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An assessment of quality of life using the WHOQOL-BREF among participants living in the vicinity of wind turbines ☆

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ABSTRACT

Living within the vicinity of wind turbines may have adverse impacts on health measures associated with quality of life (QOL). There are few studies in this area and inconsistent findings preclude definitive conclusions regarding the impact that exposure to wind turbine noise (WTN) may have on QOL. In the current study (officially titled the *Community Noise and Health Study or CNHS*), the World Health Organization QOL-BREF (WHOQOL-BREF) questionnaire provided an evaluation of QOL in relation to WTN levels among randomly selected participants aged 18–79 (606 males, 632 females) living between 0.25 and 11.22 km from wind turbines (response rate 78.9%). In the multiple regression analyses, WTN levels were not found to be related to scores on the Physical, Psychological, Social or Environment domains, or to rated QOL and Satisfaction with Health questions. However, some wind turbine-related variables were associated with scores on the WHOQOL-BREF, irrespective of WTN levels. Hearing wind turbines for less than one year (compared to not at all and greater than one year) was associated with improved (i.e. higher) scores on the Psychological domain ($p=0.0108$). Lower scores on both the Physical and Environment domains ($p=0.0218$ and $p=0.0372$, respectively), were observed among participants reporting high visual annoyance toward wind turbines. Personal benefit from having wind turbines in the area was related to higher scores on the Physical domain ($p=0.0417$). Other variables significantly related to one or more domains, included sex, age, marital status, employment, education, income, alcohol consumption, smoking status, chronic diseases and sleep disorders. Collectively, results do not support an association between exposure to WTN up to 46 dBA and QOL assessed using the WHOQOL-BREF questionnaire.

Abbreviations: ANOVA, Analysis of Variance; CNHS, Community Noise and Health Study; dBA, A-weighted decibel; dBC, C-weighted decibel; MW, megawatt; ON, Ontario; PEI, Prince Edward Island; QOL, quality of life; SAS, Statistical Analysis System; SF-36®, Short Form Health Survey; WHO, World Health Organization; WHOQOL, World Health Organization Quality Of Life; WHOQOL-BREF, World Health Organization Quality Of Life—abbreviated version of the WHOQOL 100; WTN, wind turbine noise

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1. Introduction

Quality of life (QOL) evaluation in health research emerged in the 1970s in order to supplement traditional morbidity and mortality outcomes. The meaning of the concept of QOL and how it can be reliably evaluated has been studied for many years. The World Health Organization (WHO) defines QOL as "*an individual's perception of their position in life in the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards and concerns*" (WHOQOL Group, 1994). Quality of life is a global measure, broader than health status, inherently subjective and pertains to all aspects of life important to the person (Harrison et al., 1996; Molzahn and Pagé, 2006). There is evidence that dissatisfaction with environment, psychological and/or social domains may impact physical health and well-being in individuals (Guite et al., 2006; Silva et al., 2012).

The methodologies and tools used in environmental noise studies are wide-ranging and have included participant diaries, observational checklists, specialized questionnaires, validated health measures scales and/or QOL scales. The use of a validated measure can be advantageous in that psychometric evaluation such as validity and reliability testing has been completed. In addition, the use of a standardized measure facilitates comparisons across studies enabling trends in research to be more easily examined.

Many QOL studies have used the World Health Organization QOL (WHOQOL)-100, a questionnaire consisting of 100 items divided into multiple domains, which has demonstrated discrimination between healthy and ill populations (WHOQOL Group, 1998). An abbreviated 26-item version (i.e. WHOQOL-BREF) has also been used in numerous studies to evaluate perceptions of health. This questionnaire, developed using data from 30 international field centres, has been found to be an effective cross-cultural assessment of QOL with good to excellent psychometric properties of reliability and validity (Kalfoss et al., 2008; Skevington et al., 2004). The WHOQOL-BREF consists of 4 domains, Physical Health, Psychological, Social Relationships, and Environment. Each domain is comprised of multiple questions that are considered together in the derivation of each domain score. In addition to the 4 domains, the WHOQOL-BREF includes two standalone questions to assess rated QOL and Satisfaction with Health (WHOQOL Group, 1994).

Some environmental noise studies have utilized QOL measures to quantify and compare community response to different noise sources (Shepherd et al., 2010; Welch et al., 2013), with the general observation that increasing exposure to noise is associated with decreased QOL. As reliance on wind power as a source of energy increases, the introduction of wind farms into communities is sometimes resisted or negatively received based, at least in part, on the perception that exposure to wind turbine noise (WTN) has adverse impacts on health and QOL. In a review of literature related to the health effects of WTN, the Council of Canadian Academies (2015) concluded that the only health effect with sufficient evidence for a causal association with exposure to WTN was long term annoyance. Among the Council's key findings was an acknowledgement that there was a paucity of epidemiological studies to draw upon and those that did exist suffered from methodological problems that included, but were not limited to weak statistical power, bias, and lack of controls. Other reviews by researchers and government agencies have reached similar conclusions (Chief Medical Officer of Health Ontario, 2010; Knopper et al., 2014; MassDEP and MDPH, 2012; Merlin et al., 2014; Oregon Health Authority, 2013; Schmidt and Klokker, 2014).

In comparison to the large body of scientific literature examining the response to transportation noise, there are few original epidemiological studies that have investigated the possible impact on QOL among communities living within the vicinity of wind turbines and among those studies, only a limited number of them have utilized validated instruments to examine QOL (Onakpoya et al., 2014). Shepherd et al. (2011) reported that individuals who lived near a wind farm scored worse on general QOL and on the Physical and Environment domains of the WHOQOL-BREF compared to a geographically and socioeconomically matched group living at least 8 km from any wind farms. Conflicting results were found in two other wind turbine studies (Mroczek et al., 2012; Nissenbaum et al., 2012), where QOL was evaluated using a Short Form Health Survey (SF-36®) to examine health outcomes in individuals who lived close to wind turbines and those who lived further away. Nissenbaum et al. (2012) reported lower scores on the mental, but not physical component of the SF-36®, among 38 participants living between 375 m and 1400 m of a wind turbine when compared to 41 participants living between 3.3 km and 6.6 km from a wind turbine. This is in contrast to the findings from a much larger study by Mroczek et al. (2012) where *improved* QOL for all SF-36® domains was found among those living at the closest distance to a wind farm (i.e. <700 m), in comparison to those living beyond 1500 m. In an extended analysis, Mroczek et al. (2015) reaffirmed a higher reported QOL among participants living closer to wind turbines, relative to those living further away and reported that the stage of the wind farm development was an important factor in this regard. These incongruent results, in addition to their methodological issues, small sample sizes and low response rates underscored the need for more research.

Where wind turbines are concerned, it has also been shown that there can be adverse community reactions to features that go beyond WTN emissions. In particular, self-reported health effects have been attributed to features such as shadow flicker. Wind turbine shadow flicker is a phenomenon caused by the flickering effect of rotating blades periodically casting shadows over some but not all neighbouring properties and through windows (Bolton, 2007; Department of Energy and Climate Change (DECC), 2011; Saidur et al., 2011). With their blade length accounted for, utility-scale wind turbines can reach 130 m and wind farms can include dozens of wind turbines. Their height necessitates aircraft warning signals (e.g. blinking lights on the turbine nacelle) and the visual intrusion of wind turbines on the landscape, in addition to WTN, are features that are known to underlie the response to wind turbines (Harding et al., 2008; Pedersen and Larsman, 2008; Pohl et al., 1999; Smedley et al., 2010; van den Berg et al., 2008). While the annoyance response to shadow flicker and/or blinking lights on top of wind turbines has been investigated (Katsaprakakis, 2012; Pohl et al., 2000, 2012), the only field study to assess QOL measures as a function of shadow flicker exposure was published in German by Pohl et al. (1999). In this study, exposure to shadow flicker was related to decreased QOL and elevated annoyance (Pohl et al., 1999).

In assessing the potential contribution that exposure to wind turbines may have on health and QOL, it is important to consider personal and situational factors that may influence reported QOL. For instance, expectations of negative reactions and worry about perceived risk may play a role in self-reported health impacts related to wind turbines (Crichton et al., 2014; Henningsen and Priebe, 2003). Others have found attitudinal factors, personality traits and personal benefit from wind turbines influenced the magnitude of the annoyance to wind turbines; which in turn may be responsible for reported health effects (Chapman et al., 2013; Rubin et al., 2014; Taylor et al., 2013; Pedersen et al., 2009). Regardless of the mechanisms, it is well known that self-reported health is highly correlated with QOL (Bowling, 1995; Hutchinson et al., 2004).

The objective of the present paper was to assess self-reported QOL among individuals living in areas with varying levels of WTN