestic heating', 'increase biofuels for district heating for environmental reasons, even though it is more expensive', 'increase wood domestic heating to reduce GHG ', 'wood burning causes air pollution so don't increase', 'biofuels for cars reduce greenhouse gas emissions', 'biofuels cause problems in the countries where they are grown', 'Kuopio should encourage use of biofuels in traffic' and 'air pollution has not been noticeable in the past 2 weeks'. Respondents were asked how often on average they spent their free time in nature.

We approached resilience chiefly through the concept of ontological security: a long term sense of feeling secure in oneself which allows oneself to deal with life's challenges (Giddens, 1991; Kearns et al., 2000; Liu et al., 2016) given that climate change is likely to present significant challenges. Ontological security was measured through a modified form of the validated psychosocial benefits from home scale (Kearns et al., 2000) to apply to wider aspects of people's lives which has been used in the sister survey in Suzhou (China) (Liu et al., 2016) and a study of smokers attempting to cope with the challenge of quitting smoking (Dobbie et al., 2015). The ten items are intended to measure psychosocial feelings which may connect wellbeing to external factors through feelings of protection, control and prestige (Hiscock et al., 2001). All items are answered on a 5 part Likert scale. The items linked to protection are 'I can deal with stress' and 'I feel safe'; the items linked to control are 'I feel in control' and 'I can do what I want, when I want'; the items linked to being valued are 'most people would like a life like mine' and 'I feel I'm doing well in life' and items linked to response to change are 'my life has a sense of routine', 'I worry about things going wrong' (reversed), 'I enjoy a challenge' and 'I'm frightened of change' (reversed).

Unsatisfactory conditions in various life domains create stress and undermine resilience (Baum et al., 1999) thus we measured satisfaction with respondents' current job, current standard of living, housing, family life, health, social life and the economic situation in Finland. A

symptom of inadequate resilience can be poor health (Suominen et al., 2001). To measure physical health, respondents were asked whether in the past year they had a stroke, chronic obstructive pulmonary disease (COPD), heart problems, asthma, bronchitis or lung cancer. Depression in the past year was used as a measure of mental health. Respondents also self-assessed their general health.

The following sociodemographic characteristics were included: gender, age, household composition and socioeconomic status: low socioeconomic status was signalled by a basic level of education or unemployment or living in a district with a low average annual income and not having any of the indicators of high socioeconomic status. The indicators of high socioeconomic status were living in an owner occupied detached house or living in a district with a high average annual income and not having any of the indicators of low socioeconomic status. Survey type (online or postal) was also included. Other respondents were classified as mid SES. Thus individual and area level variables were incorporated.

2.3. Analysis

SPSS version 21 Generalised Estimating Equations (a form of generalised linear model) allowed clustering by district to be taken into account. Comparing the characteristics of the respondents with the Kuopio population suggested that survey respondents were more likely to be female, in older age groups and from more affluent districts. Thus multivariable models needed to include age, gender, SES and district as 'design variables' in addition to survey type. The multivariable modelling tested for multicollinearity and excluded variables using a backwards stepwise method at every stage. The modelling stages were (1) the design variables only, (2) groups of similar variables, with a significant bivariable relationship with wellbeing were entered, (3) all variables that survived the backwards elimination at stage 2 were entered, (4) previously non-significant variables were re-entered individually and backwards elimination repeated if necessary. (5) The final model included the design variables and any other variables which retained significance (p < 0.05).

3. Results

We tested the relationships between living conditions which could be altered by climate change policies, and wellbeing. The final multivariable model is presented in Table 1. Age was the only significant sociodemographic variable. The highest wellbeing was among 62 to 70 years olds and the lowest among the 31 to 48 year olds. Respondents who were depressed had significantly lower wellbeing than other respondents. Respondents who were more highly satisfied with their health and their social life had significantly higher wellbeing.

Respondents with higher wellbeing had higher levels of ontological security: prestige (other people would like a life like mine), control (I can do what I want when I want), protection (I feel safe) and resilience (I can deal with stress and I *don't* worry about things going wrong). A shorter distance to greenspace and spending more time in nature were significantly associated with wellbeing. Residents who indicated their homes were too cold in winter had significantly lower wellbeing. Indoor smoke (not tobacco) and still air or stuffiness were less of an issue for those who had higher levels of wellbeing.

4. Discussion

Some living conditions were more strongly linked to wellbeing than others. In the discussion we consider which adaption and mitigation policies may have co-benefits for wellbeing based on the associations identified in our multivariable modelling. More longitudinal research will be needed to establish causal relationships: in our discussion of the policies given previous research outlined in the introduction, our assumption is that the causal direction is that living conditions impact wellbeing rather than vice versa. Note three additional policies which could not be assessed adequately via our multivariable modelling strategy are discussed in the supplemental file.

4.1. Mitigation policies

4.1.1. Make housing energy efficient to reduce need for heating
Too cold housing was associated with poorer wellbeing. Thus improving efficiency should improve wellbeing if, as a result, buildings' indoor temperatures are warmer and more inhabitants are able to achieve thermal comfort (Zhou et al., 2016). However respondents who lived in stuffy houses had poorer wellbeing. Thus it is important that ventilation is appropriate (Schulze and Eicker, 2013; Tuomisto et al., 2015).

4.1.2. Increased use of wood burning for domestic heating
Respondents who had a problem with smoke indoors had poorer wellbeing. This negative finding accords with the overall finding of the URGENCHE project that wood burning would increase disease via raised air pollution and thus this policy would not be recommended (Sabel et al., 2016).

4.1.3. Support active transport over motorised transport
Usual transport mode and satisfaction with parking were not associated with wellbeing in the final model suggesting that policies making private vehicle use and parking more difficult could be continued without unduly changing wellbeing. Elsewhere URGENCHE findings supported promoting active transport due to air pollution reductions and rises in physical activity (Sabel et al., 2016).

Table 1
Living conditions significantly associated with wellbeing in final model.[a]

Domain	Condition	B (95%SE)
Health	Not depressed	576 (162 to 989)
Satisfaction	Satisfied with health	434 (310 to 558)
	Satisfied with social life	471 (349 to 593)
Ontological security	Can deal with stress	362 (257 to 468)
	Can do what I want when I want	169 (92 to 247)
	Other people would like a life like mine	177 (34 to 321)
	I feel safe	256 (51 to 462)
	Don't worry about things going wrong	212 (82 to 342)
Satisfaction with home	Satisfied with distance to greenspace	175 (60 to 291)
	Home too cold during the winter *less* of the time	183 (90 to 275)
Air quality at home	Smoke (not including tobacco) a problem at home *less* of the time	187 (34 to 341)
	Still air or stuffiness a problem at home *less* of the time	145 (23 to 268)
Nature	Spends free time in nature *more* often	191 (107 to 276)

[a] The model controlled for the following design variables: age, gender, socioeconomic status, survey type (online or postal), missing data on the nature variable. All these variables were non-significant with the exception of age where younger respondents experienced lower wellbeing than older respondents (p = 0.008). Other variables had been excluded from the final model due to non-significance and multicollinearity (see supplemental file).

4.2. Adaption policies

4.2.1. Increase green spaces and vegetation

Two variables regarding green space were independently significant in the final model. Respondents who spent more of their free time in nature had higher wellbeing as did those who were more satisfied with the distance to travel from their homes to green space. These results corroborate results from the UK about the centrality of green space to wellbeing (Alcock et al., 2014).

4.2.2. Increase resilience of the population

The two most important elements of satisfaction for wellbeing were satisfaction with health and satisfaction with social life. In addition to satisfaction with health, depression was also associated with subjective wellbeing. The importance of health as a determinant of wellbeing has been noted elsewhere (Boarini et al., 2012). As part of the URGENCHE project two wellbeing surveys were undertaken. In addition to the Kuopio survey reported herein, a similar survey was carried out in Suzhou, China. The questionnaires were not identical as they reflected issues of concern locally but in the Suzhou survey satisfaction with health and social life were associated with wellbeing in the final multivariate model (Liu et al., 2016). Thus policy makers need to work to keep their populations healthy. That satisfaction with social life, rather than for example family, was important supports that policy makers also should work to develop social capital in their communities in order to build resilience (Helliwell et al., 2014).

Two ontological security items closely connected to resilience ('I can deal with stress' and 'I worry about things going wrong') were associated with wellbeing in the final model. Items intended to measure feelings of protection, control and feeling valued also were significantly associated with wellbeing in the final model. Policymakers need to help their population feel safe, be able to make their own choices and develop a sense of self-worth in order to develop their resilience.

4.2.3. Reduce socioeconomic inequalities

Socioeconomic status was a predictor in the base model (low SES B = −705 p < 0.001, mid SES B = −483 p = 0.013) (high SES was the reference) but not in the final model. This suggests that improving less advantaged members of society's living conditions may enhance their wellbeing.

4.3. Limitations

This was a cross sectional survey so we can only say that we have identified associations rather than predictors of wellbeing. The survey took place in Winter thus the variables relating to the winter conditions were stronger predictors than their summer counterparts. Ideally a survey with similar questions would take place in the summer to see how long lasting winter affects are and have a comparison of winter and summer factors.

Wellbeing is treated as a continuous variable in this analysis. There are many other measures of wellbeing (Hiscock et al., 2014) and it is possible that different conclusions would have been made had a different measure been used.

Kuopio is a small city with a subarctic climate. It is surrounded mostly by forests and lakes in a region with a very low population density. Thus its inhabitants are not living in conditions typical of a large proportion of the world's population. Furthermore its population is very fortunate in some respects; some of the factors of interest could not be adequately modelled due to small numbers: only 18 respondents had mould growth in their homes, only 16 respondents had someone smoking tobacco in their home and only 13% had noticed air pollution in the last two weeks. Nevertheless climate change is happening in Kuopio as it is in the rest of the world and the factors studied have resonance elsewhere. In Kuopio, climate change is resulting in higher winter temperatures and, consequently, loss of snow cover, wetter and darker winter days and reduced opportunities for winter sports.

5. Conclusions

Climate change mitigation and adaptation policies may have wellbeing implications for citizens, particularly in urban areas. Enlarging green space and energy efficient improvements in housing (as long as ventilation is adequate) have potential to enhance wellbeing but perceptible smoke emissions from wood burning for domestic heating may weaken wellbeing. There was no evidence that supporting people to change transport mode per se would challenge wellbeing. More widely, supporting citizens to have a satisfying social life, to feel safe, have choices, have self-worth and resilience may improve wellbeing. Longitudinal research is needed to understand the implications of interrelated policies further. The respondents from Kuopio had a good quality of life with very few respondents having damp related mould in their homes or observing air pollution. We urge city policy makers to consider potentially substantial health and wellbeing impacts when legislating for climate change policies within their jurisdictions.

Transparency document

The Transparency document associated with this article can be found, in online version.

Conflicts of interest

The authors have no conflicts of interest.

Acknowledgements

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.pmedr.2017.03.019.

References

Addy, C.L., Wilson, D.K., Kirtland, K.A., Ainsworth, B.E., Sharpe, P., Kimsey, D., 2004. Associations of perceived social and physical environmental supports with physical activity and walking behavior. Am. J. Public Health 94 (3):440–443. http://dx.doi.org/10.2105/ajph.94.3.440.

Alcock, I., White, M.P., Wheeler, B.W., Fleming, L.E., Depledge, M.H., 2014. Longitudinal effects on mental health of moving to greener and less green urban areas. Environ. Sci. Technol. 48 (2), 1247–1255.

Amundsen, A.H., Klaeboe, R., Fyhri, A., 2008. Annoyance from vehicular air pollution: exposure-response relationships for Norway. Atmos. Environ. 42 (33):7679–7688. http://dx.doi.org/10.1016/j.atmosenv.2008.05.026.

Ball, K., Cleland, V.J., Timperio, A.F., Salmon, J., Giles-Corti, B., Crawford, D.A., 2010. Love thy neighbour? Associations of social capital and crime with physical activity amongst women. Soc. Sci. Med. 71 (4):807–814 http://dx.doi.org/10.1016/j.socscimed.2010.04.041.

Baum, A., Garofalo, J., Yali, A., 1999. Socioeconomic status and chronic stress: does stress account for ses effects on health? Ann. N. Y. Acad. Sci. 896 (1), 131–144.

Berry, H.L., Bowen, K., Kjellstrom, T., 2010. Climate change and mental health: a causal pathways framework. Int. J. Public Health 55 (2), 123–132.

Blackman, T., Harvey, J., Lawrence, M., Simon, A., 2001. Neighbourhood renewal and health: evidence from a local case study. Health Place 7 (2), 93–103.

Boarini, R., Comola, M., Smith, C., Manchin, R., & De Keulenaer, F. (2012). What makes for a better life?: the determinants of subjective well-being in oecd countries–evidence from the gallup world poll. Retrieved from

Braubach, B., Tobollik, M., Mudu, P., et al., 2015. Development of a quantitative methodology to assess the impacts of urban transport interventions and related noise on wellbeing. Int. J. Environ. Res. Public Health 12 (6), 5792–5814.

Butler, S., Williams, M., Tukuitonga, C., Paterson, J., 2003. Problems with damp and cold housing among pacific families in New Zealand. N. Z. Med. J. 116 (1177), U494.

City of Kuopio, 2009. Preventing climate change. Retrieved from. https://old.kuopio.fi/web/environment/preventing-climate-change.

Collier, M.J., Nedović-Budić, Z., Aerts, J., et al., 2013. Transitioning to resilience and sustainability in urban communities. Cities 32 (Supplement 1):S21–S28 http://dx.doi.org/10.1016/j.cities.2013.03.010.

de Vries, S., Verheij, R.A., Groenewegen, P.P., Spreeuwenberg, P., 2003. Natural environments - healthy environments? An exploratory analysis of the relationship between greenspace and health. Environ. Plan. A 35 (10):1717–1731. http://dx.doi.org/10.1068/a35111.

Dobbie, F., Hiscock, R., Leonardi Bee, J., et al., 2015. Evaluating long term outcomes of nhs stop smoking services (elons): a prospective cohort study. Health Technol. Assess. 19 (95):1–156. http://dx.doi.org/10.3310/hta19950.

Dratva, J., Zemp, E., Dietrich, D.F., et al., 2010. Impact of road traffic noise annoyance on health-related quality of life: results from a population-based study. Qual. Life Res. 19 (1):37–46. http://dx.doi.org/10.1007/s11136-009-9571-2.

Eurofound, 2012. European quality of life surveys (eqls). 16th November. Retrieved from. http://www.eurofound.europa.eu/surveys/eqls/index.htm.

Evans, J., Hyndman, S., Stewart-Brown, S., Smith, D., Petersen, S., 2000. An epidemiological study of the relative importance of damp housing in relation to adult health. J. Epidemiol. Community Health 54 (9):677–686. http://dx.doi.org/10.1136/jech.54.9.677.

Fritze, J.G., Blashki, G.A., Burke, S., Wiseman, J., 2008. Hope, despair and transformation: climate change and the promotion of mental health and wellbeing. Int. J. Ment. Heal. Syst. 2 (1), 13.

Giddens, A., 1991. Modernity and Self Identity: Self and Society in the Late Modern Age. Polity Press, Cambridge.

Guite, H., Clark, C., Ackrill, G., 2006. The impact of the physical and urban environment on mental well-being. Public Health 120, 1117–1126.

Haines, A., McMichael, A.J., Smith, K.R., et al., 2009. Public health benefits of strategies to reduce greenhouse-gas emissions: overview and implications for policy makers. Lancet 374 (9707):2104–2114 http://dx.doi.org/10.1016/S0140-6736(09)61759-1.

Hajdu, T., Hajdu, G., 2014. Reduction of income inequality and subjective well-being in Europe. Economics 8 (2014–35), 1–29.

Hanibuchi, T., Kondo, K., Nakaya, T., Shirai, K., Hirai, H., Kawachi, I., 2012. Does walkable mean sociable? Neighborhood determinants of social capital among older adults in japan. Health & Place 18 (2):229–239 http://dx.doi.org/10.1016/j.healthplace.2011.09.015.

Helliwell, J., Huang, H., Wang, S., 2014. Social capital and well-being in times of crisis. J. Happiness Stud. 15 (1):145–162. http://dx.doi.org/10.1007/s10902-013-9441-z.

Hensher, D.A., 2008. Climate change, enhanced greenhouse gas emissions and passenger transport – what can we do to make a difference? Transp. Res. Part D: Transp. Environ. 13 (2):95–111 http://dx.doi.org/10.1016/j.trd.2007.12.003.

Hiscock, R., Kearns, A., Macintyre, S., Ellaway, A., 2001. Ontological security and psychosocial benefits from the home: qualitative evidence on issues of tenure. Hous. Theory Soc. 18 (1–2), 50–66.

Hiscock, R., Mudu, P., Braubach, M., Martuzzi, M., Perez, L., Sabel, C., 2014. Wellbeing impacts of city policies for reducing greenhouse gas emissions. Int. J. Environ. Res. Public Health 11 (12), 12312–12345.

Hopkins, D., Williamson, T., 2012. Inactive by design? Neighborhood design and political participation. Polit. Behav. 34 (1):79–101. http://dx.doi.org/10.1007/s11109-010-9149-2.

Hopton, J., Hunt, S., 1996. The health effects of improvements to housing: a longitudinal study. Hous. Stud. 11 (2):271–286. http://dx.doi.org/10.1080/02673039608720856.

Hyndman, S.J., 1990. Housing dampness and health amongst British Bengalis in East London. Soc. Sci. Med. 30 (1):131–141. http://dx.doi.org/10.1016/0277-9536(90)90336-q.

IPCC, 2014. Summary for policymakers. In: Field, C.B., Barros, V.R., Dokken, D.J., Mach, K.J., Mastrandrea, M.D., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1–32.

Kearns, A., Hiscock, R., Ellaway, A., Macintyre, S., 2000. "Beyond four walls". The psychosocial benefits of home: evidence from west central Scotland. Hous. Stud. 15 (3), 387–410.

Keim, M.E., 2008. Building human resilience: the role of public health preparedness and response as an adaptation to climate change. Am. J. Prev. Med. 35 (5):508–516 http://dx.doi.org/10.1016/j.amepre.2008.08.022.

Klaeboe, R., Amundsen, A.H., Fyhri, A., 2008. Annoyance from vehicular air pollution: a comparison of European exposure-response relationships. Atmos. Environ. 42 (33): 7689–7694. http://dx.doi.org/10.1016/j.atmosenv.2008.04.049.

Leyden, K.M., 2003. Social capital and the built environment: the importance of walkable neighborhoods. Am. J. Public Health 93 (9), 1546–1551.

Li, H.-J., Yu, W.-B., Lu, J.-Q., Zeng, L., Li, N., Zhao, Y.-M., 2008. Investigation of road-traffic noise and annoyance in Beijing: a cross-sectional study of 4th ring road. Arch. Environ. Occup. Health 63 (1):27–33. http://dx.doi.org/10.3200/aeoh.63.1.27-33.

Lim, Y.-H., Kim, H., Kim, J.H., Bae, S., Park, H.Y., Hong, Y.-C., 2012. Air pollution and symptoms of depression in elderly adults. Environ. Health Perspect. 120 (7):1023–1028. http://dx.doi.org/10.1289/ehp.1104100.

Liu, M., Huang, Y., Hiscock, R., et al., 2016. Do climate change policies promote or conflict with subjective wellbeing: a case study of Suzhou, China. Int. J. Environ. Res. Public Health 13 (3). http://dx.doi.org/10.3390/ijerph13030344.

Maimaitiyiming, M., Ghulam, A., Tiyip, T., et al., 2014. Effects of green space spatial pattern on land surface temperature: implications for sustainable urban planning and climate change adaptation. ISPRS J. Photogramm. Remote Sens. 89, 59–66.

Mason, P., Kearns, A., Bond, L., 2011. Neighbourhood walking and regeneration in deprived communities. Health Place 17 (3):727–737 http://dx.doi.org/10.1016/j.healthplace.2011.01.010.

Menz, T., 2011. Do people habituate to air pollution? Evidence from international life satisfaction data. Ecol. Econ. 71:211–219. http://dx.doi.org/10.1016/j.ecolecon.2011.09.012.

Nguyen, D., 2010. Evidence of the impacts of urban sprawl on social capital. Environ. Plann. B. Plann. Des. 37 (4):610–627. http://dx.doi.org/10.1068/b35120.

Paavola, J., Adger, W.N., 2006. Fair adaptation to climate change. Ecol. Econ. 56 (4): 594–609 http://dx.doi.org/10.1016/j.ecolecon.2005.03.015.

Packer, C.N., Stewartbrown, S., Fowle, S.E., 1994. Damp housing and adult health - results from a life-style study in Worcester, England. J. Epidemiol. Community Health 48 (6): 555–559. http://dx.doi.org/10.1136/jech.48.6.555.

Pelling, M., 2011. Adaptation to Climate Change: From Resilience to Transformation. Routledge, London.

Poortinga, W., 2006. Perceptions of the environment, physical activity, and obesity. Soc. Sci. Med. 63 (11):2835–2846 http://dx.doi.org/10.1016/j.socscimed.2006.07.018.

Psychiatric Research Unit at the Medical Health Centre North Zealand, 2013. Who-five well-being index (who-5). 26th September. Retrieved from. http://www.who-5.org/.

Public Health Agency of Canada, 2014. What is active transportation? 4th November 2014. Retrieved from. http://www.phac-aspc.gc.ca/hp-ps/hl-mvs/pa-ap/at-ta-eng.php

Renalds, A., Smith, T.H., Hale, P.J., 2010. A systematic review of built environment and health. Fam. Community Health 33 (1), 68–78.

Richard, L., Gauvin, L., Gosselin, C., Laforest, S., 2009. Staying connected: neighbourhood correlates of social participation among older adults living in an urban environment in Montreal, Quebec. Health Promot. Int. 24 (1):46–57. http://dx.doi.org/10.1093/heapro/dan039.

Rogers, S., Halstead, J., Gardner, K., Carlson, C., 2011. Examining walkability and social capital as indicators of quality of life at the municipal and neighborhood scales. Appl. Res. Qual. Life 6 (2):201–213. http://dx.doi.org/10.1007/s11482-010-9132-4.

Sabel, C., Hiscock, R., Asikainen, A., et al., 2016. Public health impacts of city policies to reduce climate change: findings from the Urgenche Eu-China project. Environ. Health 8 (15 (Suppl 1)):25. http://dx.doi.org/10.1186/s12940-016-0097-0.

Schreckenberg, D., Griefahn, B., Meis, M., 2010. The associations between noise sensitivity, reported physical and mental health, perceived environmental quality, and noise annoyance. Noise Health 12 (46):7–16. http://dx.doi.org/10.4103/1463-1741.59995.

Schulze, T., Eicker, U., 2013. Controlled natural ventilation for energy efficient buildings. Energ. Buildings 56, 221–232.

Shenassa, E.D., Daskalakis, C., Liebhaber, A., Braubach, M., Brown, M., 2007. Dampness and mold in the home and depression: an examination of mold-related illness and perceived control of one's home as possible depression pathways. Am. J. Public Health 97 (10):1893–1899. http://dx.doi.org/10.2105/ajph.2006.093773.

Sjølie, H.K., Solberg, B., 2011. Greenhouse gas emission impacts of use of Norwegian wood pellets: a sensitivity analysis. Environ. Sci. Pol. 14 (8):1028–1040 http://dx.doi.org/10.1016/j.envsci.2011.07.011.

Statistics Finland, 2016. Largest Municipalities. 1st January 2016. Retrieved from. http://www.stat.fi/tup/suoluk/suoluk_vaesto_en.html.

Suominen, S., Helenius, H., Blomberg, H., Uutela, A., Koskenvuo, M., 2001. Sense of coherence as a predictor of subjective state of health: results of 4 years of follow-up of adults. J. Psychosom. Res. 50 (2), 77–86 http://dx.doi.org/10.1016/S0022-3999(00)00216-6.

SurveyMonkey. (n.d.). Sample size calculator. Retrieved from https://www.surveymonkey.co.uk/mp/sample-size-calculator/

Szyszkowicz, M., 2007. Air pollution and emergency department visits for depression in Edmonton, Canada. Int. J. Occup. Med. Environ. Health 20 (3):241–245. http://dx.doi.org/10.2478/v10001-007-0024-2.

Szyszkowicz, M., Rowe, B.H., Colman, I., 2009. Air pollution and daily emergency department visits for depression. Int. J. Occup. Med. Environ. Health 22 (4):355–362. http://dx.doi.org/10.2478/v10001-009-0031-6.

Szyszkowicz, M., Willey, J.B., Grafstein, E., Rowe, B.H., Colman, I., 2010. Air pollution and emergency department visits for suicide attempts in Vancouver, Canada. Environ. Health Insights 4, 79–86.

Toit, L.D., Cerin, E., Leslie, E., Owen, N., 2007. Does walking in the neighbourhood enhance local sociability? Urban Stud. 44 (9):1677–1695. http://dx.doi.org/10.1080/00420980701426665.

Tuomisto, J.T., Niittynen, M., Pärjälä, E., et al., 2015. Building-related health impacts in European and Chinese cities: a scalable assessment method. Environ. Health 14 (1): 1–13. http://dx.doi.org/10.1186/s12940-015-0082-z.

UNEP, 2009. Buildings and climate change: summary for decision-makers. Retrieved from. http://www.unep.org/sbci/pdfs/SBCI-BCCSummary.pdf.

Welsch, H., 2006. Environment and happiness: valuation of air pollution using life satisfaction data. Ecol. Econ. 58 (4):801–813. http://dx.doi.org/10.1016/j.ecolecon.2005.09.006.

White, M.P., Alcock, I., Wheeler, B.W., Depledge, M.H., 2013. Would you be happier living in a greener urban area? A fixed-effects analysis of panel data. Psychol. Sci. 24 (6): 920–928. http://dx.doi.org/10.1177/0956797612464659.

WHO Regional Office for Europe, 2007. Large analysis and review of European housing and health status (Lares): preliminary overview. Retrieved from. http://www.euro.who.int/en/health-topics/environment-and-health/Housing-and-health/activities/the-large-analysis-and-review-of-european-housing-and-health-status-lares-project.

Wilkerson, A., Carlson, N.E., Yen, I.H., Michael, Y.L., 2012. Neighborhood physical features and relationships with neighbors: does positive physical environment increase neighborliness? Environ. Behav. 44 (5):595–615. http://dx.doi.org/10.1177/0013916511402058.

Wood, A.M., Boyce, C.J., Moore, S.C., Brown, G.D.A., 2012. An evolutionary based social rank explanation of why low income predicts mental distress: a 17 year cohort study of 30,000 people. J. Affect. Disord. 136 (3):882–888 http://dx.doi.org/10.1016/j.jad.2011.09.014.

Wood, L., Frank, L.D., Giles-Corti, B., 2010. Sense of community and its relationship with walking and neighborhood design. Soc. Sci. Med. 70 (9):1381–1390 http://dx.doi.org/10.1016/j.socscimed.2010.01.021.

Yoshida, T., Osada, Y., Kawaguchi, T., Hoshiyama, Y., Yoshida, K., Yamamoto, K., 1997. Effects of road traffic noise on inhabitants of Tokyo. J. Sound Vib. 205 (4):517–522 http://dx.doi.org/10.1006/jsvi.1997.1020.

Zhou, Z., Zhang, S., Wang, C., Zuo, J., He, Q., Rameezdeen, R., 2016. Achieving energy efficient buildings via retrofitting of existing buildings: a case study. J. Clean. Prod. 112 (Part 5):3605–3615 http://dx.doi.org/10.1016/j.jclepro.2015.09.046.