



Cumulative effects of noise and odour annoyances on environmental and health related quality of life



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ABSTRACT

Noise and odour annoyances are important considerations in research on health effects of air pollution and traffic noise. Cumulative exposures can occur via several chemical hazards or a combination of chemical and stressor-based hazards, and related health outcomes can be generalized as manifestations of physiological and/or psychological stress responses. A major research challenge in this field is to understand the combined health effects of physiological and psychological responses to exposure. The SF-12 Health Survey is a health related quality of life (HRQoL) instrument designed for the assessment of functional mental and physical health in clinical practice and therefore well suited to research on physiological health outcomes of exposure. However, previous research has not assessed its sensitivity to psychological stress as measured by noise annoyance and odour annoyance. The current study validated and tested this application of the SF-12 Health Survey in a cross-sectional study ($n = 603$) that included exposure assessment for traffic noise and air pollution in Windsor, Ontario, Canada. The results indicated that SF-12 scores in Windsor were lower than Canadian normative data. A structural equation model demonstrated that this was partially due to noise and odour annoyances, which were associated with covarying exposures to ambient nitrogen dioxide and traffic noise. More specifically, noise annoyance had a significant and negative effect on both mental and physical health factors of the SF-12 and there was a significant covariance between noise annoyance and odour annoyance. The study confirmed a significant effect of psychological responses to cumulative exposures on HRQoL. The SF-12 Health Survey shows promise with respect to assessing the cumulative health effects of outdoor air pollution and traffic noise.

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1. Introduction

No research to date has examined how exposures to environmental noise and air pollution and consequent levels of noise annoyance and odour annoyance may interact to affect health related quality of life (HRQoL). The separate effects of air pollution and environmental noise on cardiovascular disease and other health outcomes are well documented (Brook et al., 2004; Münzel et al., 2014). Previous studies also demonstrate dose–response relationships between odour annoyance and air pollution as well as noise annoyance and environmental noise (Atari et al., 2012; Klæboe et al., 2000). Interestingly, previous research indicates

that there is a strong interaction effect of noise and air pollution on both types of annoyance (Klæboe et al., 2000; Meline et al., 2013; Oiamo et al., 2015). Although work examining cumulative exposure effects on cardiovascular disease outcomes has only appeared recently (e.g., Beelen et al., 2009; Ganet et al., 2012), Brook et al. (2011) argue that the evidence base is strong enough to include environmental exposures to noise and air pollution as modifiable risk factors for hypertension in clinical practice. However, this evidence is based predominantly on direct effects, such as effects of air pollution through inhalation and effects of noise through involuntary arousals during sleep, as the potential health effects of subjective responses have received less attention.

Noise annoyance is most commonly operationalized as a disturbance or disruption to intended activities, either measured on a general adjectival scale or by reference to specific activities (Fields et al., 2001; Michaud et al., 2008a). However, there are several conceptual definitions of noise annoyance, which have different implications for environmental health research and consequently

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health promotion. In general, noise annoyance is either conceptualized as a moderator of health outcomes (e.g., (Babisch et al., 2013)) or as an indicator of a psychological stress response to noise exposure (Evans and Cohen, 1982).

A recent meta-analysis showed that there is a significant and positive relationship between noise annoyance and risk of cardiovascular disease (Ndrepepa and Twardella, 2011). In research where annoyance is considered a potential moderator, the main focus is still on a biomedical health outcome. Consequently, there is no opportunity to understand how a given health outcome may interact with annoyance to affect overall health and wellbeing. Conversely, Fig. 1 conceptualizes annoyance as a cognitive, psychological response to ambient stressors, which can exist independently or in combination with direct effects of exposures to air pollution and noise. Understanding combined effects of psychological and physiological responses has potential implication for health promotion, particularly among groups at risk for cardiovascular disease (Münzel et al., 2014).

Measureable effects on disease outcomes do not need to be present for annoyance to affect health as defined by the World Health Organization (WHO, 1948): “A complete state of physical, mental and social well-being and not merely the absence of disease or infirmity.” The WHO Guidelines for Community Noise defines annoyance as “[...] a feeling of displeasure associated with any agent or condition, known or believed by an individual or group to adversely affect them,” which implies that annoyance is a cognitive evaluation contingent on perceptions of risk (Berglund et al., 1999). To this end, annoyance serves as a general term for a range of negative emotions such as anger, depression, anxiety and exhaustion. However, their subclinical severities evade the biomedical definition of health. The equivocal conceptualization of noise annoyance as a health outcome or health mediator is therefore, at least in part, due to different definitions of health.

A similar definitional problem exists for odour annoyance. Most research conceptualizes odour annoyance as dependent on hedonic tone (i.e., level of unpleasantness or pleasantness of odour) and a subjective nuisance that may be associated with levels of air pollution exposure (Forsberg et al., 1997; Williams and McCrae, 1995), or a consequence of odour and air pollution impacts on health through its irritant properties, cardiovascular, respiratory and psychobiological effects (Claeson et al., 2013; Jacquemin et al., 2007; Schiffman and Williams, 2005). Similar to noise annoyance, research on health symptoms associated with odour annoyance provide mixed results, suggesting that it may be more appropriate to instead consider annoyance as an indicator of coping with ambient stressors, which nonetheless implies the activation of a potentially chronic stress response (Stenlund et al., 2009; Sucker et al., 2001; Winneke et al., 1996).

Shusterman (1992) argues that the distinction of annoyance as a

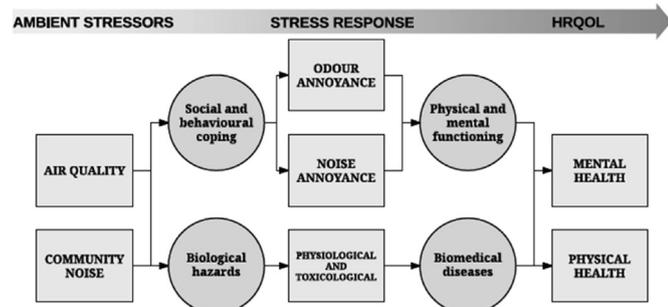


Fig. 1. Conceptual diagram of odour and noise annoyances as mediators or moderators of health.

subjective response or health outcome is irrelevant for scientific purposes and a matter of legal interpretation for regulation. Conversely, we argue that the distinction for scientific purposes is crucial to support legal interpretations. Other than for example reducing cardiovascular disease risk, research to date does not offer a clear picture of the potential health benefits of mitigating annoyance. Such benefits may include reducing the appearance of social and behavioural coping mechanisms that impact HRQoL. Instead, research has demonstrated that annoyances relate to subtle and complex interactions between risk perceptions, coping, physical surroundings and sociocultural circumstances (Berglund et al., 1999; Luginaah et al., 2002a,b,c; Parr, 2006). In this sense both odour and noise annoyance may be considered more than merely mediators of something more serious, but the lack of reference to annoyance in current regulation suggests that additional evidence is needed. In this respect, alternatives to the biomedical perspective on health provide a theoretical and conceptual foundation.

Embodiment of the ecological context is a central construct in the ecosocial perspective on social epidemiology and recognizes that human biology cannot be fully understood without knowledge of individual and societal ways of living (Krieger, 2001). A rich body of literature relevant to environmental and HRQoL has demonstrated how embodiment is situated in place and is the outcome of interactions between environment and society. For example, Parr (2010) used community case studies of environmental change throughout Canada to illustrate how responses to environmental stimuli depend on senses tuned to local context and its environmental and sociocultural histories. Coping with ambient stressors can be emotion- or problem-oriented, and Cavalini et al. (1991) argue that passive resignation is the modal response to emotion-oriented coping with unpleasant odours.

Botteldooren and Lercher (2004) distinguish between three styles of problem-oriented coping with odours and noise that seek to mitigate the ambient stressor by attempting to reduce exposure. These are active coping through changing individual behaviours, social coping by seeking social or administrative support, and political coping by way of mobilizing citizen power. Social and political coping depend on the context of place, which can influence the experience of air pollution and furthermore public perceptions of its health risks (Bickerstaff, 2004; Day, 2007). However, it can be argued that active coping depends more on characteristics of the physical environment than the context of place as such. This study attempts to demonstrate that coping with cumulative exposures can affect health. This is predicated on the conceptualization of annoyance as an indicator of coping with the ambient stressors traffic noise and outdoor air pollution. The concept of HRQoL is utilized to demonstrate that mitigating annoyance can have public health benefits.

1.1. Environmental and health related quality of life

There is a strong tradition for looking at mental health and more generally subjective health and wellbeing within environmental health research on ambient exposures (e.g., Heinonen-Guzejev et al., 2012; Sygna et al., 2014). Standardized scales and questionnaires such as the Hopkins Symptoms Checklist and the Quick Environmental Exposure and Sensitivity Inventory are commonly utilized, but focussing on subjective health alone does not capture potential effects of ambient exposures on overall health and wellbeing. As an alternative, health related quality of life is a holistic measure of health status composed of several dimensions, generally categorized as physical, mental and social wellbeing, and it is therefore well suited to measure the multidimensional effects of annoyance.

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