# Turning to the Source: Assessing the Evidence Sources Used to Describe the Potential Human Health Impacts of Wind Turbines by Public Health Organization Websites and Community Group Websites Using a Social Network Analysis Approach

**by**

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## Author's Declaration

This thesis consists of material all of which I authored or co-authored: see Statement of Contributions included in the thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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## Statement of Contributions:

I was the sole author for the content of this thesis with the following exceptions:

Chapter 2

Feedback for this chapter was provided by Drs. Shannon Majowicz (School of Public Health and Health Systems, University of Waterloo), Philip Bigelow (School of Public Health and Health Systems, University of Waterloo) and John McLevey (Knowledge Integration, Sociology & Legal Studies, University of Waterloo).

Chapter 4

Methods

The data analysis for this chapter was done in consultation with Dr. Shannon Majowicz.

Chapter 5

Methods

The methods for this chapter were developed in consultation with Dr. John McLevey and with preliminary input from Dr. Peter Carrington (Sociology & Legal Studies, University of Waterloo).

**Abstract:**

Introduction: Wind turbines are a source of renewable energy that has become more common in Canada in the past decades. Concerns have been raised over potential adverse health effects from exposure to wind turbines, particularly wind turbine noise. A disagreement exists over the potential harm from exposure to wind turbines to human health, where many public health organizations state that there are no direct human health impacts from wind turbine exposure, while many community groups state that wind turbines are harmful to human health.

Objectives: 1. Determine the types of evidence cited by community group websites, and by public health organization websites, to support their respective positions on the potential health effects of wind turbines; and 2. Assess the pattern of citations or links to the evidence used by community groups and public health organizations to characterize and interpret these patterns of evidence citation and to see whether and how these patterns differ between the two groups.

Methods: Websites of Canadian community groups, public health organizations, environmental non-governmental organizations (eNGOs) and academic organizations were identified using an Internet search strategy. The identified websites with content on wind turbines and human health that met the inclusion criteria were characterised with a data collection tool to gather information about the webpage structure and its links to evidence sources and other organizations' websites. Descriptive statistical analysis was performed on the website characteristics and evidence and organization citation data. Testing for significant differences between community groups and public health organizations was done using t-tests and chi-squared tests. Adjacency matrices were created to represent the presence of ties between organization websites and between organization websites and evidence sources. Graphs (sociograms) were created based on the adjacency matrices to visualise the relationship between the different types of organizations as well as between organizations and evidence sources. Additional centrality measures were calculated for the visualised networks and representations of structural equivalence were created to determine whether nodes in the network were similar.

Results: 67 identified websites met the inclusion criteria: 2 academic organizations (3%), 6 eNGOs (9%), 18 public health organizations (27%) and 41 community groups (61%). Significant differences were found between community group websites and public health organization websites in their position on wind turbines and human health, and the presence of website components (social media or a news section). Community group websites were significantly more likely to cite blogs, news, video evidence, and personal accounts/testimony than public health organization websites, but no significant difference was found in the citation of peer-reviewed literature or grey literature. Significant differences for mean citation counts between community group websites and public health organization websites were found for experimental studies with controls, grey literature, and observational study without controls. Community group websites predominantly linked to other community group websites and public health organization websites predominantly linked to government and other public health organizations websites.

Social network analysis of the 67 Canadian organization websites determined that websites tended to link to other organization websites of the same organization type. The network structure lacked a central node and was divided according to the websites' position on whether wind turbines were potentially harmful to human health—where websites within the network clustered by position. There was structural equivalence between organization websites by organization type, where certain national and provincial websites had similar roles within the network.

The results from examining the network between the 67 Canadian organization websites and the 584 evidence sources identified differences in the specific evidence sources and types of evidence that were cited. When the network analysis was limited to evidence sources with more than two citations, the evidence citations were found to be similar in type (reviews, grey literature and cross-sectional surveys) but varied by the specific evidence source cited. The type of grey literature cited varied by organization type, where community group websites tended to cite grey literature that originated from community groups and public health organization websites tended to cite grey literature that originated from public health organizations, government or industry. Higher quality evidence sources were shared between websites across the organization types, but the lower quality evidence sources citations were predominantly shared between organization websites of the same type.

Conclusions: The network of Canadian organization websites with content on wind turbines and human health was structured according to organization type and position on potential health effects. Grey literature, reviews and cross-sectional surveys were the most frequently cited evidence sources and evidence citation patterns differed by organization type. These results provide a basis for understanding which types of evidence sources are used to substantiate positions on wind turbines and human health and how public health practitioners and researchers can approach the uncertainties in the evidence base on the topic.

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# Table of Contents

## List of Figures:

## List of Tables:

# Chapter 1: Introduction and Overview:

Wind turbines have gained popularity in the past few decades as a source of renewable electricity, with Ontario being the Canadian provincial leader in wind energy production (Government of Ontario, 2016). In certain jurisdictions, like the province of Ontario, community groups and citizens have expressed concerns about the potential health effects of wind turbines (Jeffery, Krogh, & Horner, 2013a). Public health organizations have responded to these concerns by conducting literature reviews (usually not systematic reviews or meta-analyses) of the available evidence, and have generally found that the evidence does not support most of the purported claims of ill health caused by wind turbine exposure, although wind turbine noise has been linked to annoyance and sleep disturbance (Schmidt & Klokker, 2014). Public health units and other public health organizations have continued to review the potential health impacts of wind turbines, and share their findings with the public (Chief Medical Officer of Health Ontario, 2010; Colby et al., 2009).

Some Ontario communities have voiced concern over the installation of wind turbines locally, and community groups in those areas have shared a perspective that wind turbines can cause negative health outcomes. Many of the community organizations have an organized online presence, with websites and social media elements to disseminate their concerns or ideas.

Given that a substantial disagreement may exist between public health organizations and community groups on the issue of the potential health effects of wind turbines, understanding the evidence upon which the two sides base their claims of the health impacts of wind turbines could help explore why this disagreement exists, including whether different evidence is being used, or whether the same evidence is being interpreted differently by the two sides.

By characterizing the online representations of evidence on the potential health effects of wind turbines by different types of organizations on this issue, insight into the type of evidence used and the degree of shared sources between the types of organizations will be gained, which can ultimately help determine whether the different types of organizations are relying on different sources of evidence, or interpreting the same evidence differently. Such an assessment has not been conducted to-date, neither in Canada nor in other countries (e.g., Australia, United Kingdom, or the United States of America) where wind turbines are in place.

I assessed Canadian websites of both public health organizations and community groups, characterizing the type of evidence used to substantiate claims on the health effects of wind turbines and used social network analysis to understand whether the pattern of citations to other organizations and evidence sources differs between the two groups. Additionally, websites of Canadian environmental non-governmental organizations (eNGOs) and academic organizations that had content online on the topic of wind turbines and human health were similarly characterized and assessed. Content such as social media and links to news websites fell outside the scope of this thesis but their presence was noted. I characterized and visualized the relationships between the types of groups and the specific evidence sources they cited to determine whether and how the patterns of citations differed by group type.

# Chapter 2: Literature Review

## 2.1. Background

Wind turbines are a source of renewable energy that produces less pollution than many other sources (Onakpoya, O'Sullivan, Thompson, & Heneghan, 2015). Wind turbines have been used in a number of countries around the world for several decades but their use has been growing in North America over recent years, where Canada has experienced a rapid growth in the wind energy sector since the 1990s (Council of Canadian Academies, 2015). Wind turbines rely on wind to generate electricity and as they do not use fossil fuels, wind turbines offer energy without greenhouse gas emissions or air pollution other than those produced during their construction and installation (McCubbin & Sovacool, 2013). Wind turbines are typically tall structures with a tower and base upon which is a nacelle and a rotor with spinning blades (Council of Canadian Academies, 2015).

Wind turbines have been promoted for their reduced carbon footprint and lower impact on the environment, but they have been associated with some potential adverse health effects and environmental and social impacts. Recommendations about the proper siting of wind turbines to minimize their adverse impacts have been given by governmental agencies. In Ontario, for example, the minimum set-back distance is 550 meters (Government of Ontario, May 1, 2016).

## 2.2 Potential Health Impacts of Wind Turbines

The direct potential health impacts of wind turbines include ice throw (ice being thrown from the blades during cold weather which could potentially injury people in close proximity), falls from height for those who work on the wind turbines, shadow flicker (which theoretically can provide a visual trigger for people with photosensitive epilepsy), and structural failure risk which can injure people if the structure or its component parts collapse on them (Knopper & Ollson, 2011a). The potential indirect health impacts of wind turbines include those related to the noise that the wind turbines produce, which can potentially cause distress, sleep disturbance, stress (where chronic physiological stress can increase the risk of diseases ranging from cardiovascular disease, diabetes, hypertension and mental health impacts such as mood disorders (e.g. anxiety or depression)) (Jeffery, Krogh, & Horner, 2014a; Nissenbaum, Aramini, & Hanning, 2012; Onakpoya et al., 2015; Schmidt & Klokker, 2014; Shepherd, McBride, Welch, Dirks, & Hill, 2011a).

The downstream health impacts from recurrent sleep disturbance can also result from an increased stress response and potentially include increased risks of cardiovascular disease and mood disorders, although the evidence is inadequate to demonstrate a causal relationship (Council of Canadian Academies, 2015). The noise levels produced by wind turbines are not likely sufficient to cause hearing loss or other auditory health impacts, and there is inadequate evidence to demonstrate a causal link (Council of Canadian Academies, 2015).

### 2.3 Prior Reviews of Wind Turbine Exposure and Human Health Effects

A number of reviews of the body of evidence surrounding the potential human health effects of wind turbines have been published. These reviews range from grey literature reviews for government agencies or NGOs, to literature reviews, to formal systematic reviews. Systematic reviews that have examined the potential health impacts of wind turbines include the following:  Knopper and Ollson reviewed the research literature and conclude that there was no evidence of a direct causal link between exposure to wind turbines and human health concerns, but that a link to annoyance has been found (Knopper & Ollson, 2011a).

Arra et al (2014) looked at 18 studies and found "the presence of reasonable evidence (Levels Four and Five) supporting the existence of an association between wind turbines and distress in humans." (Arra, Lynn, Barker, Ogbuneke, & Regalado, 2014). They argue that their review supports a dose-response relationship between distance from wind turbines and human distress, where this relationship showed consistency of association. Jeffrey et al (2014) conclude that sufficient evidence exists to support that symptoms can result from annoyance to wind turbine noise (Jeffery et al., 2014a). They highlight that the amplitude modulation of wind turbines and audible low frequency noise, and "tonal, impulse and nighttime noise can contribute to annoyance and other effects on health." They mention that inaudible low frequency noise or infrasound from wind turbines may also impact human health, but that more research is needed.

Schmidt and Klokker (2014) write that annoyance and sleep disturbance (self-reported) are associated with exposure to wind turbines, and that more research is needed to better understand the association (Schmidt & Klokker, 2014). McCunney et al assessed the scientific literature on the impact of wind turbines and human health and found "no convincing or consistent evidence that wind turbine noise is associated with any well-defined disease outcome" (R. J. McCunney, Mundt, Dobie, Kaliski, & Blais, 2015), however, they did find that wind turbine noise can be associated with annoyance. The authors assessed previous reviews as well as primary studies and found that there was a lack of any cohort or case-control studies—all of their analysis is based on 20 studies ("14 observational and 6 controlled human exposure studies"). They identified a lack of cohort or longitudinal studies to definitively address the issue of temporal causality.

Onakpoya et al (2015) reviewed the impact of wind turbine noise on sleep and quality of life and found that in the seven studies they assessed in their meta-analysis, that living in areas with wind turbines results in increased "annoyance" and "may also be associated with sleep disturbances and decreased quality of life" (Onakpoya et al., 2015). They argue further research is needed to explore this association, and that their meta-analysis and systematic review supports the findings of previous review articles on this topic. They state that the relationship between wind turbine noise and annoyance is controversial, as there is disagreement between studies on the plausibility of the relationship. An engineering review identified wind turbine noise's association with annoyance and its possible links with sleep disturbance and psychological distress (Saavedra & Samanta, 2015). They describe the potential impacts of low frequency noise and infrasound associated with wind turbines. They argue "more research is needed to establish a connection between wind turbine noise and potential effects on human health." The conclusions of the reviews tend to substantiate the existence of annoyance associated with wind turbine noise exposure but not direct human health impacts.

### 2.4 Unwanted Non-Health Impacts of Wind Turbines

Wind turbines—in particular the noise they produce—have been associated with annoyance, which can be defined in numerous ways but typically describes the state of feeling irritation from an external factor. The World Health Organization characterizes annoyance as "a feeling of discomfort which is related to adverse influencing of an individual or a group by any substances or circumstances" (Niemann & Maschke, 2004). The annoyance that wind turbines can cause may be due to a number of factors, including their noise, their aesthetics, their presence on the landscape or proximity to where individuals live or work (Yu, Behm, Bill, & Kang, 2017). A prospective cohort study conducted in a community in Ontario before and after wind turbines began operation in the area found evidence that individual factors, such as negative attitudes towards wind turbines or concerns about property values, and annoyance influenced the reported worsening of measures of health and quality of life (Jalali et al., 2016).

Annoyance differs from a health hazard, which is a substance, event or object that can cause harm to individuals exposed to it. Provincial legislature has formal definitions for health hazards, where specific criteria need to be met to label something a health hazard. An example appears in the Health Protection and Promotion Act in Ontario where it is defined as "(a) a condition of a premises, (b) a substance, thing, plant or animal other than man, or (c) a solid, liquid, gas or combination of any of them, that has or that is likely to have an adverse effect on the health of any person" (Government of Ontario, 2015). Annoyances are not typically included in categorizations of risks to human health, but some have advocated that if a broad definition of health is used, such as the World Health Organization's definition of health as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity", then annoyance does detract from health and can be considered a health issue (Jeffery et al., 2014a; Michaud, Keith, & McMurchy, 2005). Typically, public health organizations do not consider annoyance as a health issue but may address its potential downstream impacts that arise from chronic stress.

Aesthetics and potentially the restorative properties of the natural landscape can be impacted by the presence of wind turbines (Pedersen & Waye, 2004; Pedersen & Larsman, 2008; Shepherd et al., 2011a). The presence of wind turbines on the natural landscape can affect how the environment is perceived and potentially increase annoyance and detract from natural beauty and its restorative potential (Devine-Wright & Howes, 2010; Pedersen & Waye, 2004). A small cross-sectional survey in Norway found annoyance with wind turbines was linked to concerns about wind turbines degrading the visual aesthetics of the landscape and attitudes towards renewable energy sources (Klæboe & Sundfør, 2016).

Wind turbines may have other potential non-health adverse impacts , such as environmental impacts—where wind turbines can injure or kill other species like migratory birds and bats if they are improperly sited (particularly in migratory bird pathways), or if sited on crucial habitat for endangered species (Drewitt & Langston, 2006). Concerns have been raised about wind turbines potentially impacting agriculture, marine life and water quality (Bergström et al., 2014; Shreve, 2016; Wang, Wang, & Smith, 2015; Zhang, Markfort, & Porte-Agel, 2013).

Wind turbines can be a significant source of community noise in areas without other sources of noise, particularly at a night. Increased noise from wind turbines can impact annoyance and health-related quality of life in a dose-response manner (Arra et al., 2014; Shepherd, McBride, Welch, Dirks, & Hill, 2011b). The impact of wind turbines noise on annoyance, sleep and perceived health effects could be related to multiple other factors, including proximity, the types of noises emitted, noise sensitivity of residents, the pre-installation ambient noise levels in the community, meteorological events, and the type of housing in which individuals reside (Mroczek, Banas, Machowska-Szewczyk, & Kurpas, 2015; Onakpoya et al., 2015; Schmidt & Klokker, 2014). A 2016 prospective cohort study examined objective measures of noise and sleep before and after wind turbines began operation in a community and found increased rates of poor sleep quality, daytime sleepiness, and insomnia subsequent to wind turbines beginning operation—which were strongly associated with negative attitudes to wind turbines, concerns about property values and wind turbine visibility from home (Jalali, Nezhad-Ahmadi, Gohari, Bigelow, & McColl, 2016). Another study found that the odds-ratio of insomnia was higher in areas where the noise exposure from wind turbines exceeded 40db at night, and was also associated with visual annoyance with wind turbines and self-reported noise sensitivity (Kageyama, 2016; Kageyama, Yano, Kuwano, Sueoka, & Tachibana, 2016). Night noise has been linked to sleep disturbance and downstream chronic health effects resulting from chronic stress, although the evidence is limited (Hurtley, 2009). A systematic review found a strong association between road noise and ischemic heart disease (Kempen, Casas, Pershagen, & Foraster, 2018). Recommendations have been developed in Europe about the allowable night noise limits (Hurtley, 2009), although the level of noise produced by wind turbines would typically be less than that found in urban areas or locations in proximity to airports, major roadways or train tracks. A 2016 cross-sectional study with subjective and objective measures did not demonstrate an association between wind turbine noise exposure and sleep disruption (Michaud et al., 2016). The ideal study design to assess the impact of noise exposure on health is unclear, but may involve comparison of self-rated health or other markers before and after an exposure to a source of community noise with a control group of a matched community without the new community noise source.

Concerns have also been raised about the infrasound produced by wind turbines (Jeffery et al., 2014a; Salt & Kaltenbach, 2011)—which is sound that is below the normal range of hearing—although little evidence exists that infrasound has health impacts (Bolin, Bluhm, Eriksson, & Nilsson, 2011; Crichton & Petrie, 2015c). Similarly, the electromagnetic fields (EMF) produced by wind turbines have been argued to have potential health impacts; although the level of evidence linking adverse health impacts from EMF is weak (McCallum, Aslund, Knopper, Ferguson, & Ollson, 2014).

### 2.5 Concerns about Wind Turbine Exposure and Human Health

In certain countries, the use of wind turbines has raised objections or concerns from communities about the potential harms of wind turbines (Devine-Wright, 2005a; Knopper & Ollson, 2011a; Wilson & Dyke, 2016). Controversy has arisen following the self-publication of a book by Dr. Nina Pierpont called "Wind Turbine Syndrome", which presented a series of case examples of individuals who ascribe their ill health to exposure to wind turbines and which proposed the existence of "wind turbine syndrome" (Pierpont, 2009). This book coincided with an increase in community opposition to wind turbines in North America, where health impacts were cited as a reason to stop wind turbine development (Colby, 2008; Knopper & Ollson, 2011a). Case definitions for wind turbine syndrome have been proposed (McMurtry, 2011; McMurtry & Krogh, 2014), which have received criticism for lack of validity and specificity (R. McCunney, Morfeld, Colby, & Mundt, 2015a). The biological plausibility of the vestibular symptoms of wind turbine syndrome within the framework of present knowledge has been questioned (R. V. Harrison, 2015). A group of researchers previously proposed "vibro-acoustic disease" as a means by which wind turbines could harm humans (Branco & Alves-Pereira, 2004), although their research and disease definition has not been recognized or accepted by mainstream science (Chapman & St George, 2013; Knopper & Ollson, 2011b).

Wind turbine sites tend to be in rural areas, where value is placed on 'peace and quiet' (Jeffery et al., 2014a). These rural areas bear the potential harms from wind turbine use and social, economic and political factors affect how they are supported in a given community. Pre-existing negative attitudes towards renewable energy also impact community acceptance of wind turbines (Pohl, Gabriel, & Hübner, 2018). Community support for wind turbines may be higher if economic incentives are given—although the relationship is unclear (Onakpoya et al., 2015)—or if sufficient political or community consultation is provided (Anderson, 2013). Collaborative planning efforts could impact the amount of annoyance and perceived health effects experienced by a community (Christidis & Law, 2012a). Including the rural perspective in renewable energy initiatives could be important, as urban residents may differ from rural residents in their preferences for renewable energy projects (Bergmann, Colombo, & Hanley, 2008), such that the acceptability of renewable energy initiatives can vary by region. In Ontario, a lack of procedural justice elements, particularly in influencing where wind turbines are sited, has impacted support for wind turbines (Walker & Baxter, 2017b).

Some researchers have argued that concerns and opposition against wind turbines are communicated socially through a contagion effect (Chapman, St. George, Waller, & Cakic, 2013; Chapman, 2014)—where media coverage of wind turbines includes 'fright factors' (Deignan, Harvey, & Hoffman-Goetz, 2013a)—and that the perception that they are harmful derives from exposure to the idea that they are harmful with a potential nocebo effect (Crichton & Petrie, 2015a; Tonin, Brett, & Colagiuri, 2016a). The role of negative attitudes or expectations in inducing annoyance or symptoms is unclear, but may influence the perception of noise (Taylor, Eastwick, Wilson, & Lawrence, 2013), where a previous negative perception of wind turbines has been associated with annoyance in those who were strongly annoyed by them (Pohl et al., 2018). Other researchers noted that a "plethora of factors" impacted the social response to wind turbines (Songsore & Buzzelli, 2015) and that multiple frames could be used to assess their risks and benefits.

Wind turbines as a health issue have attracted community concern and can be contrasted against other environmental health issues that have caused community opposition including aggregates (quarries), energy-from-waste facilities, electromagnetic fields, landfills, and nuclear facilities. Community groups opposed to wind turbines have arisen in multiple communities where wind turbines have been developed or proposed (Baxter, Morzaria, & Hirsch, 2013). Other sources of community noise can also result in community opposition, although most have not focused on the health impacts of noise. Some have categorized opposition against wind turbines as a form of NIMBYism, which stands for "not-in-my-backyard", where groups oppose development in areas that are close to where they live, work or play (Petrova, 2013), although in the context of wind turbines the situation may be more complex than pure NIMBYism (Devine-Wright, 2005b; Petrova, 2013).

Public health organizations have been brought into debates on the potential impacts of wind turbines on human health due to their role in health protection, chronic disease prevention, population health status assessment, and health promotion (Knopper & Ollson, 2011a; Naylor, 2003). Public health has a mandate to protect the health of the population from health hazards, and public health organizations at the local, provincial/state and national level have examined and reported on the potential for wind turbines to impact human health (Chief Medical Officer of Health Ontario, 2010; Council of Canadian Academies, 2015). Public health organizations can include local or regional health units or authorities, provincial or state organizations, federal agencies, non-governmental organizations (NGOs) that focus on specific public health or population health issues, as well as academic centres and public health associations.

### 2.6 Characterization of the Human Health Risk from Exposure to Wind Turbines

Part of the process of risk assessment is the characterization of the risk posed by a substance or issue to human health. The United States of America's Environmental Protection Agency (US EPA) has developed a model of human health risk assessment for environmental human health issues that includes four steps: hazard identification, dose-response assessment, exposure assessment, and risk characterization (US Environmental Protection Agency, 2015). In this model, risk characterization draws upon the results of the preceding three steps to describe the extent to which an issue poses a human health threat. If controversy exists over whether the assessments done in this process adequately reflect the true risk to human health, individuals can derive different risk characterization conclusions depending on what factors they include in the dose-response or exposure assessment. The social amplification of risk framework provides a theoretical basis to understand how 'risk events', like the development of a wind turbine farm, can be have their perception of risk attenuated or intensified (Pidgeon & Henwood, 2010).

When a risk assessment is conducted, the results need to be communicated to the communities that may be exposed to the environmental issue. If the perception or characterization of the risk by community members differs from that of the regulatory or scientific perspective, then a disagreement with the risk assessment process, distrust of risk communication messages or outrage may occur (Sandman, 1987; Sandman, 1993). In communities where outrage over an environmental health issue exists, the concern about the risk can be communicated socially (Crichton & Petrie, 2015a). Some researchers have assessed the concept of social contagion for the potential negative health effects of wind turbines (Crichton et al., 2014), where community concern over health impacts may increase the risk of perceived health effects due to psychogenic (nocebo) causes (Crichton, Dodd, Schmid, Gamble, & Petrie, 2014; Crichton et al., 2014; Crichton & Petrie, 2015b). It is difficult to isolate the role of negative expectations from wind turbine noise exposure from the impact of the noise itself, although experimental evidence suggests that expectations can explain some of the perceived symptoms (Crichton et al., 2014; Tonin et al., 2016a) and annoyance (Pohl et al., 2018) reported from wind turbine exposure.

Understanding the evidence used to support the perspective that wind turbines have negative potential health impacts in a community could inform future risk communication strategies, given that if community groups and public health organization cite different types of evidence, interpret the same evidence differently or characterize the risk differently, then this could impact their perception of risk and the amount of trust they place in organizations who rely on communication strategies that characterize risk differently.

### 2.7 Concepts of Evidence for Public Health Issues

Evidence, in scientific terms, refers to studies or information that can be used to support a position or hypothesis. Scientific evidence generally refers to peer-reviewed sources. Other forms of evidence can be used outside of scientific debate, particularly in legal or lay arguments. To support epidemiologically claims of health effects from wind turbines requires scientific evidence, as public health and medicine relies on scientific evidence for decision-making. Not all evidence is equal, and multiple systems have been developed to evaluate or synthesize evidence so that its relative quality and impact can be compared (S. West et al., 2002), some specific to public health. An example of an evidence ranking system used by public health is the GRADE systematic approach (Grades of Recommendation, Assessment, Development, and Evaluation), which was designed to allow clinicians to make decisions based on the body of available evidence (Guyatt et al., 2008). Other systems for assessing evidence have been developed with a greater focus on public health (Jacobs, 2012; Rychetnik, Frommer, Hawe, & Shiell, 2002).

While publication in a peer-reviewed journal is typically needed for evidence to be considered reliable in a scientific debate, the robustness of the evidence may depend on the specific journal and peer-review process that is used. High quality peer-reviewed journals have a thorough peer-review process. Not every journal meets this standard, however, where some have less rigorous peer-review processes. In recent years, so-called predatory journals and many low quality journals have emerged which publish articles without adequate peer-review. "Predatory" journals are those which charge potential authors fees for publication and do not enact sufficient peer-review—these tend to aggressively recruit articles and provide a forum for researchers to publish without regard to the quality of the research (Beall, 2013). A list was created of known predatory journals that help audiences know whether articles are appearing in a less reputable journal (Beall, 2012); however this list was no longer updated as of early 2017. Other organizations have maintained the existing list, but there has not yet been a concerted effort to create a definitive list of questionable publications. Documents that are published without an external peer-review process, such as presentations at conferences, grey literature like governmental reports, commentaries, or editorials may offer ideas and arguments about issues but do not typically get used as scientific evidence. Opinions, personal experience or anecdotes can be used in less formal situations as evidence but are not scientific.

Epidemiology tends to assess research articles and evidence sources based on study design and the quality of the source publication, but other disciplines have developed more formal methodologies to assess how information is used. Bibliometrics is a separate field of study related to the analysis of written materials like books, journal articles or other media through the application of statistical methods (De Bellis, 2014). Related fields of study include informetrics (which applies mathematical methodology to the study of information) and scientometrics (which uses statistical methods to assess scientific information (De Bellis, 2014). These fields can examine citations and produce metrics of research impact such as citation-based indicators (e.g., impact factor) and explore the structure of scientific knowledge (Cooper, 2015; De Bellis, 2014). Bibliometrics has begun to assess the changes in knowledge dissemination and citation afforded by the Internet (Cronin & Sugimoto, 2014). Bibliometric methods can be used to understand how scientific consensus is established about previously contentious scientific topics (Shwed & Bearman, 2010). Network approaches to bibliometrics can be used to assess citation networks and determine the centrality (impact) of individual citations (nodes) to the network (J. D. West & Vilhena, 2014). Researchers have used bibliometric methods to better understand the citation patterns in interdisciplinary HIV/AIDS research and explore the segmentation of specific research topics within or between certain disciplines (Adams & Light, 2014).

Examining the type of evidence that gets used in debates about the potential health impacts of wind turbines and their quality can help provide insight into where the actors (the different organizations by organization type) get their evidence, and whether they use similar evidence and interpret it differently or if they are drawing from different types of evidence to frame their arguments.

### 2.8 Social Network Analysis to Assess Online Wind Turbine Evidence Citation Patterns

Social network analysis is a methodology that applies graph theory to social actors like individuals or organizations, and creates a representation of the relationship between them (Scott & Carrington, 2011). Social network analysis looks at the relationships between nodes and their attributes. Networks can be uni-modal (where all nodes are equivalent) or have more than one mode (where each mode can represent different levels of organization, such as individuals versus groups (Scott, 2012)). Relationships between nodes in social network analysis are often called ties or links, and can be directed or undirected—meaning that the ties can be unidirectional from one node to another (e.g., a website linking another website), or that the ties between nodes does not have a direction (e.g., friendship between individuals (Scott & Carrington, 2011). Nodes can have many or few ties to each other, and the relative position of nodes within the network can be designated as core or peripheral.  Social network analysis was primarily used in sociology research until relatively recently, where other scientific disciplines have begun to use its methods in a variety of settings (Scott & Carrington, 2011), as follows. Public health researchers have applied social network analysis to models of communicable diseases to assess how a disease is transmitted within a community (Scott & Carrington, 2011). Social network analysis methodology has also been used to assess anti-community water fluoridation sentiment in online communities (Seymour, Getman, Saraf, Zhang, & Kalenderian, 2015). Other applications have included examining citation and author relationships in academic communities to assess where networks exist, and in investigating criminal networks (Scott, 2012).

Due to the amount of data required and the complexity of its mathematical methods, dedicated software packages are often used when conducting social network analysis. Several different software platforms are commonly used, with many of them being freely available to researchers. Certain software programs focus on specific aspects of social network analysis, such as large data sets or the visualization of results. The choice of the specific software program may depend on the goals of the research.

## Chapter 3: Goals and Objectives

### 3.1 Study Rationale

The issue of wind turbines impacting human health has generated concern within specific communities with resultant investigation by academics and public health organizations. Evidence is cited by community groups, academic organizations, environmental non-governmental organizations (eNGOs) and public health organizations to support positions about the potential health effects of wind turbines. It is unclear what type of evidence is used to support these positions and whether the same evidence is cited by the different types of groups. Therefore, this thesis assessed the types of evidence cited by the websites of Canadian community groups, academic organizations, eNGOs and public health organizations that held a position on the potential health effects of wind turbines, and used social network analysis methodologies to examine how the citation patterns between organizations and evidence, as well as between organizations, differed by organization type to characterize citation patterns and assess for differences between organization types.

The thesis identified what evidence types were most frequently cited and classified the types of evidence used. It identified the quality of the evidence (as per a hierarchical classification) used to support different positions on the potential harms of wind turbines on human health.

### 3.2 Research Objectives

The goal of this thesis was to examine whether and how community group websites that have a position on the potential human health effects of wind turbines differ in the type of evidence used to support claims of adverse health effects of wind turbines, compared to the type of evidence used by public health organization websites in addressing these concerns, and to assess the pattern of evidence source citations used by both types of organizations, by social network analysis.

To meet the above goal, the specific objectives of this thesis were to:

1. Determine the types of evidence cited by community groups, and by public health organizations, to support their respective positions on the potential health effects of wind turbines—where the types of cited evidence was further characterized into categories following an evidence hierarchy (Chapter 4); and
2. Assess the pattern of citations or links to the evidence used by community groups and public health organizations to characterize and interpret these patterns of evidence citation and to see whether and how these patterns differ between the two groups (Chapter 5).

## 3.3 Research Ethics Approval

In June 2016, Julie Joza (Senior Manager, Research Ethics, Office of Research, University of Waterloo) was contacted as a preliminary first step. Discussion indicated that according to the University of Waterloo Office of Research Ethics decision-tree that, as the research involves publicly available data, the thesis was exempt from research ethics review.

# Chapter 4. Differences in Online Evidence Citation and Organization Citation Related to Wind Turbines and Human Health by Different Types of Organizations

## 4.1 Objective

The objective was to identify the types of evidence used by community group websites, and by public health organization websites, to support their respective positions on the potential health effects of wind turbines—where the types of cited evidence were further characterized into categories following an evidence hierarchy.

## 4.2 Methods

### 4.2.1 Approach

To determine what type of evidence was used to support an organization's position on the potential health effects of wind turbines, websites of community groups and public health organizations were identified using an Internet search strategy, and the webpages assessed with a data collection tool to gather information about the webpages and their ties to evidence sources and other organizations' websites. Qualitative data were collected from each organization's website by manually reviewing the website and the evidence cited, including the type and specific evidence sources cited, the citation of other organizations, and assessing elements of the website's structure using a research tool.

The two main groups of interest, community groups and public health organizations, were defined as follows:

- Community groups were defined as identifiable community groups or organizations with a stated advocacy position on wind turbines and human health, limited geographically to Canada.
- Public health organizations were defined as any public health units, provincial public health organizations and federal public health organizations, national quasi-governmental organizations like the National Collaborating Centre on Environmental Health or relevant research bodies that have addressed the health impacts of wind turbines, limited geographically to Canada.

These groups were identified through internet searches using specific search terms, limited geographically to Canada (including local, provincial and national organizations). Additional organizations were found by assessing the webpages and posted documents of organizations identified by the search for references or links to other organizations.

Based on the results of the initial search, two additional categories of organizations were added to the analysis to provide a broader perspective of evidence citation patterns:

- Environmental non-governmental organizations (eNGOs) were defined as a not-for-profit organization that focuses on environmental issues but includes a stated position on wind turbines and human health.
- Academic organizations were defined as a post-secondary or research-focused institution that has a position on the impacts of wind turbines on human health.

To identify the evidence used by those groups identified above, the websites of the specific groups were screened for posts or documents that referred to the health impacts of wind turbines. Data were collected using RefWorks 2.0 online citation database (http://www.refworks.com) and Microsoft Excel 2010 (Version 14.0.7195.5000).

#### 4.2.2 Search strategy

To identify Canadian organizations with webpages on wind turbines and health, an Internet search strategy was created in English and French. The intent of the search strategy was to identify all Canadian public health organizations and community groups that had publicly available webpages that discussed the potential human health impact of wind turbines.

For a website to meet the inclusion criteria, it had to originate from a Canadian organization from one of the previously described four categories and contain publically-accessible content (not gated by a password or requiring membership/joining a group) that discussed the potential effects of wind turbines on human health. The study was limited to Canadian-based sources to keep the scope focused and feasible, as well as to reduce potential cultural or political differences between countries with respect to the history of renewable energy and community opposition to it.

Websites were excluded from the analysis if they belonged to commercial interests or the wind turbine industry, due to their potential for conflict of interest. Websites that belonged to a specific person, such as an individual's blog or personal webpage, were excluded from analysis. Websites that were hosted on social media platforms like Facebook were also excluded from analysis due to privacy concerns and the potential for content to be unavailable to individuals who were not members of the group. The search strategy excluded any websites that were not in English or French, news websites, websites that lacked a discussion of the potential health effects of wind turbines (such as community group websites that focused exclusively on environmental concerns or property value concerns in their opposition to wind turbines), archived websites whose content was only available on Internet archiving services, academic publications, and political or governmental websites that were procedural in nature (i.e.,  meeting minutes, agendas, or deputations). Publicly available websites were assessed exclusively. Webpages that required registration or membership to view content were not assessed.

Organization webpages were identified from April 19 to May 16, 2017 using specific search terms in four Internet search engines. The search terms used were ("wind turbine" OR "wind farm" OR "wind energy") AND (Health OR Annoyance OR ill OR sick) AND (Canada). The search string was used on Google, Duckduckgo, Bing, and Yahoo.  To identify French language websites, a separate search with (Éoliennes AND santé AND Quebec) was performed in these same four search engines.

For all searches, the first 200 results were scanned for relevance (i.e.,20 pages search results containing 10 links per page were scanned). If new or relevant websites were identified in the final 20 results (i.e., on 19$^{th}$ or 20$^{th}$ page), scanning continued until no new or relevant results were found for two consecutive pages. Websites met the inclusion criteria if they: (1) represented an organization in Canada, and; (2) discussed wind turbines and potential health effects.

To identify comprehensively all public health unit webpages of relevance, a separate directed public health organization search was done using ("Jurisdiction Name" OR "Public Health Unit Name") AND "public health"  AND "wind turbine" on Google to identify additional public health organizations. To ensure all Ontario public health units were included, each of the 36 public health unit webpages in Ontario as listed on the Association of Local Public Health Agencies (ALPHA) website (www.alphaweb.org/) were directly evaluated for wind turbine related content through searching for "turbine" OR "wind" on their internal website search tools. Additional organizations were found by assessing the webpages or documents of community organizations identified by the search for references or links to other organizations.

#### 4.2.3 Assessing webpages

If the websites contained multiple sections or topics, only sections relevant to wind turbines and their potential human health impacts were included—this required assessing the structure of the website to identify any pages that explicitly discussed issues related to health (defined as "health" or terms related to health such as "illness", "disease", "sick") or related topics (defined as "noise", "infrasound", or "EMF"). In situations where the website included its own news section (excluding content directly copied or imported from the RSS feed of another website) with articles related to health, the first 20 pages of results were included if it was not possible to search specifically for news items with tags related to health.

#### 4.2.4 Data collection tool development

A data collection tool (Appendices:

Appendix 1: Identified Website Characteristics Data Collection Tool) and an accompanying data dictionary that defined each variable to be collected (Appendix 4: Data Dictionary for Website Characteristics Data Collection Tool) were created for gathering data from each of the identified websites to ensure that they were coded consistently (Krippendorff, 2012). The data of interest included website attribute data (such as the organization name, organization type, URL, Contact address, date of creation and date of update), and types of evidence cited on the website. Each website was assigned a unique ID number. Each organization's website had the peer-reviewed or grey literature evidence it cited recorded in a separate data collection tool (see Appendix 2: Cited Evidence Source Data Collection Tool and Appendix 5: Data Dictionary for Website Citation Details (Peer-reviewed or Grey Literature Evidence)), where for each evidence source cited, attributes of the source such as the category of evidence, whether it was peer-reviewed or not, whether quality concerns were found for the publication, whether the evidence appeared in a known predatory journal,  and the reference in American Psychological Association (APA) format were recorded. For grey literature evidence, the type of grey literature was further characterized by whether it was produced by an academic organization, community group, eNGO, health NGO, government, industry, public health organization or if its origin was unclear. Grey literature sources were also characterized by whether the grey literature source was a consultant report or not. Each cited reference was also assigned a unique ID number preceded by an "A". Additional data about the citations to other organizations from an organization's website were recorded in a separate section. The details of the collection tool variables are recorded in Appendix 3: Cited Website Data Collection Tool and in Appendix 6: Data Dictionary for Website Citation Details Tool (Other Organization).

An initial piloting of the variables on a number of the websites identified definitions that needed additional clarification in the data dictionary, and assessed the scope of the data collected by the variables in the data collection tool. The organization type variable required refinement to distinguish between different types organizations of interest, including community groups, public health organizations, environmental non-governmental organizations (eNGO) and academic institutions. In addition to the previously defined community group and public health organization, eNGO was defined as a body that focuses on environmental issues but includes a stated position on wind turbines and human health and academic organization was defined as a university or research-focused body that has a position on the impacts of wind turbines on human health; and other described organizations that do not meet the above criteria (excluding industry or commercial organizations).

Variables that were collected using the data collection tool to characterize the websites included organization name; organization type; position on wind turbines and human health on website (harmful, not harmful or unclear);-website URL; date of creation; date of last update; subsection on health present; subsection on noise present; subsection on EMF/infrasound present; whether links to other organizations were present; and contact address (if it was available). In addition, multiple variables were included in the data collection tool that indicated whether a specific type of evidence was cited (blogs, peer-reviewed articles, grey literature, news, social media (including specific platforms)).

For the website evidence citation data, a separate section of the tool recorded multiple fields to gather data on the evidence sources including the category of evidence, whether it was published in a known predatory journal, whether quality concerns for the publication were present, and the organization's attitude towards the evidence cited. To determine whether a source was published in a predatory journal, I checked whether the publication or its publishing organization was listed on Beall's list of Predatory Journals or Publishers. Quality concerns were identified with an Internet search of "[publication title] AND quality" and scanning first 30 results.

Each cited evidence source had a unique ID assigned and corresponding data collected on a separate citation data table. The peer-reviewed and grey literature evidence sourced on the webpages was classified into different categories, as per the data dictionary. The quality of the peer-reviewed evidence was characterized using a hierarchy of evidence for study design based on the system used by the Canadian Taskforce for Preventive Health Care (Canadian Task Force on Preventive Health Care, 2014). This hierarchy characterizes quality in descending order as follows:

1. systematic reviews of randomized controlled trials (RCTs);
2. RCTs with a minimum sample size of 30 in each arm;
3. systematic reviews of non-randomized controlled trials;
4. non-randomized controlled trials;

5. observational studies with controls (prospective and retrospective cohorts, case–control studies, studies with before-and-after designs);
6. observational studies without controls (cross-sectional, case series); and
7. ecologic studies and surveys.

I simplified the hierarchy of peer-reviewed publications in this subject setting in the cited evidence data collection tool to include experimental study with controls, experimental studies without controls, observational study with controls, cohort study and case-control studies(as subsets of observational studies with controls), observational study without controls, case reports (as a subset of observational studies without controls) and reviews. For the purposes of this chapter, cross-sectional surveys were characterised as a separate category and not included within observational studies without controls due to their frequent citation. I organized the data in this manner to reflect the type of evidence typically used in public health research, where randomized controlled trials are not often methodologically feasible. Non-peer reviewed sources, including grey literature, were characterized by type but not ranked further according to the hierarchy due to a lack of standardized means of ranking or comparing these evidence sources systematically. Books, book chapters, conference papers, editorials, letters and theses were included as separate categories. A table describing the different sources was created in Excel.

I recorded data on citations or links from one organization to another organization in the context of the potential human health effects of wind turbines using a cited organization data collection tool. This tool captured data on links to other organizations' websites that were outside of the initial list of identified websites, and assigned a unique ID number to each additional identified organization website. I further characterized the cited organization by a number of variables, including the organization name, URL, whether the organization was cited as supportive evidence for the original website's position, whether the organization was linked as an allied organization, organization type, whether the organization was non-Canadian, and whether the link was dead or led to the wrong page on an organization's webpage. The type of organizations included academic, community group, eNGO, government, industry, public health organizations and unclear classification.

The category of grey literature was subdivided into a number of subcategories based on authorship (academic, community group, eNGO, government, health NGO, industry, journal (non-peer-reviewed), public health organization and unclear origin). To account for some of the grey literature having been prepared by independent consultants or contractors for another organization, the variable 'consultant report' was used to flag grey literature that was contracted to a third party.

All identified websites that met the inclusion/exclusion criteria were recorded in an Excel datasheet. All identified websites were saved as PDF (using CutePDF software) and webpage (HTML) files for further analysis.

#### 4.2.5 Data Validation

A secondary data validation step was performed on a random subset of the identified websites by having two independent assessors review the websites and use the data collection tool to gather data from each of the sites. The results of the two analyses were compared using Cohen's Kappa to ensure consistency between the responses and to identify and correct any potential ambiguities in the definitions.

#### 4.2.6 Data Analysis Methods

All data were collected in Excel tables. Adjacency and affiliation matrices (Scott, 2013) were created in Excel for the relevant data and are described in further detail in Chapter 5. The data sheets were converted to CSV format for analysis in R. Dead links were coded as a single category.

All computations were done in Excel 2010 (Version 14.0.7195.5000, R version 3.4.0 (2017-04-21) Platform: i386-w64-mingw32/i386 (32-bit), or R Studio Version 1.1.383 using the functionalities of R with additional modules added to R and R Studio to permit further characterization of the data. The psych, plyr, and dplyr modules were loaded into R Studio and used to allow counts and categorization of the collected data by variables like group type, and for hypothesis testing by group variables and logistic regression by group variables. Analysis of academic organization and eNGO data was provided for contrast in the descriptive analysis, however they were excluded from detailed statistical analysis due to the small number of websites in both of these group types. Excel and R were used to create counts of the website variable results, including:

- number of websites;
- number of websites by organization type (group type)
- date of website creation
- date of last update
- total number of unique evidence sources cited
- mean number of evidence sources cited (compared against mode and median) for each organization type
- comparison of evidence source citation counts by organization type
- counts of evidence source citation by evidence source type; and
- comparison of evidence source citation counts for each evidence source type by organization type.

The proportion of websites that contained specific website features for each type of organization was calculated using R. Means and counts were also calculated in R.

Differences in mean counts for variables between community groups and public health organizations were compared using t-tests in R. Differences in proportions for categorical variables between community groups and public health organizations were compared using Pearson chi-squared tests in R. Note this hypothesis testing for differences excluded academic and eNGOs due to the small numbers of those types of organizations in the data. Logistic regression was used in R to explore whether categorical website characteristic variables, or citation variables, were associated with whether a website was from a community group or public health organization.

Counts of evidence citations by evidence type for the organization types and proportions with means and 95% confidence intervals by variable type were calculated. I counted the number of links to other organizations on the websites for each website and I calculated the mean number of links per website. The linked organization data was further characterised by cited organization type and counts and proportions were calculated by organization type. The organization citation data were further characterized by whether they were non-Canadian organizations, cited as supportive evidence or included as allied organizations. The number of dead or wrong links was counted individually and by organization type.

Multiple logistic regression was performed to assess for differences in website characteristics between community groups and public health organizations, where the website characteristic variables that were significant from chi-squared testing were placed in a multiple logistic regression model in R. As the initial model generated from all the variables was not statistically significant, variables were then pruned in a step-wise manner. The initial (non-significant) model used organization type as the outcome and website characteristics as independent variables: 'Social Media Any', Facebook, Twitter, 'blogs cited', 'News section', 'Personal account', video, 'contact details', 'News cited', and 'Other social media'.

## 4.3 Results:

### 4.3.1 Search Strategy Results

From the English Google search, over 1,390,000 results were found, of which the first 200 were scanned for relevance. From the French Google search, 212,000 results were found and the first 200 scanned. From the Bing search, over 37,900 results were found, of which the first 200 results were scanned. From the Yahoo search, over 3,250,000 results were found, of which the first 210 results were scanned. Additional websites were not found after the approximately 120$^{th}$ result.

A total of 67 websites were identified that met the inclusion criteria. Of these, 2/67 (3%) were academic organizations, 6/67 (9%) were eNGOs, 18/67 (27%) were public health organizations and 41/67 (61%) were community groups. Out of the total 67 organizations, 38 were identified with the broad search strings: 7 public health organizations, 24 community groups, 5 environmental NGOs and 2 academic organizations. This was complemented by the directed search strings by jurisdiction, which yielded 11 more public health organizations, 17 more community groups and 1 more eNGO.

Some of the public health organization websites (11/18; 61%) were difficult to find when searching via Internet search engines—meaning that they were found only with the directed search by jurisdiction, compared to 17/41 (41%) of community group websites. French language websites were uncommon, with 2/67 websites found in the French language search

### 4.3.2 Website Characterization Results

The position each organization held on the human health impacts of wind turbines were as listed in Table 1 below. The issue of the potential human health effects from wind turbines showed a contrast between the organization types. Most of the 67 included Canadian organization websites were from community groups (41/67; 61%) and of these, the majority (39/41; 95%) characterized wind turbines as harmful to human health. This is in contrast to the other types of organizations, where 13/18 (72%) of public health organization websites characterized wind turbines as not harmful to human health, with the remaining 5/18 (28%) not taking a clear position on this characterization. Both of the academic organization websites characterized the relationship between wind turbine exposure and adverse human health effects as unclear, whereas the eNGO websites all (6/6; 100%) stated that wind turbines do not harm human health. For the different organization types, only community groups took the position that wind turbines are harmful to human health. Using chi-squared testing, there was a significant difference between public health organizations and community groups on the position on wind turbines and human health ($\chi$-squared = 50.689, df = 2, p-value = 9.838e-12 ).

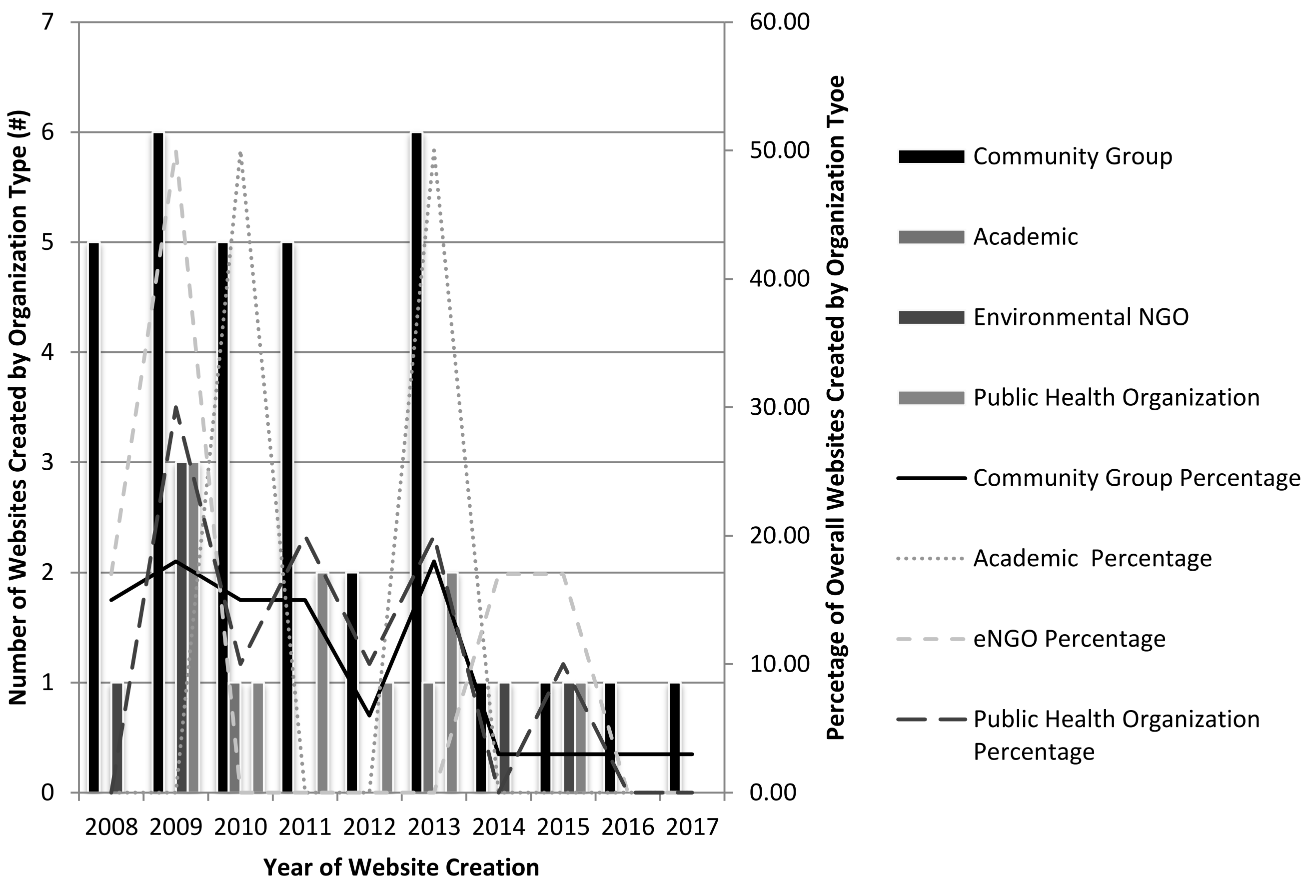
**Table 1.** Position on wind turbines and human health by organization type for the 67 Canadian organization websites with content on wind turbines and human health

| Organization Type (n) | Position on Wind Turbines and Human Health | | |
|---|---|---|---|
| | Harmful | Not harmful | Unclear |
| Academic (2) | 0/2 (0%) | 0/2 (0%) | 2/2 (100%) |
| Community Group (41) | 39/41 (95.1%) | 1/41 (2.4%) | 1/1 (2.4%) |
| Environmental NGO (6) | 0/6 (0%) | 6/6 (100%) | 0/6 (0%) |
| Public Health Organization (18) | 0/18 (0%) | 13/18 (72.2%) | 5/18 (27.8%) |

The websites were created from 2008 onwards, with the most recent being created in 2017. Most community group websites with known creation dates were created from 2008-2013 (29/33; 88%), and public health organizations websites with known creation dates were created from 2009-2013

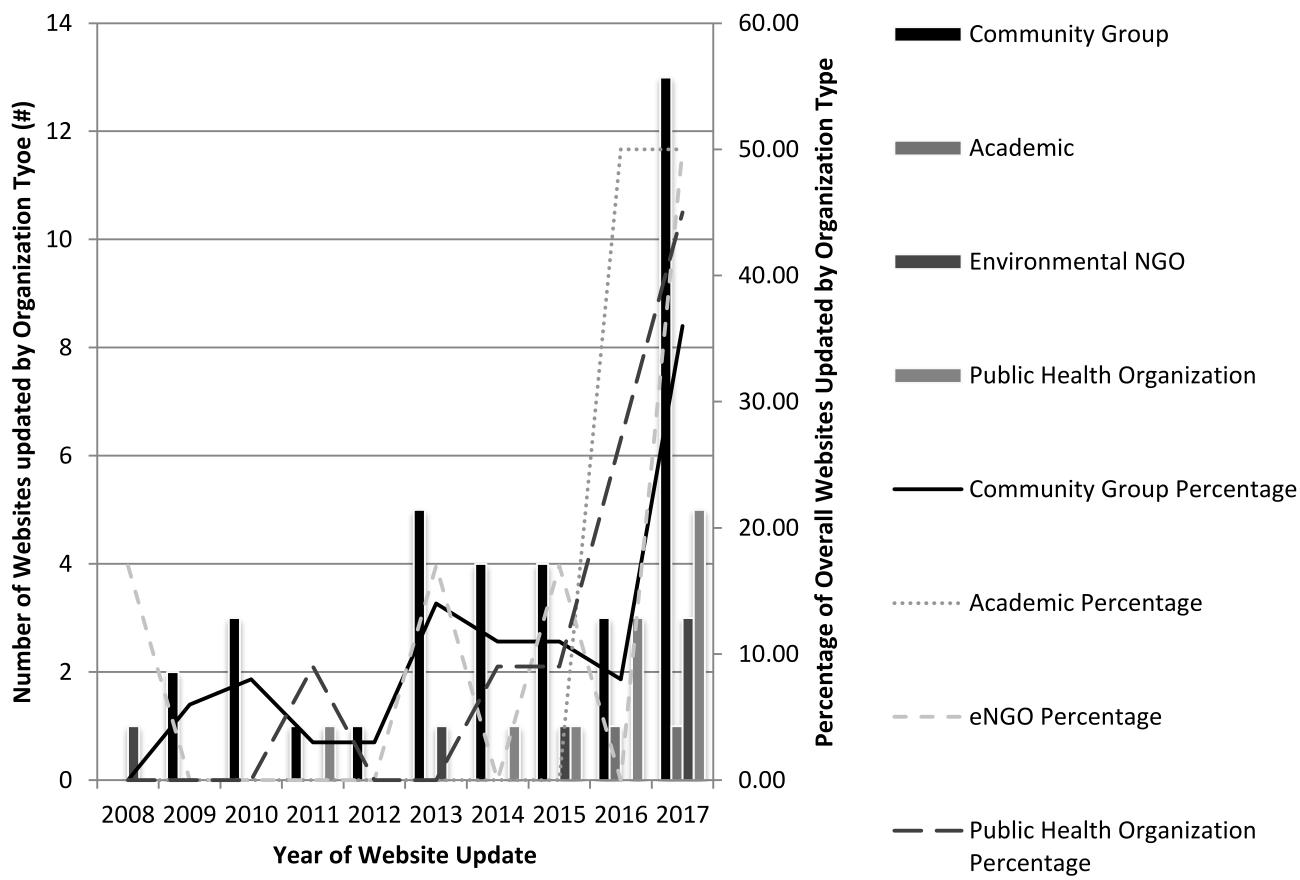
(8/10; 80%). The websites for eNGOs with known creation dates were created from 2008-2009 (4/6; 67%) or 2014-2015 (2/6; 33%), and the two academic websites were from 2010 and 2013. Sixteen websites did not have clear dates of creation available (8 of the 41 community groups (20%) and 8 of the 18 public health organizations (44%)). Generally, community group websites were created earlier than public health organizations (see Figure 1 below), as the median creation dates were different when testing with the Wilcoxon rank test (V = 45, p-value = 0.008433).

**Figure 1.** Website creation date by year by organization type for the 67 Canadian organization websites with content on wind turbines and human health




Figures 1 and 2 illustrate the number of websites created or updated per year for each of the organization types (bars) and the percentage of the overall number of websites that were created or updated in a given year (lines). The line component of the graph provides a representation of when the websites were either created or updated by organization type over time. Most websites (55/67; 82%) had a date of last update present. The two academic organization websites were updated in 2016 and 2017, respectively. While the range of years for last update went from 2009 to 2017 for community group websites, most with a known date of last update (29/36; 81%) were updated since 2013 and 13 out of 36 (36%) websites were last updated in 2017. The dates of last update for the eNGO websites ranged from 2008-2017, with 3/6 (50%) being updated in 2017 and the other three websites last updated in 2008, 2013 and 2015, respectively. The date of last update for public health organizations ranged from 2011-2017, with 8 out of 11 (73%) websites with known dates of last update being updated in 2016-2017( See Figure 2 below).

**Figure 2.** Year of website last update by organization type for the 67 Canadian organization websites with content on wind turbines and human health




The results of the dates of creation and last update suggest that the bulk of organization websites with content on wind turbines and human health were created within a five year period (2008-2013) and that most have been updated since 2016, but that proportionately fewer community group websites were updated recently in 2017 (where 13/36 (36%) community group websites were updated in 2017 compared to 5/11 (45%) public health organization websites, 1/2 (50%) of academic organization websites and 3/6 (50%) of eNGO websites). Most community group websites were last updated since 2013 (29/36; 81%). This is in comparison to academic organizations; where both websites were updated in 2016-2017, eNGOs, where 3/6 websites were updated in 2017; and public health organizations, where 8/11 websites with known dates of last update were updated in 2016-2017—although it was unclear when any substantive changes were last made. These results suggest that there was six year period (2008-2013) when websites were actively being created and that website content updates, at least with respect to community group websites, may be becoming less frequent.

The structure of websites varied by organization type (see Table 2 below), where community group websites were more likely to have news sections compared to other types of groups (44% compared to 0%, 33% and 6%) and were less likely to have social media components (39% compared to 50%, 83% and 78%). Most websites included a specific subsection on health (36/67; 54%), whereas 17% of community group and public health organization websites included subsections on noise and the impact of EMF/Infrasound (Table 2). Public health organization websites were more likely to have a social media component and community groups were more likely to have a news section on their websites. There was no significant difference in the presence of a health, noise, or EMF/infrasound section between community group and public health organization websites. The observed structural differences in the presence of news or social media on the organizations' websites may reflect strategies for engagement (social media use versus a news section).

**Table 2.** Structural characteristics of Canadian organization websites with content on wind turbines and human health by organization type

| Organization Type ( n= 67) | Academic (2) | Community Group (41) | Environmental NGO (6) | Public Health Organization (18) | χ –squared test between community group and public health organization (p value)* *df =1 |
|---|---|---|---|---|---|
| Subsection on Health present | 2 (100%) | 22 (54%) | 3 (50%) | 9 (50%) | 0.067 (0.80) |
| Social Media Component Present | 1 (50%) | 16 (39%) | 5 (83%) | 14 (78%) | 7.52 (0.0061) |
| News section present | 0 (0%) | 18 (44%) | 2 (33%) | 1 (6%) | 8.42 (0.0037) |
| Noise subsection present | 2 (100%) | 7 (17%) | 2 (33%) | 3 (17%) | 0.0015 (0.97) |
| EMF/Infrasound Subsection present | 1 (50%) | 7 (17%) | 1 (17%) | 3 (17%) | 0.0015 (0.97) |

Although the website characterization tool did not characterize the specific news sections in depth, it appeared that the news sections on community group websites linked to posts on other community group websites, external news articles and provided updates on local wind turbine projects. The public health organization, eNGO and academic organization websites appeared to not have a news section directly related to the wind turbines content—the news sections on these websites, when present, provided updates on the organization as a whole—and were not characterized as part of the wind turbine and human health websites.

The details of the social media elements present on the websites are shown in Table 3 below. Most organizations with social media components on their websites used both Facebook and Twitter. For websites with social media components, 15/16 (94%) community groups used Facebook and 12/16 (75%) used Twitter 1, compared to 14/14 (100%) public health organizations for both Facebook and Twitter, 5/5 (100%) eNGOs for both Facebook and Twitter, and 1/2 academic organizations for Twitter only (50%). Instagram use was uncommon (3/67) and Tumblr was not used (0/67). The predominant other social media platforms used were YouTube, Pinterest and Flickr. Public health organizations also tended to use other social media platforms more than other types of organizations (12/14 [86%] compared to 3/16 [19%] community groups, 3/5 [60%] eNGOs and 0/2 [0%] academic organizations, with a p-value of 0.0000014 compared to community group websites). Community groups and public health organizations differed significantly in the use of Facebook, Twitter and Other Social Media, where public health organization websites used these platforms more (see Table 3).

**Table 3.** The presence of social media platforms on Canadian organization websites with content on wind turbines and human health by organization type with χ-squared Testing

| Organization Type ( n= 67) | Academic (2) | Community Group (41) | Environmental NGO (6) | Public Health Organization (18) | χ –squared test between community group and public health organization websites (p value)* *df =1 |
|---|---|---|---|---|---|
| Facebook | 0 (0%) | 15 (37%) | 5 (83%) | 13 (72%) | 6.37 (0.012) |
| Twitter | 1 (50%) | 12 (29%) | 5 (83%) | 14 (78%) | 11.94 (0.00055) |
| Instagram | 0 (0%) | 1 (2%) | 1 (17%) | 1 (6%) | 0.37 (0.54) |
| Tumblr | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | N/A |
| Other Social Media (e.g. YouTube, Pinterest, Flickr) | 0 (0%) | 3 (7%) | 3 (50%) | 12 (67%) | 23.24 (0.0000014) |

Links to other organizations were found in the majority of websites, irrespective of the organization type both academic organizations had links to other organizations (2/2 [100%]), as did 39/41 (95%) of community groups, 4/6 (67%) eNGOs and 16/18 (89%) public health organizations. No significant difference were found between public health organizations and community groups with Pearson chi-squared testing (χ-squared = 0.76893, df = 1, p-value = 0.3805). Further specific analysis of website links is subsequently discussed in 4.3.4 Other Website Citation Results.

Contact addresses were found on the websites for the majority of organizations. Community group websites provided contact address information less frequently (15/41; 37%) than the other organization types (academic organizations [2/2; 100%], eNGOs [6/6; 100%], and public health organizations [17/18; 94%]). Public health organization websites were significantly more likely to have contact information present than community group websites ($\chi$-squared=16.871, df=1, p-value=4.001e-05). Although not mapped, it was noted that all of the academic organizations and eNGOs provided contact information located in urban areas (i.e., Toronto, Vancouver, Halifax, Hamilton), whereas the public health organizations' and community groups' contact details identified a mix of rural and urban areas.

Applying multiple logistic regression to determine whether website characteristics could predict if a website would be a community group or public health organization website, the final multiple regression model contained 'contact details', 'News cited', and 'Other social media' as independent variables. Table 4 provides the details of the coefficient estimates ($\beta$) and the odds ratios (ORs), where contact details had an OR of 32.85 and 'other social media' had an OR of 33.62—indicating that the presence of these variables were a strong predictor for a website being a public health organization website—and 'news cited' had an OR of 0.025—making it a predictor for a website being from a community group. The presence or absence of these features on a website would be fairly strong predictors of whether a website is from a community group or public health organization.

**Table 4.** Logistic regression coefficients and odds ratio for website characteristics to predict organization type (community group or public health organization) for Canadian organization websites with content on wind turbines and human health

| Coefficient | β Estimate | ORs | Standard Error | Z value | PR (>\|z\|) |
|---|---|---|---|---|---|
| Intercept | -2.87 | N/A | 1.46 | -1.97 | 0.049 |
| Contact Details | 3.49 | 32.85 | 1.55 | 2.26 | 0.024 |
| News Cited | -3.70 | 0.025 | 1.30 | -2.86 | 0.0043 |
| Other social media platforms | 3.52 | 33.63 | 1.30 | 2.70 | 0.0069 |

### 4.3.3 Evidence Citation Results

Each website was assessed for the types of evidence they cite with respect to human health and wind turbines (see

Table **5**). Overall, community group websites were more likely to cite blogs, news, video evidence and personal accounts/testimony than the other types of groups, where 76% of community group websites cited blogs compared to 0-17% for the other types of organizations' websites, news at 80% compared to 17-50% for other types of organizations' websites, video evidence at 56% compared to 0-17% for the other organizations' websites and personal accounts/testimony at 44% compared to 12% overall for the combined other websites. The proportion of websites that included any citation of grey literature was high for all organization types (2/2 academic organizations [100%], 29/41 community groups [71%], 5/6 eNGOs [83%] and 15/18 public health organizations [83%]) with no significant difference when comparing community group websites and public health organization websites using $\chi$ –squared testing. The use of personal account/testimony was present on the websites of 1/2 (50%) academic organizations, 18/41(44%) of community groups, 2/6 (33%) of eNGOs but not in any (0/18; 0%) of the public health organization websites.

Comparing how community group websites and public health organization websites cited different types of evidence found significant differences for the citation of blogs, news, video evidence, and personal accounts/testimony (Table 5). There was no significant difference in citation of evidence types between community group websites and public health organization websites for peer-reviewed literature or grey literature, as both organization types cited these types of evidence at similar proportions (Table 5).

**Table 5.** Evidence type citation by websites (n=67) by organization type for the Canadian organization websites with content on wind turbines and human health

| Evidence type cited | Organization Type (n) | | | | |
|---|---|---|---|---|---|
| | Academic (2) | Community Group (41) | Environmental NGO (6) | Public Health Organization (18) | χ –squared test between community group and public health organization websites (p value)* *df =1 |
| Blogs | 0 (0%) | 31 (76%) | 1 (17%) | 2 (11%) | 21.11 (4.33E-06) |
| Peer-reviewed Articles | 2 (100%) | 19 (46%) | 3 (50%) | 10 (56%) | 0.42 (0.51) |
| Grey literature | 2 (100%) | 29 (71%) | 5 (83%) | 15 (83%) | 1.05 (0.31) |
| News | 1 (50%) | 33 (80%) | 3 (50%) | 3 (17%) | 21.42 (3.69E-06) |
| Video evidence | 0 (0%) | 23 (56%) | 1 (17%) | 0 (0%) | 17.15 (3.45E-05) |
| Personal account/testimony | 1 (50%) | 18 (44%) | 2 (33%) | 0 (0%) | 11.37 (0.00075) |

Analysis of the specific categories of the conventional evidence sources cited by the different websites is presented in Table 6. The two academic organization websites had no statistically significant results in terms of mean citations of different types of written evidence. The eNGO websites did not cite the majority of written evidence categories; only the categories of cross-sectional survey, experimental study with controls, grey literature, observational study with controls and review had citations. The overall number of academic organization and eNGO websites was small, where none of their mean citations of written evidence sources were statistically significant at the 95% confidence level. When assessing community group and public health organization websites overall, the websites of both organization types had statistically significant mean citations for reviews, grey literature, and cross-sectional surveys, where the mean number of sources per organization were higher for public health organization websites. Community group websites also had statistically significant 95% confidence intervals for the mean citations per organization for conference papers, editorials, experimental studies with controls, letters, and observational studies with controls. The increased number of categories of evidence that community group websites were found to have means with statistical significance at the 95% confidence level could reflect the higher number of community group websites included in the analysis (n=41, compared to n=18 for public health organization websites).

When considering only evidence sources ranked higher on the hierarchy of evidence (experimental studies and observational studies including cohort studies and cross-sectional surveys), less than half of the citations from academic organization websites (91/263 (35%)), community group websites (68/379 (18%)), eNGO websites (3/29 (10%)) and public health organization websites (124/368 (34%)) met the higher rank criteria. If only community group websites and public health organization websites were assessed for citing higher ranked evidence, a significant difference was found ($t = -2.2976$, $df = 57$, p-value = 0.02527), with mean citations of 1.63 and 6.89 per website respectively, where public health organization websites cited higher ranked evidence more often.

**Table 6.** Mean citation of evidence category per website by organization type and citation counts by organization type with percentage of total evidence by organization type, with t-test results comparing public health organizations and community groups

| Evidence category (total citations = 1039) | Academic (n=2; citations = 263) | | Community Group (n=41; citations = 379) | | eNGO (n=6; citations = 29) | | Public Health Organization (n=18; citations = 368) | | t-test between community group and public health organization websites (p-value)* *df=57 |
|---|---|---|---|---|---|---|---|---|---|
| | Mean [95% CI] | Count (%) | Mean [95% CI] | Count (%) | Mean [95% CI] | Count (%) | Mean [95% CI] | Count (%) | |
| Experimental Study With Controls | 13.5 [-158.02, 185.02] | 27 (10.3%) | 0.098 [0.002, 0.19] | 4 (1.1%) | 0.2 [-0.26, 0.60] | 1 (3.4%) | 1.3 [-0.33, 2.89] | 23 (6.3%) | -2.34 **(0.023)** |
| Experimental Study Without Controls | 4 [-46.85, 54.85] | 8 (3.0%) | 0.1 [-0.01, 0.16] | 3 (0.8%) | 0 [N/A] | 0 (0%) | 0.3 [-0.08, 0.75] | 6 (1.6%) | -1.81 (0.076) |
| Cohort Study | 3.5 [-40.97, 47.97] | 7 (2.7%) | 0.07 [-0.01, 0.16] | 3 (0.8%) | 0 [N/A] | 0 (0%) | 0.2 [-0.18, 0.52] | 3 (0.8%) | -0.74 (0.46) |
| observational study with controls | 9.5 [-111.25, 130.25] | 19 (7.2%) | 0.4 [0.15, 0.68] | 17 (4.5%) | 0.2 [-0.26, 0.60] | 1 (3.4%) | 1.6 [-0.28, 3.39] | 28 (7.6%) | -1.90 (0.063) |
| observational study without controls | 6.5 [-76.07 89.07] | 13 (4.9%) | 0.05 [-0.02, 0.12] | 2 (0.5%) | 0 [N/A] | 0 (0%) | 0.6 [-0.03, 1.25] | 11 (3.0%) | -2.73 **(0.0083)** |
| Cross-sectional Survey | 8.5 [-61.40, 78.40] | 17 (6.5%) | 0.93 [0.06, 1.79] | 39 (10.3%) | 0.2 [-0.26 0.60] | 1 (3.4%) | 2.9 [0.17, 5.72] | 53 (14.4%) | -1.87 (0.067) |
| Review | 30 [-249.51, 309.51] | 60 (22.8%) | 2.9 [0.96, 4.75] | 117 (30.9%) | 0.5 [-0.38, 1.38] | 3 (10.3%) | 4.1 [0.22, 7.89] | 73 (19.8%) | -0.65 (0.52) |
| Thesis | 1 [-11.67, 13.67] | 2 (0.8%) | 0 [N/A] | 0 (0%) | 0 [N/A] | 0 (0%) | 0.1 [-0.06, 0.17] | 1 (0.3%) | -1.53 (0.13) |
| Book | 3.5 [-40.97, 47.97] | 7 (2.7%) | 0 [N/A] | 0 (0%) | 0 [N/A] | 0 (0%) | 0.1 [-0.06, 0.17] | 1 (0.3%) | -1.53 (0.13) |
| Book Chapter | 7 [-81.95, 95.95] | 14 (5.3%) | 0.05 [-0.02, 0.12] | 2 (0.5%) | 0 [N/A] | 0 (0%) | 0.4 [-0.18, 1.06] | 8 (2.2%) | -1.98 (0.052) |
| Case Control Study | 1 [-11.67, 13.67] | 2 (0.8%) | 0 [N/A] | 0 (0%) | 0 [N/A] | 0 (0%) | 0 [N/A] | 0 (0%) | N/A |
| Case Report | 3 [-35.09, 41.09] | 6 (2.2%) | 0.07 [-0.04, 0.18] | 3 (0.8%) | 0 [N/A] | 0 (0%) | 0.3 [-0.31, 0.86] | 5 (1.4%) | -1.025 (0.31) |
| Editorial | 0 [N/A] | 0 (0%) | 0.17 [0.01, 0.33] | 7 (1.8%) | 0 [N/A] | 0 (0%) | 0 [N/A] | 0 (0%) | 1.46 (0.15) |
| Letter | 0.5 [-5.88, 6.88] | 1 (0.4%) | 0.2 [0.06, 0.43] | 10 (2.6%) | 0 [N/A] | 0 (0%) | 0 [N/A] | 0 (0%) | 1.77 (0.082) |
| Conference Paper | 7.5 [-62.40, 77.40] | 15 (5.7%) | 1.2 [0.08, 2.31] | 48 (12.7%) | 0 [N/A] | 0 (0%) | 1.3 [-0.15, 2.82] | 24 (6.5%) | -0.14 (0.89) |
| Grey Literature | 32.5 [-253.39, 318.39] | 65 (24.7%) | 3.0 [1.63, 4.42] | 124 (32.7%) | 3.8 [-1.58, 9.24] | 23 (79.3%) | 7.3 [3.02, 11.65] | 132 (35.9%) | -2.53 **(0.014)** |

For all organization types, the most cited categories of evidence were grey literature followed by reviews, where these two categories of evidence comprised 47.5% of academic organization citations, 63.6% of community group citations, 89.6% of eNGO citations and 55.7% of public health organization citations. When assessing for differences in the citation of lower ranked evidence sources between community groups and public health organizations,  no significant difference was found using a t-test ($t = -1.3919$, $df = 57$, $p\text{-value} = 0.1694$), with mean citations of  7.61 and 13.6 per website respectively. This suggests that lower ranked evidence sources were cited at similar rates by the websites of both community groups and public health organizations.

Significant differences were found between community group websites and public health organization websites for the mean citations by evidence type of a number of evidence categories: experimental studies with controls, grey literature, and observational study without controls, where public health organization websites had higher mean citations (See Table 6). Several other categories of evidence were close to the 95% significance level but did not meet the criteria for statistical significance: book chapters, cross-sectional surveys, and observational studies with controls. Academic organization websites or eNGO websites were not compared to the other types of organizations due to the small number of included websites.

In terms of evidence sources, a total of 584 unique evidence sources were cited across all 67 of the websites. Overall, there were 1039 instances of evidence being cited. Out of these 584 evidence sources, 433 (74%) were cited once. The evidence sources were characterized by their respective category of evidence (see Table 7). Overall, grey-literature had the highest number of unique evidence sources (176/584; 30%), followed by reviews (121/584; 21%), and conference papers (63; 11%). When examined by organization type, the 2 academic organization websites cited 257 unique evidence sources, the 41 community group websites cited 175 unique evidence sources, eNGO websites cited 27 unique evidence sources and public health organization websites cited 262 unique evidence sources. The top 24 cited evidence sources overall are listed in Table 8. Comparing the top three most commonly cited evidence sources between community group websites and public health organization websites found that these sources differed completely (details are available in Appendix 7: Most Frequently Cited Evidence Sources by Organization Websites with Content on Wind Turbines and Human Health Overall and by Organization Type.) Further analysis of the patterns of citations is detailed in chapter 5.

**Table 7**. Counts and percentage of total unique evidence source by evidence categories for all Canadian organization websites with content on wind turbines and human health

| Category of evidence | n (%) |
|---|---|
| Experimental Study With Controls | 48 (8.2%) |
| Experimental Study Without Controls | 13 (2.2%) |
| Cohort Study | 13 (2.2%) |
| observational study with controls | 47 (8.0%) |
| observational study without controls | 22 (3.8%) |
| Cross-sectional Survey | 27 (4.6%) |
| Review | 121 (20.7%) |
| Thesis | 3 (0.5%) |
| Book | 8 (1.4%) |
| Book Chapter | 21 (3.6%) |
| Case Control Study | 2 (0.3%) |
| Case Report | 12 (2.1%) |
| Editorial | 3 (0.5%) |
| Letter | 5 (0.9%) |
| Conference Paper | 63 (10.8%) |
| Grey Literature | 176 (30.1%) |
| *Total* | *584* |

**Table 8.** Top 24 citations overall across all Canadian organization websites with content on wind turbines and human health by citation count (n)

| Reference (APA style) | n |
|---|---|
| Pierpont, N. (2009). Wind turbine syndrome. K-Selected Books. | 20 |
| Chief Medical Officer of Health Ontario. (2010). The potential health impact of wind turbines. | 19 |
| Nissenbaum, M. A., Aramini, J. J., & Hanning, C. D. (2012). Effects of industrial wind turbine noise on sleep and health. Noise and Health, *14*(60), 237. | 11 |
| Krogh, C. M., Gillis, L., Kouwen, N., & Aramini, J. (2011). WindVOiCe, a self-reporting survey: adverse health effects, industrial wind turbines, and the need for vigilance monitoring. Bulletin of Science, Technology & Society, *31*(4), 334-345. | 11 |
| Colby WD, Dobie R, Leventhall G, Lipscomb DM, McCunney RJ, Seilo MT, et al. Wind turbine sound and health effects. An expert panel review: American Wind Energy Association & Canadian Wind Energy Association; 2009. | 10 |
| Pedersen, E., van den Berg, F., Bakker, R., & Bouma, J. (2009). Response to noise from modern wind farms in The Netherlands. The Journal of the Acoustical Society of America, 126(2), 634-643. | 10 |
| Pedersen, E., & Persson Waye, K. (2004). Perception and annoyance due to wind turbine noise—a dose–response relationship. The Journal of the Acoustical Society of America, 116(6), 3460-3470. | 9 |
| Pedersen, E., & Waye, K. P. (2007). Wind turbine noise, annoyance and self-reported health and well-being in different living environments. Occupational and environmental medicine, 64(7), 480-486. | 9 |
| Paller, C., Bigelow, P., Majowicz, S., Law, J., & Christidis, T. (2013). Wind turbine noise, sleep quality, and symptoms of inner ear problems. In Toronto (ON): Symposia of the Ontario Research Chairs in Public Policy (p. 17). | 8 |
| Arra, I., Lynn, H., Barker, K., Ogbuneke, C., & Regalado, S. (2014). Systematic Review 2013: Association between wind turbines and human distress. Cureus, 6(5). | 8 |
| Møller, H., & Pedersen, C. S. (2011). Low-frequency noise from large wind turbines. The Journal of the Acoustical Society of America, 129(6), 3727-3744. | 8 |
| Salt, A. N., & Hullar, T. E. (2010). Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing research, 268(1), 12-21. | 8 |
| Salt, A. N., & Kaltenbach, J. A. (2011). Infrasound from wind turbines could affect humans. Bulletin of Science, Technology & Society, *31*(4), 296-302. | 8 |
| Thorne, B. (2011). The problems with "noise numbers" for wind farm noise assessment. Bulletin of Science, Technology & Society, 31(4), 262-290. | 8 |
| World Health Organization, & World Health Organization. (1999). Guidelines for community noise. WHO, Geneva. | 8 |
| Jeffery, R. D., Krogh, C., & Horner, B. (2013). Adverse health effects of industrial wind turbines. Canadian Family Physician, 59(5), 473-475. | 7 |
| van den Berg F, Pedersen E, Bouma J, Bakker R. WINDFARM perception. Visual and acoustic impact of wind turbine farms on residents. 2008 [cited 2009 Aug 27]; FP6-2005-Science-and-Society-20, Specific Support Action, Project No. 044628. | 7 |
| Krogh, C. M. (2011). Industrial wind turbine development and loss of social justice?. Bulletin of Science, Technology & Society, 31(4), 321-333. | 7 |
| Phillips, C. V. (2011). Properly interpreting the epidemiologic evidence about the health effects of industrial wind turbines on nearby residents. Bulletin of Science, Technology & Society, 31(4), 303-315. | 7 |
| McMurtry, R. Y., & Krogh, C. M. (2014). Diagnostic criteria for adverse health effects in the environs of wind turbines. JRSM open, 5(10), 2054270414554048. | 7 |
| Jakobsen, J. (2005). Infrasound emission from wind turbines. Journal of low frequency noise, vibration | 7 |

| | |
|---|---|
| and active control, 24(3), 145-155. | |
| Hurtley, C. (Ed.). (2009). Night noise guidelines for Europe. WHO Regional Office Europe. | 7 |
| Harrison, J. P. (2011). Wind turbine noise. Bulletin of Science, Technology & Society, *31*(4), 256-261. | 7 |

I assessed the additional recorded characteristics of websites' evidence source citations (Table 9). Out of the total 1039 instances of evidence being cited, 488 of these (47%) were of peer-reviewed sources. The proportion of peer-reviewed sources out of all evidence sources cited by community group websites was 34% (129/379) compared to 62% (162/263) for academic organization websites, 17% (5/29) for eNGO websites and 52% (192/368) for public health organization websites.

Although the proportion of websites that cited any peer-reviewed sources overall was similar between organization types, the proportion of evidence sources that was peer-reviewed was different between organization types. Predatory journals were cited only twice out of all cited sources (by community group websites)—with one additional unclear source cited by an academic organization website. The citation of evidence with identified quality concerns was more common, out of the total 1039 instances of evidence being cited, 172 of these (17%) were of sources with publication quality concerns. The proportion of sources having quality concerns being cited by community group websites was 109/379 (29%) compared to 13/263 (5%) for academic organization websites, 4/29 (14%) for eNGO websites and 46/368 (13%) for public health organization websites. The attitude towards the evidence cited was predominantly neutral (1020/1039 (98%)) across all citations. Negative attitudes towards the cited evidence source were seen in just 3.7% of community group website citations of evidence and 1.1% of public health organization website citations. Community group websites and public health organization websites (Table 9) had significant differences in the proportion of their evidence citations that were peer-reviewed ($\chi$-squared = 26.542, df = 2, p-value =1.724e-06), the proportion of evidence citations with identified publication quality concerns ($\chi$-squared = 30.019, df = 1, p-value =4.279e-08) and the websites' attitude towards the evidence citations (χ-squared = 5.3694, df = 1, p-value = 0.02049). Community group websites and public health organization websites had no significance differences in the citation of sources that appeared in known predatory journals (χ-squared = 1.9472, df = 1, p-value = 0.1629).

**Table 9**. Evidence citation characteristics by organization type for Canadian organization websites with content on wind turbines and human health

| Evidence Citation Characteristic | (n =1039) | Academic (263) | Community Group (379) | eNGO (29) | Public Health Organization (368) | Total | χ-squared test between community group and public health organization websites (p-value) |
|---|---|---|---|---|---|---|---|
| Peer-reviewed | Yes | 162 (62%) | 129 (34%) | 5 (17%) | 192 (52%) | 488 (47%) | 26.542 **(1.72e-06)** |
| | No | 85 (32%) | 223 (59%) | 24 (83%) | 150 (41%) | 482 (46%) | |
| | Unclear | 16 (6%) | 27 (7%) | 0 (0%) | 26 (7%) | 69 (7%) | |
| Predatory Journal | Yes | 0 (0%) | 2 (0.5%) | 0 (0%) | 0 (0%) | 2 (0.2%) | 1.9472 (0.16) |
| | No | 262 (99.6%) | 377 (99.5%) | 29 (100%) | 368 (100%) | 1036 (99.7%) | |
| | Unclear | 1 (0.4%) | 0 0 (0%) | 0 (0%) | 0 (0%) | 1 (0.1%) | |
| Publication Quality Concerns Present | Yes | 13 (5%) | 109 (29%) | 4 (14%) | 46 (13%) | 172 (17%) | 30.019 (**4.28e-08)** |
| | No | 250 (95%) | 270 (71%) | 25 (86%) | 322 (87%) | 867 (83%) | |
| Attitude to evidence | Negative | 0 (0%) | 14 (4%) | 0 (0%) | 4 (1%) | 18 (2%) | 5.3694 (**0.020)** |
| | Neutral | 263 (100%) | 365 (96%) | 28 (97%) | 364 (99%) | 1020 (98%) | |
| | Positive | 0 (0%) | 0 (0%) | 1 (3%) | 0 (0%) | 1 (0%) | |

#### *4.3.3.1 Grey Literature Citation*

Table 10 provides the details of the mean number of citations per website for each organization type by grey literature type. Community group websites cited grey literature from community groups predominantly with some academic and unclear source grey literature, whereas public health organization websites tended to cite predominantly grey literature from government, industry and public health organizations with some citation of academic and community group grey literature. Consultant reports were found most frequently in government and industry grey literature (66.1% and 63.5% respectively). When testing for differences in the citation patterns of grey literature between community group websites and public health organization websites through the use of t-tests, there were no statistically significant differences found.

**Table 10.** Grey literature citation mean citation by Canadian organization websites with content on wind turbines and human health with 95% confidence interval, consultant report proportion and t-test results comparing community group websites and public health organization websites

| Grey Literature evidence type | Academic | Community Group | eNGO | Public Health Organization | Consultant Report | T- test between community group and public health organization websites (p-value))* *df= 57 |
|---|---|---|---|---|---|---|
| Academic | 0 [0] | 0.32 [0.11, 0.52] | 0.67 [-1.05, 2.38] | 0.61 [0.04, 1.18] | 35.7% | -1.25 (0.21) |
| Community Group | 1.5 [-17.56, 20.56] | 1.32 [0.69, 1.94] | 0 [0] | 0.67 [0.05, 1.28] | 7.1% | 1.28 (0.24) |
| e NGO | 0 [0] | 0.20 [-0.03, 0.42] | 0.17 [-0.26, 2.91] | 0.17 [-0.02, 0.35] | 22.2% | 0.16 (0.87) |
| Government | 1 [-11.71, 13.71] | 0.63 [-0.12, 1.38] | 1.33 [-0.25, 2.91] | 1.78 [0.33, 3.22] | 66.1% | -1.59 (0.12) |
| Health NGO | 0 [0] | 0.07 [-0.04, 0.18] | 0 [0] | 0.11 [-0.05, 0.27] | 0 | -0.40 (0.69) |
| Industry | 1 [-11.71, 13.71] | 0.49 [-0.06, 1.04] | 0.5 [-0.38, 1.38] | 1.5 [0.39, 2.61] | 63.5% | -1.88 (0.065) |
| Journal | 0 [0] | 0.27 [0.07, 0.47] | 0 [0] | 0 [0] | 0 | 1.79 (0.079) |
| Public Health Organization | 1.5 [-17.56, 20.56] | 0.83 [-0.09, 1.74] | 1.33 [-0.50, 3.17] | 2.06 [0.98, 3.13] | 0 | -1.61 (0.11) |
| Unclear | 0 [0] | 0.15 [0.03, 0.26] | 0 [0] | 0.33 [-0.8, 0.75] | 23.1% | -1.21 (0.23) |

### 4.3.4 Other Website Citation Results

When assessing the citations of other websites by the 67 Canadian organization websites with content on wind turbines and human health (Table 11), academic organization websites had a higher mean number of websites cited by category compared to the other types of organization websites for all categories, except for academic organizations and unclear. Community group websites cited other community group websites most frequently, with a mean of 11.32 citations per website). Other types of websites were cited significantly by community group websites were government, industry and public health organizations, although the mean citation rates by community group websites were less than 1. The eNGO websites had no significant citation rates of other organization types, and the mean citation rates were 1 citation per website for government and public health organization websites and less than 1 for other types. Public health organization websites' mean citations of government (1.28) and other public health organizations (1.56) websites were significant at the 95% confidence level, otherwise the mean citations of other organization types' websites were insignificant.

**Table 11.** Counts and mean citations of other organization type websites by organization type for Canadian organization websites with content on wind turbines and human health

| Additional Cited Organization type (total= 184) | Citing Organization Type | Academic (n=2) | Community Group (n=41) | eNGO (n=6) | Public Health Organization (n=18) | T-test between community group and public health organization websites (p-value)* *df =57 |
|---|---|---|---|---|---|---|
| Academic (n=2) | # citations | 1 | 3 | 0 | 1 | 0.24 (0.81) |
| | Mean | 0.5 [-5.853, 6.853] | 0.0732 [-0.0100, 0.157] | 0 [n/a] | 0.0556 [-0.0617, 0.173] | |
| Community Group (n=124) | # citations | 50 | 464 | 4 | 8 | 2.94 **(0.0047)** |
| | Mean | 25 [-279.949, 329.949] | 11.317 [6.397, 16.238]* | 0.667 [-0.604, 1.938] | 0.444 [-0.0139, 0.903] | |
| eNGO (n=7) | # citations | 2 | 1 | 3 | 2 | -1.06 (0.29) |
| | Mean | 1 [-11.706, 13.706] | 0.0244 [-0.0249, 0.0737] | 0.5 [-0.378, 1.378] | 0.111 [-0.123, 0.346] | |
| Government (n=22) | # citations | 7 | 10 | 6 | 23 | -3.47 **(0.0010)** |
| | Mean | 3.5 [-15.559, 22.559] | 0.244 [0.0742, 0.414] * | 1 [-0.327, 2.327] | 1.278 [0.411, 2.145] * | |
| Industry | # citations | 7 | 7 | 3 | 11 | -1.91 |

| | | | | | | |
|---|---|---|---|---|---|---|
| (n-=21) | Mean | 3.5 [-15.559, 22.559] | 0.171 [0.0313, 0.310] * | 0.5 [-0.378, 1.378] | 0.611 [-0.0525, 1.275] | (0.061) |
| Public Health Organization (n=5) | # citations | 12 | 26 | 6 | 28 | -3.41 **(0.0012)** |
| | Mean | 6 [n/a] | 0.634 [0.3724, 0.896] * | 1 [-0.327, 2.327] | 1.556 [0.959, 2.152] * | |
| Unclear (n=3) | # citations | 1 | 2 | 1 | 0 | 0.944 (0.349) |
| | Mean | 0.5 [-5.853, 6.853] | 0.0488 [-0.0201, 0.118] | 0.167 [-0.262, 0.595] | 0 [n/a] | |

Community group websites and public health organization websites had significant differences in the mean citation rates for community group websites, government and public health organizations—where community group websites were more likely to link to other community group websites; and public health organizations websites were more likely to link to government or public health organization websites (Table 11).

**Table 12.** Links to other websites by organization type and citation characteristics for the Canadian organization websites with content on wind turbines and human health

| Group type (n) (total links) | Linked Organization Type | n (%) | Cited as supportive evidence (%) | Cited as allied organization | Non-Canadian organization |
|---|---|---|---|---|---|
| Academic (2) (total links: 80 mean links per website: 40) | Academic | 1 (1.3%) | 0 (0%) | 0 (0%) | 1 (100%) |
| | Community Group | 50 (62.5%) | 0 (0%) | 0 (0%) | 7 (14%) |
| | Environmental NGO | 2 (2.5%) | 0 (0%) | 0 (0%) | 0 (0%) |
| | Government | 7 (8.8%) | 0 (0%) | 0 (0%) | 1 (14%) |
| | Industry | 7 (8.8%) | 1 (14%) | 0 (0%) | 4 (57%) |
| | Public Health Organization | 12 (15%) | 7 (58%) | 0 (0%) | 1 (8%) |
| | Unclear | 1 (1.3%) | 1 (100%) | 0 (0%) | 0 (0%) |
| Community Group (41) (total links: 513 mean links per website: 13 ) | Academic | 3 (0.6%) | 2 (67%) | 0 (0%) | 0 (0%) |
| | Community Group | 464 (90.4%) | 83 (18%) | 147 (32%) | 128 (28%) |
| | Environmental NGO | 1 (0.2%) | 0 (0%) | 1 (100%) | 1 (100%) |
| | Government | 10 (1.9%) | 4 (40%) | 0 (0%) | 0 (0%) |
| | Industry | 7 (1.4%) | 2 (29%) | 0 (0%) | 2 (29%) |
| | Public Health Organization | 26 (5.1%) | 11 (42%) | 0 (0%) | 4 (15%) |
| | Unclear | 2 (0.4%) | 0 (0%) | 0 (0%) | 1 (50%) |
| Environmental | Academic | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |

| | | | | | |
|---|---|---|---|---|---|
| NGO (6) (total links: 23 mean links per website: 4 ) | Community Group | 4 (17.4%) | 2 (50%) | 0 (0%) | 2 (50%) |
| | Environmental NGO | 3 (13.0%) | 1 (33%) | 0 (0%) | 0 (0%) |
| | Government | 6 (26.1%) | 6 (100%) | 0 (0%) | 2 (33%) |
| | Industry | 3 (13.0%) | 2 (67%) | 0 (0%) | 0 (0%) |
| | Public Health Organization | 6 (26.1%) | 5 (83%) | 0 (0%) | 0 (0%) |
| | Unclear | 1 (4.3%) | 1 (100%) | 0 (0%) | 1 (100%) |
| Public Health Organization (18) (total links: 73 mean links per website: 4) | Academic | 1 (1.4%) | 1 (100%) | 0 (0%) | 0 (0%) |
| | Community Group | 8 (11.0%) | 6 (75%) | 0 (0%) | 6 (75%) |
| | Environmental NGO | 2 (2.7%) | 2 (100%) | 0 (0%) | 2 (100%) |
| | Government | 23 (31.5%) | 20 (87%) | 0 (0%) | 4 (17%) |
| | Industry | 11 (15.1%) | 10 (91%) | 0 (0%) | 6 (55%) |
| | Public Health Organization | 28 (38.4%) | 23 (82%) | 0 (0%) | 2 (7%) |
| | Unclear | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) |

When assessing whether other organizations' websites were being linked as supportive evidence for the organization's position on its website on wind turbines and human health effects (**Table 12**), academic organization websites linked to public health organization websites as supportive evidence over the half of the time (7/12 [58%]) when they were cited, and industry rarely (1/7 [14%]). Community group websites linked to other community groups as supportive evidence infrequently (83/464 [18%]). Community group websites linked to other organization types less often but these links were more likely to be supportive evidence; where links to academic organizations were as supportive evidence for 2/3 links (67%), government 4/10 links (40%), industry 2/7 links (29%), and public health organizations 11/26 links (42%). The eNGO websites linked to other organizations' websites as supportive evidence frequently, with all (6/6) government links being cited as evidence (100%), public health organization linked as evidence in 5/6 links (83%), industry linked as evidence in 2/3 links (67%), community groups linked as evidence in 2/4 links (50%) and eNGOs were linked as evidence in 1/3 links (33%). Most public health organization website links to other organizations were as supportive evidence, such as academic (1/1 links [100%]), eNGO (2/2

[100%]), industry (10/11 [91%]), government (20/23 [87%]), public health organization (23/28 [82%]) and community groups (6/8 [75%]).

Table 13 presents the overall counts and proportions for the characteristics for the links to other organizations by linked organization type for all links across all organization websites. Government (30/46; 65%) and public health organizations (46/72; 64%) were most often linked as supportive evidence, followed by academic organizations (3/5; 60%) and industry (15/28; 54%). Links to eNGO and community group websites occurred much less frequently as supportive evidence (3/8; 38% and 91/526; 17% respectively).

Only community group websites linked to other organization websites as allied organizations, and this was overwhelmingly (147/148 [99.3%]) to other community groups; 147/464 (32%) of links to other community groups were as allied organizations. There was a single instance of a community group linking an eNGO as an allied organization. Academic organizations, eNGOs and public health organizations did not cite explicitly other organizations' websites as allies. It was noted that larger provincial or national community group websites tended to include lists of allied local community groups as signatories or to direct visitors to find their local community group.

Non-Canadian organizations were cited 175 times across all websites (175/689; 25% of all lined organizations). Industry websites were the most likely to be non-Canadian (12/28; 43%), followed by eNGOs (3/8; 38%) and community groups (143/526; 27%). Community group websites linked to non-Canadian organizations most frequently, representing 27% (136/513) of links, a similar proportion to public health organization websites at 27% (20/53). Academic organization and eNGO websites linked to non-Canadian organizations less frequently, at 18% (14/80) of links and 22% (5/23) of links, respectively. The majority of these non-Canadian links, overall, were to community group and industry websites.

Dead links and moved (wrong) links were encountered infrequently, at proportions of overall links of 10% (67/689) and 12% (85/689) respectively. Most of these dead or moved links were to community group websites, at 81% (54/67) and 65% (55/85) respectively. These dead links could represent organizations that were no longer in operation or no longer maintain a website. Roughly a quarter of links to industry websites (7/28; 25%) and government websites (10/46; 22%), and half of links to eNGO websites (4/8; 50%) were wrong links, where the link was to the correct organization website, but resulted in an error message. Proportions of dead and wrong links were lower for links to public health organization websites and academic organization websites All linked organizations that were characterized as 'unclear' had dead links.

**Table 13.** Overall characteristics for links to other organizations from Canadian organization websites with content on wind turbines and human health and t-test results comparing community group websites with public health organization websites

| Linked Organization Type (n) (total 689) | Academic (5) | Community Group (526) | eNGO (8) | Government (46) | Industry (28) | Public Health Organization (72) | Unclear (4) | χ-squared between community group and public health organization websites (p-value)* *df = 1 |
|---|---|---|---|---|---|---|---|---|
| Cited as supportive evidence | 3 (60%) | 91 (17%) | 3 (38%) | 30 (65%) | 15 (54%) | 46 (64%) | 2 (50%) | 134.17 **(< 2.2e-16)** |
| Included as allied organization | 0 (0%) | 147 (28%) | 1 (13%) | 0 (0%) | 0 (0%) | 0 (0%) | 0 (0%) | 28.18 **(1107e-07)** |
| Non-Canadian Organization | 1 (20%) | 143 (27%) | 3 (38%) | 7 (15%) | 12 (43%) | 7 (10%) | 2 (50%) | 0.026 (0.87) |
| Dead Link | 0 (0%) | 54 (10%) | 0 (0%) | 4 (9%) | 2 (7%) | 3 (4%) | 4 (100%) | 0.71 (0.40) |
| Wrong Link | 0 (0%) | 55 (10%) | 4 (50%) | 10 (22%) | 7 (25%) | 9 (13%) | 0 (0%) | 29.28 **(6.27e-08)** |

Significant differences were found between the proportion of community group website links and public health organization website links to other organizations' websites as supportive evidence, where public health organizations are more likely to link as supportive evidence, the inclusion of other organizations' websites as allied organizations, where only community groups were found to have this characterization, and the presence of wrong links, where public health organizations were more likely to have wrong links than community groups (Table 13).

The multiple logistic regression model generated from using all the variables ('Group type', 'Cited as supportive evidence for position', 'Included as allied organization', 'Non-Canadian Organization', 'Dead Link', and 'Wrong link') was not statistically significant, and variables were pruned in a step-wise manner, beginning with 'Included as allied organization' as this variable was only found in one of the organization type's websites (community groups) and could potentially confound the results. Other variables were removed in turn, creating a significant logistic regression model to predict whether a website would be a community group or public health organization based on the presence of the citations of other websites as supportive evidence or wrong links (Table 14).

**Table 14.** Logistic regression coefficients and values for characteristics of website links to other organizations used to predict whether a website belonged to a public health organization or a community group

| Coefficient | β Estimate | OR | Standard Error | Z value | PR (>\|z\|) |
|---|---|---|---|---|---|
| Intercept | -4.08 | N/A | 0.35 | -11.72 | < 2e-16 |
| Wrong link | 1.84 | 6.30 | 0.38 | 4.80 | 1.59e-06 |
| Cited as supportive evidence for position | 3.28 | 26.54 | 0.37 | 8.91 | < 2e-16 |

Table 15 provides a list of the top 19 linked websites across all organizations, including the 67 organization websites that met the inclusion criteria and other websites. The most frequently cited websites between community group websites and public health organization websites differed in content and frequency, where only two websites appeared in both group types' respective top nine cited websites (Health Canada and National Wind Watch). The top nine websites cited by community groups were almost all (8/9 [89%]) other community group websites (see Table 16). The top nine websites cited by public health organizations included public health organizations (3), government websites (2), industry websites (2), and community group websites (2). All of the top nine organizations were provincial, national or international organizations—local organizations were cited less frequently. The specific patterns of citations are explored in Chapter 5.

**Table 15.** Top 19 websites across all Canadian organization websites with content on wind turbines and human health listed by citation count (n) and website name

| n | Website Name |
|---|---|
| 32 | Wind Concerns Ontario |
| 29 | National Wind Watch |
| 26 | Ontario Wind Resistance |
| 26 | Health Canada |
| 19 | The Society for Wind Vigilance |
| 19 | wind turbine syndrome |
| 17 | CMOH Ontario |
| 15 | EPAW |
| 14 | North American Platform Against Windpower |
| 14 | Ontario Ministry of the Environment |
| 13 | The WindAction Group |
| 9 | CanWEA |
| 8 | Wind Victims Ontario |
| 8 | IllWind Reporting |
| 7 | NCCEH |
| 7 | Mothers Against Wind Turbines Inc |
| 7 | Alliance to Protect Prince Edward County |

| | |
|---|---|
| 7 | Wainfleet Wind Action Group |
| 7 | MIDDLESEX-LAMBTON WIND ACTION |

**Table 16.** Top 9 Most frequently cited websites by Canadian community group websites and public health organization websites with content on wind turbines and human health (* indicates linked non-Canadian website)

| Community Groups (# websites citing) | Public Health Organizations (# websites citing) |
|---|---|
| Wind Concerns Ontario (29) | Health Canada (9) |
| Ontario Wind Resistance (26) | CMOH Ontario (9) |
| National Wind Watch (26)* | Ontario Ministry of the Environment (6) |
| The Society for Wind Vigilance (18) | National Collaborating Centre on Environmental Health (5) |
| Health Canada (15) | American Wind Energy Association (3)* |
| Wind Turbine Syndrome (15)* | CanWEA (3) |
| North American Platform Against Windpower (14) | Ministry of Energy and Infrastructure (3) |
| European Platform Against Windpower (14)* | National Wind Watch (2)* |
| The WindAction Group (12)* | Epilepsy Foundation (2)* |

## 4.4 Discussion:

The potential impact of wind turbines on human health has been a contentious issue in areas of Canada over the past decade (Knopper & Ollson, 2011a; Songsore & Buzzelli, 2015). I identified 67 different Canadian organization websites that provided content on the issue and evidence to substantiate their position on whether wind turbines were harmful or not. The website characterization tool provided a means to understand the characteristics of the websites for the four different types of organizations (academic organizations, community groups, eNGOs and public health organizations.) The Internet is a means of disseminating information to the public and organizations like public health units or community groups increasingly engage with the public on public health related issues like wind turbines and human health using websites or social media (Davies et al., 2014). Characterising how the information is provided on the organization's website and what evidence is used yielded insight into the similarities and differences between organization types in how they engage with information—where community group websites were found to use more untraditional sources of evidence like blogs, videos, and news articles, while public health organization, eNGO and academic organization websites used traditional evidence sources more often. This observed difference between community group websites and the websites of the other organization types may relate to a number of factors, including the purpose of the webpage (e.g. to organize community members for political action versus providing information on the topic for the public), institutional policies on what content is allowed on the organization's website, the availability of evidence or resources at the time the website content was published, and the level of training in science communications of the website content writer.

The observed high proportion of websites with news sections present on the community groups' websites may relate to the more focused topic areas on these websites, where any news section would provide updates concerning wind turbines. The presence of news sections may be a means for the community groups' websites to alert their communities about developments or new findings, particularly when the website lacked social media components. For the other types of organizations, the resources needed to curate and post to a news section may be pooled across the entire organization or handled by a dedicated communications team that is separate from the content expertise teams. Certain community group websites appeared to use RSS feeds from other larger community group organizations to supplement their own news sections, or reposted content directly from those websites. This could impact the frequency with which new information on the issue would appear on the website.

The higher proportion of social media components found on public health organization websites (78%) and eNGO websites (83%) compared to community group websites (39%; p-value = 0.0061) may be related to the comparative size of the organizations and recognition of the value of social media in public health or in environmental advocacy for community engagement and awareness.

The use of specific social media platforms was higher for public health organization and eNGO websites (72% and 83%% used Facebook respectively; 78% and 83% used Twitter) compared to the use within community group websites (37% used Facebook and 29% used Twitter). Public health organization websites had a higher proportion of use of other social media platforms as well, which includes sites like Youtube or Pinterest, when compared to community group websites. Given that social media websites themselves were not assessed in this research, it cannot be ruled out that some community group websites had corresponding Facebook, Twitter or other social media accounts related to their organization that were not seen when reviewing the content. Additionally, some community groups were established earlier than public health organizations, when social media may have been less frequently used. Maintaining a social media presence requires resources that smaller community groups may not have. Further research into social media use by organization websites could examine how much evidence is discussed and presented on those platforms with respect to public health issues like wind turbines and human health. This research could not capture any potential organizations whose online presence appeared solely through social media platforms, and this remains a potential limitation of the study.

The presence of social media components on the website does not provide information on how effectively or frequently they are used to convey information to the public about the potential health impacts of wind turbines. Many public health organizations have a social media presence as part of their broader communication strategy, where wind turbine health effects would be but one of many potential topics to discuss. It is unclear how many people would be exposed to the social media presence of each organization and whether postings about the potential health impacts of wind turbines are read and shared with others on social media.

The differences found between community group websites compared to the other organizations' websites in terms of structure and content may be due in part to organizational differences in size, funding, resources, website policies and staffing. The website structure itself can impact the use of evidence to support positions on the effects of wind turbines on human health, as the arrangement of information on the website can make it easier or more difficult to include specific types of information. For example, if a news section is present with the technical ability to allow for links to news stories from other organizations, it may be easier to include these sources as evidence. In contrast, if an organization has internal website content policies that limit the use of media like videos or links to external documents, this could impact the type of evidence that is cited. Organizations may have rules or best practice guidelines on website content that limit content that originates from other sites, including video or personal websites, as a means of protecting their content and maintaining consistency  The observed difference in the presence of contact information between community group websites and public health organization websites may reflect that community groups were often grassroots organizations composed of individuals within the community, who may not have a formal office, whereas the other organizations may be larger with a formal business location.

The websites' apparent position on whether wind turbines are harmful to human health aligned with the organization type, where most community group websites characterised wind turbines as harmful—the only organization type to do so—and most public health organization websites characterised wind turbines as not harmful. The characterization of wind turbines as harmful, not harmful or unclear with respect to human health may depend on whether the assessment included annoyance and indirect health effects as harms. It is important to note that the definition of 'harmful' used by organizations (or researchers) may vary, as some organizations may include annoyance or sleep disturbance as a harm, whereas others may categorize only direct health effects as a harm (Horner, Jeffery, & Krogh, 2011). Taking a broad definition of health for communities that includes individual and social well-being may be useful in conceptualizing the concerns expressed by organizations that view wind turbines as harmful (Baxter et al., 2013). The relative low evidentiary basis may also play into labelling the impact as 'unclear'. Comprehensive reviews of the evidence base for the potential human health impacts of wind turbines discuss found evidence to support adverse outcomes like distress, annoyance and potentially sleep disturbance, but were unable to draw conclusions about other potential health effects (Arra et al., 2014; Council of Canadian Academies, 2015; Onakpoya et al., 2015)

There was a virtual absence of community group websites that provided information to the public that wind turbines were not harmful to humans—this role appeared to be performed by eNGO websites and supported by public health organization websites. A potential explanation for this absence could be that only those with sufficient motivation, such as those who are concerned about their health while living near wind turbines, would create a group or website on this issue. Even if other individuals in a community had a different perspective on wind turbines and human health and posted that information on social media, blogs or individual websites, that information would have been excluded from analysis due to the exclusion criteria. The use of community group websites may be to inform other members of the community about the identified concerns and to encourage community members to engage with decision-makers or join the group. In the absence of collaborative planning processes in some regions (Christidis & Law, 2012a), grassroots opposition may be one of the few available means to address their local concerns. The high number of local community group websites opposed to wind turbines could be a symptom of profound community dissatisfaction with the development of wind turbine projects locally.

The results did demonstrate that language was a factor in identifying some of the relevant Canadian websites. If French language were excluded from the assessment, a provincial public health organization website and a Quebec community group would have been missed. It was noted that the French language community website identified by the French language search string was the sole community group that classified wind turbines as not harmful to human health.

Grey literature alone comprised 24.7% of academic organization citations, 32.7% of community group citations, 79.3% of eNGO citations and 35.9% of public health organization citations. The quality of grey literature evidence sources can vary drastically by document, as they are not peer-reviewed to ensure some external quality control. The quality of the review articles was also dependent on the underlying evidentiary base and the methods used in the review—while the review itself can be done using exacting standards, if the evidence base is lacking, the findings of their review may reflect the limitations of the available scientific data.

The results suggested that there were no significant differences in how health information was structured on the websites between public health organizations and community groups, such as the presence of subsections on health, noise and EMF/Infrasound. The most common observed structure was that all information on wind turbines and human health were pooled into a single page or section. In particular, when the issue of wind turbines and human health was part of a subset of a community group's concerns about wind turbines' adverse impacts, or when multiple environmental health issues were covered on a public health organization's website, a specific health impact subsection would be used. Roughly half of all organizations (other than academic organizations) had a subsection on health on their websites, and a proportionately equal low amount had noise or EMF/infrasound subsections (~17% for community groups and public health organizations). Although EMF, infrasound and low frequency noise have been identified as a concern by some researchers (Ambrose, Rand, & Krogh, 2012; Havas & Colling, 2011; Jeffery, Krogh, & Horner, 2013b; Jeffery, Krogh, & Horner, 2014b; Salt & Kaltenbach, 2011), others have dismissed these issues as unlikely to be a cause for the reported health effects (Jakobsen, 2005; Leventhall, 2006; McCallum et al., 2014).

Non-health adverse impacts of wind turbines, such as the effect on property values and environmental harms, were noted but not assessed on multiple websites. This is consistent with assessments of the reasons for opposition to wind turbines by community groups, where multiple factors including health impacts were of concern (Songsore & Buzzelli, 2015; Walker & Baxter, 2017a).

The issue of wind turbines and human health effects from a community perspective may have been most active online from 2008-2013, as fewer websites were created after 2013. While some community group websites appear extremely active on the issue, with regular updates, many others showed significantly less activity since 2016—with certain websites referring readers to follow provincial community groups as they would no longer be updating content. The reasons that websites stopped updating content are unclear, but could be related to changes on the provincial level (i.e., renewable energy policy changes) or at the local level (i.e., decisions about wind turbine development have concluded, gradual attrition of members from groups). The Premier of Ontario asserted that wind turbine projects would not be forced on unwilling communities, where many communities have listed themselves as unwilling hosts (Songsore & Buzzelli, 2015; Walker & Baxter, 2017b) —although more recent changes to Provincial procurement policies could increase the levels of opposition to wind turbine development in Ontario (Walker & Baxter, 2017a). In the context of academic organization, eNGO and public health organization websites, the issue of wind turbines and human health may be a small part of their website content and its review and updates may not be routine.

Addressing community concerns about wind turbines may require responding to multiple factors, including allowing communities to be involved with the planning process, having some community benefit from, or co-ownership of, the wind farm, and communication and openness about the development process (Breukers & Wolsink, 2007; Christidis & Law, 2012b; Devlin, 2005; Musall & Kuik, 2011; Wolsink & Breukers, 2010). Having renewable energy policies that take a top-down approach a limit local decision-making in wind turbine siting may have impacted community concern and opposition (Breukers & Wolsink, 2007). Community consultations about planned wind turbine projects and ongoing monitoring of noise may be additional means of addressing community concerns (Kurpas, Mroczek, Karakiewicz, Kassolik, & Andrzejewski, 2013).

Concerns about the potential health impacts of wind turbines have been voiced in several countries and websites were cited from the US, Australia and Europe (Langer, Decker, Roosen, & Menrad, 2018; Petrova, 2013; Tonin, Brett, & Colagiuri, 2016b). Research into the public perception of wind turbines has been performed in Canada, the UK, the USA and several European countries (Devine-Wright, 2005a). While the results of this thesis reflect a uniquely Canadian web-presence and may not be able to be extrapolated to other jurisdictions, there were a number of non-Canadian websites that were cited frequently by Canadian websites. It is unclear whether the results for the Canadian organization websites' structure and citations would be shared by other jurisdictions, given a different historical and political relationship with wind power. However, it was noted that several of the frequently linked non-Canadian organization websites were organizations opposed to wind turbines that allied with other non-Canadian community groups.

The role of geography—in particular urban versus rural impacts—on this issue was unclear. Contact information was significantly more likely to be found on public health organization websites compared to community group websites, and was present on all academic and eNGO websites. It was beyond the scope of the research project to map all of the organizations' known locations by community and test for differences in rurality measures between them. Many of the identified local public health organization websites represented predominantly rural areas, which could indicate that the issues of wind turbines and human health effects have been raised there. Given the lower availability of the community groups' contact information (only 37% had the information available), it is unclear whether the absence of contact details would allow for statistically informative analysis. Even when contact details were absent, the geographic area that the website represented was usually evident by the name or context of the organization. Mapping the geographic locations where the organizations are based and matching these locations to a measure of rurality like a rural index could potentially assess for the presence of a rural/urban divide on the issues and explore local social factors (Songsore & Buzzelli, 2015).

The larger number of community group websites compared to other types of organizations identified with content on wind turbines and human health may reflect the role of the websites in advocacy and outreach within the community and to decision-makers. The smaller number of identified websites that address the issue from an academic, public health or environmental perspective may be due to a number of factors, including the broad mandate of the organizations and the perceived importance of the issue compared to other public health or environmental issues. Additional reasons why other Canadian academic organization, eNGO and public health organization websites may not have content on the issue of wind turbines and human health include resource limitations, the restricted amount of evidence on this topic, and organizational decisions on communication strategies. The larger number of community group websites compared to public health organization websites could also be due to the structure of local public health organizations, where a given public health unit may cover multiple municipalities. A single public health organization may be responsible for multiple communities where wind turbines were a concern—which could partially explain why more community group websites were identified compared to public health organization websites.

Compared to the other types of organizations, public health organization websites were more difficult to find when using search engines. Public health organizations may be able to increase their websites' visibility on this issue by assessing their websites' structure and content and making changes to increase the public visibility of the sites in search results. Other types of organizations, specifically community groups and eNGOs, may have more flexibility than public health organizations in determining the structure of their websites which may impact their websites' visibility. Having website content that is difficult to find on Internet search engines may limits its effectiveness in risk communication strategies.

Content that addresses the heightened risk perception and fear that some communities experience through citing high quality research and effective risk communication strategies may help alleviate some of the concerns voiced by community groups (Roberts & Roberts, 2013). Specifically addressing the concerns raised by community members during the planning process may help increase community engagement and reduce uncertainty (Howard, 2015).

The broad types of evidence used by the different types of organization websites showed variation, where community group websites were significantly more likely to cite blogs, news, video evidence and personal accounts or testimony compared to public health organization websites. Public health organization websites never cited video or personal account/testimony and rarely cited blogs or news, which could be related to institutional website rules governing the type of content that can be included on the website or an avoidance of less-scientifically rigorous evidence sources. Blogs, videos and personal accounts or testimony may provide a more direct explanation of the issues surrounding wind turbines and human health in accessible language. The reliability of the anecdotal or subjective evidence sources may be low and could spread misinformation (Knopper & Ollson, 2011a). The use of these subjective sources to supplement the traditional peer-reviewed or grey literature sources could increase the accessibility and public engagement of the websites, but would also need to be vetted for privacy and legal issues.

Peer-reviewed articles and grey literature sources were commonly cited to a degree by all websites. Other than academic organizations, roughly half of all organizations' websites cited peer reviewed articles and the majority of all websites cited grey literature sources. The specific evidence sources cited varied significantly between community group and public health organization websites, where significant differences were found in the citation of experimental studies with controls, grey literature, and observational study without controls. The types of evidence that are highest on the hierarchy of evidence—such as experimental studies with or without controls, observational studies with or without controls, or cohort studies—represented a lower proportion of the evidence cited. This could relate to study designs like randomized control trials or experimental studies having less applicability for public health issues like environmental exposures, where blinding the study participants to an exposure may be unfeasible. For environmental exposures of public health concern, other study designs may be favoured in the hierarchy of evidence (Shelton, 2014) such as observational studies with plausibility designs (Victora, Habicht, & Bryce, 2004). The relative lack of highly ranked study design evidence on the subject of wind turbine noise on sleep and quality of life has been discussed in a previous systematic review and meta-analysis, where only 18 studies met their inclusion criteria, and these were all cross-sectional surveys (Onakpoya et al., 2015).

Overall, community group websites tended to cite conference papers, cross-sectional surveys, grey literature and reviews, and public health organization websites tended to cite conference papers, cross-sectional surveys, grey literature and reviews, as well as experimental studies with controls and observational studies with controls. The decision to cite peer-reviewed sources as evidence sources on the websites, compared to popular literature or the Internet (Knopper & Ollson, 2011), could relate to the levels of scientific literacy and knowledge of what sources are scientifically reliable by the website content creators. The relatively higher citation of experimental and observational studies with controls by public health organizations may reflect an attempt to use the highest quality evidence possible in their analyses, where public health organizations were significantly more likely to have higher quality evidence on their websites compared to community groups.

The results suggest that novel study designs may be needed for the subject of wind turbines and human health, as relatively few high quality study design studies were available to address raised concerns (Council of Canadian Academies, 2015). While further research into the health effects of wind turbines has been advocated (Horner et al., 2011), it has been recommended that future research adopt prospective cohort methodologies and not use the cross-sectional survey methodologies due to potential biases and little expected gain (R. J. McCunney et al., 2015). Specifically, studies are needed with objective outcome measures to understand the potential auditory and visual impacts of wind turbines on health (Onakpoya et al., 2015). Decisions by research funders and researchers on how to allocate resources and time to explore health hazards may impact the availability of research on the topic currently and in the future.

The reliance on grey literature and reviews may be an artefact of the low evidentiary basis for the issue and the absence of high quality studies on wind turbines and human health at the time the website content was created. It could also reflect the importance of certain key documents, like the

WHO's Night Noise Guidelines for Europe or Pierpont's Wind Turbine Syndrome, in the discussions of the topic (Hurtley, 2009; Pierpont, 2009). Another potential reason for the observed frequent citation of grey literature could relate to the accessibility of the documents compared to peer-reviewed articles. It was noted that some websites appeared to host pdfs of peer-reviewed articles on their websites, which may be a means of avoiding having the website audience pay or register with a publisher to read the article. The impact of pay-walls on the citation of peer-reviewed articles is unclear.

The common citation of grey literature may be problematic for supporting positions on a topic like wind turbines and human health. Grey literature itself can vary in quality, even independent of a peer-review process, as it is a broad category that includes papers written by content area specialists as well as documents created by individuals without subject matter expertise (Mahood, Van Eerd, & Irvin, 2014; Paez, 2017). Grey literature can be time-consuming to find but can reduce publication bias in systematic reviews on a topic (Paez, 2017). The type of grey literature cited by websites appeared to differ by organization, where academic organizations, environmental NGOs and public health organizations' websites tended to cite government, public health organizations and industry, while community group websites tended to cite documents from community groups. No significant differences were found between community groups and public health organizations, which could be due to the relatively smaller number of specific grey literature sources by website and insufficient sample size to detect differences. Further research into the use of grey literature may provide additional insight into how these forms of evidence are used to support positions in topics with a low evidentiary basis. Chapter 5 contains further discussion on the issues surrounding the frequent citation of grey literature by the organization websites.

Predatory journals were not significantly cited by any organizations, with only two citations by community groups and an additional unclear source cited by an academic organization. This could be due to a number of reasons: the first being that predatory journals have been an emerging issue which may not have yet filtered into the evidentiary base; the second being that predatory journals may not be cited due to low quality; and the third being that the detection of predatory journals was insufficient. Predatory journals have the potential to dilute scientific understanding with bogus research and author misconduct, due to the lack of a rigourous peer review process (Beall, 2013).

In contrast to the citation of known predatory journals, the citation of evidence with quality concerns was common. Some of these concerns include the publications not having a clear or transparent peer-review process, not following criteria for clinical guidelines (McCunney, Morfeld, Colby, & Mundt, 2015b), conflicts of interest (Lercher & Tchounwou, 2017; Shepherd, 2017), industry-involvement (McMurtry & Krogh, 2016), and publications within unindexed journals. The absence of a peer-review process for some types of sources (grey literature, certain conference papers) led to additional concerns about the quality of evidence being cited.

The linking of other websites as supportive evidence or allied organizations varied by organization type. Public health organizations were more likely to cite other organizations' websites as supportive evidence for their positions. In contrast, the phenomenon of having lists of allied websites was unique to community group websites; none of the other organization types had similar lists of links on their websites. The use of linking to allied organizations allows for pooling resources together, such as sharing RSS news feeds or links to evidence sources, as well as presents the optics of a unified coalition of organizations that agree on the issue of whether wind turbines impact human health. Public health organizations or eNGOs could similarly link to other organizations' webpages on the topics of interest as a means of recognizing the work done by other organizations and to bolster the organization's stance on an issue. This 'allied' approach may be limited in the public health context by a number of ways, including; the need for public health organizations to agree on a strategy for an issue; the mandate of local or regional public health organizations; website content rules; and the availability of resources to identify relevant information on other public health organizations' websites and maintain links to external sites. Increased coordination of resources between organization websites could be a means of presenting evidence without duplicating efforts. A potential solution would be to have a third-party public health organization on a national or provincial scale manage the content and provide a central hub for the sharing of resources and links. A provincial or national organization could help formally share tools or resources from individual local public health organizations, but this would need to be adequately planned and resourced.

Organizations may need to make decisions about how to approach the relative lack of high quality studies to support the stated position on wind turbines and human health, including whether to collaborate with other organizations as allies, potentially funding new research, whether to undertake a new review of existing evidence, or to cite studies that are not as directly applicable. Resources that are devoted to addressing wind turbines and human health may not be available for other issues—such as to respond to other local community concerns. Working or coordinating with larger organizations may be a means for smaller organizations with a smaller resource base to address local concerns on this potential health issue.

### 4.4.1 Limitations

There were a few limitations to this research in this chapter. This analysis assumed that a website's position on the health impact of wind turbines by organizations would be supported by evidence and this evidence would be cited on the website. This assessment excluded specific types of subjective evidence that may be used in some instances to determine the potential for harm, such as personal opinion or experience. Additionally, if the reason for a website's position on the health impact of wind turbines ultimately stemmed from values or inherent beliefs, this analysis would not be able to address those aspects.

The exclusion criteria for organization websites excluded any websites that were housed on social media websites. If organizations used social media platforms exclusively for their content, these website were not assessed. It is not known what proportion of organizations exists exclusively on social media and how that would impact the results of this analysis. The exclusion of analysis of social media components of websites also infers that another potential source of evidence citation was not included in the analysis—although to do so may have generated some potential ethical considerations. I was only able to compare citation patterns on organization documents and not social media postings or individual user comments. I did not directly assess how videos, social media or news stories were used as evidence, but I did document their presence or absence on the websites.

Due to the scope of data, where 67 websites were initially identified and 184 additional websites were cited during the analysis, in depth characterization of the additional websites was not possible. Similarly, a qualitative analysis of the 584 individual cited evidence sources (to assess for quality and grade on relevance to the topic of wind turbines and human health) was not performed due to resource limitations. Assessing for scientific rigour and peer-review process quality concerns as attributes for evidence sources may require further refined strategies. The direct relevance of the specific sources cited to the issue of wind turbines and human health was not captured by the research tool. I noted that some of the experimental studies dealt with animal models and that some of the observational studies dealt with exposure to other sources of community noise. Further characterization of the cited evidence sources in terms of their relevance to human health impacts of wind turbines could improve the assessment of the cited evidence sources. Furthermore, assessing and grading the quality of the cited reviews (such as indicating whether they followed the strict systematic review or meta-analysis methodologies) would additionally provide information on the comparative quality of the reviews cited. Additionally, non-peer reviewed evidence sources were problematic to place in a hierarchy, due to their heterogeneity and a lack of standardized means of ranking or comparing these evidence sources systematically.

The direct relevance of each evidence source to the issue of wind turbines and human health was not coded. Refining the hierarchy of evidence to include measures of the relevance of the evidence source to the issue may be needed. This could be done by assigning a weight based on the applicability to the context.

Excluding industry or commercial interest websites from the analysis due to their potential for financial conflict of interest limited the analysis to organizations without a direct financial stake in the situation. Similarly, excluding political websites and documents may have reduced the analysis' understanding of the role of political organizations in the determination of the health impacts of wind turbines.

The website characterisation tool did not include a field for identifying the focus of the hosting website to distinguish whether the content on wind turbines and human health was central to the organization's mandate or a smaller subset of a broader mandate as this appeared to be align directly with the organization type—where this issue was a central of almost all community group websites but was a small part of the website content for all academic organizations, eNGOs and public health organizations. Measures of website effectiveness, reach, or impact were also not available.

Identifying evidence sources as predatory journals or having been flagged for issues related to scientific rigour or quality was difficult as it assumed that an external party had assessed the source for its rigour and made its findings easily available. It is possible that predatory publishers or low quality evidence sources were not flagged as such due to lack of available previous scrutiny. Having a secondary quality assessment step for each evidence source could help flag publications with quality concerns, but may be resource intensive.

For some websites, it was difficult to identify dates of creation or of last update. The website dates were analysed based on the available data, but data were missing for some of the websites. It was also unclear for many websites what information was updated or included at specific times, making it difficult to retrospectively assess how cited evidence sources changed over time.

# Chapter 5: Social Network Analysis of Organization Website Citations of Other Websites and Evidence Sources Related to Wind Turbines and Human Health

## 5.1 Objective

The objective of this chapter was to assess the pattern of citations or links to the evidence used by community groups and public health organization websites to determine whether the patterns differed between the two types of organizations (Objective 2).

## 5.2 Methods

### 5.2.1 Data Collection and Affinity Matrix Development

Using the data collection tool described previously in Chapter 4, each of the included 67 Canadian organization websites with content on wind turbines and human health had data about its links to other organizations and evidence sources recorded. A matrix table representing whether a given organization linked to another was created. This citation table included the original list of unique organizations on the vertical axis and the list of organizations including additionally identified organizations on the horizontal axis. For each cell on the table, 0 indicated no citation and 1 indicated a citation. This table was converted into an affinity matrix by including the additional organizations on the vertical axis and recording 0 for all of these additional cells—as the affinity matrix only included directed ties from the original 67 organization websites to other organization websites. For the purposes of the social network analysis, all ties were considered directed.

I created a second separate matrix table for each of the 67 organization websites to each unique evidence source, where the vertical axis was the 67 organization websites and the horizontal axis was the cited evidence sources. For each cell on the table 0 indicated no citation and 1 indicated a citation. This matrix was converted into an affinity matrix by having the 67 organizations listed on the horizontal axis and the cited evidence sources also appear on the vertical axis, but recording 0 for all of their cells as only citations (directed ties) from the 67 websites to the evidence sources were considered in this matrix. The relationship data between each of the 67 organization websites were also placed in both affinity matrices, where all organizations were listed on the X and Y axis and the presence of a link/citation was indicated with 1 and the absence of a link/citation was indicated with 0. For analysis of the bipartite network of citations from the 67 organizations to evidence sources, these cells were all converted to '0' for the descriptive measures of the network.

Additional matrices were created from the original matrices to assess aspects of the evidence citation network and organization citation network by removing columns or rows according to additional variables found in the website characterization tool. This included removing all organizations from the organization citation matrices other than the initial 67 organizations of interest, to analyze how the initial 67 organizations relate to each other, as well as removing the academic organizations and eNGOs, and additionally comparing only inter-community groups and inter-public health organization networks. Additionally, the organization citation matrices was converted into adjacency matrices that only included Canadian/Non-Canadian organizations, organizations that were included as allies at least once, and organizations that were cited as supportive evidence at least once.

In terms of the adjacency matrices that dealt with evidence citation, additional matrices were created from the original matrix based on node attributes by removing the academic organizations and eNGOs, including only highly cited evidence sources (evidence sources that were cited at least 2 or 3 times), and citations by evidence type, including sub-types of grey literature. Adjacency matrices were created using only peer-reviewed and non-peer-reviewed sources to distinguish between the two types of sources, as well as an adjacency matrix that contained only high level evidence sources as per the hierarchy of evidence. An adjacency matrix that included only evidence with quality concerns was also created.

### 5.2.2 Data Analysis and Graph (Sociogram) Development

The data was assessed in a different order than the previous chapter, as organization citation data were assessed before evidence citation data. A preliminary analysis of the social network of the 67 groups identified was performed first, followed by subgroup analysis by organization type, and then an assessment of the relationships with other organizations' websites. The bipartite (two types of nodes) network between the 67 organizations and individual evidence sources was assessed last.

The data was first represented visually as a network using a data mapping software program, where the nodes were colour-coded to distinguish the different types of organizations and types of evidence. A visual analysis was done to examine how the patterns differ. Descriptive measures for the network as a whole were characterised, followed by measures for networks only including a subset of the nodes such as public health organization websites, community group websites or evidence that had been cited more than once or twice.

The observed patterns were assessed to see whether (hypothesis 1) organizations of each type tended to cluster together, (hypothesis 2) public health organizations tended to cluster with different sources of evidence than community groups, and (hypothesis 3) the quality of evidence with which public health organizations and community groups tended to cluster were different. Social network analysis routines were used in the R with additional modules (igraph, statnet and SNA) to test these hypotheses. The data were assessed with social network analysis using either a one-mode or a two-mode (bipartite) network model where nodes represent either organizations or evidence sources. Ties between nodes were directed.

Block models and cluster dendrograms were used to characterize the pattern of connections seen in the social network to understand the underlying structure of the network and identify structurally equivalent nodes and their roles in the network.

The attributes for the different organizations and evidence sources were recorded on separate Excel datasheets in CSV format. For the purposes of social network analysis, cross-sectional surveys as a subset of observational studies without controls were considered as a separate class of evidence source due to their frequent citation. The adjacency matrix rows and columns were labelled by unique ID numbers. For each unique ID number, attributes such as the organization type, and additional characteristics as described in Chapter 4 were included as separate columns. Two of the community group websites that belonged to advocacy organizations for a specific disease (epilepsy), were classified as 'health NGO' for the purpose of social network analysis as they differed in purpose and context from the other community groups.

The data were collected on a spreadsheet using Microsoft Excel 2010 (Version 14.0.7195.5000). The affiliation matrix data tables were converted to a CSV file and analysed using statistical software R version 3.4.0 (2017-04-21) Platform: i386-w64-mingw32/i386 (32-bit), and R Studio Version 1.1.383. I used multiple additional modules on R, including the statnet module, the SNA (social network analysis) module and the igraph module.

The affinity matrices were imported into R as CSV files with the supplemental SNA, stanet and igraph modules loaded into R as needed. The relationships between the nodes were mapped using igraph and the additional network centrality measures such as degree (mean degree), density, diameter, closeness, Eigenvector, reciprocity, assortativity and betweenness, were assessed with SNA and igraph.

Each adjacency matrix was plotted on a separate graph (sociogram) with all nodes. The nodes on the graphs were colour-coded based on the organization or evidence type cited for readability purposes and to indicate attributes. The initial sociograms to describe the network used a uniform node size for all nodes. Separate sociograms were made where the nodes size was represented by its total degree (number of ties to or from the node).

The 67 websites identified meeting the inclusion criteria were first assessed as a unimodal network. All ties were considered directed, as the ties represented links from one organization website to another that may not be reciprocated, as well as to organization websites or evidence sources that were not assessed for further ties. The initial network included ties to and from all of the 67 websites. The adjacency matrix with the additional organizations was assessed with the original 67 websites as a unimodal network with directed ties. The adjacency matrix with the 67 organizations and the evidence sources were assessed as a bipartite (two modes) network with directed ties. A version of this evidence citation matrix was created that included the ties between organizations for visualization purposes, however, the analyses of the data were done solely on the matrix with bipartite ties between organization websites and evidence.

Additional adjacency matrices were created using the website citation characteristics as described previously, such as citing as supportive evidence or as allied organizations for organizational ties, or quality concerns being present with evidence sources, to create subsets of the network. These additional adjacency matrices permitted the creation of sociograms which represented the impact of the website citation characteristic of interest. The website citation characteristics were also used as attributes for the nodes in specific sociograms, where the network structure did not change but the colour-coding of the nodes allowed visual analysis of the network by website citation characteristic.

For the assessment of the citation of higher level of evidence sources, additional adjacency matrices were created for citations of both higher and lower level of evidence sources, in addition to the specific category of review. The category of higher level of evidence included study designs ranked higher in the hierarchy of evidence (experimental studies and observational studies including cohort studies and cross-sectional surveys), reviews were considered separately, and lower level of evidence represented the remaining categories. An additional adjacency matrix was created to assess the citation of grey literature, where the sociogram represented the different categories of grey literature through node colour.

Centrality measures were calculated for the social networks. The concept of centrality in social networks describes whether a specific organization can be found to be central to others, either locally (to its neighbours) or globally (to the network as a whole (Scott, 2013)). Local point centrality describes measures of whether a node has a large number of connections to other neighbouring nodes, whereas global point centrality describes whether the node has a strategically significant point in the network (Scott, 2013). Degree centrality is a measure of the number of ties a node has to other nodes in its local environment (Scott, 2013). Degree centrality can be calculated in terms of total number of ties to other nodes, as well as differentiating between incoming or outgoing ties in directed graphs (Scott, 2013). A distinct measure of centrality is betweenness, which describes the proportion of paths from one node to another within a network that must pass through a specific node. Betweenness describes dependencies on nodes and the role of nodes as intermediaries in a network (Scott and Carrington, 2011; Scott, 2013). Closeness centrality is a measure of the distance required to reach all other nodes in a network from a specific node. Estimated closeness used diameter as the cutoff distance to allow for calculations when nodes were not connected into the greater network. Eigenvector centrality assesses for how much a given node is connected to other influential nodes in a network.

Network measures were used to describe the properties of the network. Density is a measure of the level of linkage among points in a graph like a sociogram (Scott, 2013) and is calculated by dividing the number of ties between nodes in a graph by the number of potential ties between all pairs of nodes in a graph. Density can range from 0 (no ties between any nodes) to 1 (all nodes are connected to each other). The diameter of the network—the greatest distance between any pair of nodes (Scott, 2013)—was also measured. The centre of the sociogram can be approximated with eccentricity scores, if present. I recognized that network measures for any analysis that includes organizations or evidence sources beyond the 67 organizations that met the inclusion criteria will be lower due to the exclusion of ties from the other organizations or evidence sources from the analysis. In general, as the size of a network increases, network measures such as density or centrality will be smaller (Scott, 2013).

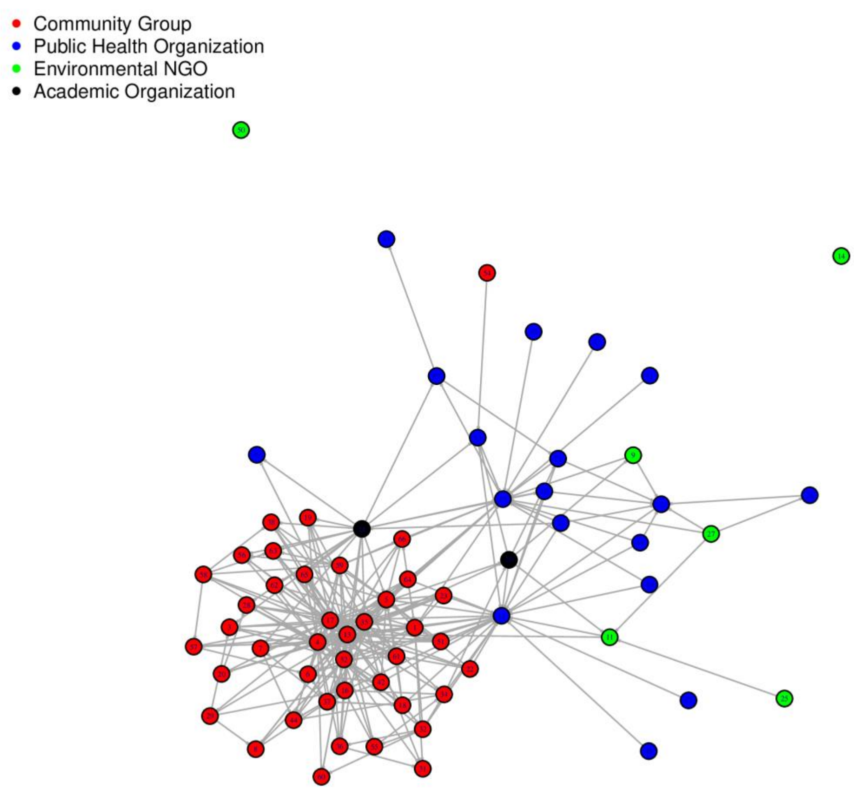
Clique and community detection were performed on the adjacency matrices in R using SNA to classify websites that belong to specific subgroups. Block models and cluster dendrograms algorithms were used in R using the statnet module to assess for structural equivalence between nodes in the networks. Structural equivalence describes the situation where two nodes in a social network have identical relational ties to and from all other nodes (Faust & Wasserman, 1992). Cluster dendrograms are tree diagrams that illustrate hierarchical clustering of nodes from a social network. The block models were presented as image sociomatrices and show the presence of structurally equivalent clusters where the density for the cluster is higher than the average density for the network (Scott, 2013). In these image sociomatrices, a cell with a structurally equivalent cluster is coloured black and a cell without a structurally equivalent cluster is white.

## 5.3 Results

### 5.3.1 Assessment of the 67 identified organization websites with content on wind turbines and human health network

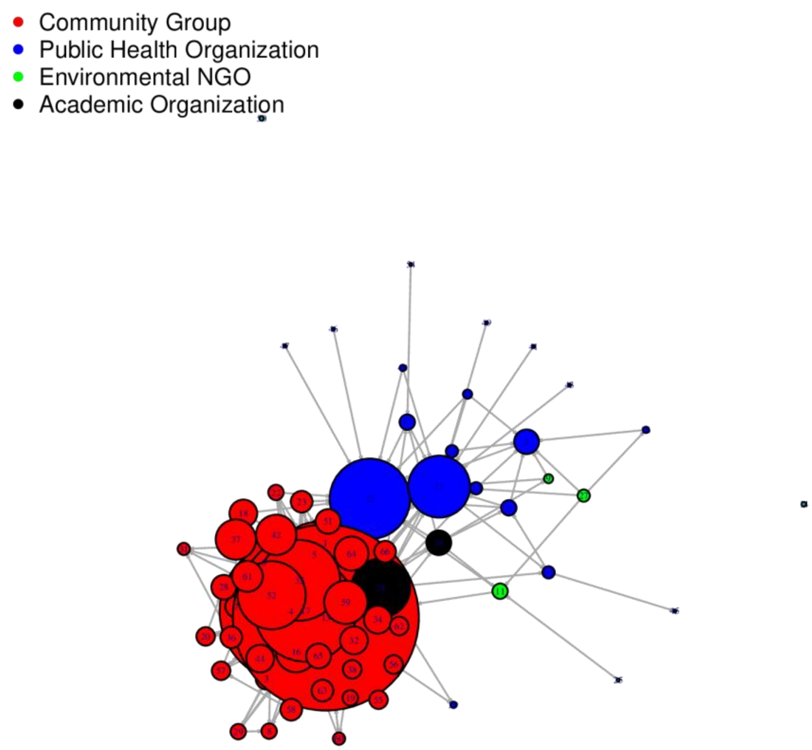
The links between the 67 identified organization websites were assessed and the results of this social network are presented in Figure 3.

**Figure 3.** Sociogram representing the network between the 67 Canadian organization websites with content on wind turbines and human health by organization type



The overall network between the 67 organization websites had apparent clustering of the websites by organization type (Figure 3). Two eNGO websites were completely separate from the network. Visually, the community group websites appeared to predominantly connect with each other. Public health organization websites appeared to connect with each other as well as eNGO websites. One academic organization website appears to be connected with all the other group types. When degree (the amount of ties to or from an organization website) was included in the visualization of the social network through node size, a number of community group websites appear to be highly connected to others (Figure 4), where in this sociogram at least four community group website nodes were substantially larger than others, and two public health organization websites and one academic organization website also demonstrated larger node size. Degree and the position of nodes within the network illustrated the relative importance of the nodes to the network. In this network, four community group websites, one academic organization website and two public health organization website appeared larger and central within the network. The community group nodes appeared larger than most of the nodes for the other types of organizations. The community group portion of the network appears more densely connected than the portion of the network with the nodes from the other organization types.

**Figure 4.** Sociogram representing network between 67 Canadian organization websites with content on wind turbines and human health by organization type with node size representing degree




In this social network, the mean degree (number of links to and from a website) was 9.19. Comparing the degree distribution between nodes, overall most nodes had relatively low degree measures (meaning fewer links to and from the website), but a small number had higher degree (see histogram in Figure 5, Figure 6 and Table 17). In examining the 10 organization websites with the highest overall degree measures (meaning the largest number of links to and from the website), most (7/10) were community groups, followed by public health organizations (2/10) and an academic organization (1/10). The top three community group websites had a balance between incoming and outgoing links (32:28, 26:20; and 13:20 respectively), and represented provincial or national level organizations. These organizations appear to have a central role in the network. The public health organization websites with larger degree were also provincial or national, and had a higher proportion of incoming links (26:0 and 17:3 respectively), where they were cited by other organization websites predominantly. The local community group websites in the top 10 of all websites had a higher proportion of outgoing links (8:18; 3:19 respectively) and tended to link to other organization websites rather than being cited by another organization website. The remaining community group websites were provincial in nature and had either a high proportion of incoming links (19:2) for an organization whose role was to host evidence resources or a balance between the two (8:8) for another provincial level organization. The academic organization website predominantly had outgoing links (18:1) as it cited other organization websites in its content.

**Figure 5.** Degree distribution in sociogram for the 67 organization websites with content on wind turbines and human health

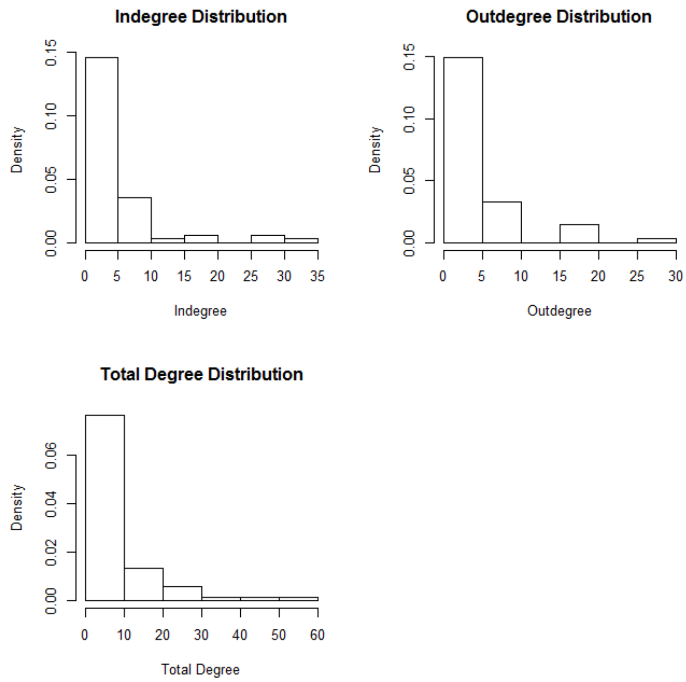



**Figure 6.** Cumulative frequency by degree for the social network of the 67 Canadian organization websites with content on wind turbines and human health

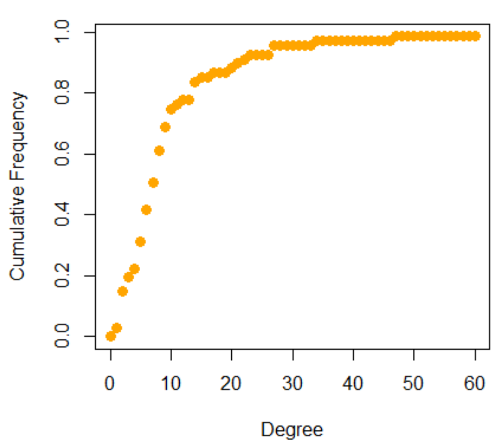


**Table 17.** Degree measures for 10 Canadian organization websites with content on wind turbines and human health with total highest overall degree

| Organization Type | Indegree | outdegree | All degree |
|---|---|---|---|
| Community Group | 32 | 28 | 60 |
| Community Group | 26 | 20 | 46 |
| Community Group | 13 | 20 | 33 |
| Public Health Organization | 26 | 0 | 26 |
| Community Group | 8 | 18 | 26 |
| Community Group | 3 | 19 | 22 |
| Community Group | 19 | 2 | 21 |
| Public Health Organization | 17 | 3 | 20 |
| Academic | 1 | 18 | 19 |
| Community Group | 8 | 8 | 16 |

Using estimated closeness (the reciprocal of the sum of the shortest paths from one node to all other nodes in the network) as a global measure of centrality found that provincial or national community group websites were central to the network (5 of the 10 highest scores), and that two local community group websites, one academic organization website, one provincial public health organization website and one national public health organization website were in the top 10 highest ranked organizations (See Table 18). These organizations overlapped with the organizations with the highest degree centrality. The mean estimated closeness was 0.00075. The mean distance for the network, which is the mean number of links to get from one website to another, was 2.52. The reciprocity measure for the network was 0.32, which shows that approximately one third of the network website pairs with directed links had links to and from each website. Assortativity is a measure within a network for the preference by which a node will connect with other similar nodes. In this network, the nominal assortativity by group type was 0.48.

**Table 18.** Top 10 Canadian organization websites with content on wind turbines and human health within the network of 67 organization websites by estimated closeness scores

| Organization Type | Estimated Closeness (all) |
|---|---|
| Community Group | 0.0044 |
| Public Health Organization | 0.0042 |
| Community Group | 0.0041 |
| Public Health Organization | 0.0041 |
| Community Group | 0.0041 |
| Academic | 0.0040 |
| Community Group | 0.0040 |
| Community Group | 0.0040 |
| Community Group | 0.0039 |
| Community Group | 0.0039 |

The transitivity of the network was also measured, where transitivity represents situations where a website that links to another website with directed links to and from the two websites would also be connected with a third website with directed links as a triad (i.e. three websites all link to each other in perfect transitivity). Table 19 demonstrates the 16 potential classes for these three nodes, and only a small number (7) had perfect transitivity

**Table 19.** Transitivity of the network of 67 Canadian organization websites with content on wind turbines and human health as represented by the Triad Census (16 potential states)

| Triad Census | X |
|---|---|
| 003 A, B, C, empty triad | 34482 |
| 012 A->B, C | 8758 |
| 102 A<->B, C | 1604 |
| 021D A<-B->C | 487 |
| 021U A->B<-C | 738 |
| 021C A->B->C | 434 |
| 111D A<->B<-C | 411 |
| 111U A<->B->C | 362 |
| 030T A->B<-C, A->C | 155 |
| 030C A<-B<-C, A->C | 9 |
| 201 A<->B<->C. | 278 |
| 120D A<-B->C, A<->C | 34 |

| | |
|---|---|
| 120U A->B<-C, A<->C. | 60 |
| 120C A->B->C, A<->C | 35 |
| 210 A->B<->C, A<->C. | 51 |
| 300 A<->B<->C, A<->C, completely connected | 7 |

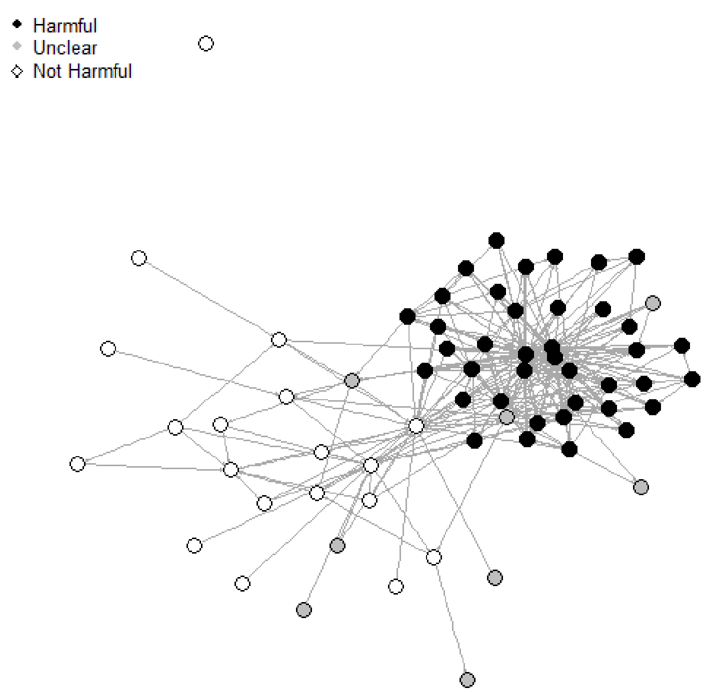
The mean estimated betweenness for the network was 63.84—where betweenness measures the role of nodes as intermediaries on the path between two other nodes. Table 20 presents the top ten websites by group type and betweenness score. This list of the top 10 websites by betweenness scores had similarities to the other measures in terms of the appearance of common organizations (3 provincial and 1 national community group, and 1 provincial public health organization). However, the list varied by the presence of a distinct academic organization, an e NGO and two local public health organizations.

**Table 20**. Top 10 Canadian organization websites with content on wind turbines and human health within network of 67 websites by betweenness score by organization type

| **Organization Type** | Betweenness |
|---|---|
| Community Group | 1303.93 |
| Public Health Organization | 763.04 |
| Community Group | 456.35 |
| Community Group | 372.89 |
| Community Group | 260.52 |
| Academic | 230.27 |
| environmental NGO | 99.04 |
| Community Group | 93.06 |
| Public Health Organization | 83.01 |
| Public Health Organization | 80.60 |

The density for the sociogram of the network of the 67 organization websites with content on wind turbines and human health was 0.070—where density is the number of ties in a graph divided by the number of potential ties. This measure identifies that there were few links between most organization websites in the network. Density measures were expected to be low given the size of the network and the likelihood that many nodes would be unconnected. The diameter of the network was 6 (when excluding the unconnected websites). The eccentricity results for this sociogram did not indicate that any website was central to the sociogram, as 20 websites were equally 'central' with an eccentricity of 3.

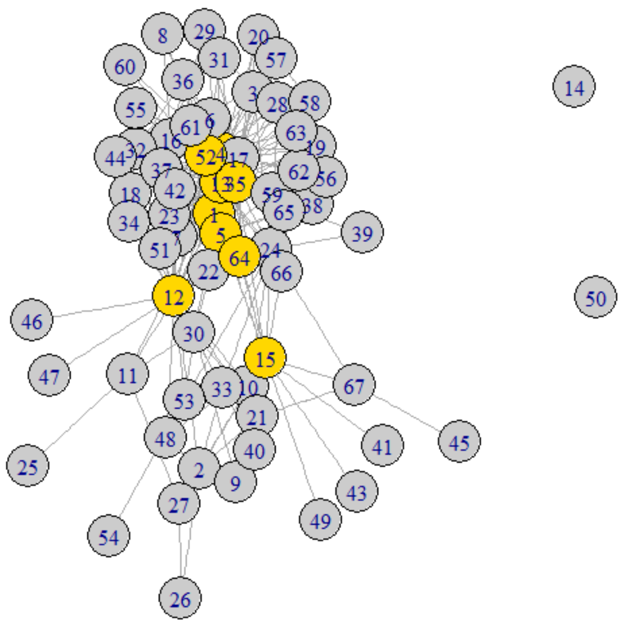
**Figure 7.** Sociogram of 67 Canadian organization websites with content on wind turbines and human health by position on human health impacts of wind turbines




When the network was assessed by the attribute "position on wind turbines and human health" (Figure 7), websites that were characterized as taking the position that wind turbines were "harmful" to human health were found to be clustered on one side of the network, whereas those that were characterized as viewing wind turbines as "not harmful" were clustered on the other, with the 'unclear' websites found dispersed in the network. This pattern was similar to that seen with the organization type, where community groups and 'harmful' and public health organizations and 'not harmful' appeared to be consistent.

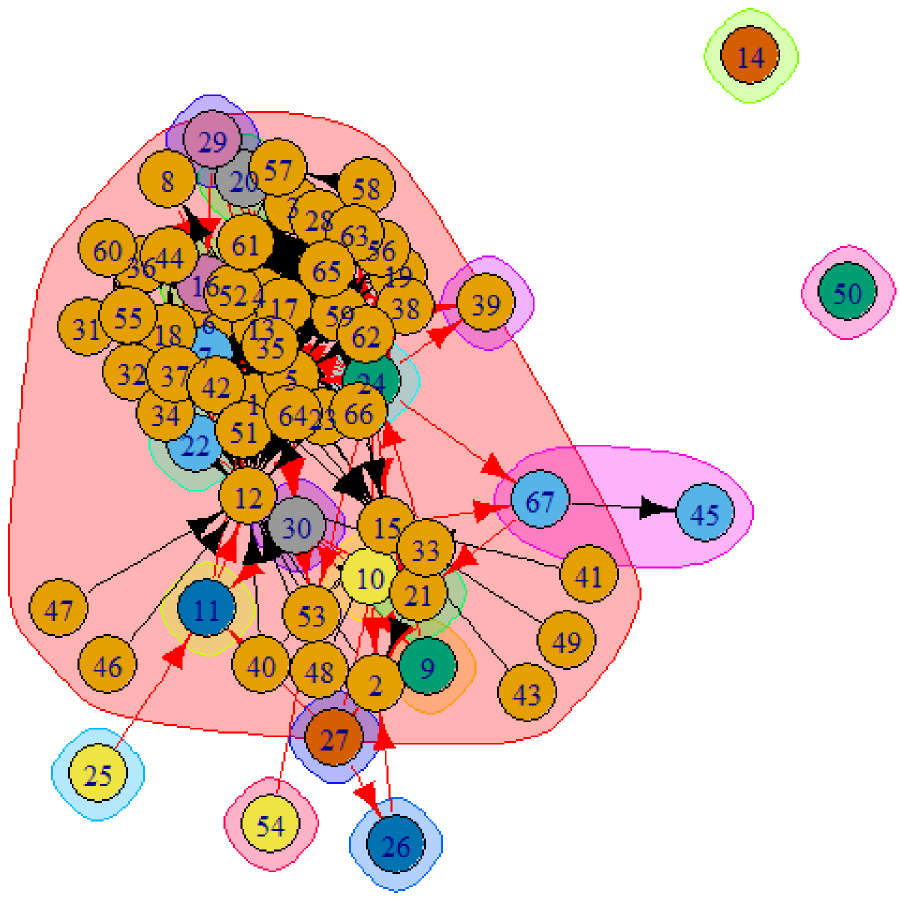
Clique detection on the network of the 67 websites identified four cliques with 6 members each, representing a total of nine different organizations in different clique configurations. Three of these nine organization websites were present in all four cliques: two provincial community groups and one regional community group. Three community groups were present in three of the four cliques with six members (one provincial and two local community groups). The three remaining websites were present each in one of the six member cliques (one provincial community group, one provincial public health organization and one national public health organization.) Figure 8 slows the members of the six member cliques in gold and the rest in grey.

**Figure 8.** Clique detection (gold) in the network of 67 Canadian organization websites with content on wind turbines and human health



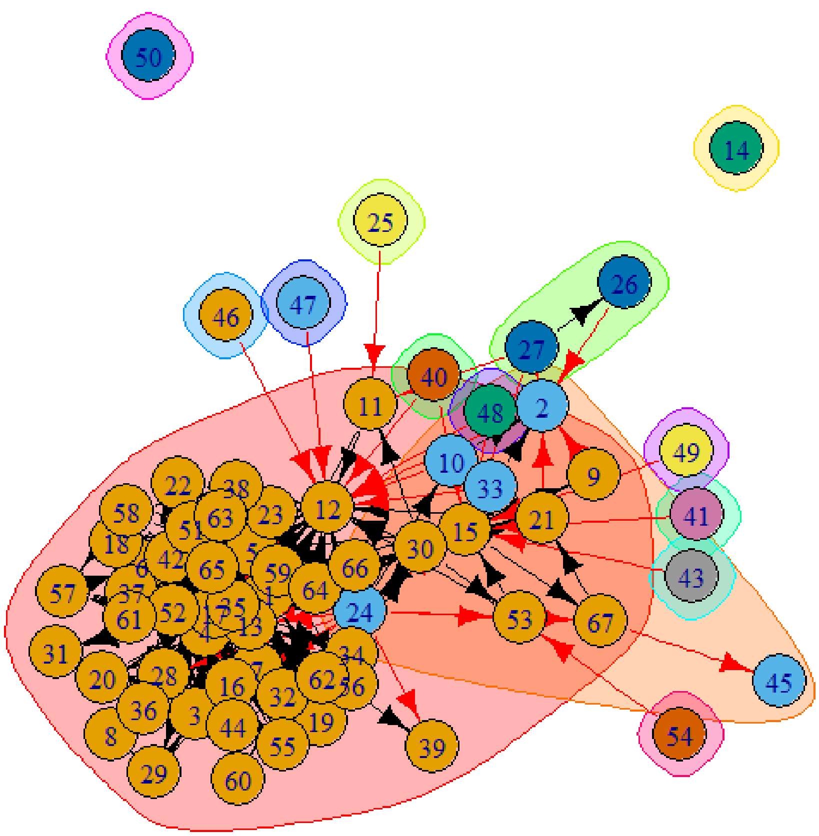

Community detection algorithms identified communities of websites within the network (Figure 9), where the majority of nodes belonged to a single community and represented mostly community group websites with some public health organization websites. A smaller number of websites were outside the community and represented a mix of eNGO and public health organization websites. While a few websites appeared outside of the community, the majority were positioned within the larger community—even if they were identified as a separate community by the circle surrounding the node.

**Figure 9.** Community detection within the network of 67 Canadian organization website with content on wind turbines and human health



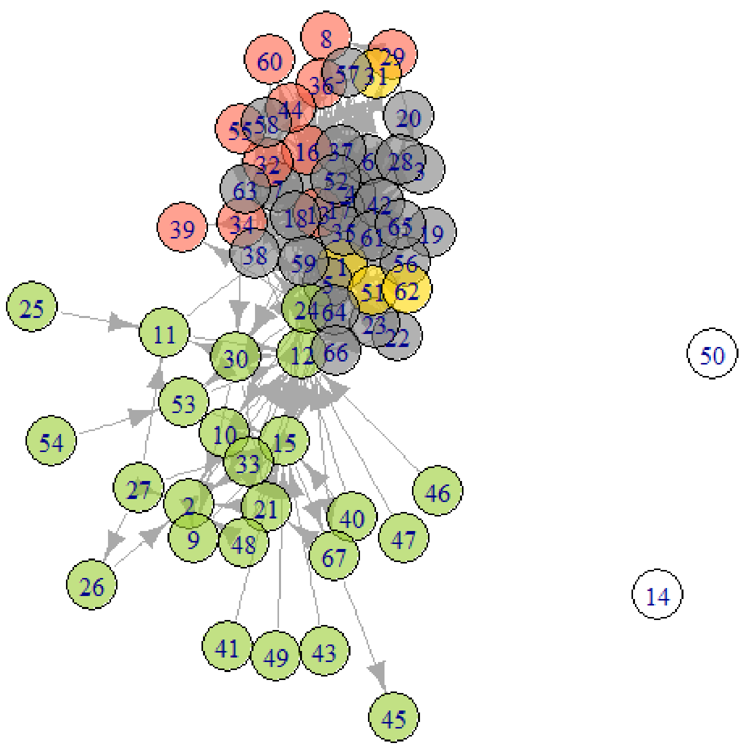

When community identification was done using a propagating label method (Figure 10), the communities within the graph appeared to vary. In this graph nodes 24 and 30 (academic organization websites) appeared central and between the communities. Public health organization websites and eNGO websites were on the right side of the community in a separate group with some overlap to the greater community, whereas community group websites were almost all clustered on the left side of the graph. This method more clearly demonstrated differences between the websites by organization type.

**Figure 10.** Community detection in network of 67 Canadian organization websites with content on wind turbines and human health using propagating label method



When using community detection based on greedy optimization of modularity (Figure 11), all public health organization websites but one (red 39) and both academic organization websites were found in the green nodes. This graph suggested that there was a community of community group websites (grey) that is closely linked, with a few more peripheral community group websites in yellow and red. Two eNGO websites were outside of the network (white).

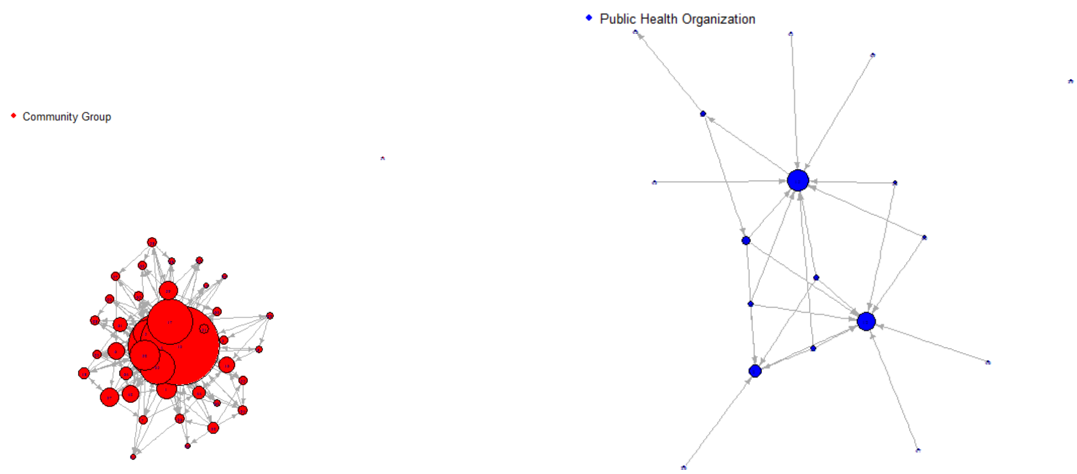
**Figure 11.** Community detection of network of 67 Canadian organization websites with content on wind turbines and human health based on greedy optimization of modularity



Sociograms were created for the ties between community groups and the ties between public health organizations to visualize the network by group type (Figure 12).

**Figure 12.** Sociograms representing networks of links between a) community group websites and b) public health organization websites with content on wind turbines and human health as subcomponents of the 67 identified website networks.

a) b)




The sociogram (Figure 12a) representing the network of community group websites demonstrated a single organization website with a much larger degree than the other websites, in addition to four other websites that had a proportionately larger degree. This showed that the network was dominated by a five community group websites where one website specifically played a central role. The sociogram (Figure 12b) representing public health organizations had three organizations whose websites had a larger degree compared to most other public health organizations. This network of public health organization websites appeared more diffuse and less centralized than the community group website network. Centrality measures for the 67 website network and the two subcomponents were summarized in Table 21. Direct comparison of some of the measures was not informative, as some of the measures like density were dependent on the size of the network. The diameter of the network was similar between the two subcomponents graphs. The mean degree was higher for community groups compared to both the 67 website network and public health organizations. The public health organization website network had substantially lower measures of mean betweenness, mean closeness and reciprocity, and higher mean Eigenvector scores compared to the community group websites network. This suggests that the social networks of the community group websites compared to public health websites were different in terms of the network characteristics, where the social network of the community group websites was more dense, and had reciprocal links between websites, and where the social network based on public health organization websites was more likely to have websites with high Eigenvector scores (websites were more likely to link to influential websites within the network, but that websites were less likely to be in a path of links from one website to another, the paths between websites were longer and websites were less likely to link back to a website that had linked to it.

**Table 21.** Centrality measures summary for 67 website networks and subcomponent networks of community group and public health websites

| Organization Type | Mean Degree | Density | Reciprocity | Mean Betweenness | Mean Closeness | Mean Eigenvector | Diameter | Assortativity |
|---|---|---|---|---|---|---|---|---|
| All 67 websites | 9.19 | 0.070 | 0.32 | 63.84 | 0.00075 | 0.22 | 6 | 0.48 |
| Community Group | 10.83 | 0.14 | 0.44 | 35 | 0.0075 | 0.33 | 4 | N/A |
| Public Health Organization | 2.89 | 0.085 | 0 | 4.28 | 0.0042 | 0.43 | 4 | 0 |

Block modelling to assess for structural equivalence between websites in the network—meaning that organization websites have similar positions and roles within the 67 website network—demonstrated that structural equivalence was found between a number of websites (Figure 13 and Figure 14).

**Figure 13.** Block model image of network of 67 Canadian organization websites with content on wind turbines and human health with cluster dendrogram

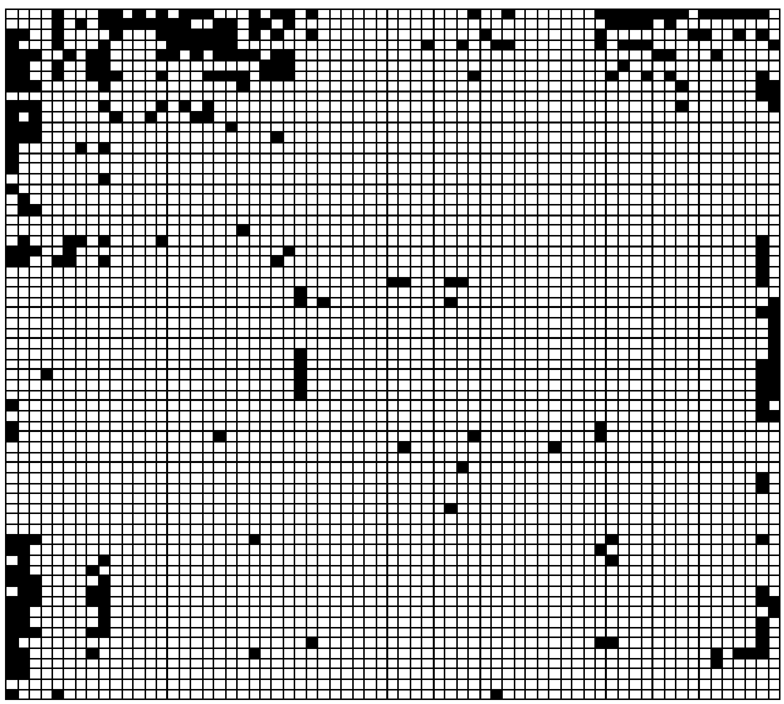
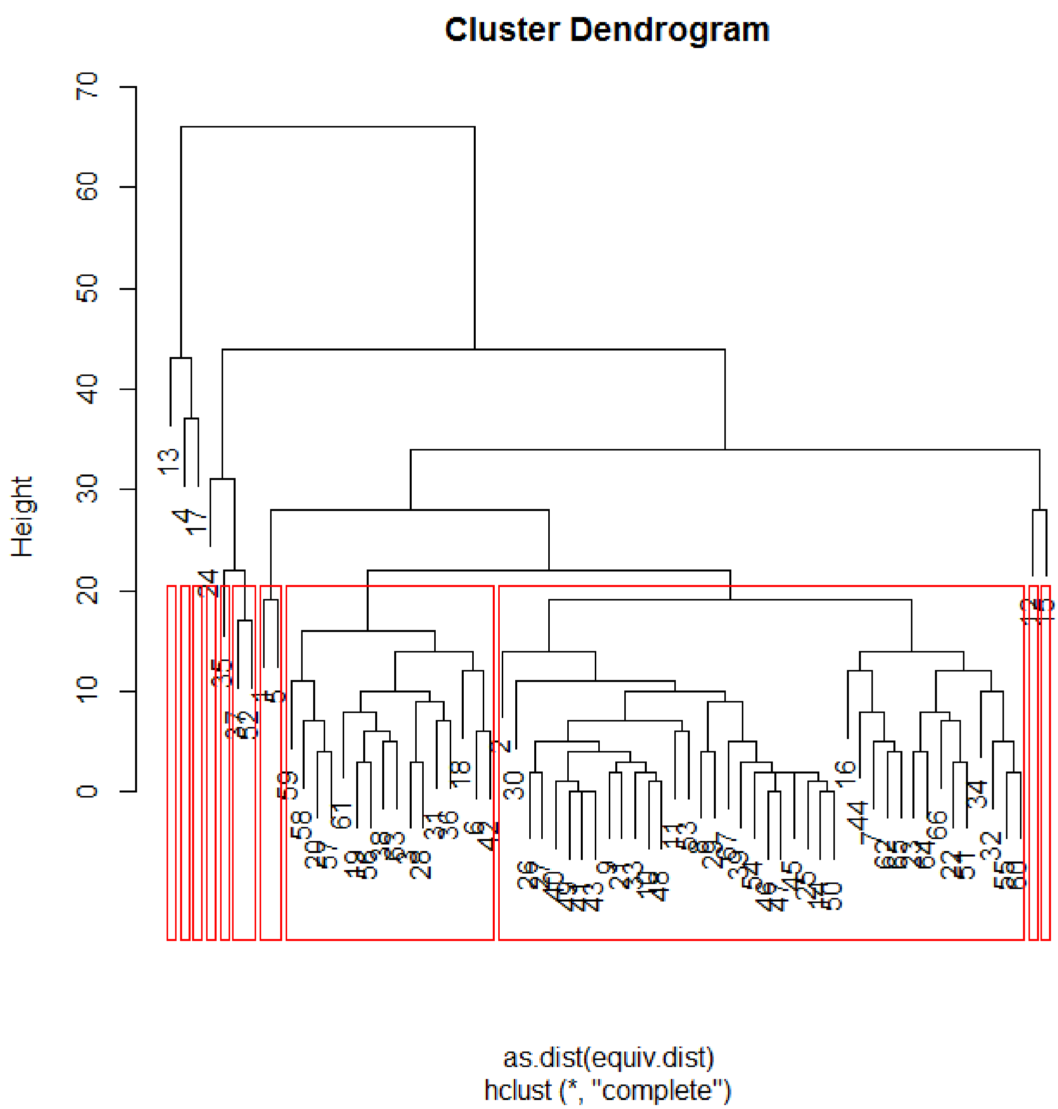


**Figure 14.** Cluster dendrogram of network of 67 Canadian organization websites with content on wind turbines and human health




The block model and the cluster dendrogram showed multiple levels within the network where websites had structurally equivalent roles based on their affiliations with other websites. The provincial and national community group websites (13, 4, 17) were separate, with 4 and 17 occupying a similar level. An academic organization website (24) also has its own level, and two provincial/national public health organizations (12, 15) have a similar role. The majority of the websites, including community groups and public health organizations, were at a similar lower hierarchical level. The block modelling was able to identify websites that had a role distributing information and coordinating at a regional or national level.

### 5.3.2 Assessment of Social Network of 67 Canadian Organization Websites with Content on Wind Turbines and Human Health with Additional Organizations

Once the structure and features of the 67 organization social network had been determined, sociograms with the additional 184 cited organizations were also created (Figure 15, Figure 16).

**Figure 15.** Sociogram of network of 67 Canadian organization websites with content on wind turbines and human health with links to all other 184 organization website citations

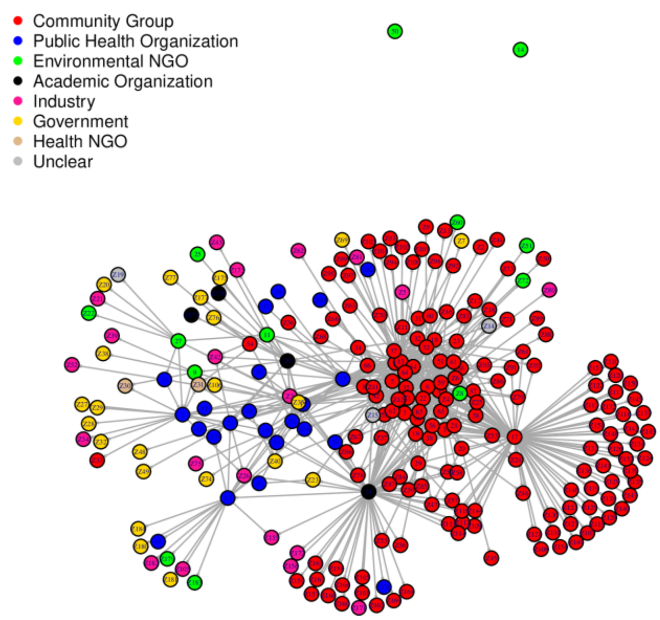
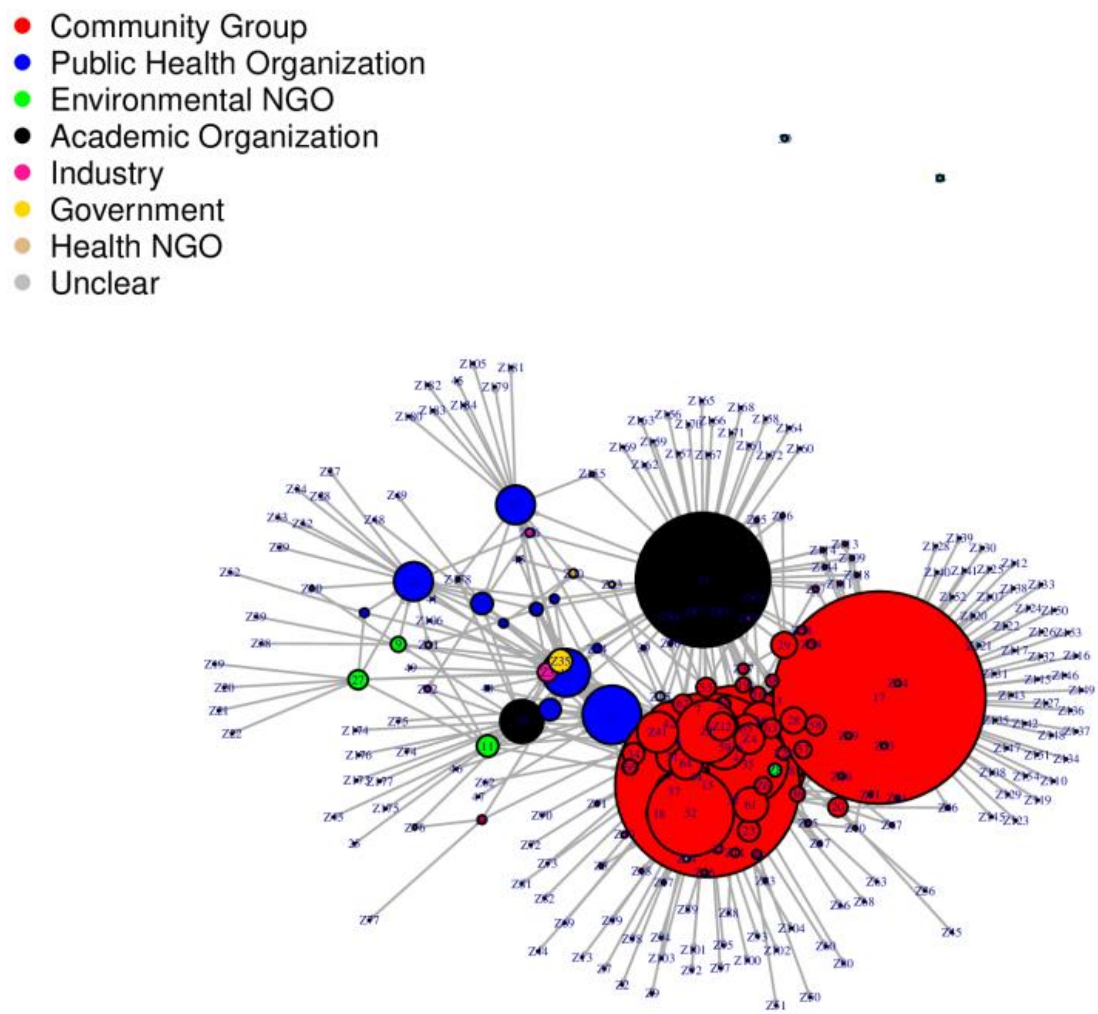


**Figure 16.** Sociogram of network of Canadian organization websites with content on wind turbines and human health with links to all other organization website citations where node size relates to degree




The sociograms in Figure 15 and Figure 16 represented a network with a total of 251 websites, where the initial 67 websites linked to an additional 184 websites. These additional 184 websites were from a variety of organizations: 2 academic, 122 community group, 7 eNGO, 22 government, 2 health NGO, 21 industry, 5 public health organizations and 3 that were unclear as the links to the organization website were dead. Several community group websites were found to have much higher degrees than the majority of websites, and these represented provincial or national groups that expressed concerns over wind turbines and had a high number of links to the organization website. Community group websites appeared to have a high degree of connectivity within the network. One of the academic organizations had a high degree due to its number of links to other organizations' websites. Most public health organization, eNGO and academic organization websites appeared to be more peripheral to the network. Five public health organizations, three eNGOs, two academic organizations and one government website had relatively larger degrees in the network (Figure 16). This network only represented the pattern of directed unimodal ties between websites as determined from the originally included 67 Canadian organization websites. Ties from the additional 184 organizations to other organizations were not included in the analysis as these websites were not characterised by the website characterisation tool.

**Figure 17.** Block model image (sociomatrix) of the network of Canadian organization websites with content on wind turbines and human health and other cited organization websitesd

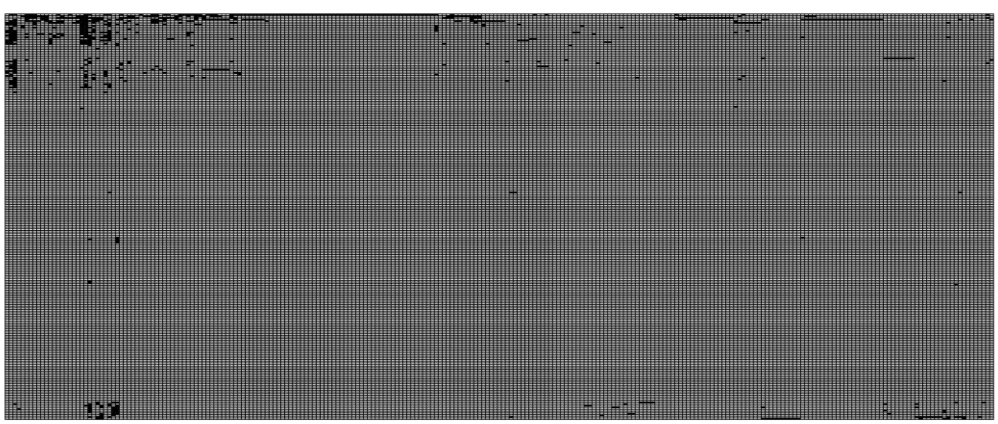
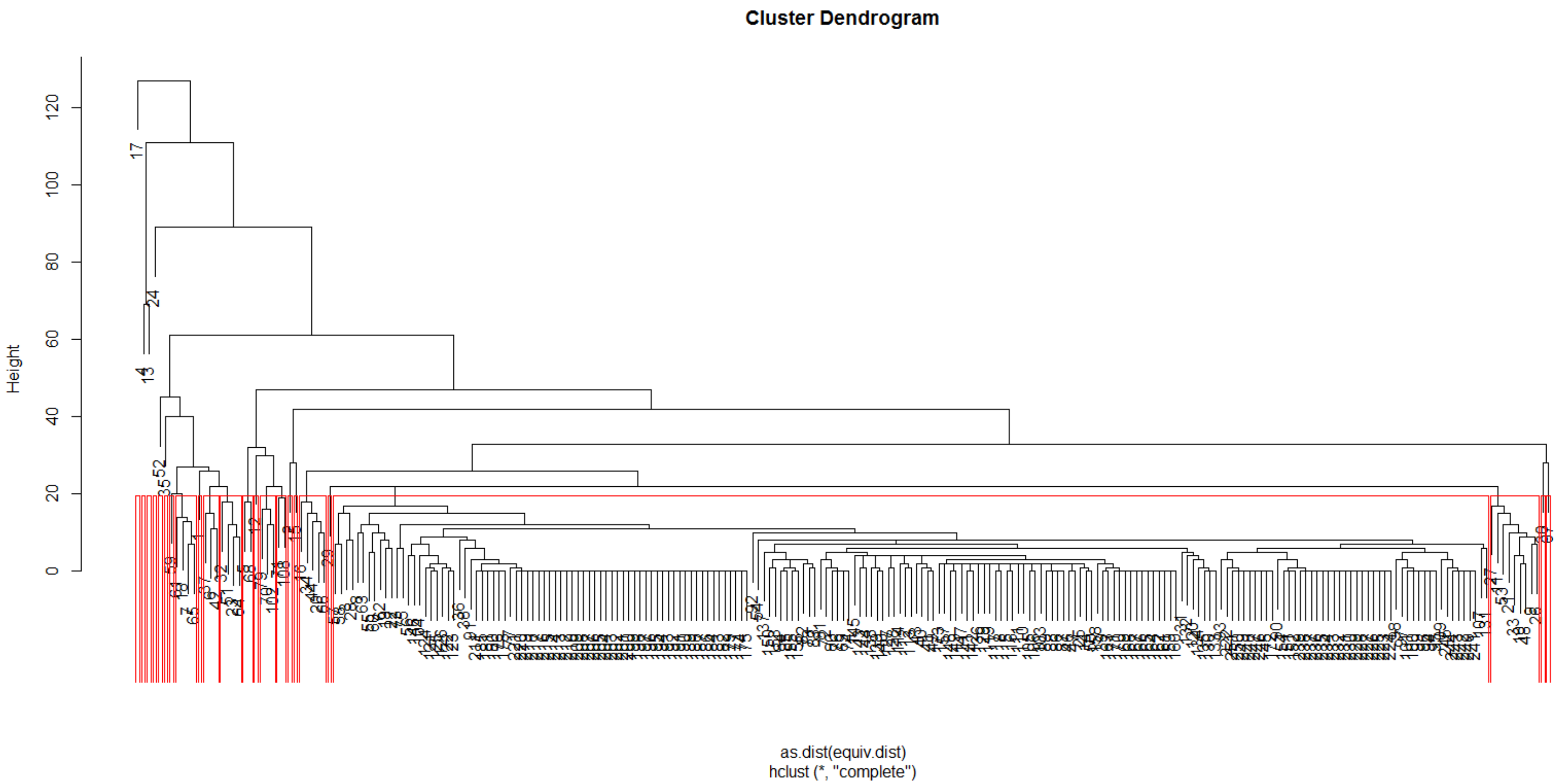


**Figure 18.** Cluster dendrogram of the network of Canadian organization websites with content on wind turbines and human health and other cited organization websites



When assessing for structural equivalence using a block model image (Figure 17) and cluster dendrogram (Figure 18), there were similar results for the original 67 websites in terms of specific provincial and national organization websites having structural equivalence by organization type, as well as local organizations having structural equivalence. The block model image suggested that there were structurally equivalent nodes with the original 67 organization websites. Most of the additional cited websites were structurally equivalent nodes that were low in the hierarchy and formed the major component of the dendrogram. A few of the additional websites were structurally similar to each other and were higher on the hierarchy within the cluster dendrogram, including two American national community groups, one European regional community group, a website based on Nina Pierpont's Wind Turbine Syndrome research, a provincial environmental ministry website, and a pro-wind turbine website.  This entails that the pattern of links within the network were similar for these organization websites.

Additional sociograms created to assess the impact of the website citation characteristics on the network included a visual representation of Non-Canadian websites in the network (Figure 19 and Figure 20), subnetworks based on allied citation status (Figure 21 and Figure 22) and 'cited as supportive evidence' status (Figure 23 and Figure 24). Figure 19 and Figure 20 presented two sociograms that visualized how the 67 websites link to non-Canadian websites in the network. A specific community group website had many links to websites of non-Canadian origin, and other nodes also appeared to have a multiple non-Canadian websites. Five non-Canadian community group websites, one non-Canadian government website and one non-Canadian public health organization website were centrally located in the network, as demonstrated in Figure 20 where node size was represented by degree. The remainder of non-Canadian websites were peripheral with one or two ties to the network. The majority of non-Canadian websites that were linked to community groups were also community group websites. The non-Canadian links from the other types of organizations tended to vary and represented multiple categories of organization websites. The centrality measures for this network were similar to those of the network with the 251 nodes as seen in Table 22.

The sociograms in Figure 21 and Figure 22 represented the network when only ties between organizations that were classified as 'linked as allied organizations' were included. This network represented 122 websites where 120 are from community groups, 1 is an eNGO and 1 is from an organization with an unclear classification. All other websites (including all academic organizations, public health organizations, industry, and government) were not connected to this network. The indegree (links to a website) in this network for websites included in the connected component ranges from 1-5, where a single organization has an indegree of 5, three organizations have an indegree of 3, 17 organization websites had an indegree of 2 and 101 organization websites had an indegree of 1. Two community group websites had large outdegrees (links from a website) of 82 and 47 respectively, one had an outdegree of 11 and the remainder had an outdegree of 0, 1, or 2. The impact of the outdegree on the network can be seen in Figure 22, where three community group websites had visibly much larger node sizes. Out of the 122 nodes in the allied subcomponent network, 34 of these represented websites in the original 67 organization websites and the remaining 88 websites were from the additional cited organization websites. Although the additional cited organizations' websites were not characterized for their ties to other organization websites, this network does illustrate that within the websites included in analysis that a small number of websites link to other organization websites as allied organizations.

The sociograms in Figure 23 and Figure 24 demonstrated a subcomponent network of nodes where each node represents an organization website that has cited another website as supportive evidence or a website that has been cited as supportive evidence. This subcomponent network had 108 nodes and 8 of categories of organization websites, where 50/108 (46%) were community group websites. This network subcomponent shows community group websites clustered on one side of the network and academic organization, public health organization, eNGO websites and the websites that they cited as evidence on the other side of the network. There are a few nodes that appear to bridge the sides of the network, including two public health organization websites, one community group website and one academic organization website, otherwise the network appeared to have clustered by organization type. The cited organization website types appeared to differ by the citing organization type, where more industry websites, government websites, eNGO websites and health NGOs were cited by the non-community group websites, whereas the community group websites predominantly cited other community group websites, with two industry websites, two government websites, two eNGO websites and a single public health organization website cited by the community group website aspect of the network.

**Figure 19.** Non-Canadian websites in the network of Canadian organization websites with content on wind turbines and human health with standard node size

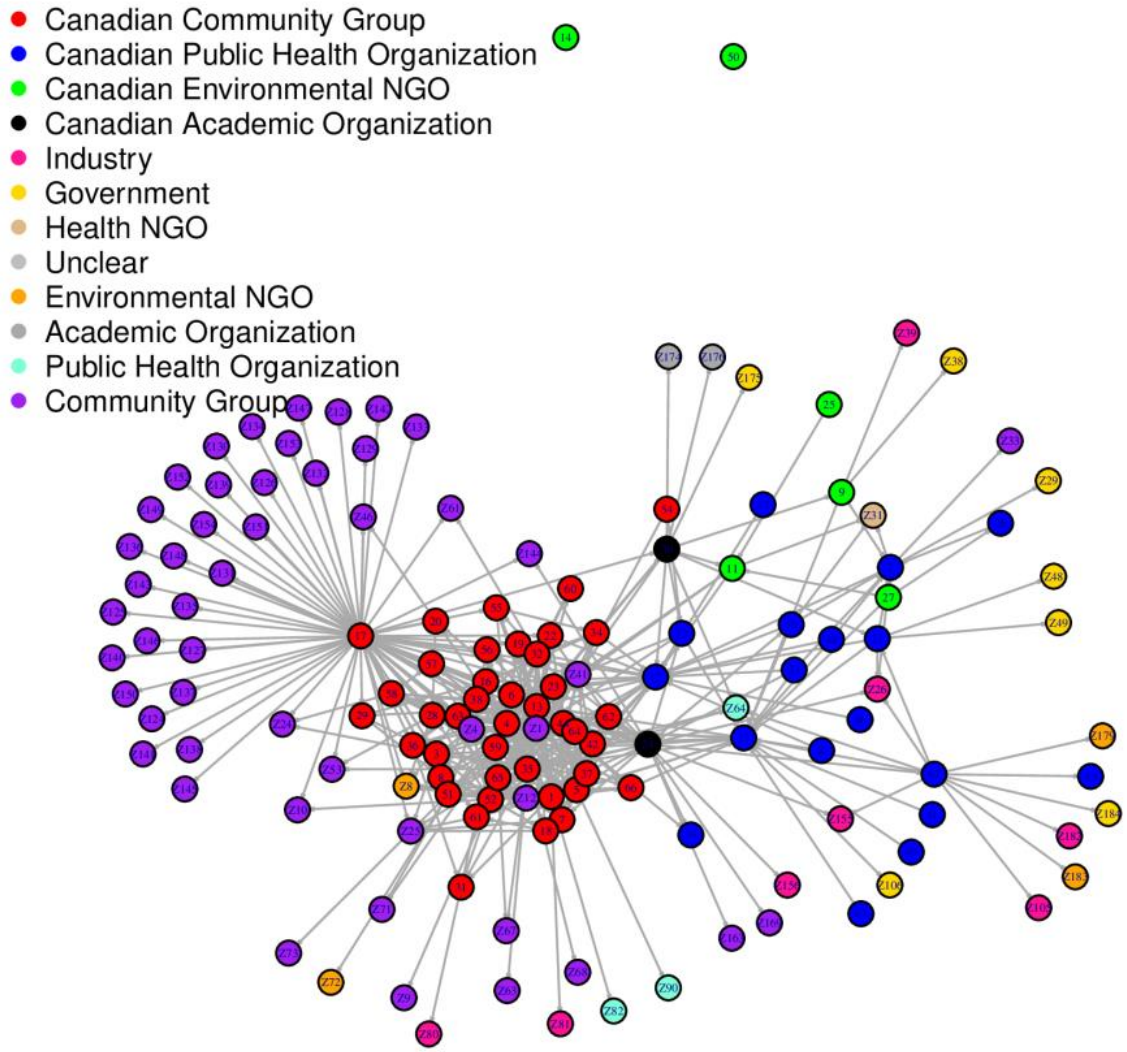


**Figure 20.** Non-Canadian websites in the network of Canadian organization websites with content on wind turbines and human health with node size by degree

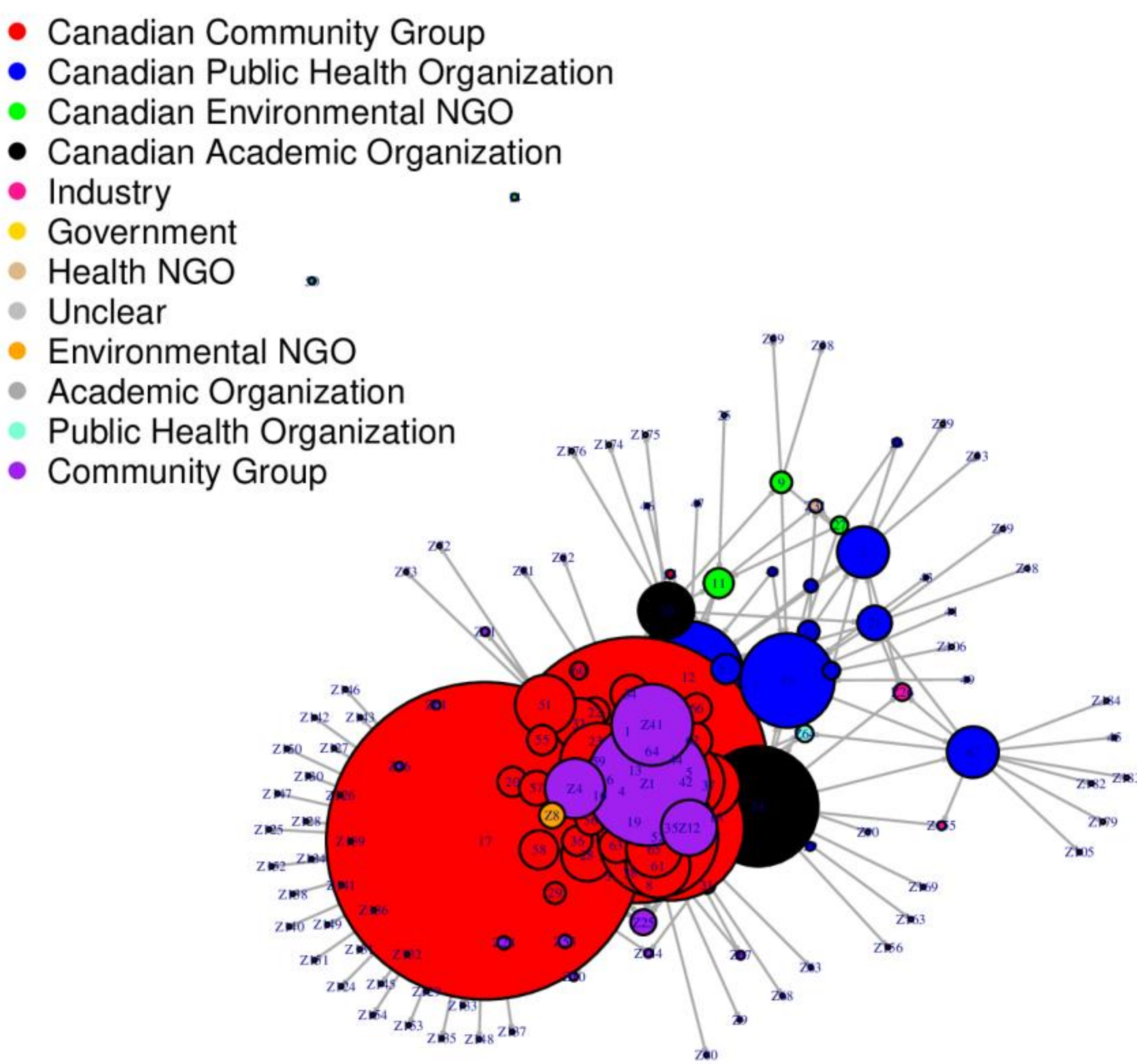


**Figure 21.** Sociogram of network with 251 organization websites with content on wind turbines and human health by cited as allied organization website characteristic

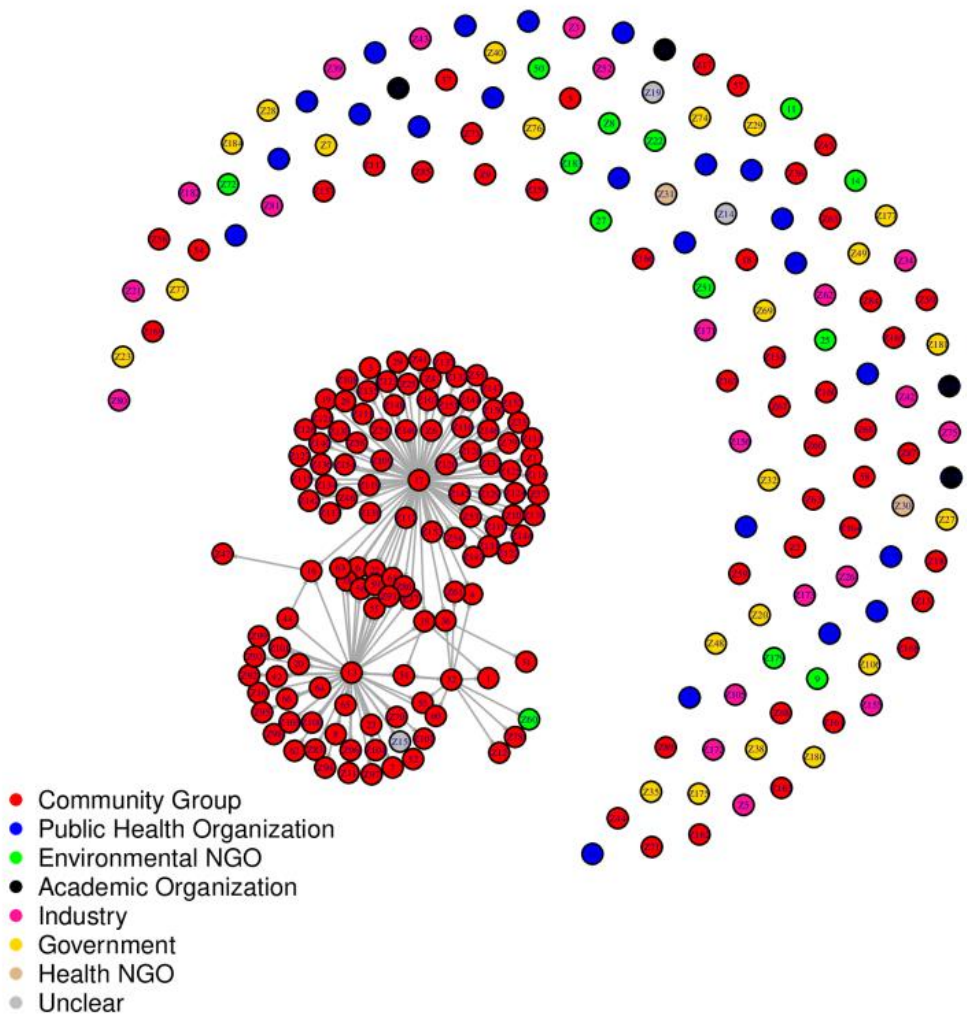


**Figure 22.** Sociogram of network with 251 organization websites with content on wind turbines and human health by cited as allied organization website characteristic with node size by degree

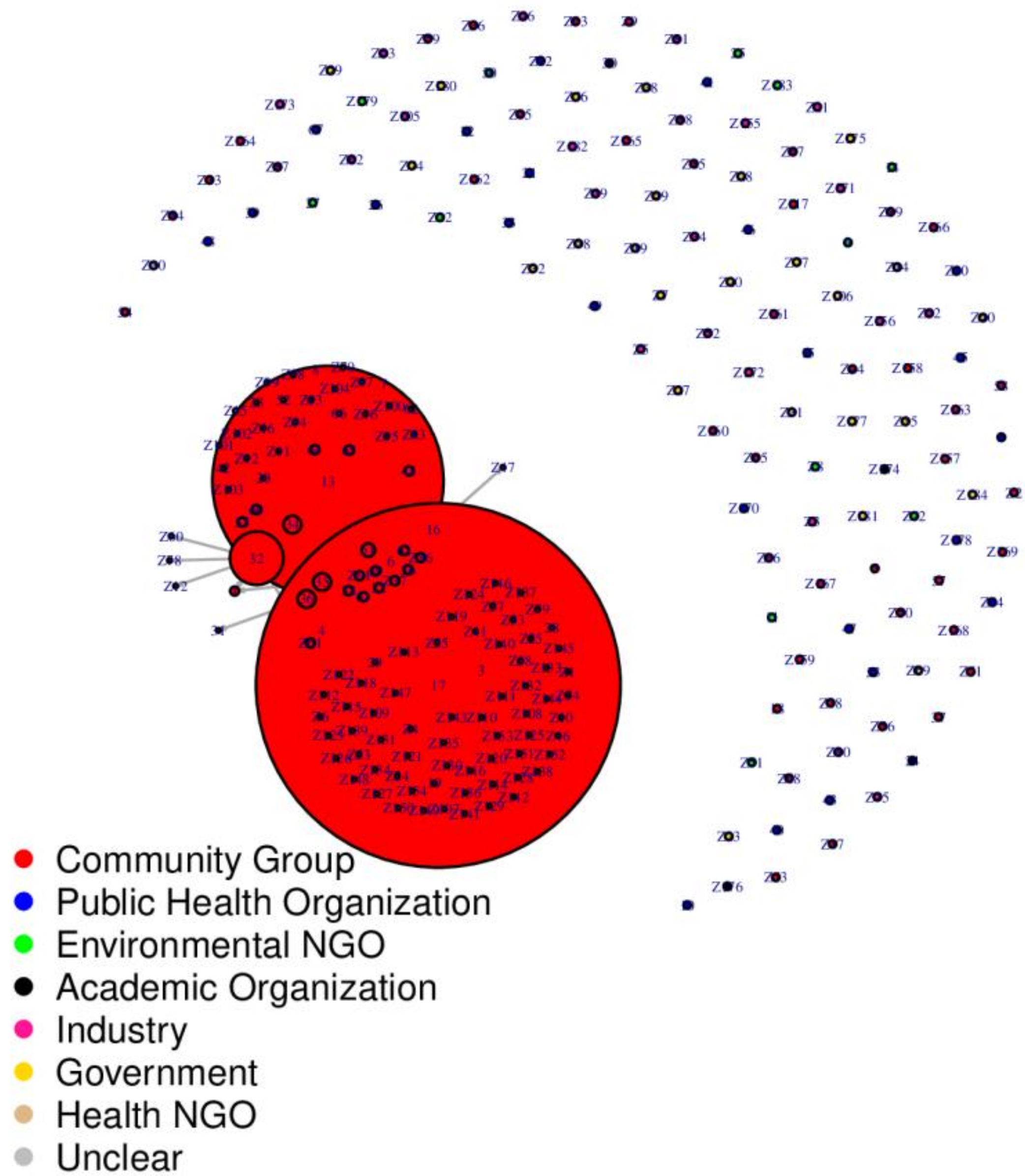


**Figure 23.** Sociogram of 251 organization websites with content on wind turbines and human health with ties to websites characterised as 'cited as supportive evidence

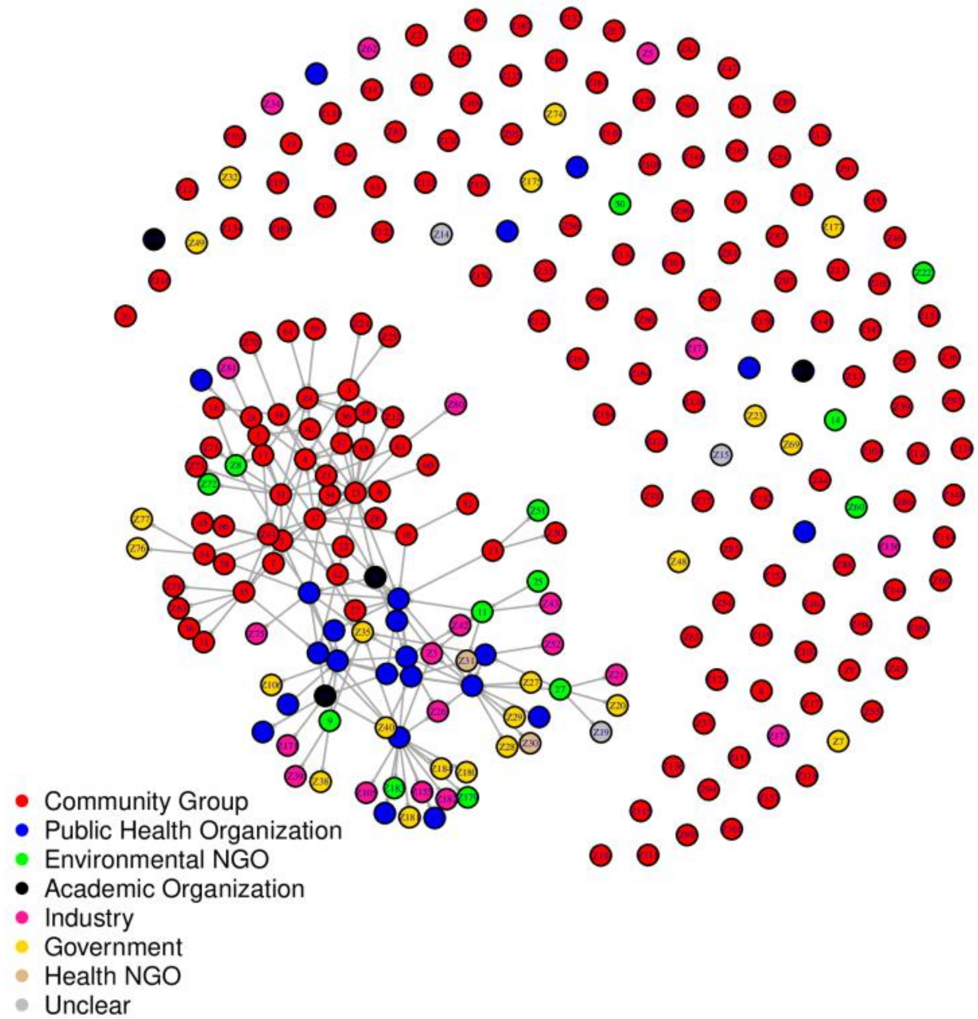


**Figure 24.** Sociogram of 251 organization websites with content on wind turbines and human health with ties to websites characterised as 'cited as supportive evidence' with node size by degree

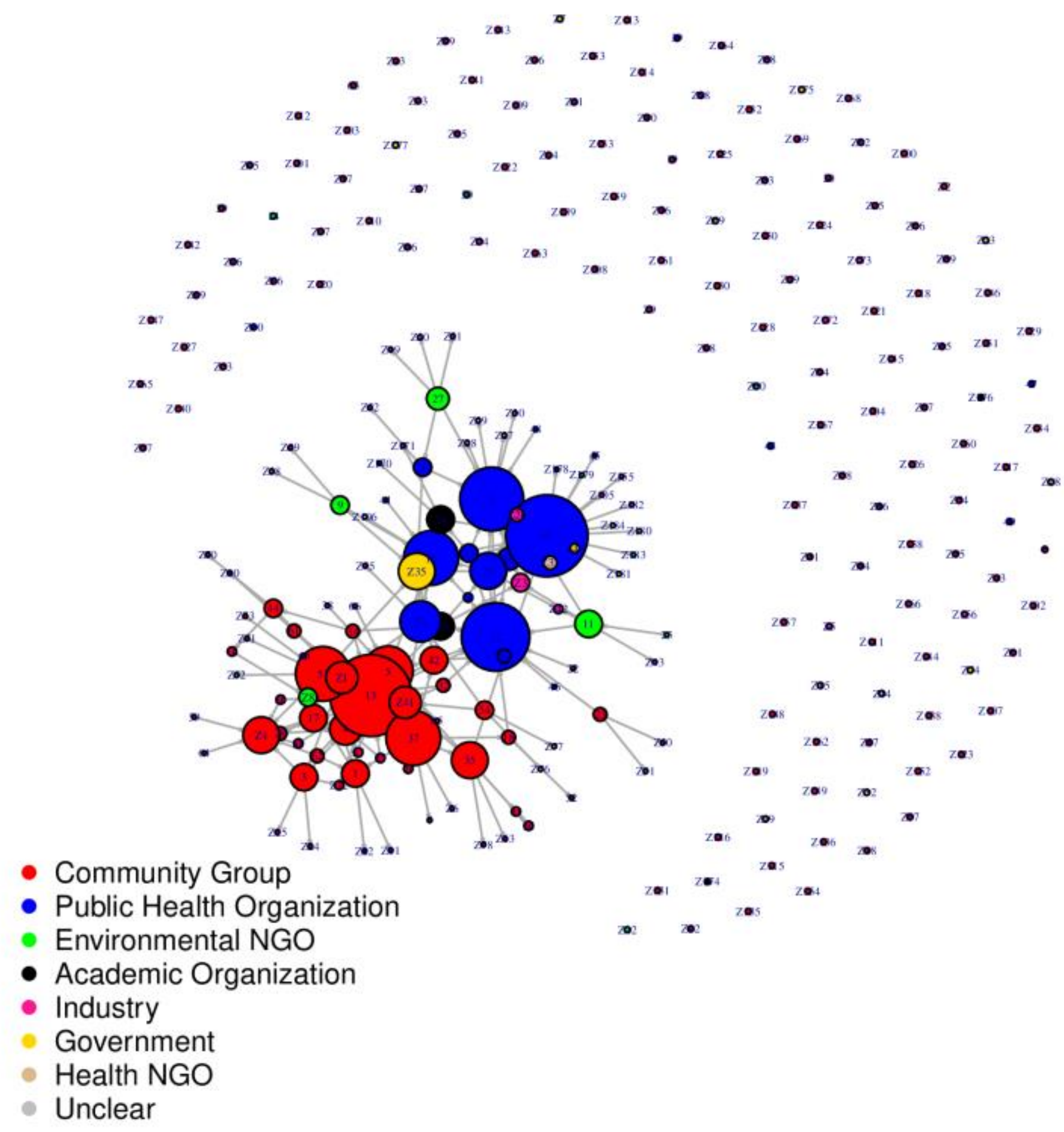


**Table 22.** Centrality measures and characteristics summary for the network of 67 organization websites with content on wind turbines and human health, networks with the additional 184 websites, and networks based on website citation attributes

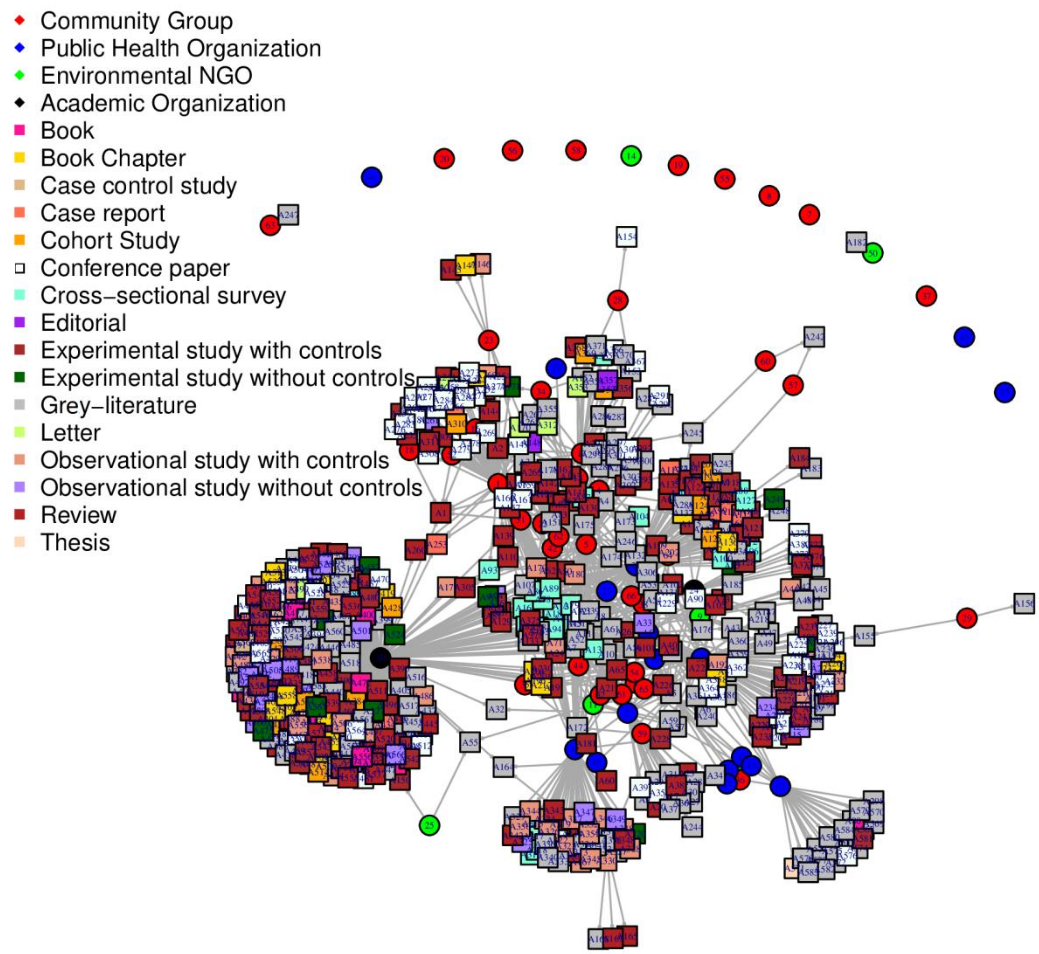
| Sociogram | Mean Degree | Density | Reciprocity | Mean Eigenvector | Mean Betweenness | Mean Closeness | Diameter | Assortativity |
|---|---|---|---|---|---|---|---|---|
| All 67 websites | 9.19 | 0.070 | 0.32 | 0.22 | 63.84 | 0.00075 | 6 | 0.48 |
| 67 websites + 184 additional websites | 5.39 | 0.011 | 0.14 | 0.092 | 96.80 | 3.46e-05 | 7 | 0.32 |
| Websites cited as supportive evidence | 1.44 | 0.0029 | 0.011 | 0.083 | 10.73 | 1.63e-05 | 8 | 0.34 |
| Websites cited as supportive evidence—major component | 3.35 | 0.016 | 0.011 | 0.19 | 24.94 | 9.91e-05 | 8 | 0.34 |
| Websites linked as allied organization | 1.19 | 0.0024 | 0.067 | 0.056 | 1.96 | 1.61e-05 | 4 | 0 |
| Allied organizations major component | 2.42 | 0.0099 | 0.067 | 0.11 | 4 | 0.00011 | 4 | 0 |
| 67 Websites + links to non-Canadian websites | 6.80 | 0.024 | 0.20 | 0.14 | 96.28 | 0.00016 | 7 | 0.40 |

The centrality measures for the original 67 organization websites network, the expanded network with the 67 websites and the additional 184 websites, as well as for the networks that were developed based on the website citation characteristics were summarized in Table 22. These centrality measures were used to describe the networks further. The centrality measures and characteristics for the network of Canadian organization websites with content on wind turbines and human health with citations of additional organization websites showed larger diameter and lower degree, density, reciprocity, mean Eigenvector score, assortativity and mean closeness compared to the initial network of 67 websites. Mean betweenness scores were lower for all networks compared to the initial network of 67 websites other than the network which included ties only to non-Canadian websites. Analysis of the major subcomponents present on the sociograms using attributes of 'cited as supportive evidence' or 'included as allied organization' found smaller diameter and mean betweenness scores, which was likely due to that assessing only a subcomponent of the graph. The lower centrality measures and characteristics observed when comparing the networks with the additional organization websites compared to the network with the 67 websites are likely related to the increased size of the network and the absence of data for the ties originating from the additional organization websites. Thus, interpretation of the network characteristics was limited to the relationships within the Canadian organization website network and its directed ties out of this network.

### 5.3.3 Assessment of Network with Evidence Citations

The structure of how the different organization websites cited evidence sources was visualised in a sociogram (Figure 25). This two-mode network included a large subcomponent with most (53/67; 79%) of the organization websites and evidence sources (582/584; 99.7%).

**Figure 25.** Sociogram of the 67 Canadian organizations with content on human health and wind turbines linking to evidence sources listed by organization type and evidence type




Centrality measures were calculated for the sociogram (Table 24), which showed a mean degree of 3.16 and a density of 0.0024, where only ties from the 67 organization websites to evidence sources—and not from evidence sources to website or to other evidence sources—were included within the network. The sociogram includes many ties (citations) of evidence sources that were only cited once (433/584; 74%). These single citation evidence sources provide additional context and support for the issue of the impact of wind turbines on human health, however they are not otherwise connected within the network. The majority of the community group websites appeared to cluster on one side of the network, while the public health organization websites appeared to cluster on the other, with some mixing between the organization types in the centre of the network. A few organization websites had citation numbers (outdegree) that were much greater than the mean of 15.5 citations per websites, including an academic organization website (238 citations), two public health organization websites (97 and 92 citations respectively) and one community group website (81 citations). These websites had undertaken extensive review of the subject of wind turbines and human health, and the number of citations reflects the breadth of their comprehensive reviews. The distribution of ties to and from nodes in the sociogram was represented by a histogram in Figure 26. The network of organization website citations was also visualised using degree for node size to show the relative contribution of each website or evidence source to the network (Figure 27). Overall, most nodes had few ties to or from their node. When degree is visualized in the sociogram through node size (Figure 27), a small number of organization websites dominated the network.

**Figure 26.** Histogram of degree distribution for 67 Canadian organizations websites with content on wind turbines and human health citation of evidence by type of degree (in, out or total)

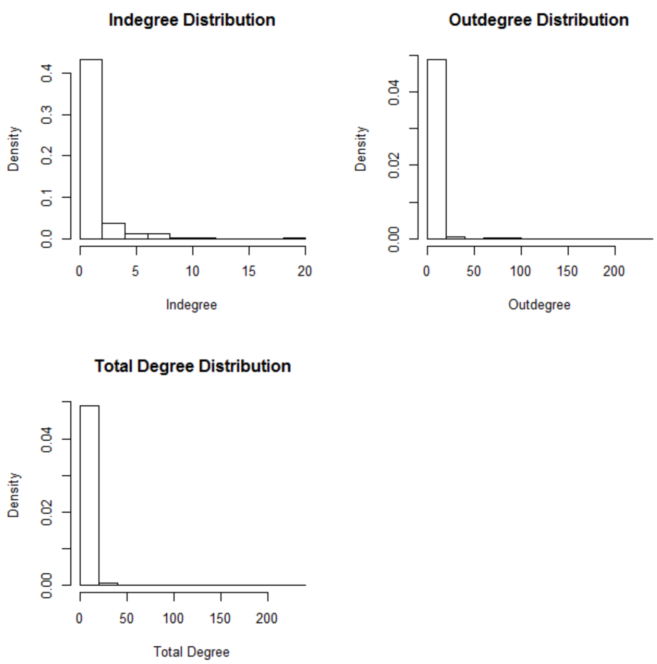
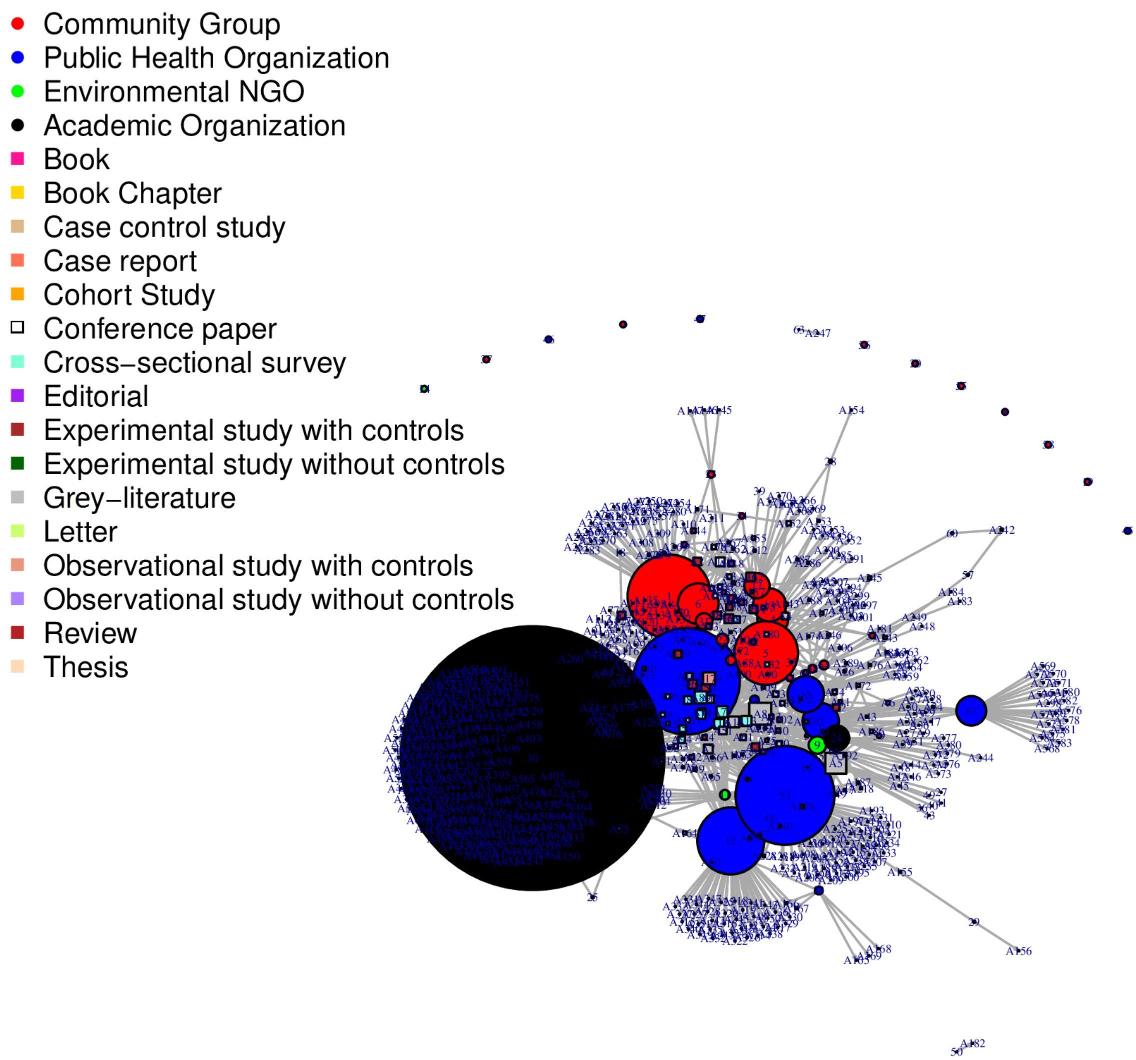
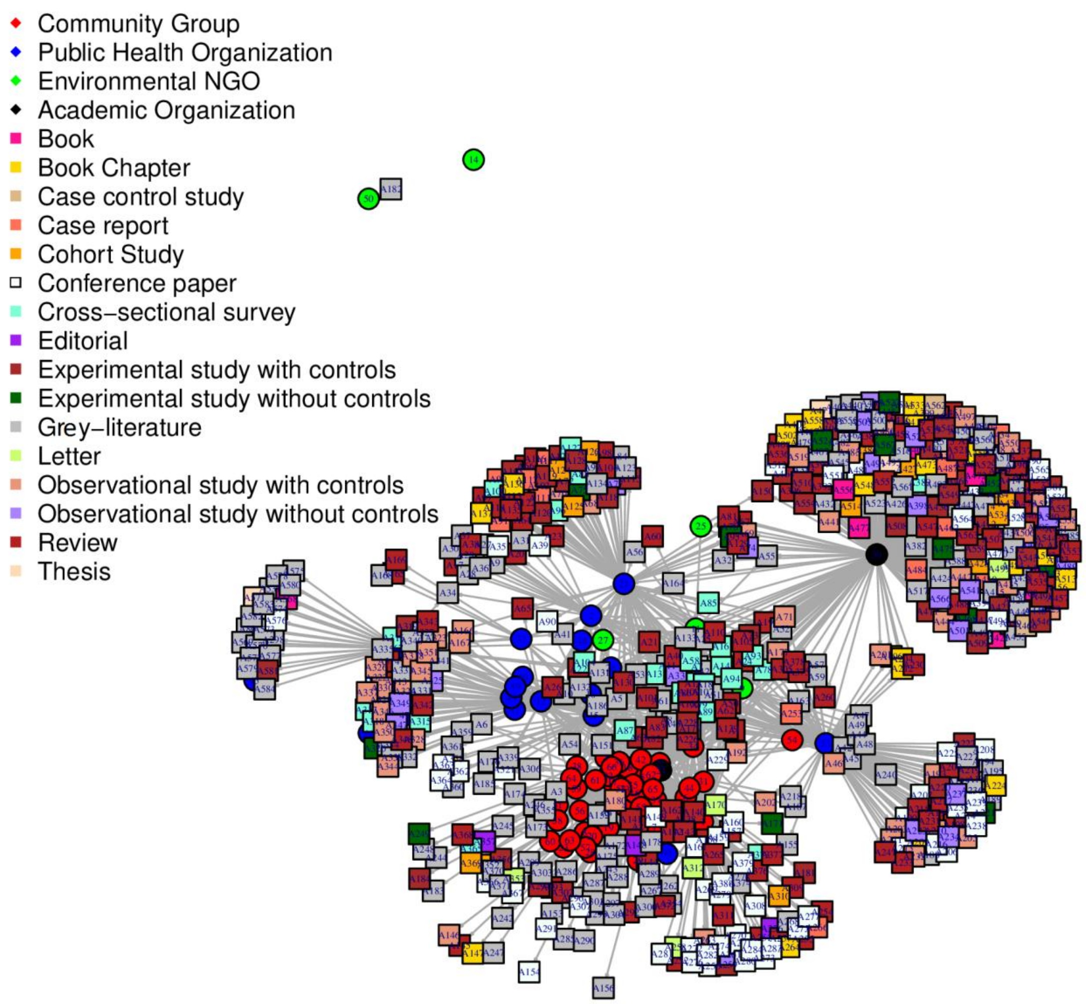


**Figure 27.** Sociogram of the citation of evidence by the 67 Canadian organization websites with content on wind turbines and human health with node size reflecting degree




For comparative purposes, the sociogram in Figure 28 illustrates the ties between the 67 organization websites with content on wind turbines and human health as well as the ties from these organizations to the evidence sources to visualise the organization website to website ties concurrently with the website to evidence sources ties. Further analyses of the evidence citation data were done solely with organization website citations of evidence sources, as the network of organization links were previously assessed.

**Figure 28.** Sociogram with all 67 Canadian organization websites with links to each organization and evidence source categorized by type




When evidence sources that were cited only once or twice were excluded, the patterns of citations were easier to discern (see the sociograms in Figure 30 and Figure 32), and the proportion of websites that were excluded from the main network component remained consistent—14/67 (21%) were not part of the network when considering all evidence sources; 14/67 (21%) remained apart when excluding sources with only one citation; and 15/67 (22%) were separate from the main network component when evidence sources with two or fewer citations were excluded. Sociograms that represented degree by node size continued to demonstrate the impact of a small number of nodes in the network (See Figure 31 and Figure 33). Grey literature, reviews and cross-sectional surveys were the most frequently cited types of evidence, representing 21 of the top 25 (85%) highest cited (7 or more citations) evidence sources in the network overall (See Appendix 7: Most Frequently Cited Evidence Sources by Organization Websites with Content on Wind Turbines and Human Health Overall and by Organization Type for the details of citation counts by evidence source). When assessing for structural equivalency for the network formed between the 67 Canadian organization websites and the evidence sources that were cited more than twice using a cluster dendrogram (Figure 29), evidence sources were found to fall into two broad divisions which included website nodes clustered by organization type. The structural equivalence between websites that were of a provincial or national scale observed in the previous dendrograms appeared to persist in this dendrogram.

**Figure 29.** Cluster dendrogram of Canadian organization websites with content on wind turbines and human health evidence citation for sources with more than two citations

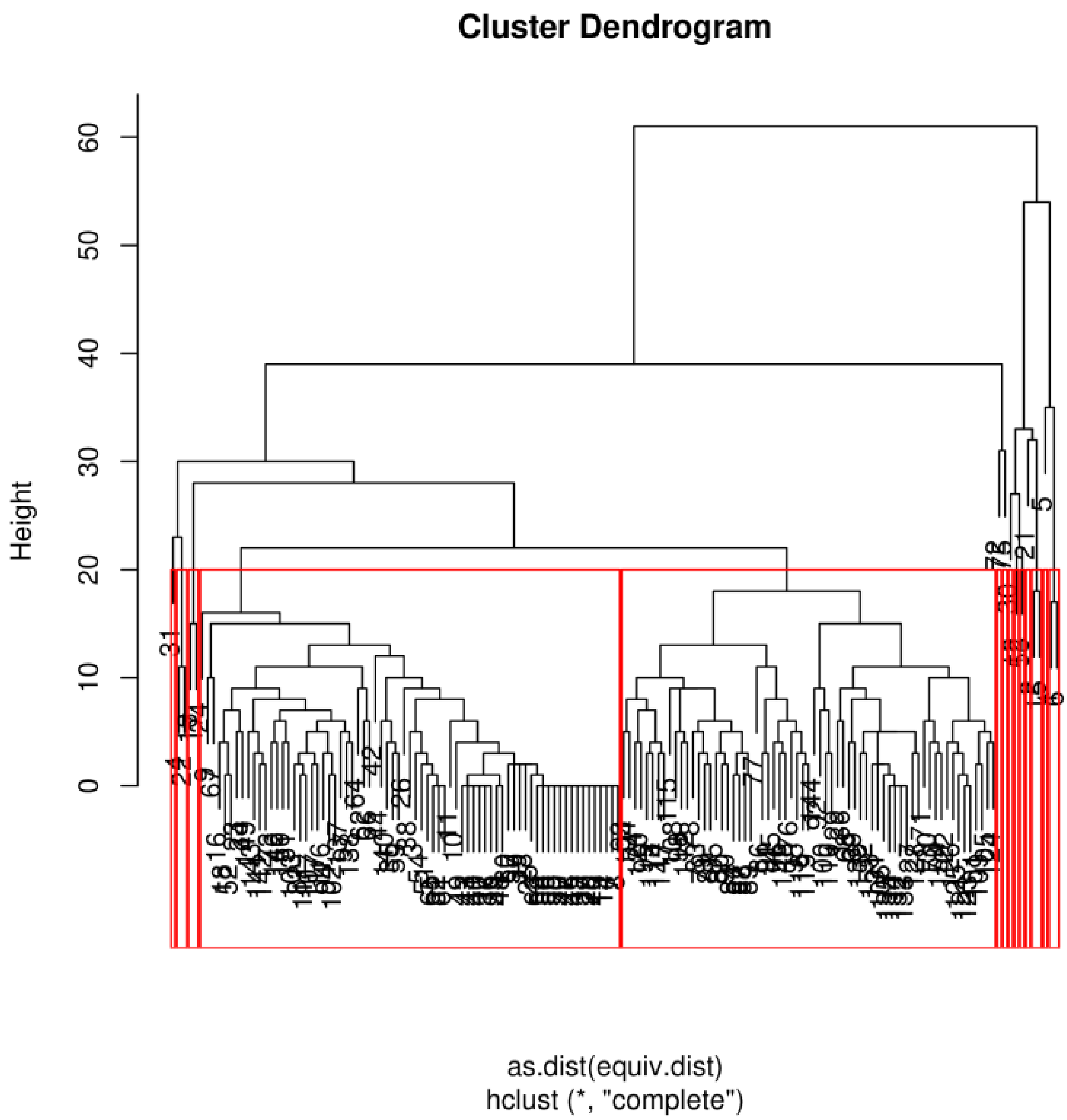


**Figure 30.** Sociogram of 67 Canadian organization websites with content on wind turbines and human health evidence citation by category for sources with more than one citation

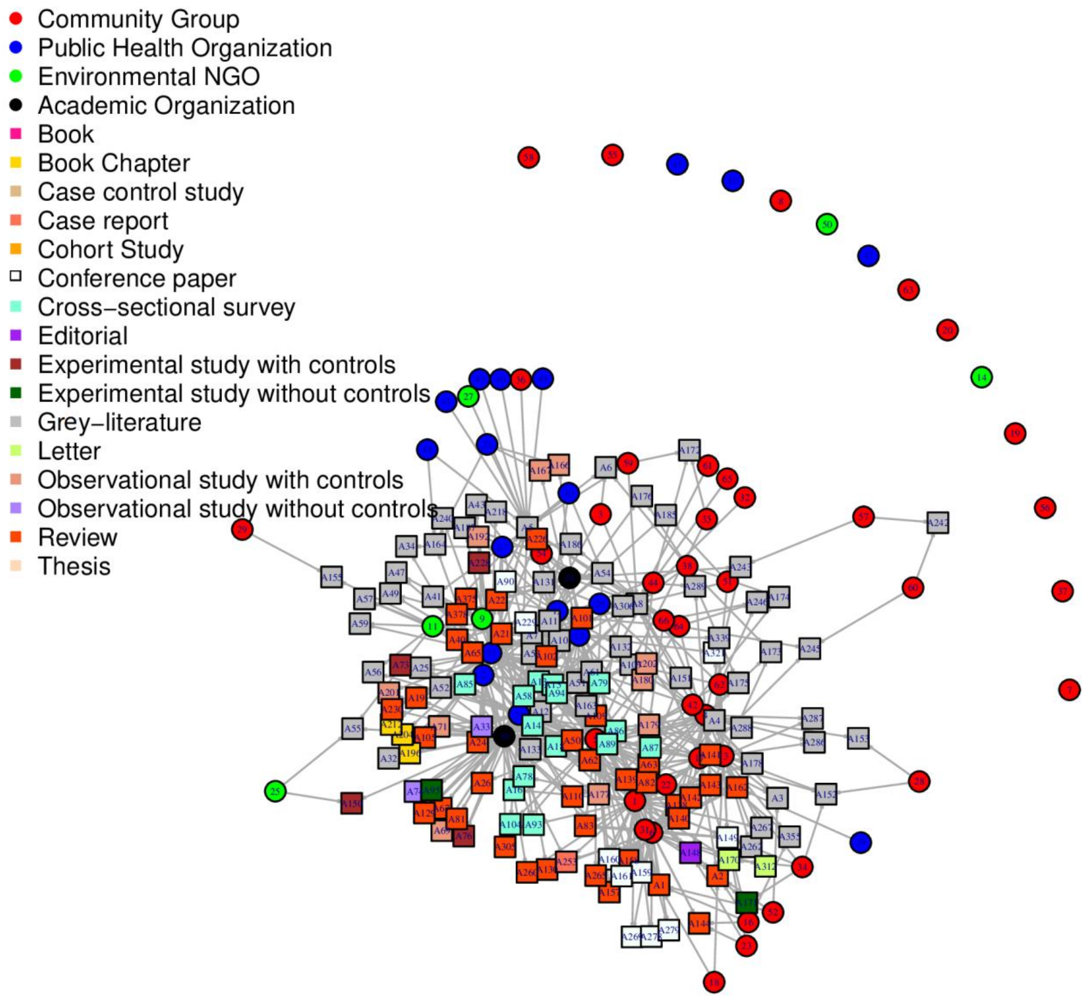


**Figure 31.** Sociogram of 67 Canadian organization websites' citation of evidence sources by category with more than one citation with node size by degree

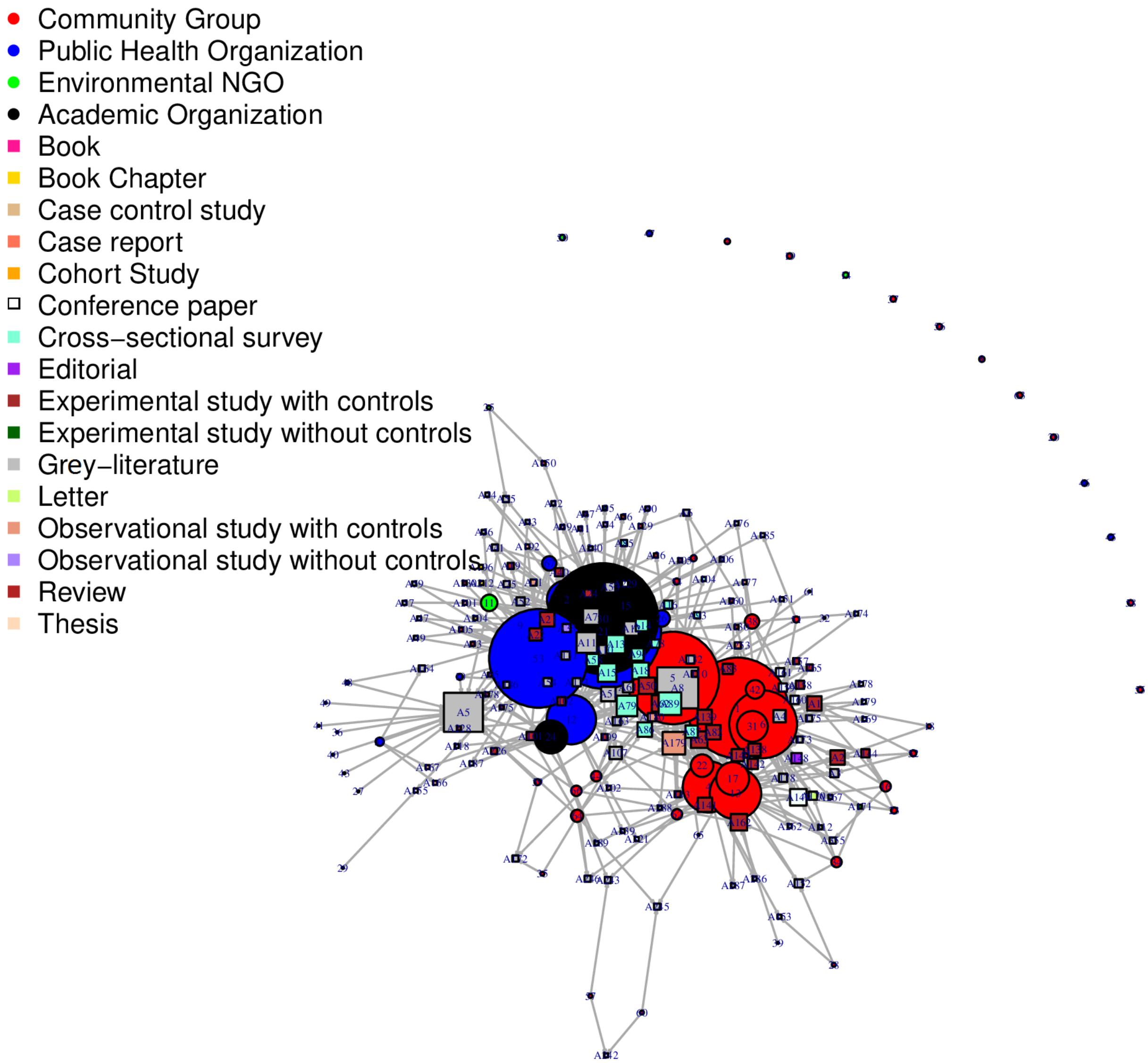


**Figure 32.** Sociogram of 67 Canadian organization websites with content on wind turbines and human health evidence citation by category for sources cited more than two times

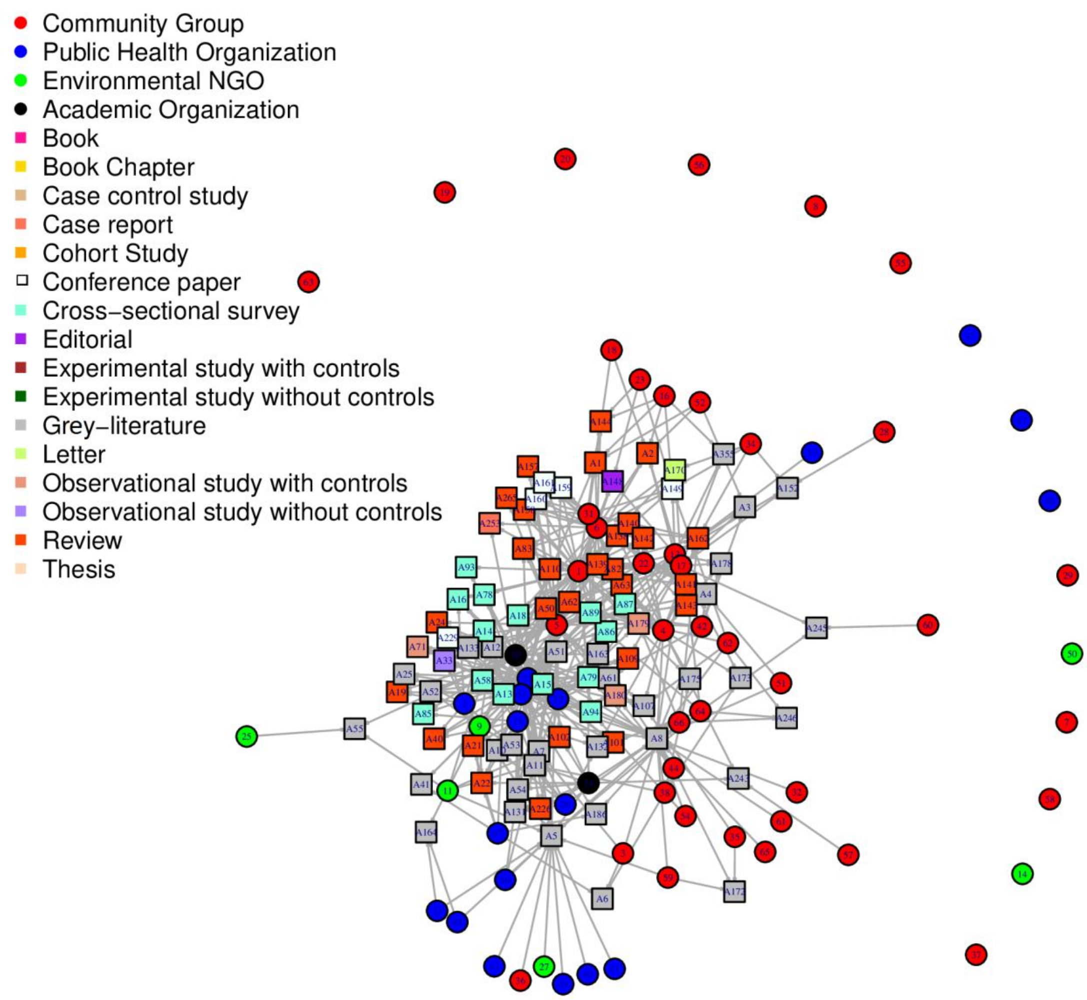
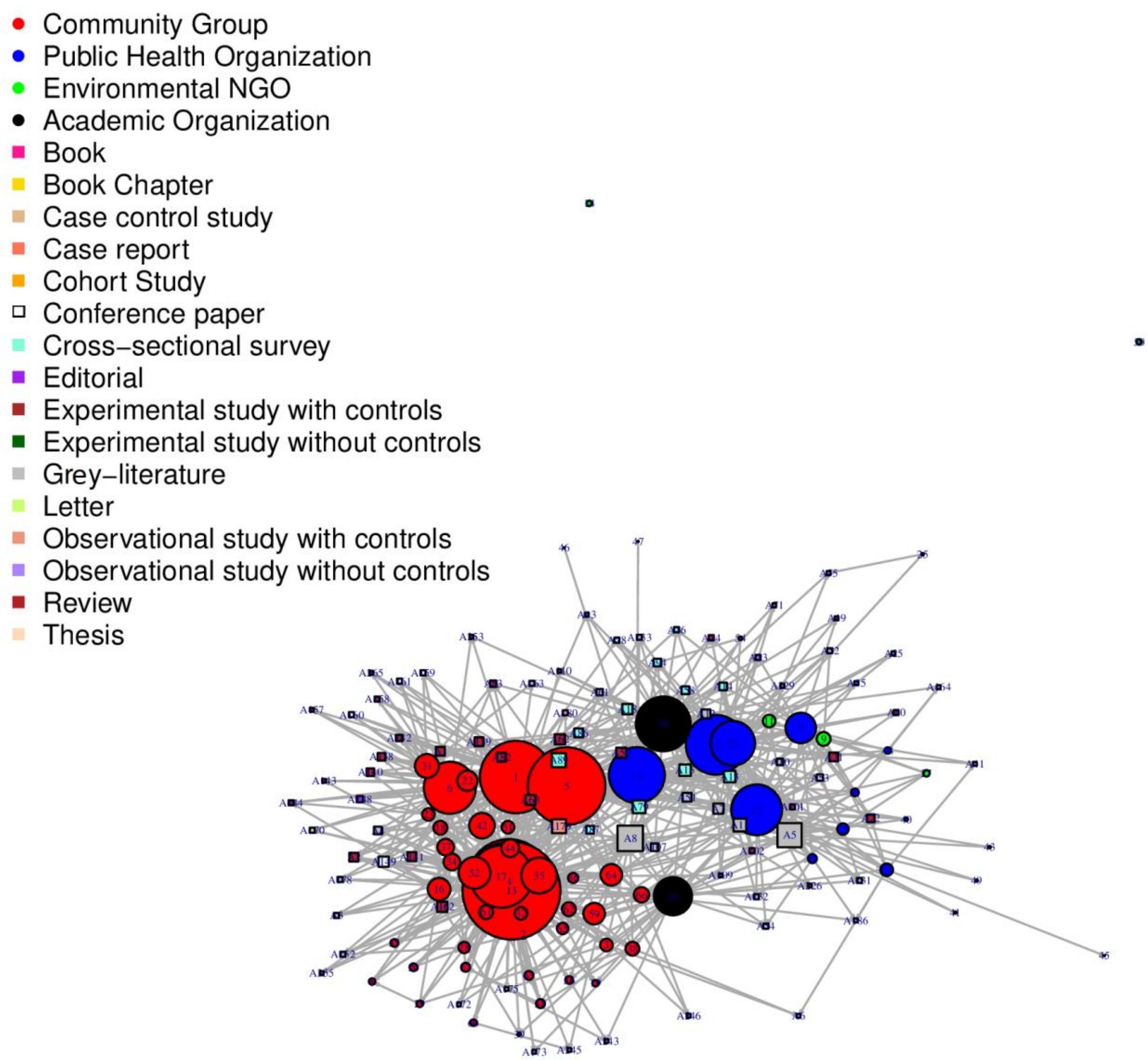


**Figure 33.** Sociogram of 67 Canadian organization websites with content on wind turbines and human health evidence citation with more than two citations by category with node size by degree




Additional sociograms that used only community group website evidence citation or only public health organization website evidence citation were created to examine the citation of evidence sources that were cited more than two times (Figure 34, Figure 35, Figure 36, and Figure 37). These networks which were comprised solely of community group websites or public health organization websites showed that a small subset of the websites and evidence sources had a larger degree within the networks. The type of frequently cited evidence was similar comparing community group and public health organization websites, although the specific sources that were cited varied by the organization type shown.

**Figure 34.** Sociogram of Canadian organization websites with content on wind turbines and human health evidence citation by evidence type for community group websites only

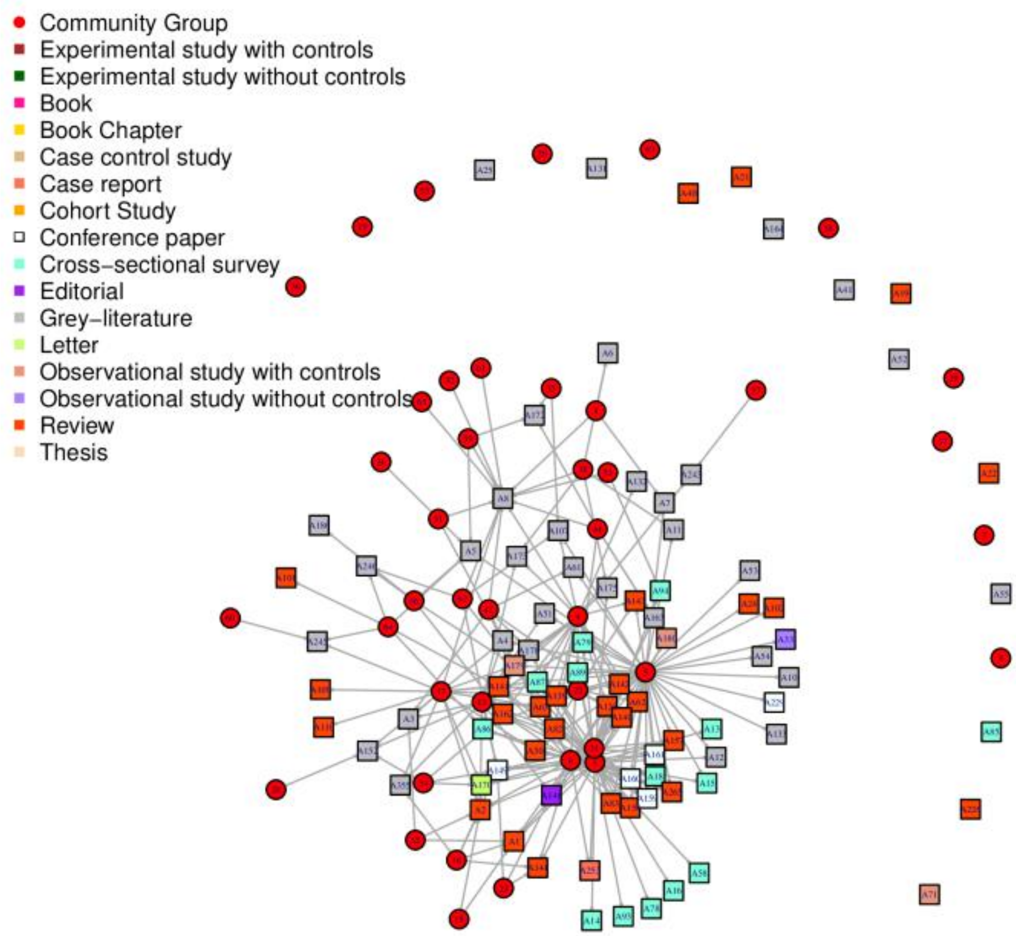


**Figure 35.** Sociogram of Canadian organization websites with content on wind turbines and human health evidence citation by evidence type with node size representing degree for community group websites only

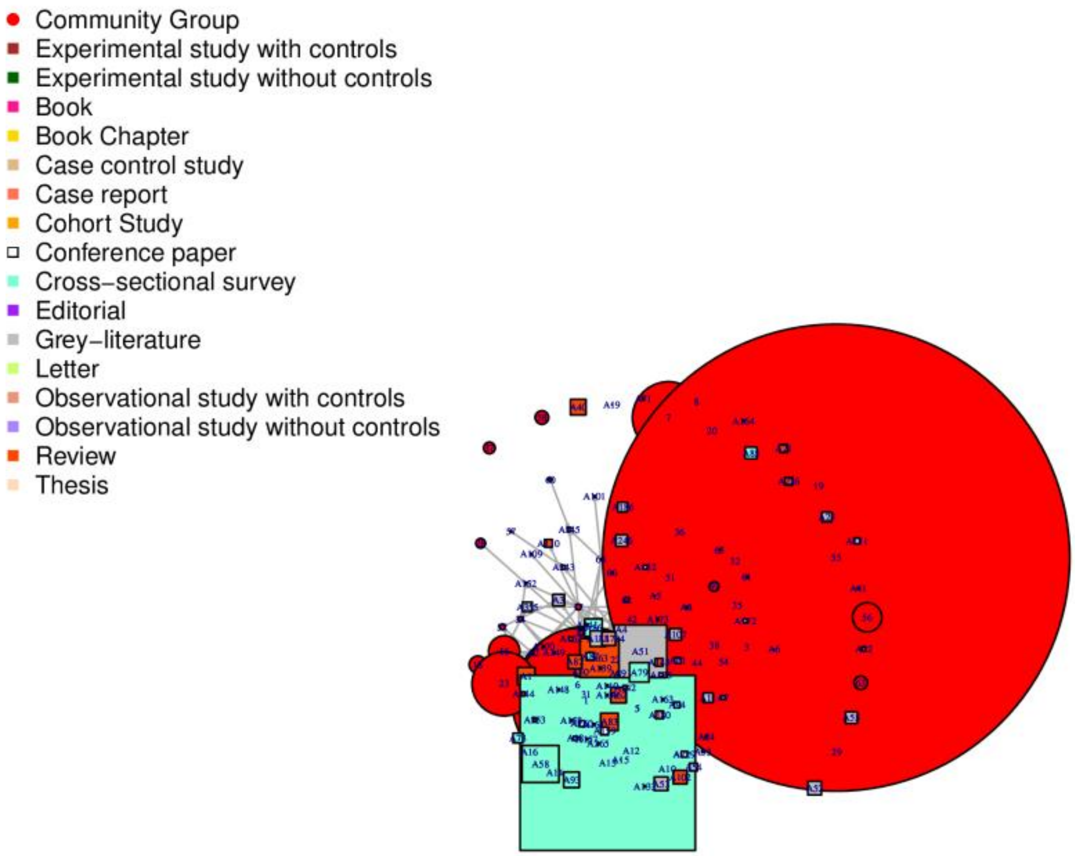


**Figure 36.** Sociogram of Canadian organization websites with content on wind turbines and human health evidence citation by evidence type for public health organizations only

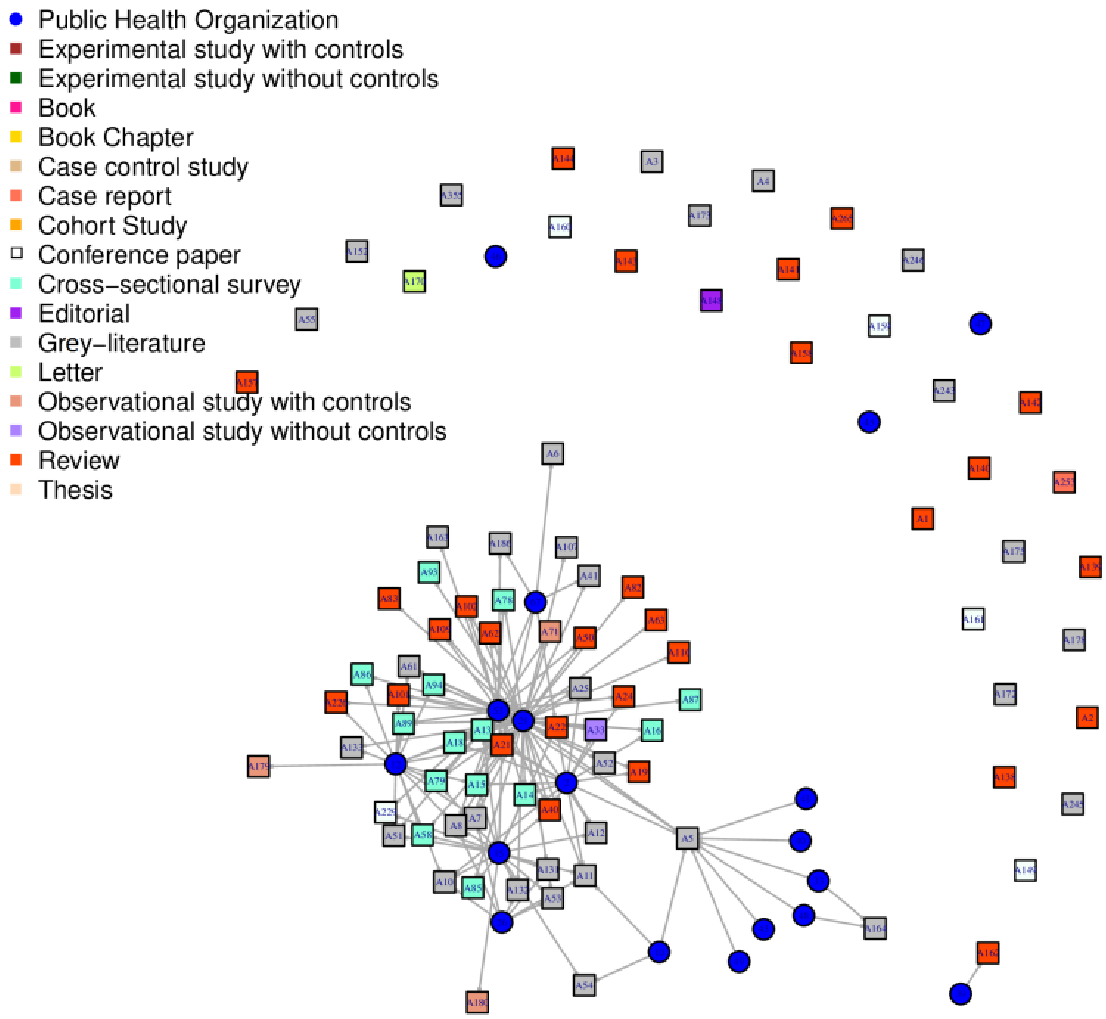
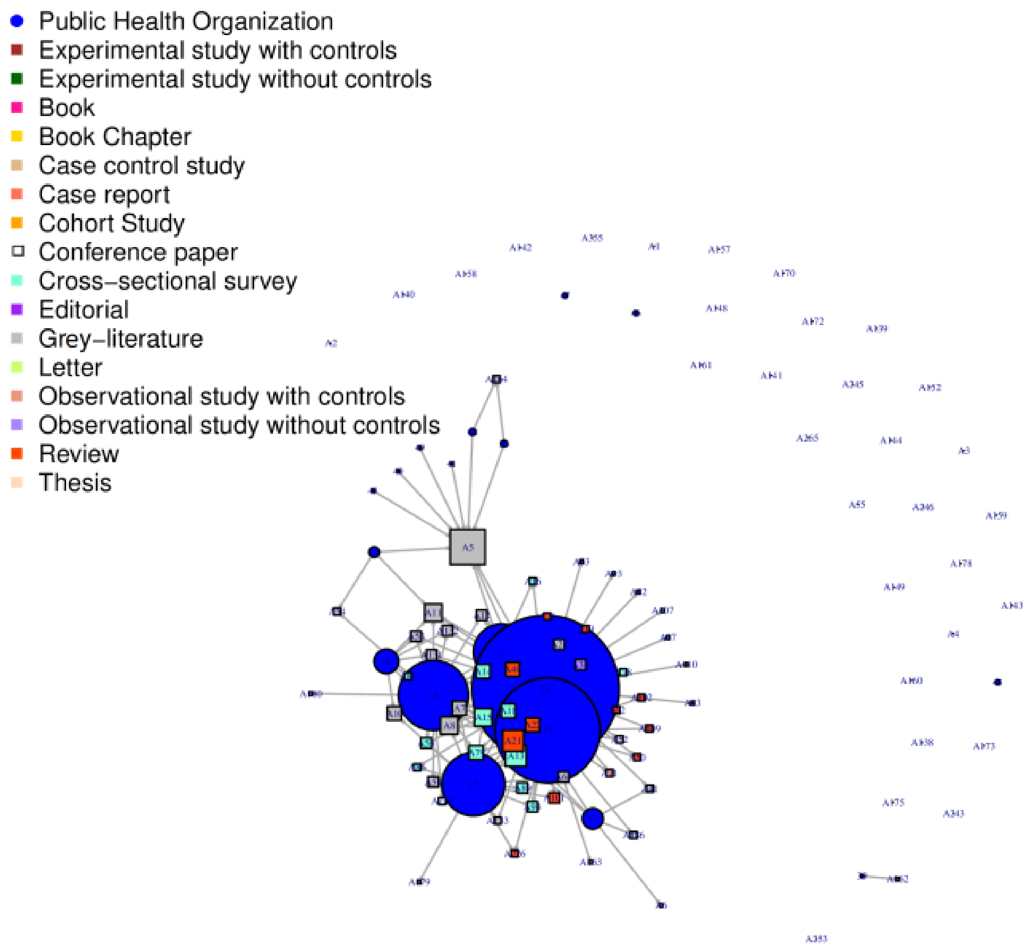


**Figure 37.** Sociogram of Canadian organization websites with content on wind turbines and human health evidence citation by evidence type with node size by degree for public health organizations only




The network centrality measures and characteristics for the networks involving only a subset of the websites by organization type were provided in Table 23. Given that the networks involved two-mode directed data with no directed ties originating from the evidence sources, the values for reciprocity, betweenness, and assortativity were all 0 for the evidence citation networks. Similarly the diameter of the network was 1 for all evidence citation networks. The mean degree for the networks increased as only the more frequently cited evidence sources were considered. The mean degree per website was higher for community group websites compared to public health organization websites when considering the citation of evidence—irrespective of whether all evidence sources were considered, or only the subsets of more frequently cited evidence. The density of the networks increased as the evidence citations were limited to only frequently cited evidence sources, however, direct comparison of density measures between the networks with community group websites and the networks with public health organization websites was not possible given the differing numbers of websites in the networks. The mean closeness and mean Eigenvector values increased in the networks as the evidence citations were limited to frequently cited evidence sources.

**Table 23.** Network centrality measures and characteristics for networks of 67 Canadian organization websites with content on wind turbines and human health by evidence citation by citation count and by network subgraph by organization type

| Sociogram | Mean Degree | Density | Mean Closeness | Mean Eigenvector |
|---|---|---|---|---|
| All 67 websites | 9.19 | 0.070 | 0.00075 | 0.22 |
| 67 websites + all evidence | 3.16 | 0.0024 | 2.37e-06 | 0.038 |
| Public health organization websites only with all evidence | 2.65 | 0.0048 | 1.34 | 0.081 |
| Community group websites only with all evidence | 3.63 | 0.0090 | 2.49e-05 | 0.99 |
| 67 Websites and cited >1 evidence | 5.49 | 0.013 | 2.19e-05 | 0.15 |
| Public health organization websites only cited >1 evidence | 3.62 | 0.016 | 8.40e-05 | 0.15 |
| Community group websites only Cited >1 evidence | 4.48 | 0.017 | 5.81e-05 | 0.15 |
| 67 Websites and cited >2 evidence | 6.09 | 0.020 | 4.34401e-05 | 0.20 |
| Public health organization | 4.35 | 0.032 | 0.00022 | 0.20 |

| | | | | |
|---|---|---|---|---|
| websites only cited >2 evidence | | | | |
| Community group websites only cited >2 evidence | 4.90 | 0.024 | 9.44e-05 | 0.18 |

Cluster dendrograms (Figure 38 and Figure 39) used to assess for structural equivalence of the nodes in the networks formed by community groups or public health organization websites' ties to evidence with more than two citations found that a number of websites were structurally distinct from the majority of nodes and each other, representing community groups or public health organizations that represented provincial or national level issues as well as a local community and a public health unit with a comprehensive background on the issue. The cited evidence sources showed predominantly structural equivalence, although key grey literature reports were distinct on both dendrograms.

**Figure 38.** Cluster dendrogram for network of Canadian community group websites with content on wind turbines and human health evidence citations with more than two citations

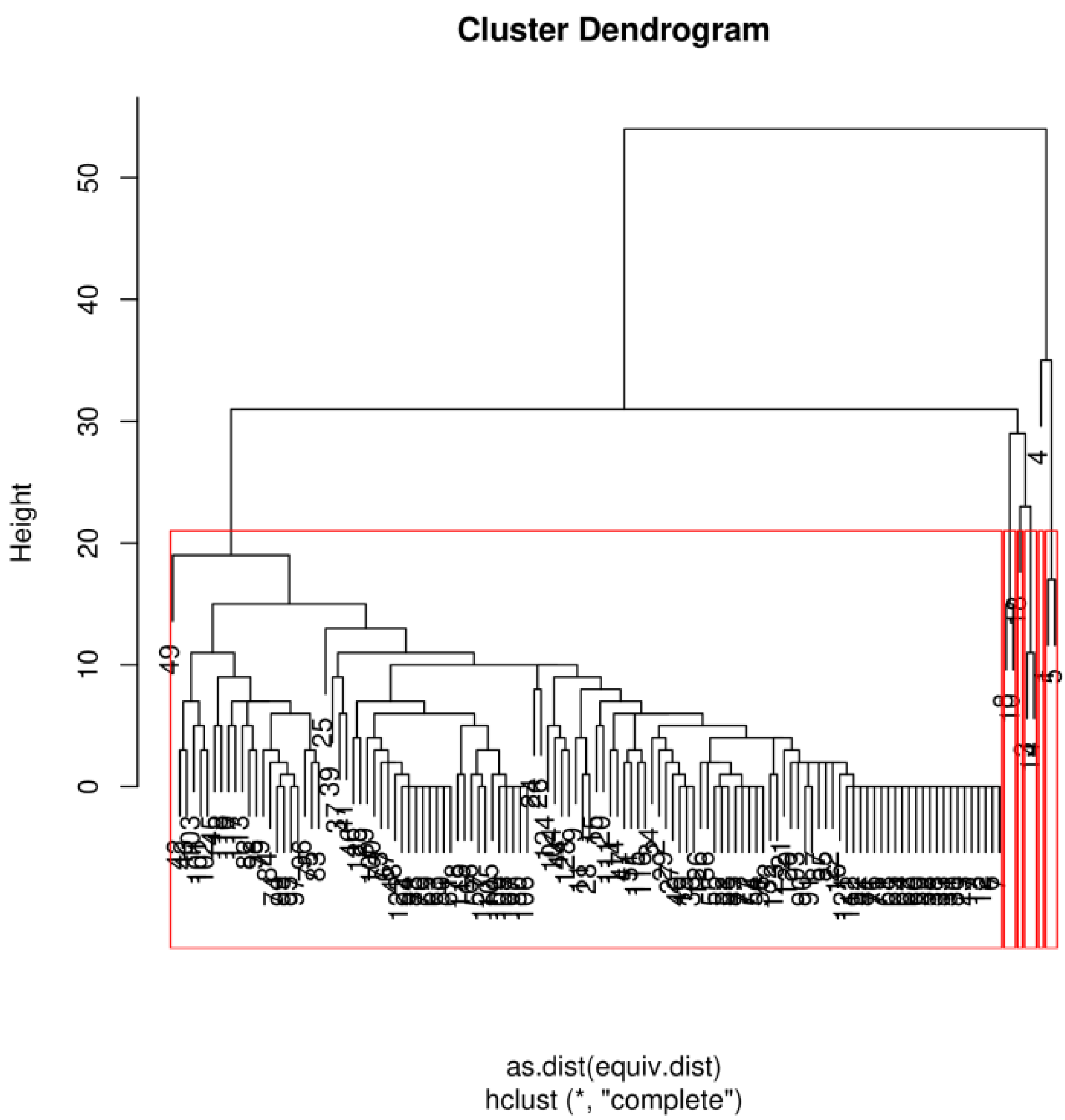
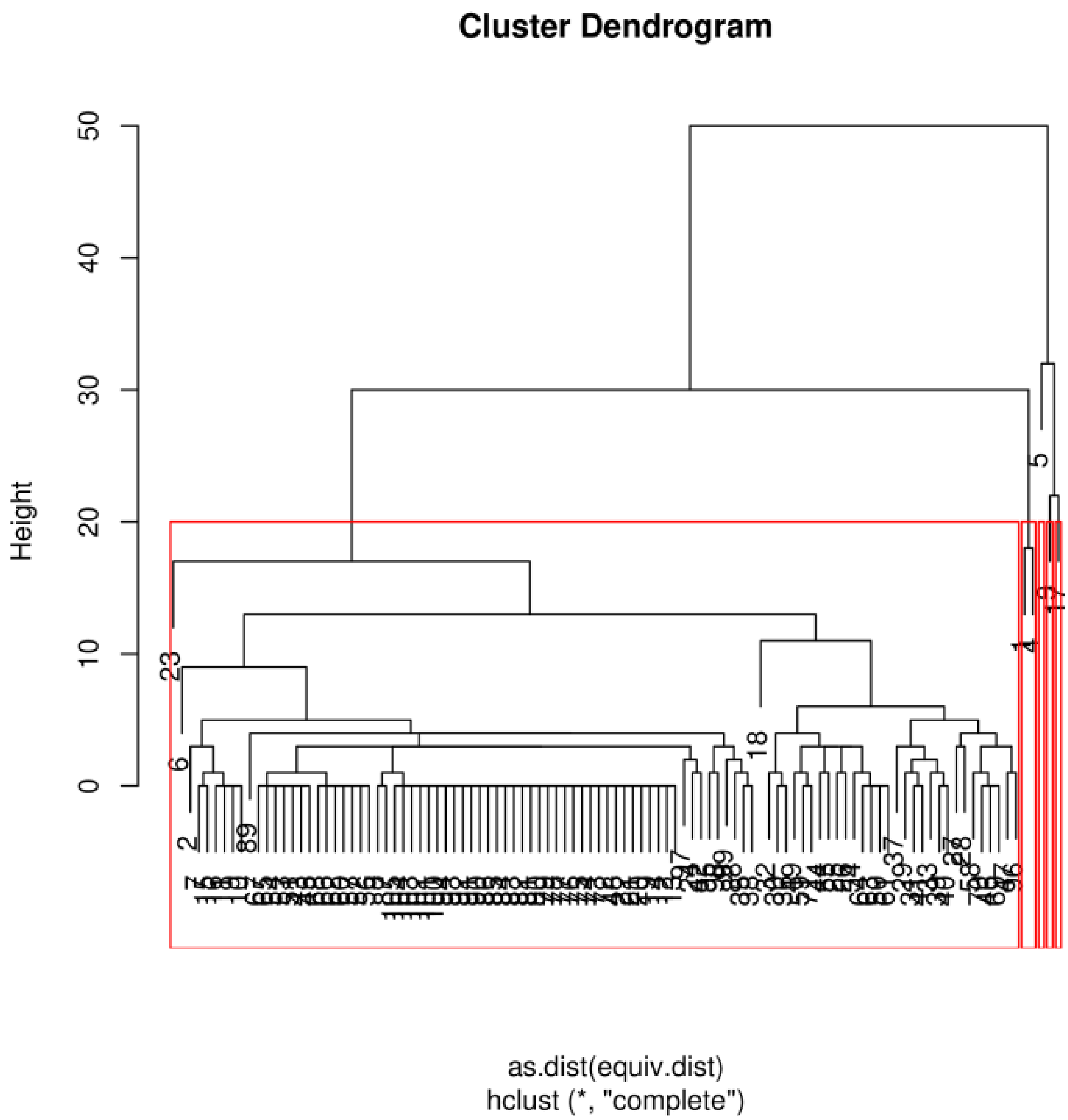


**Figure 39.** Cluster dendrogram for network of Canadian public health organization websites with content on wind turbines and human health evidence citations with more than two citations



When the level of evidence for the evidence citations was considered, the network in Figure 40 demonstrated the majority of evidence sources cited overall were from lower level evidence sources, and many of the higher level evidence sources were cited only once by websites with a high number of evidence citation links. The impact of these nodes with high numbers of citations on the network was visualised by having node size by degree (Figure 41). When considering only more frequently cited evidence sources (sources cited more than once (Figure 42), the majority of evidence citations were lower level of evidence or reviews, with most of the higher level evidence sources present in the centre of the network or located within a part of the network with public health organizations and academic organizations. The sociogram representing the level of evidence for evidence sources with more than two citations (Figure 43) was similar to the sociogram for evidence sources cited more than once, where the majority of evidence nodes were lower level of evidence or reviews. In this sociogram of evidence sources that were cited more than twice, nodes representing the higher level evidence tended to be located in the centre of the network, or linked by academic or public health organization websites. Most websites linked to reviews or lower level evidence sources, but when visualised with node size representing degree (Figure 44) eight evidence sources with a higher level of evidence were central in the network and cited by community group, academic organization and public health organization websites. Additionally, two lower level evidence sources were prominent within the network and predominantly tied to community group websites and public health organization websites respectively. The specific evidence sources were distributed throughout the network, where certain sources were central and cited by all organization type websites and other, lower level of evidence, sources were located peripherally and cited by groups of websites of the same organization type. This demonstrated that while some evidence sources were shared, many of the evidence sources (predominantly lower level of evidence) cited by community groups or by the other organization types varied and were not shared across organization types.

**Figure 40.** Canadian organization websites with content on wind turbines and human health citation of evidence sources characterized by level of evidence

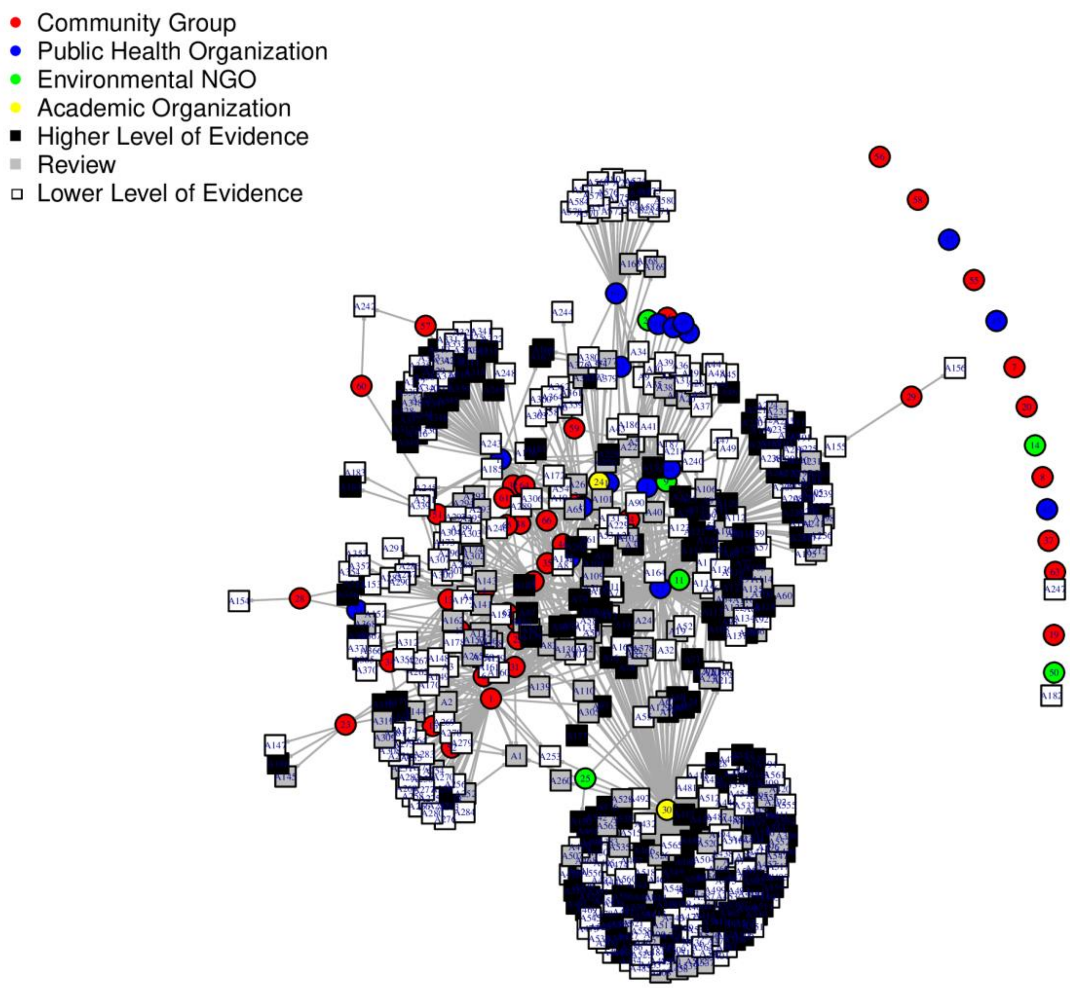


**Figure 41.** Canadian organization websites with content on wind turbines and human health citation of evidence sources characterized by level of evidence and node size indicating degree

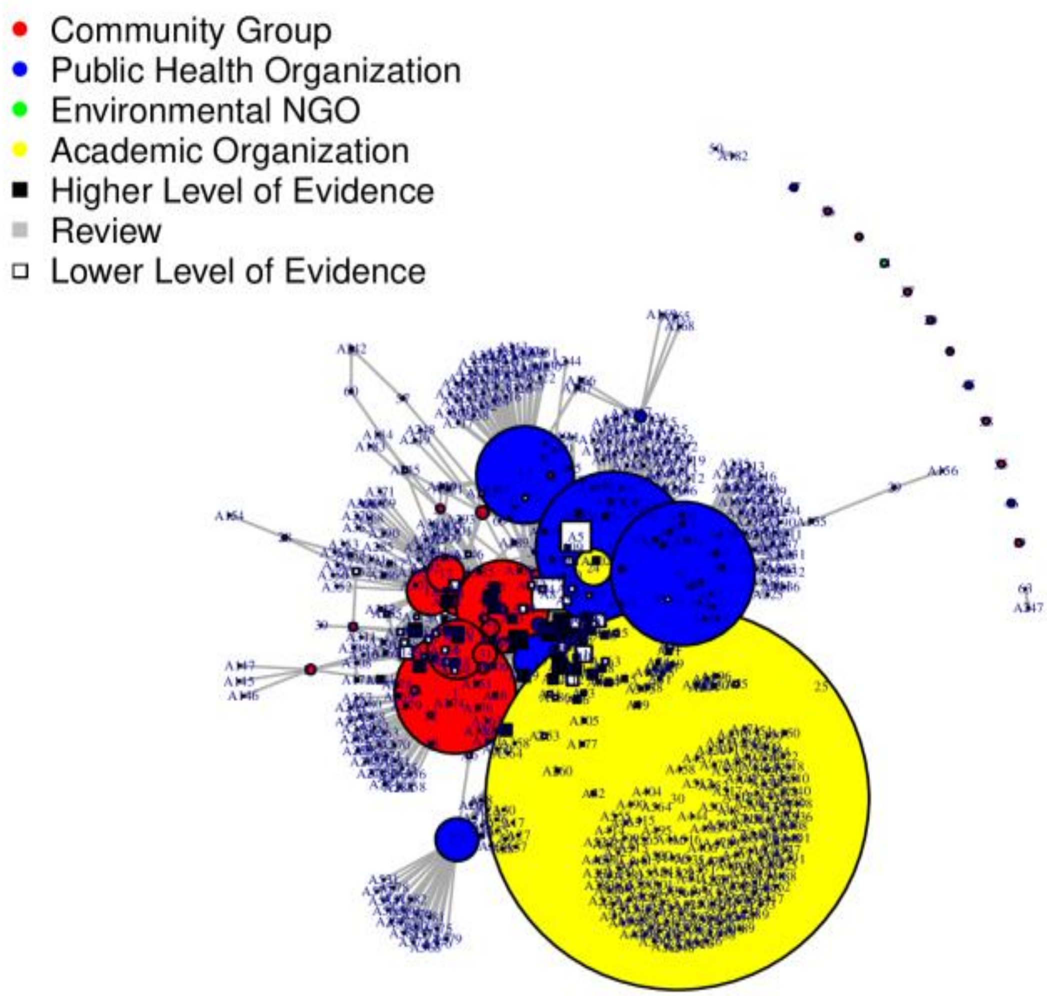


**Figure 42.** Canadian organization websites with content on wind turbines and human health citation of evidence sources cited more than once characterized by level of evidence

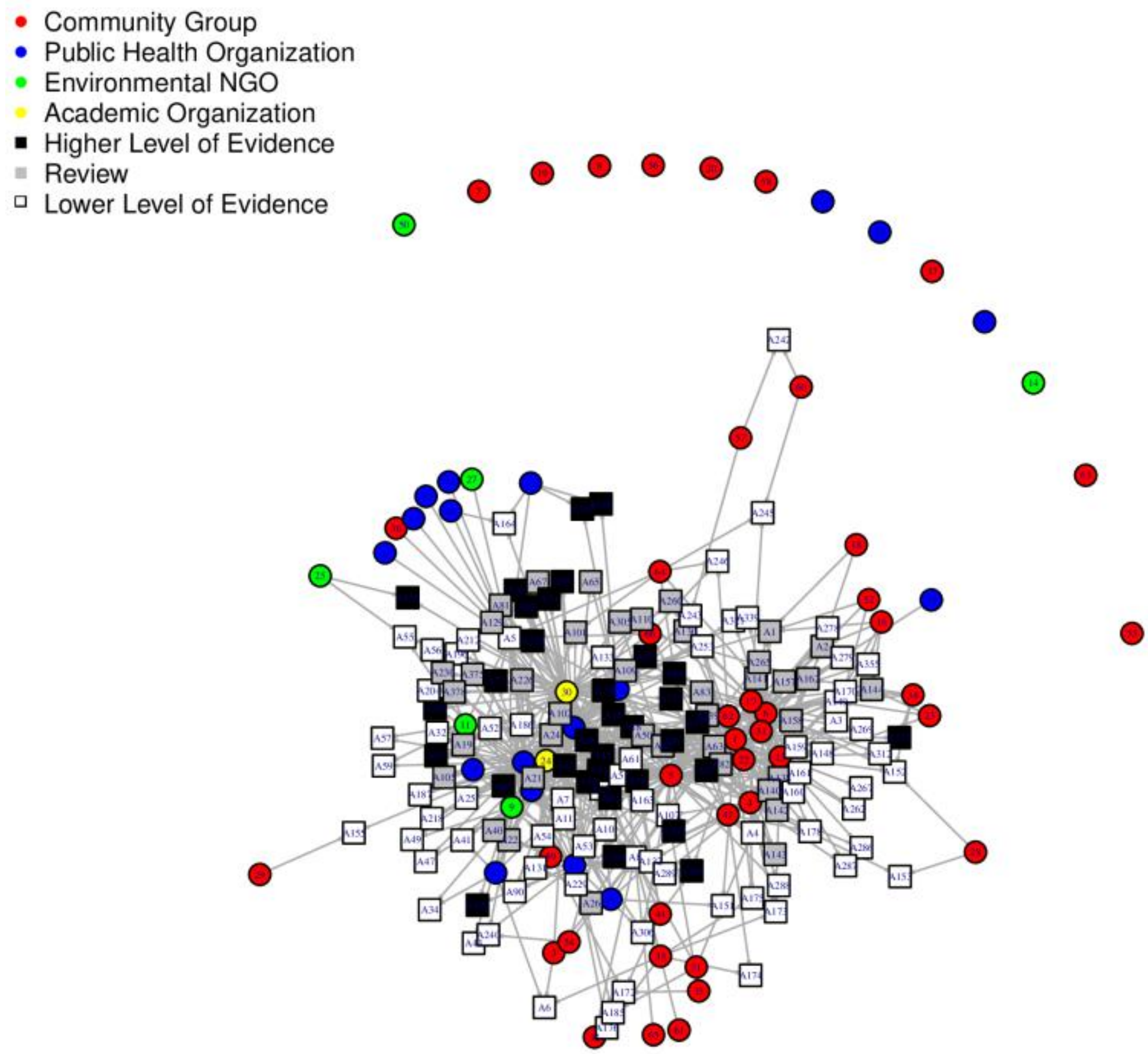


**Figure 43.** Canadian organization websites with content on wind turbines and human health citation of evidence sources cited more than twice characterized by level of evidence

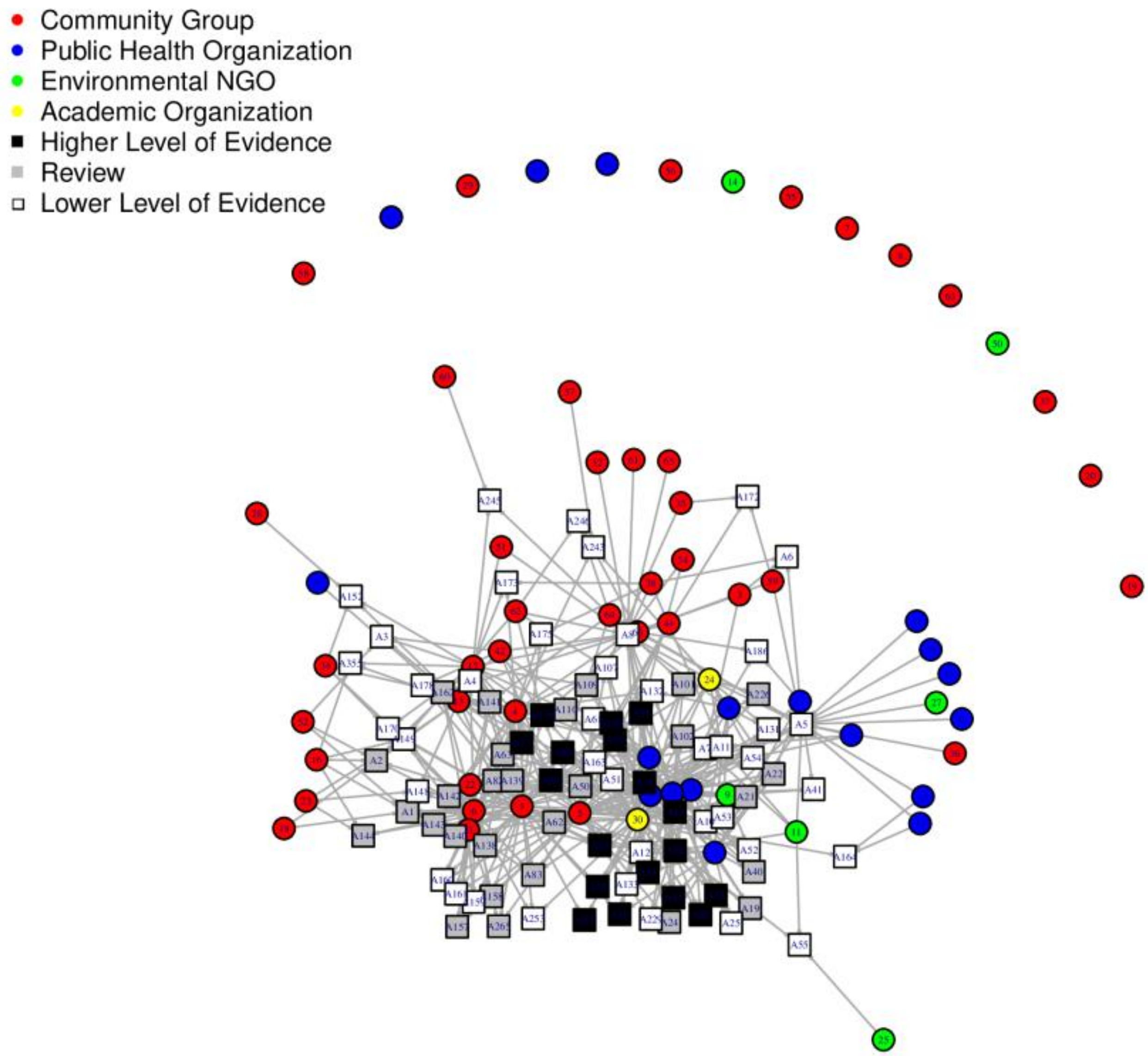
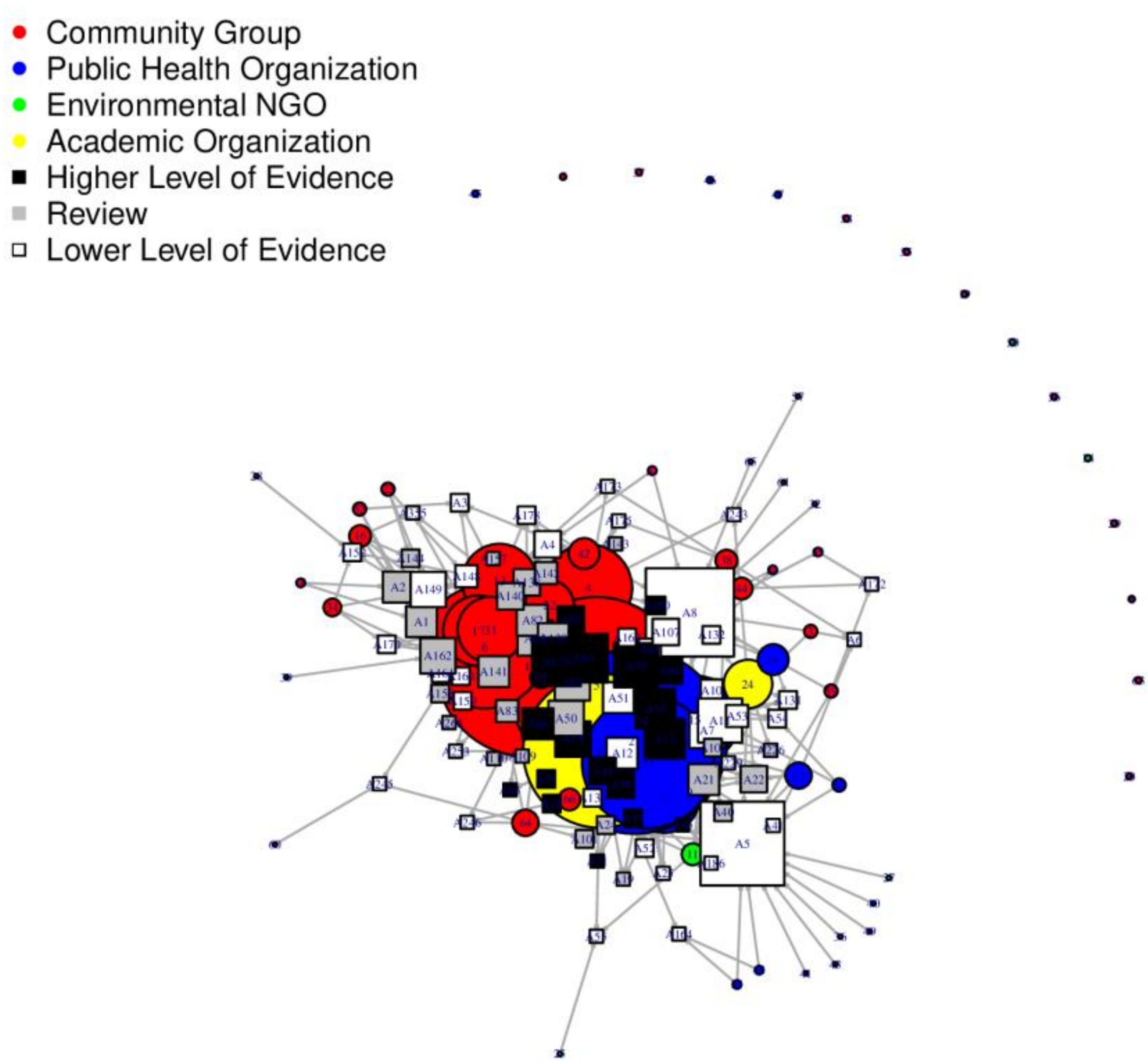


**Figure 44.** Canadian organization websites with content on wind turbines and human health citation of evidence sources cited more than twice characterized by level of evidence with node size by degree




A sociogram representing evidence sources by peer-reviewed status (Figure 45) showed that many of the peripheral evidence sources cited once by academic or public health organization websites with many evidence citations were peer-reviewed, but the evidence citations within the centre of the network were a mix of peer-reviewed and not peer-reviewed sources. Most of the evidence sources that are cited multiple times, as represented by degree (Figure 46), were peer-reviewed, with two central evidence sources with large degree that were not peer-reviewed. When limiting the evidence sources to those cited more than once or twice (Figure 47 and Figure 48), the cited evidence sources were a mix of peer-reviewed, unclear peer-reviewed and not peer-reviewed sources which were distributed throughout the network. Many of the evidence sources that were central to the network and cited more than twice were reviews and cross-sectional surveys, as seen in Figure 32, and these types of studies would normally be peer-reviewed. Although a significant difference was found between community groups and public health organization in the citation of peer-reviewed evidence sources in Chapter 4, this difference may be due to the impact of sources that were cited once.

**Figure 45.** Sociogram of evidence source citation by peer-reviewed status by Canadian organization websites with content on wind turbines and human health

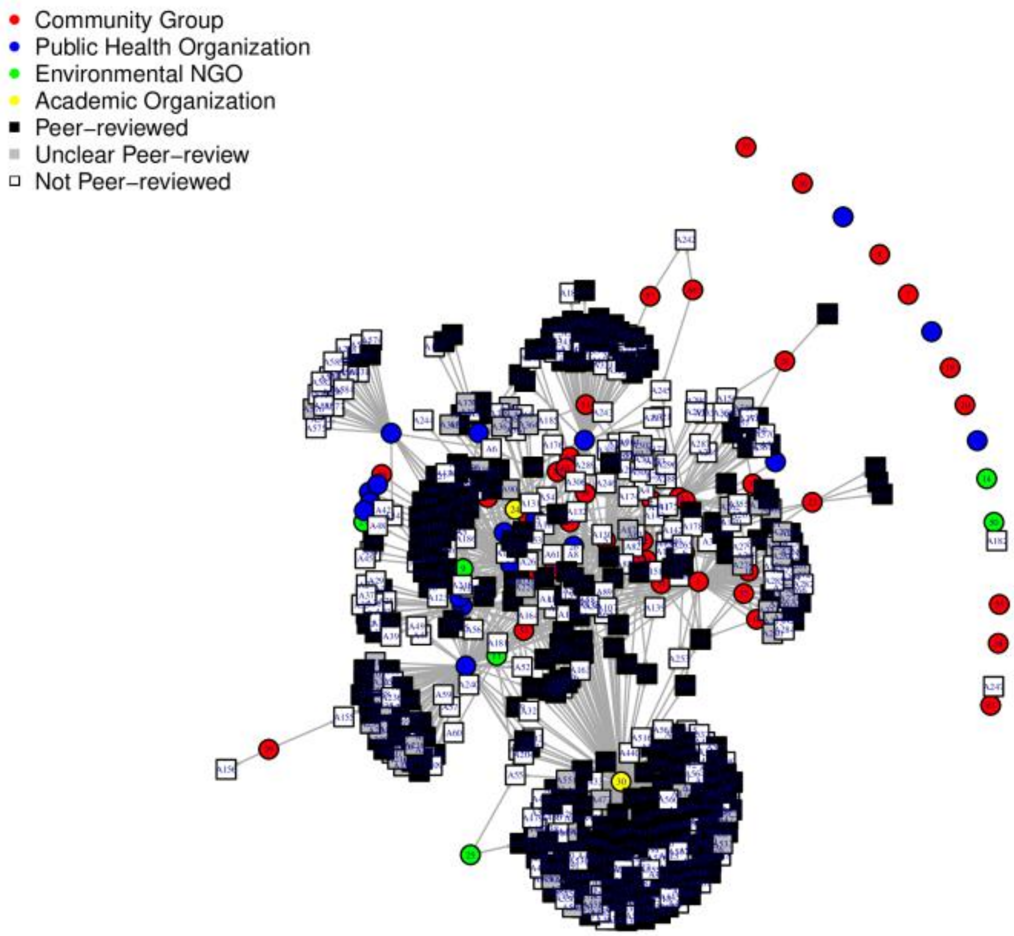


**Figure 46.** Sociogram of evidence source citation by peer-reviewed status by Canadian organization websites with content on wind turbines and human health with node size by degree

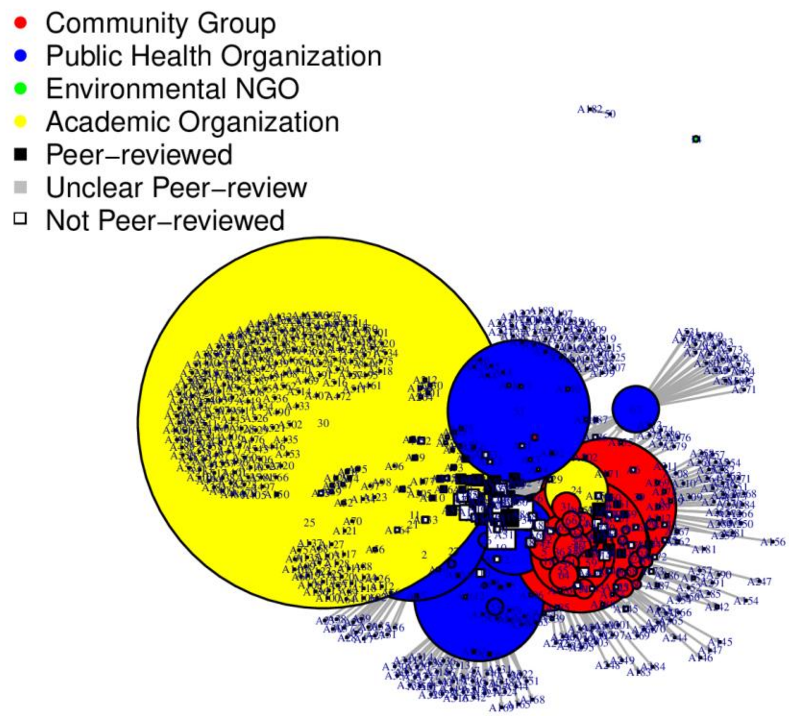


**Figure 47.** Sociogram of evidence source citation by peer-reviewed status by Canadian organization websites with content on wind turbines and human health for sources cited more than once

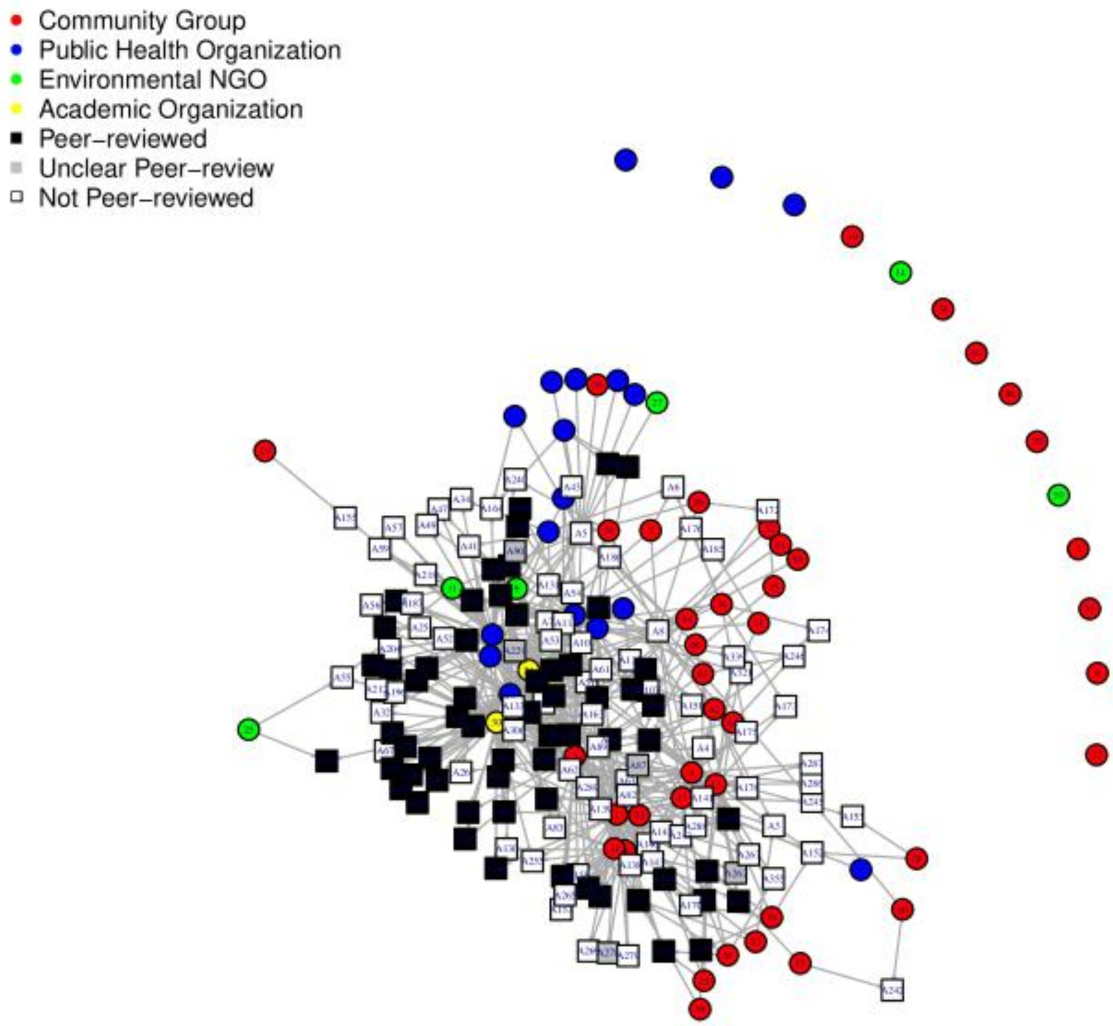


**Figure 48.** Sociogram of evidence source citation by peer-reviewed status by Canadian organization websites with content on wind turbines and human health for evidence sources cited more than twice

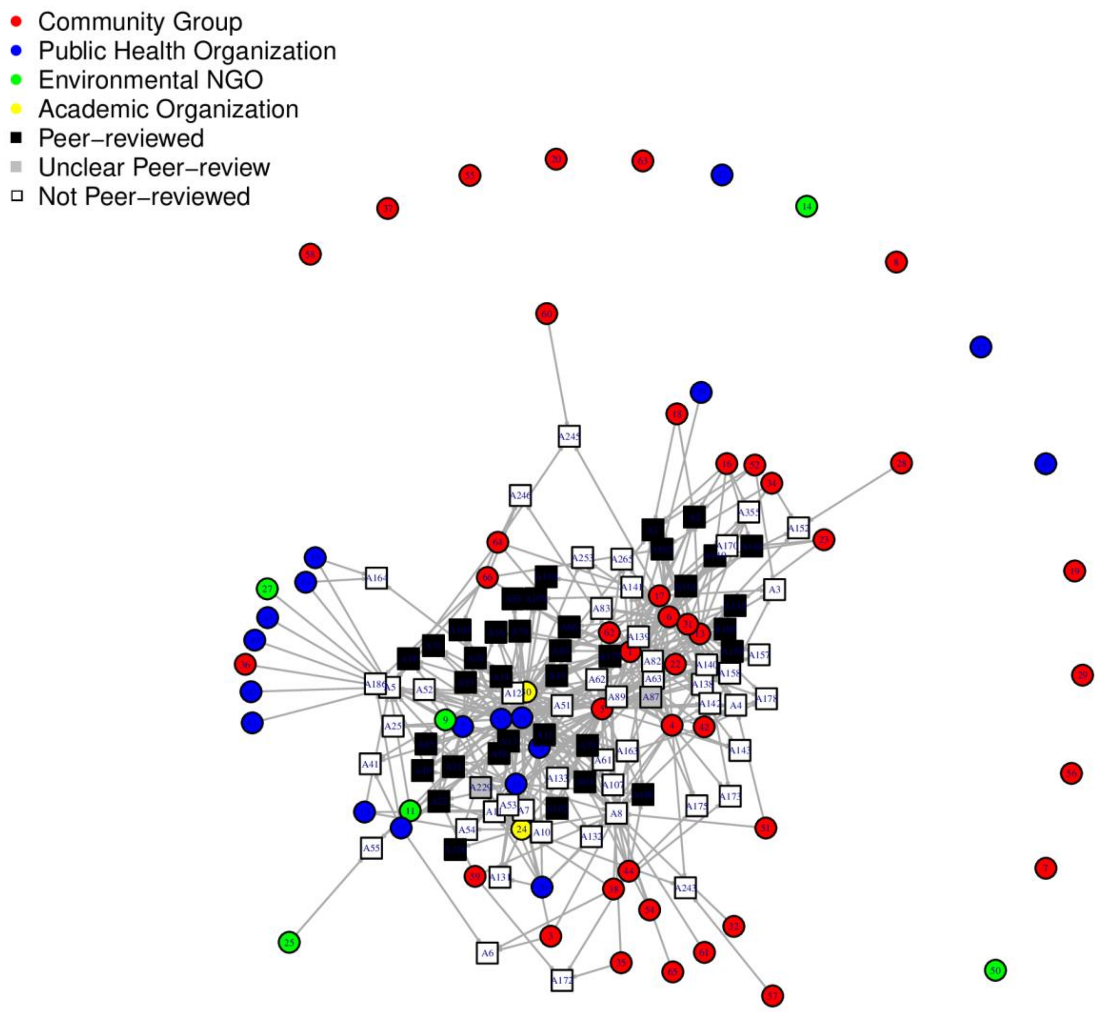
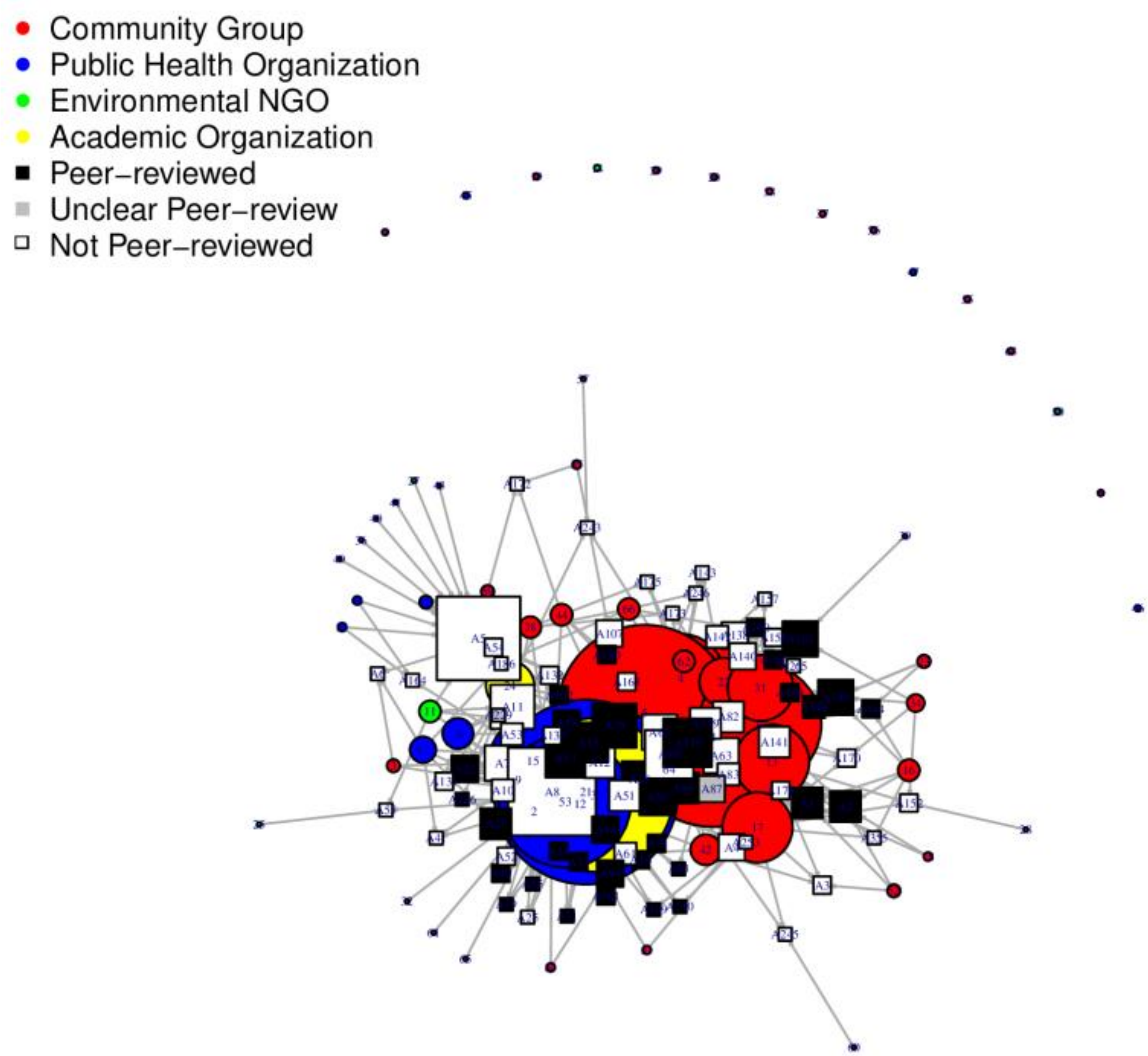


**Figure 49.** Sociogram of evidence source citation by peer-reviewed status by Canadian organization websites with content on wind turbines and human health for evidence sources cited more than twice by node size as degree




When degree was included in the sociogram for the citation of evidence sources that were cited more than twice characterised by peer-reviewed status (Figure 49), a mixture of peer-reviewed and not peer-reviewed evidence sources was distributed throughout the network. Two evidence sources that were not peer-reviewed were prominent and appeared tied to public health organizations.

As described in Chapter 4, publication quality concerns for specific evidence sources were found for 17% of the evidence sources and a significant difference was found in the citation of these sources between community group and public health organization websites. The sociogram in Figure 50 showed that evidence sources with publication quality concerns were cited diffusely in the centre of the network, with one public health organization website having cited many of these sources, and others being linked to community group or public health organization websites. When degree was considered, many of the evidence sources with publication concerns and larger degree appeared central to the network (Figure 51).

**Figure 50.** Sociogram of citation of evidence sources by Canadian organization websites with content on wind turbines and human health where evidence is characterised by the presence or absence of publication quality concerns

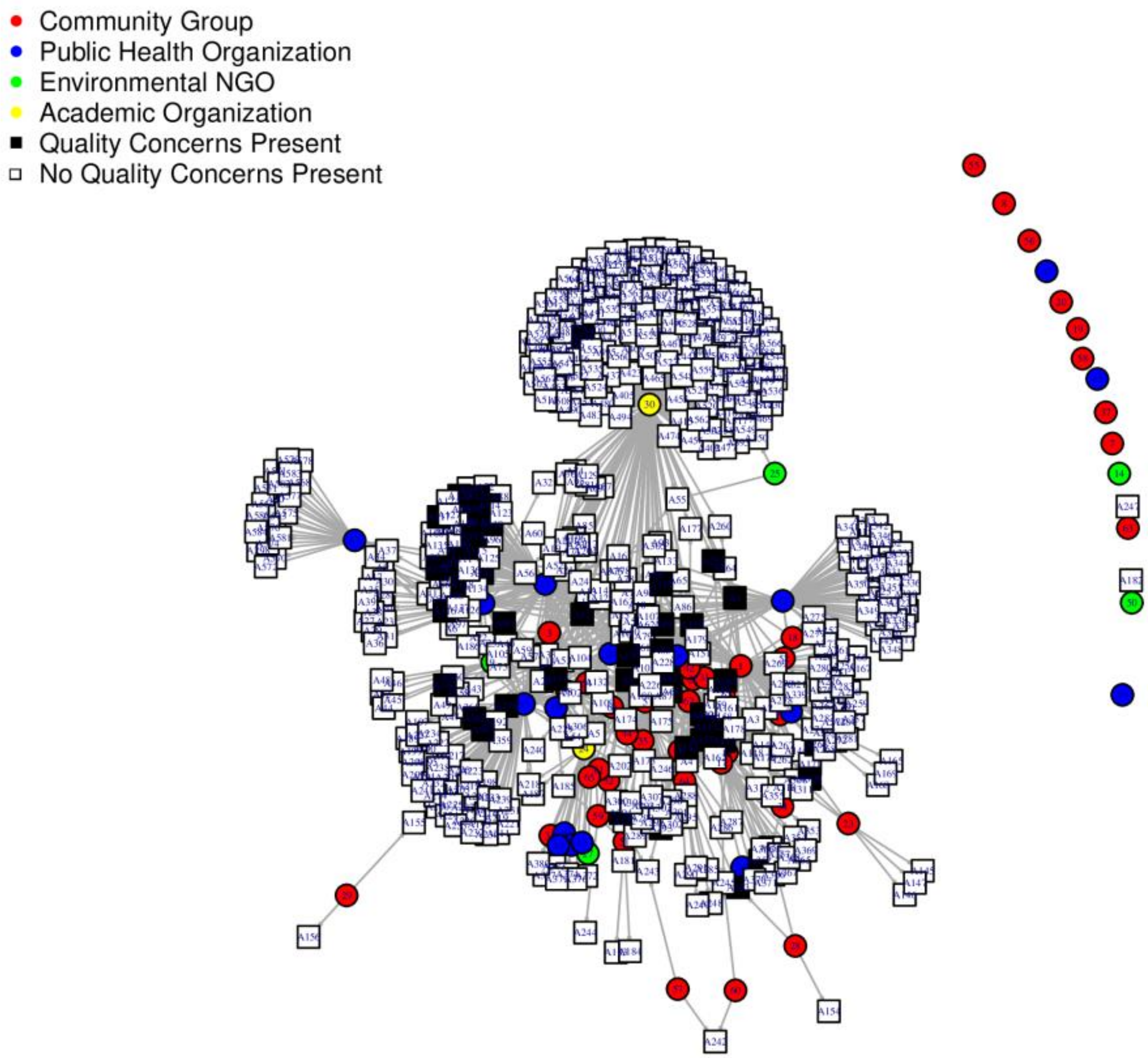
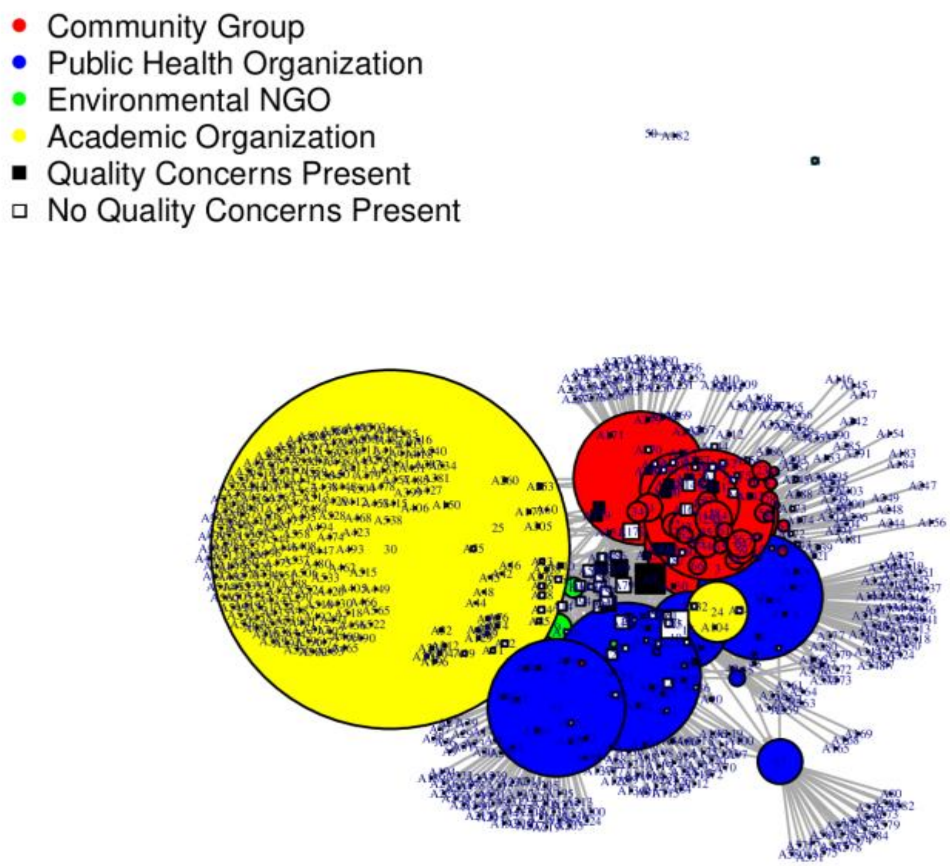


**Figure 51.** Sociogram of citation of evidence sources by Canadian organization websites with content on wind turbines and human health where evidence is characterised by the presence or absence of publication quality concerns with node size by degree




A sociogram with the citation of evidence sources that were cited more than twice (Figure 52) found that 17 of these evidence sources with publication quality concerns were tied predominantly to community group websites and three of these evidence sources with publication quality concerns were tied predominantly to public health organization websites. When the number of citations was included in a sociogram using degree as node size (Figure 53), five of these sources had large degrees and were prominent in the network. Most of these evidence sources with publication concerns were more peripherally located in the network and tied to either community group websites or public health organization websites, although some (4) appeared central to the network.

**Figure 52.** Sociogram of citation of evidence sources with more than two citations by Canadian organization websites with content on wind turbines and human health where evidence is characterised by the presence or absence of publication quality concerns

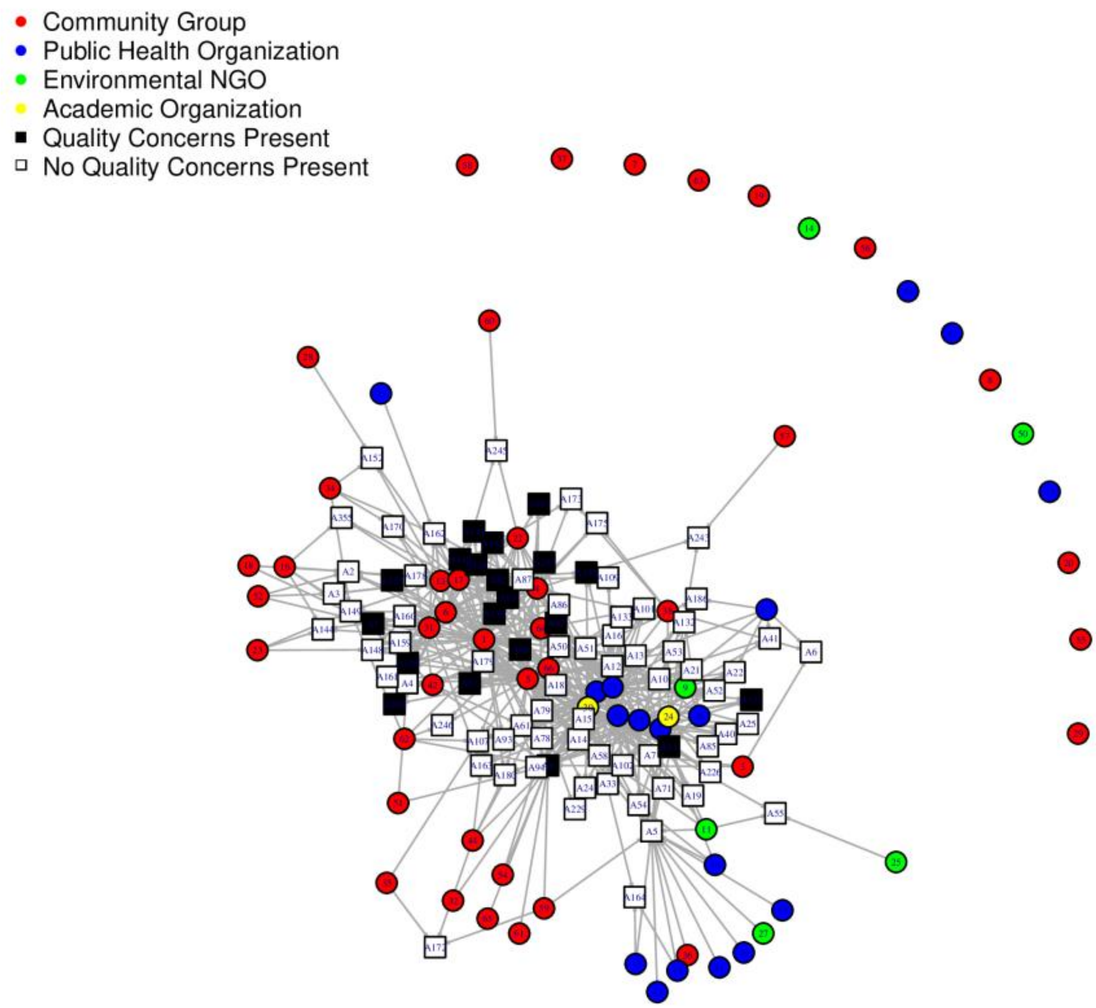
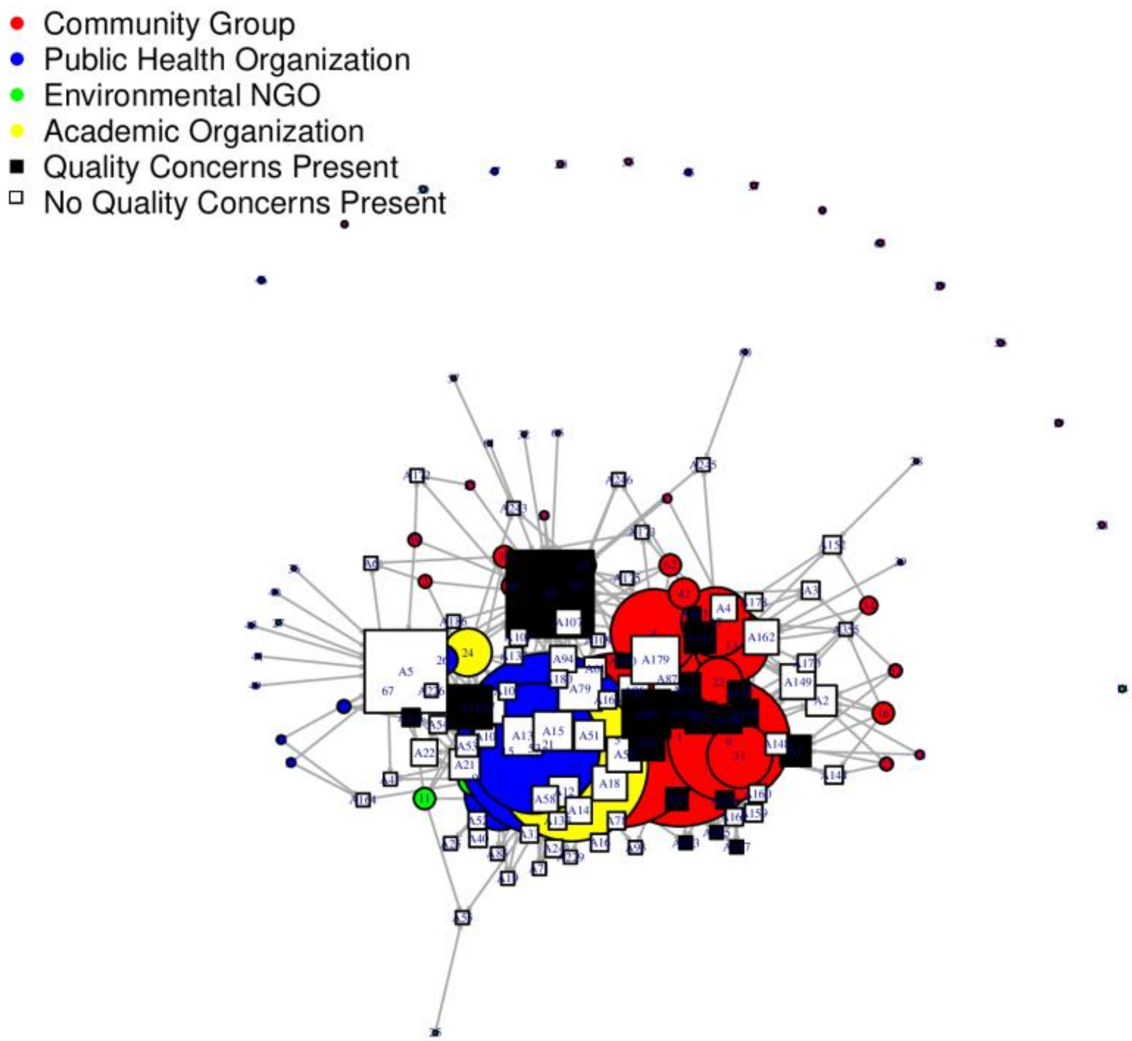


**Figure 53.** Sociogram of citation of evidence sources with more than two citations by Canadian organization websites with content on wind turbines and human health characterised by the presence or absence of publication quality concerns with node size by degree




Due to the large number of grey literature sources that were cited by organizations as evidence in their website content on wind turbines and human health, the citation of different types of grey literature was assessed separately in two sociograms (Figure 54 and Figure 55). These sociograms demonstrated the findings from Chapter 4 that community group websites tended to cite grey literature from community groups, while public health organization websites tended to cite grey literature from government, industry and public health organizations. The specific grey literature sources and categories of sources cited varied by organization type, with some shared grey literature sources characterised as originating from public health organizations, academic organizations, government, industry, or community groups—most clearly visualized when degree is included (Figure 55).

**Figure 54.** Sociogram of citation of grey literature evidence sources by Canadian organization websites with content on wind turbines and human health characterised by grey literature type

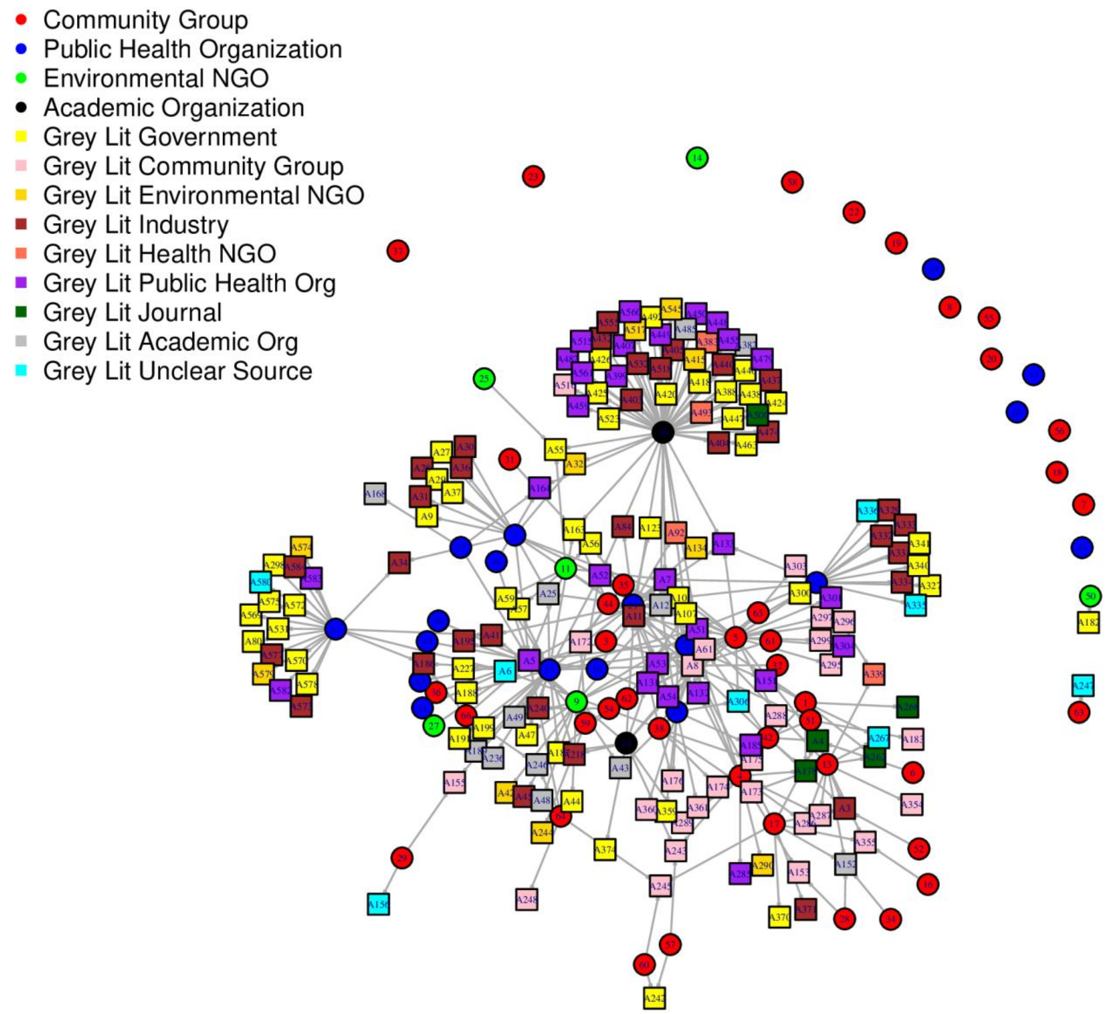
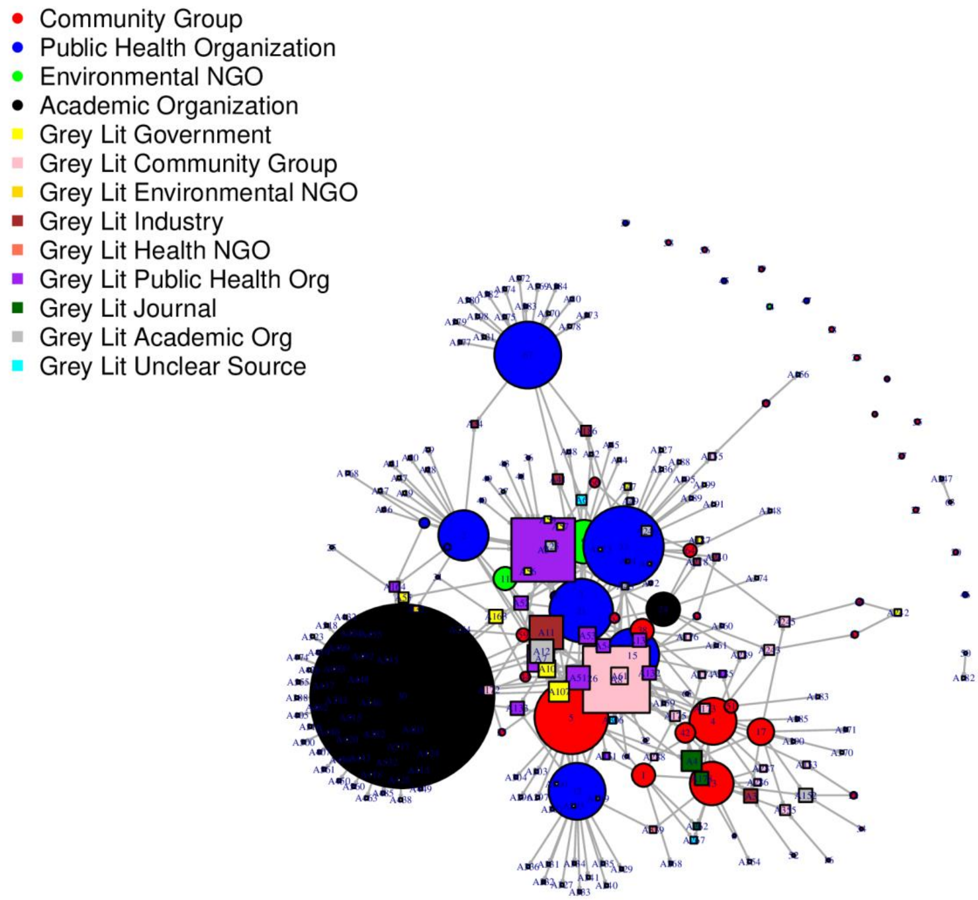


**Figure 55.** Sociogram of citation of grey literature evidence sources by Canadian organization websites with content on wind turbines and human health characterised by grey literature type where node size corresponds to degree



Centrality measures were calculated for the bipartite network with ties from the organization websites to the evidence sources (Table 24). Although calculated, reciprocity, mean betweenness and assortativity scores were not included as all were 0 for the bipartite networks, and diameter was calculated to be 1 for all of the networks apart from the original 67 Canadian organization website network (which had a diameter of 6).

**Table 24.** Centrality measures for sociogram of 67 Canadian organization websites with content on human health and wind turbines' citation of evidence sources

| Sociogram | Mean Degree | Density | Mean Closeness | Mean Eigenvector |
|---|---|---|---|---|
| All 67 websites | 9.19 | 0.070 | 0.00075 | 0.22 |
| 67 websites + all evidence | 3.16 | 0.0024 | 2.37e-06 | 0.038 |
| 67 Websites + cited more than 1 evidence | 5.49 | 0.013 | 2.19e-05 | 0.15 |
| 67 Websites + cited more than 2 evidence | 6.09 | 0.020 | 4.34401e-05 | 0.20 |
| 67 Websites + grey literature | 2.81 | 0.0058 | 1.71e-05 | 0.079 |
| 67 Websites + High quality evidence and reviews (>2 citations) | 4.62 | 0.020 | 8.09e-05 | 0.19 |
| 67 Websites and low quality evidence (>2 citations) | 3.85 | 0.018 | 8.20e-05 | 0.21 |
| 67 websites + non-peer reviewed evidence (>2 citations) | 4.53 | 0.020 | 7.66e-05 | 0.20 |
| 67 websites +peer review/non (>2 citations) | 3.86 | 0.019 | 9.72e-05 | 0.21 |

The network centrality measures and characteristics in Table 24 found that compared to the original network of 67 Canadian organization websites with content on wind turbines and human health, the mean degree, the density of the network, mean closeness, and the mean Eigenvector values were lower for the other networks, which was unsurprising given that the networks were much larger and that ties from the evidence sources to each other and to the websites were not included. Degree, mean closeness, mean Eigenvector value and density were higher for networks where the evidence sources were limited to those with two or more citations compared to the network where all the evidence sources were included, which could reflect the smaller number of nodes in the network and the increased likelihood that each evidence source was cited by multiple websites. The degree and density measures were lower for the network where only grey literature citations were included, which could represent the overall smaller number of included nodes, evidence sources and co-citations.

### 5.4 Discussion:

The results of the social network analysis from the 67 Canadian organization websites with content on wind turbines and human health found that the network was structured by organization type, where community group websites were segregated on one side of the network and tended to be more highly connected, with more websites with a higher number of links to and from other organization websites. The other side of the network consisted of public health organization websites, academic organization websites and eNGO websites that were less densely connected to each other and linked through the academic organization websites and a subset of the public health organization websites to the community group websites. The network structure showed that the network lacked a central node and was divided according to the websites' position on whether wind turbines were potentially harmful to human health. This network had communities detected according to organization type, where a subset of community group websites formed a close community and the remainder of other organization websites either formed smaller communities or were not part of a community. This finding was supplemented by analyses examining subgraphs of community group websites ties to each other as well as the subgraph of public health organization websites. Reciprocity was seen in the subgraph of community group websites and not in the subgraph of public health organization websites. This could have been due to community group websites with allied organization links having reciprocal citing of each other. The results suggested a few provincial and national organizations had prominence in both local and global centrality, whereas a few local organizations had a significant role as intermediaries in the social network. There was structural equivalence identified between the larger national and provincial organization websites within the network, which tended to align by organization type.

When the 184 additional organization websites were included in the network, community group websites continued to display a higher degree of connection with each other. The expanded network of websites demonstrated that the academic organization, eNGO and public health organization websites tended to be connected with each other, as well as link to governmental and industry websites. Assessment using additional website characteristics such as whether the website was included as an allied organization or cited as supportive evidence continued to demonstrate differences between the websites by organization type, where only community group websites had allied organization links and the citation of other organization types' websites as supportive evidence varied by citing website organization type.

The social network analysis performed on the ties from the 67 Canadian organization websites to the 584 evidence sources found differences in the specific evidence sources and types of evidence that were cited overall. However, when the network analysis was limited to frequently cited (more than two citation) evidence sources, the evidence citations were found to be similar in type (reviews, grey literature and cross-sectional surveys) but varied by the specific evidence source cited for the peripherally located evidence sources. A small number of organization websites had a much higher number of evidence citations compared to the majority of websites, which persisted when limiting the analysis to frequently cited sources.

Due to its common citation as evidence, grey literature was assessed separately by subcategory of grey literature. This analysis found variability in the type of grey literature cited by website according to organization type, where community group websites tended to cite community group grey literature and public health organization websites (as well as academic organization and eNGO websites) tended to cite grey literature that originated from public health organizations, government or industry. The specific sources that were cited tended not to be shared between organization types, although a subset of grey literature that originated from public health organizations, community groups, industry and government were more central to the network.

The quality of the cited evidence was heterogeneous when considering all evidence sources, and appeared lower when restricted to frequently cited evidence sources. The sociogram of frequently cited evidence sources characterised by level of evidence found a number of centrally located higher quality evidence sources and many peripherally located lower quality evidence sources, suggesting that the higher quality evidence sources were shared between websites across the organization types, but the lower quality evidence sources were only shared between organization websites of the same type. When the cited evidence was assessed according to peer-reviewed status and limited to frequently cited sources, there was little variation across the network. This could be due to the observed frequent citation of peer-reviewed sources like reviews and cross-sectional surveys. Evidence sources with publication quality concerns were cited throughout the network, but were observed to be cited more often by community group websites. Although a few evidence sources with publication concerns had a high degree and were more centrally located in the network, most of these evidence sources were more peripheral to the network and tended to be aligned with specific organization types.

The objective of this chapter was to assess the pattern of citations or links to the evidence used by community groups and public health organizations to determine whether the patterns differed between the two groups. The pattern of citations to other organizations and evidence sources differed by websites according to their organization type. While specific frequently cited reviews, cross-sectional surveys and grey literature sources were shared by the different organization type websites, many of the evidence sources were associated with specific organization types and not shared with the other organization types. The noted differences in level of evidence and peer-reviewed status in Chapter 4 appeared less when limiting the network analysis to frequently cited evidence sources. This suggests that analysis of the evidence sources by counts per website may need additional analyses that incorporate measures of evidence citation frequency overall for each evidence source as weights. Ties to other organization websites differed by organization type and the pattern within the 67 Canadian organization website network determined that this was associated with the websites' position on the potential health impacts of wind turbines.

The cited evidence sources found on the websites may represent a means of substantiating the organization's position on whether wind turbines are harmful or not harmful to human health, or where the uncertainties in the evidence lie. The results of the social network analysis suggest that there were a smaller number of higher level evidence sources that were frequently cited, and that many reviews and lower level of evidence sources were also frequently cited. This could relate to the available evidence base, where relatively few high level evidence sources (mainly cross-sectional surveys) were available to address the issue of wind turbines impact on human health at the time that the website content may have been developed. The frequent citation of reviews and grey literature could be an attempt to fill this evidence gap. The quality of the reviews cited also varied, as it depended on the methodology used to find sources and the quality of the evidence sources available when the review was written. Although grey literature may have followed rigorous criteria in its development (Paez, 2017), it cannot easily be classified as a higher level of evidence without undertaking a thorough review of its quality, given the lack of an external peer-review process.

Publication quality concerns were found for a significant proportion of the evidence sources, including some of the frequently cited evidence sources that were central to the network of evidence citation by the organization websites. The specific reason(s) for each of the publication quality concerns was not further characterised, but could provide insight into further aspects of the lack of consensus between organizations on the issue of wind turbines and human health. Concerns have been published about the existing wind turbine evidence over poor study design, the use of 'loaded' terminology, biases in the part of investigators or reviewers, ignoring evidence, and potential conflicts of interest (Barnard, 2013; Knopper & Ollson, 2011a; Phillips, 2011). It is unclear whether the evidence sources that were not peer-reviewed had been assessed for quality concerns, but this could add further distrust into the evidence base. Clarifying how the reliance on lower level evidence sources, including grey literature, impacts the quality concerns could provide further insight into the lack of consensus on the topic of wind turbines and human health. The evidence base overall could be improved by having further studies with a robust study design, adhering to the peer-review process and avoiding any perceived conflicts of interest with industry.

The debate within the evidence and between organizations on the uncertainties surrounding wind turbines and potential human health effects may have an impact on the reporting and diagnosis of any wind turbine related health effects. The illnesses and human health concerns reported from exposure to wind turbines tend to be subjective (Jeffery et al., 2013a; R. McCunney, Morfeld, Colby, & Mundt, 2015c; McMurtry & Krogh, 2014) and do not have available objective measures to confirm their presence or conclusively determine the causative agent. Compared to other types of disease or health effects, molecular markers cannot be used to verify infection or describe the dynamics of disease transmission—as has occurred with infectious disease transmission (Vasylyeva et al 2016). Attitudes towards wind turbines may impact perceived negative health states (Jalali et al., 2016) and the citation of evidence sources that emphasize the potential harms of wind turbines could reinforce and encourage negative attitudes towards wind turbines, which in turn could play a role in the reporting of negative health states. The impact of the nocebo effect on reported health effects is unclear, as negative expectations may impact symptom reporting, (Chapman et al., 2013; Crichton et al., 2014; Crichton & Petrie, 2015d). Research may be needed to examine the impact of wind turbine noise on reported health states in communities without exposure to messaging about the potential health impact of wind turbines. Controlling for other confounding factors that may impact the idiopathic symptoms attributed to wind turbines and annoyance may also be needed (Blanes-Vidal & Schwartz, 2016).

How and when evidence sources were shared by organization websites was unclear. The observed use of acting as allied organizations with central overarching organizations could help disseminate some of the information and evidence related to the potential harms of wind turbines. Assessing for the authorship of evidence sources and mapping citation networks or collaboration networks could provide more insight into how the evidence sources relate to each other. Further, community engagement activities like town halls or correspondence were not captured in this research, but could be a means of communicating about the evidence.

Concerns about the impacts of wind turbines extend into other non-health related areas, including property values, environmental concerns, aesthetic impact on the landscape (Petrova, 2013; Songsore & Buzzelli, 2015), the lack of procedural justice elements in the planning and siting process (Songsore & Buzzelli, 2015; Walker & Baxter, 2017b), and the energy policy tools used to promote the switch to renewable energy sources (Walker & Baxter, 2017a). Concerns have been voiced about due process and critical appraisal in the siting of wind turbines (Krogh, 2011). The isolation of concerns about the potential health effects from wind turbines from other concerns may be artificial, as individuals may have multiple co-existing concerns. It was noted that some community group websites covered multiple aspects of concerns over wind turbines, whereas the information provided by public health organizations or academic organizations tended to be focused solely on health concerns. Community health concerns may be a symptom of broader issues of relationships and structural problems within the community with respect to wind turbines (Baxter et al., 2013). Understanding the impact of the broader concerns about wind turbines on the perception of wind turbines as harmful could be considered by assessing how websites cover other potential unwanted outcomes from wind turbines.

Opposition to wind turbines in communities has been assessed from a social movement perspective and a critical theory perspective, where 'one-dimensional thinking' or ideology has been argued to be a component (Ariza-Montobbio & Farrell, 2012). It is unclear whether or how this opposition relates to broader criticism of green energy initiatives that take a top-down approach and limit local involvement (Breukers & Wolsink, 2007). Some of the community group websites were noted to have content that was skeptical of anthropogenic climate change and the use of renewable energy sources. The connection of anti-wind turbine sentiment to larger social movements is unclear and could be assessed in future research. The geographic mapping of the online website network to provide correlation with physical locations may provide further insight into aspects of this issue within communities and tie it to specific wind turbine development projects over time.

The observed differences in the specific evidence sources cited by the different types of organizations may be related to the evolving research and understanding related to noise and health. The lack of consensus on wind turbines and human health impacts relates to larger issues surrounding the health effects of chronic noise exposure, sleep disruption, annoyance and chronic stress effects (Jeffery, Krogh, & Horner, 2013c) research into the long term impacts of noise and sleep disruption are needed (Hume, Brink, & Basner, 2012; Kageyama, 2016). Current guidelines for night noise levels recommend exposures to be less than 55dB with potential health effects above 40 dB (Hurtley, 2009). Beyond the noise levels, the specific characteristics of wind turbine noise may impact annoyance experience from them (Pedersen & Waye, 2004; Pedersen, van den Berg, Bakker, & Bouma, 2009; Van den Berg, 2004) and concerns have been raised that the existing noise regulations may not address these characteristics (J. P. Harrison, 2011). The techniques used to measure noise may not provide accurate information about aspects that make the noise annoying, and social perspectives on noise may be needed to be incorporated into decision-making processes about noise (Thorne & Shepherd, 2011) A researcher found that three studies showed stress from wind turbines was associated with annoyance and not noise levels (Pedersen, 2011). Personal and contextual factors may predispose individuals to annoyance from community noise (Fields, 1993). Other poorly understood exposures like low frequency noise or infrasound have been proposed as causes of concerns from wind turbine exposure (Ambrose et al., 2012; Horner et al., 2011; Møller & Pedersen, 2011; Salt & Kaltenbach, 2011), although these have been argued to be present at insignificant levels.

The characterisation of wind turbines as harmful or not harmful within the network was associated with the organization type, where community group websites characterised wind turbines as harmful and the remainder of the organization websites characterised wind turbines as not harmful or that the effects were unclear. The positioning of the websites in the context of outrage management and trust of public health organizations and other may require building trust and relationships with the community (Fitzpatrick-Lewis, Yost, Ciliska, & Krishnaratne, 2010; Sandman, 1993). The lack of consensus around the health effects of wind turbine noise exposure, and chronic community noise exposure in general, could be impacting how evidence is being interpreted and used. Researchers using a model to understand how scientific information becomes disseminated within a community found that individuals may create "tightly-connected communities, where they support each other against commonly accepted notions" (Iñiguez, Tagüeña-Martínez, Kaski, & Barrio, 2012). Cultural values may impact how scientific consensus is perceived (Kahan, Jenkins-Smith, & Braman, 2011). Understanding how social and cultural factors impact the perception of scientific consensus could provide a further means of exploring how evidence sources are used to support positions on the potential harms of wind turbine exposure. Semantic network analysis could also be used in the context of wind turbines and human health to understand the beliefs and attitudes underlying the perspectives, as was done in the context of vaccine-hesitancy (Kang et al., 2017). Assessing social media content could also be used to analyse how concerns are communicated on an individual basis. Beyond authorship networks and collaboration networks, assessing de-identified social media postings on wind turbines and human health could allow insight into the networking of individuals in real life with respect to evidence and use, as has been done with other public health topics like water fluoridation (Seymour et al., 2015) .

Although working with wind turbine industry documents or organizations may be needed to understand the technical aspects of wind turbines, close relationships could be perceived as a conflict of interest and raise concerns that industry impacted findings. The results illustrated that public health organization websites were more likely to cite industry grey literature sources or link to wind turbine industry websites than community group websites. Public health organizations may need to consider the optics of working with the wind turbine industry when assessing the potential impacts of wind turbines. A lack of trust between community members and organizations like public health units or academic researchers could impact the ability to conduct future research and participation in studies (Lane, Bigelow, Majowicz, & McColl, 2016). While rare, community activism against research studies has been documented in the Ontario context, where community engagement and participatory research may be advised for future initiatives (Walker & Christidis, 2018).

The results of the social network analysis found differences in how public health organization websites link to each other compared to how community group websites link to each other. The public health organization websites show a lack of reciprocal links and a less centralized network. A regional provincial or national organization website to coordinate public health information exchange could be considered as a means to promote the sharing of information between public health organization websites. Further research into best practices and effective use of online resources could also aid public health organizations in increasing their reach (as was demonstrated by difficulties locating relevant local public health organization information online in Chapter 4.)

How the websites' content evolved over time was not assessed. The development of community concerns about wind turbine projects has been examined and argued to have a contagion effect over time (Chapman et al., 2013; Crichton & Petrie, 2015c). Examining how the organization websites cite evidence over time and react to new information could provide further insight into the issue. Additionally, assessing how evidence sources on the topic of wind turbines and human health cite each other over time could show how and which evidence sources become referenced by other publications and which authors tend to cite them. While the data about the dates of creation and last update give some information about the creation and evolution of the social network between the websites, it does not capture changes over time to understand how the information is diffused. Potentially, future research could examine how dated content or updates in websites provided information over time to examine how the information is diffused.

The results demonstrated that social network analysis methodologies can be used to gain additional insight into a public health issue and understand how evidence citation patterns differ between organization types. Social network analysis has begun to make an impact on specific parts of public health theory, including transmission networks, social support and social capital, health behaviour and organizational networks (Luke & Harris, 2007). Wholey et al (2009) used social network analysis to describe the structure of public health systems in rural health units (Wholey, Gregg, & Moscovice, 2009). Harris and Clements (2007) used social network analysis to describe public health emergency planning in Missouri (Harris & Clements, 2007). Nooraie et al (2017) conducted social network analysis to examine an intervention in evidence-informed decision making in three public health units (Nooraie, Lohfeld, Marin, Hanneman, & Dobbins, 2017).

Social network analysis is also used in public health to understand the transmission of sexually transmitted infections (De, Singh, Wong, Yacoub, & Jolly, 2004; Rothenberg et al., 1998), outbreak transmission (Devakumar, Kitching, Zenner, Tostmann, & Meltzer, 2013), or infection susceptibility based on vaccination status in a population, such as from seasonal influenza (Cauchemez et al., 2011; Edge, Heath, Rowlingson, Keegan, & Isba, 2015; Llupià, Puig, Mena, Bayas, & Trilla, 2016). Health behaviour spread within a social network can impact the dynamics of disease transmission—while Campbell and Salathé (2013) assessed this in the context of infectious disease, it may be possible to extrapolate some of the dynamics of individual risk to disease from health behaviour to other conditions (Campbell & Salathé, 2013). For example, the spread of obesity has been linked to social contagion within a network (Christakis & Fowler, 2007). If negative-expectations can impact susceptibility to reporting symptoms from wind turbine noise exposure (Crichton et al., 2014; Crichton & Petrie, 2015d; Tonin et al., 2016a), then the use of social network analysis to characterize beliefs and attitudes regarding wind turbines and how these beliefs are transmitted may provide insight into the emergence of community concerns..

Social network analysis can be used as an adjunct research method to strengthen public health initiatives. Smith and Graham (2018) assessed public anti-vaccination Facebook groups using a variety of analytical tools, including social network analysis (Smith et al., 2018). Further assessment of relevant social media platforms in the context of wind turbines and health may provide details of how the information is disseminated on an individual basis and the thematic content of the messages. It is unclear whether and how the social networks found by assessing individuals' participation on social media platforms would differ from the organization website network described in my research. Brunson (2013) found that social network factors played a strong role in predicting whether parents would vaccinate their children as recommended and that social network level interventions may be needed to improve vaccination rates (Brunson, 2013). Opel and Marcuse (2013) commented on Brunson's study and discuss the limitations of the methodology in helping understand whether the social network influenced the decision to vaccinate or reflects and reinforces the individual's existing beliefs (Opel & Marcuse, 2013). The evidence cited by individuals may differ from that cited publically by organizations. In the context of wind turbines and human health, the impact of organization websites in the discourse may be higher than that of individual social media users given the role of community groups in advocacy in the local context, including local decision-making. Coordination between individuals, such as through a community group, may be needed to affect change in a community where wind turbines are planned. However, the dissemination of evidence by individuals may play a role in determining which information is ultimately received and further disseminated by organizations.

#### *5.4.1 Strengths and Limitations*

Strengths of this chapter include that it allows an understanding of the pattern and relationships of citations and analysis of whether the types of organizations differ in how they link to evidence on their websites. It is an approach that has not been previously used in assessing the debate about wind turbines and human health and provided insight into how scientific evidence is being used online about a potential environmental health hazard by different types of organizations. It drew upon research methodologies that are not commonly used in public health research and provided complementary knowledge to more traditional epidemiological studies on the subject.

There were several major limitations of this research. Firstly, the relationship data from the additional organizations and evidence sources were not included in the analyses. This meant that the analysis was restricted to the included 67 Canadian organization websites for directed ties to and from other nodes (organizations and evidence sources). Ideally, the relationship data from the additional organizations and evidence sources would have been included to provide a comprehensive description of the network and all the potential ties to and from nodes within the network. The difficulty with this approach is determining the cut-offs for where the boundaries of the organizations' network lie and the effort required to assess and extract data from a potentially exponentially growing number of websites and evidence sources. Restricting the full analysis to the 67 websites that met the exclusion criteria gave a representation of how specific Canadian organizations' websites connect to each other and to the evidence. This was not an exhaustive analysis into the network surrounding wind turbines and human health as it deliberately excluded non-Canadian organizations and other types of organizations (such as industry and political organizations). The calculations for network measures, such as density or degree, were limited as they would not capture ties from organizations that were not included in the original 67 websites to other websites and were low accordingly. Additional techniques for exploring the relationships between evidence sources were not used but could be considered, such as citation mapping the evidence sources through online citation databases for sources that were indexed in major databases. This type of citation mapping would be unable to map unindexed sources like grey literature. As grey literature was a major component of the evidence sources cited overall, citation mapping of these evidence sources may require either the development of automated tools or manual review.

A second major limitation of this study was that it did not capture information about social media content related to these websites. Social media can be an important means of disseminating messages and it has been used with the online narrative related to measles vaccination on Twitter (Radzikowski et al., 2016). This type of analysis could allow more insight into the social media discourse surrounding the potential health impacts of wind turbines. Although assessment of 'fright factors' present in news media coverage of wind turbines in Ontario has been performed (Deignan, Harvey, & Hoffman-Goetz, 2013b), a qualitative study of the content of relevant social media postings could provide an additional perspective on the type of messaging used to discuss the topic. The exclusion of individuals' websites, such as blogs and personal websites, was another limitation of the research. Although there was a risk of bias and potential privacy issues if identifiable individuals' websites were included, future research may need to include these types of websites, while protecting privacy, for a thorough assessment of the network.

Another limitation of the research related to determining how and when evidence was shared between websites. This research documented patterns of evidence citation and compared them, but it was not able to state conclusively why the patterns differ. This research provided an exploratory analysis of the network between organization websites and evidence sources, but further qualitative methodologies may be needed to address the questions surrounding reasons for differences in citation patterns. It was unclear from reviewing websites how and when the transmission of evidence sources occurs. It appeared from the results that a subset of regional or national websites played roles within the network of hosting or sharing resources for other organizations. A number of the provincial or national organization websites published their own reviews or evidence sources on their websites. Qualitative studies into how the different organizations become aware of evidence sources, such as whether they conduct their own reviews of emerging research, look at the evidence sources present on other organization websites, or have informal means of sharing information, could provide a better understanding of how and why citations were shared across organizations

The characterization of the evidence sources by quality of their study designs and peer-review process was complex. The reliance in this research on documentation online or in academic journals to identify publication quality concerns with the evidence sources entails that publications had been read and publicly described as having quality concerns. Other publications, in particular lower level evidence sources such as conference papers or grey literature, may not have had their quality publically appraised or argued to be low quality. Ideally a validated standardised tool would have been available to rank the quality of each type of publication and classify them appropriately. Additionally, the quality of the peer-review process for evidence sources that had been peer-reviewed was not assessed. While predatory journals were not identified as a significant factor in the citation of evidence sources on this network, low quality journals with inadequate peer-review processes may be publishing low quality evidence sources. Clarity within academia on how to approach low quality publications with ambiguities in their peer-review processes may ultimately be needed.

Even when evidence sources were from high quality peer-reviewed journals with rigorous study designs, at times the citation may not have been appropriate for the specific issue of wind turbines and human health effects. The appropriateness of the evidence sources to the debate may also need to be assessed along with the quality of the study designs to ensure applicability to the subject matter. I noted that certain evidence sources were only obliquely related to the context of wind turbines and human health, and providing a rank of lower level of evidence to sources such as animal studies, studies on other sources of noise exposure, or experimental studies on sleep disruption would have helped further distinguish the quality of the evidence sources cited to the specific issue of wind turbines and human health.

## Chapter 6: Conclusions:

The goal of this thesis was to examine whether and how community group websites that have a position on the potential human health effects of wind turbines differ in the type, characterization and interpretation of evidence used to support their positions on the potential health effects of wind turbines, compared to the type, characterization and interpretation of evidence used by public health organization websites in addressing these concerns, and to assess the pattern of evidence source citations used by both sides, by social network analysis. The specific objectives of this thesis were to:

1. Determine the types of evidence cited by community groups, and by public health organizations, to support their respective positions on the potential health effects of wind turbines—where the types of cited evidence will be further characterized into categories following an evidence hierarchy; and
2. Assess the pattern of citations or links to the evidence used by community groups and public health organizations to characterize and interpret these patterns of evidence citation and to see whether and how these patterns differ between the two groups.

To address objective 1, 67 Canadian organization websites with content on wind turbines and human health were identified (2 academic organizations, 6 eNGOs, 18 public health organizations and 41 community groups). These websites were assessed using a standardised tool to determine their website characteristics. Most community groups (39/41; 95%) characterized wind turbines as harmful to human health. In comparison, most public health organization websites and all eNGO websites characterized wind turbines as not harmful to human health, and both academic organization websites and some (28%) public health organization websites characterized the risk as unclear. The website structure varied by organization type, where community group websites and public health organization websites differed by the presence of specific components (i.e., social media or a news section). Differences were found in the broad types of evidence that the websites cited by organization type, where community group websites were significantly more likely to cite blogs, news, video evidence, and personal accounts/testimony than public health organization websites. Both community group and public health organization websites tended to cite peer-reviewed literature (reviews and cross-sectional surveys) and grey literature. Community group websites and public health organization websites had significant differences in mean citation rates for experimental studies with controls, grey literature, and observational study without controls, where public health organizations had higher mean citation counts per website. In terms of links to other organizations, community group websites tended to link to other community group websites and public health organization websites linked to government and other public health organizations websites.

To address objective 2, analysis of the social network formed between the 67 Canadian organization websites with content on wind turbines and human health showed that websites linked predominantly with other organizations of the same organization type. Assessing the network by 'position on wind turbines and human health' found that websites clustered by their position on this issue. The network was structured by organization type, where a highly connected cluster of community group websites were found on one side of the network and on the other side there was a less densely connected cluster of public health organization websites, academic organization websites and eNGO websites. The network structure lacked a central node. This network had communities detected according to organization type. There was structural equivalence between specific larger national and provincial organization websites within the network. When the 184 additional organization websites were included in the network, the community group websites cluster continued to be highly connected. The academic organization, eNGO and public health organization websites were predominantly connected with each other, as well as government and industry websites.

The social network analysis on the ties from the 67 Canadian organization websites to the 584 evidence sources found differences in the specific evidence sources and types of evidence that were cited overall. When the network analysis was limited to frequently cited (more than two citations) evidence sources, the evidence citations were found to be similar in type (reviews, grey literature and cross-sectional surveys) but with variation in the specific evidence source cited. A small number of websites had a much higher number of evidence citations compared to the majority of websites. The type of grey literature cited varied by website according to organization type, where community group websites tended to cite community group grey literature and public health organization websites mostly cited grey literature from public health organizations, government or industry. Many peripherally located grey literature sources were not shared between organization types. It appeared that certain frequently cited higher level evidence sources were shared between the organization types, but lower level evidence sources were mostly shared between organization websites of the same type.

The results are important as they yield insight into differences between community group and public health organization websites in terms of their characteristics, how they linked to each other and to other organizations' websites, and thoroughly described and compared the types of evidence sources that were used to substantiate the websites' positions on the issue of wind turbines and human health. The social network analysis methodologies showed how the websites related to each other, other organizations, and the evidence that they cited. The results identified significant differences in the types of evidence cited and the sociograms provided visual and network measures for differences in the patterns of citation. The results highlighted that grey literature sources were frequently cited and were a key component of the evidence citation network. Understanding how different organization types cite evidence or organizations differently provided a portrait of what evidence was used to substantiate positions, which may allow for the identification of why disagreement occurs about the potential health effects of wind turbines. The results also indicated where further research may be needed, and where risk communication strategies could provide further dialogue for addressing existing concerns about the potential harms of wind turbines.

While research has previously been done on the impact of wind turbine exposure and human health, the factors that impact the perception that wind turbines are harmful to humans, and issues that contribute to community opposition to wind turbine farms, this research added insight into how evidence is used to support health claims. It provided understanding on the patterns of citation, described the types of evidence used and provided context on the quality of the cited evidence.

By identifying evidence sources that both public health organization websites and community group websites commonly cited, as well as sources that one group cited more often, further assessment of potential causes for this pattern of citation could be done—which in turn could provide a basis for communication strategies between the sides of the debate. The results of this study could act as a framework for analysis of the evidence citation patterns in other issues with polarized opinions between public health organizations and community groups, like community water fluoridation or immunization. The findings of this research could be used for future wind turbine risk assessment and characterization, by allowing risk assessors to know the breadth and types of evidence cited by organizations concerned about wind turbines and human health.

Future research directions stemming from the results of this thesis include research into the content and use of evidence on websites that discuss wind turbines and human health to better understand how evidence is incorporated into positions on the subject, including thematic analysis of website content and qualitative studies that assess the impact of the websites on potential readers. Exploring the use of video evidence by organization websites could provide further knowledge on how online videos on wind turbines and human health contribute to supporting positions on their potential health effects. During the research for the thesis, I found the use of video evidence was significantly higher for community groups compared to public health organizations. It was noted as well that some public health organizations had general links to their video-hosting social media channel (YouTube) as part of their social media presence, but no specific links to video content from this channel were found in this analysis. Evidence sources like videos and personal accounts can provide a personal context for the potential health effects of wind turbines. These sources are not evidence-based or scientific, but could have more emotional resonance and be more easily understood by members of the public.

Content analysis of YouTube videos related to immunization has already been described (Robichaud et al., 2012), and future research could assess how organizations use this medium in the context of wind turbines and human health. Future research could also expand the methods used in the thesis to assess the global network of organization websites with content on wind turbines and human health. This research may be resource intensive and benefit from tools to automate the data collection, extraction and analysis methodologies. Conducting citation mapping of the identified evidence sources, including potentially grey literature, could also provide an understanding of how the evidence sources relate to each other and how the authors of the documents are tied to each other. The prevalence of grey literature and other non-indexed publications as evidence sources may make citation mapping in this context more difficult.

Future research endeavours could also assess social media content in general related to wind turbines and human health, particularly from a qualitative or thematic perspective, to examine how this evidence is described and used in social media. Additionally, future research could look at how messaging about the potential health effects of wind turbines is conducted by different organization types and how the messages get amplified or propagated by the public. Qualitative research into the communications strategies of organizations could also provide insight into decisions about how the information is disseminated. The impact and effectiveness of social media for this topic could be explored in future research.

Although there has been substantial research on the social and political aspects of opposition to wind turbine projects, the connection of anti-wind turbine sentiment to larger social movements is unclear and could be assessed. Further exploring the urban/rural aspects of the wind turbine and human health discourse could provide additional insight into whether and why differences exist. A detailed spatial analysis of where each of the websites contact addresses was located was not performed, but subsequent research could verify whether spatial clustering of the physical location of organizations by community occurs. Given that many of the community groups arose in opposition to local wind turbine sites, and that the local public health organizations may have been asked to address wind turbines as a human health issue, it would be expected that these types of organizations would be spatially related. Community engagement strategies and discourse may be important means to consider in communities planning wind turbine development. Providing empirical information to communities about wind turbine development, as well as early informal participation in the planning processes and acknowledging community concerns have been suggested as means of reducing the annoyance associated with wind turbines (Pohl et al., 2018).

The plan for knowledge translation and dissemination of the findings of this thesis include publication in a peer-reviewed journal related to the subject, presentations to public health practitioners either at conferences or through webinars, incorporating the research into teaching for graduate students, health professional students and trainees, and encouraging public health practitioners to understand and use social network analysis in their work. The use of research methodologies from disciplines outside of standard public health practice, such as social network analysis, can provide new avenues for understanding public health issues and enrich the public health community's understanding of how the relationships between organizations and evidence sources for contentious issues and why consensus may not occur.

Practitioners and academics that work in risk communication, environmental epidemiology and public health can potentially incorporate these findings into their roles. Understanding the evidentiary basis for risk characterization could help these professionals to tailor their messages or direct future research to better address concerns. Tools for the dissemination and communication of findings from rigorous evidence sources on this topic could potentially be developed with the findings of this research.

I identified that grey literature was commonly cited as evidence, publication quality concerns were relatively common and that predatory journals were not a significant factor in the evidence sources. The findings underline the importance of evidence quality that could also be part of a knowledge translation strategy. Encouraging writers of public health grey literature documents to have their work also undergo a sufficient external peer-review process with arms-length reviewers such that they can be published, could help provide feedback about methodological concerns to strengthen the documents and for concerns to be validated by the scientific peer-review process. This thesis demonstrated that publications with significant quality concerns can impact the discourse around emerging health topics when there is a dearth of high quality evidence on the issue. The unfortunate loss of Beall's list underscores the importance of having an independent organization that is able to monitor and publicly label predatory or unacceptably low quality journals and withstand attacks from these publishers when their unacceptable peer-review processes are brought to light.

Strengths of this thesis include the application of social network analysis methodologies to evidence source and organization citation in a public health context, the description of the network of Canadian organization websites with content on wind turbines and human health, the characterization of what evidence was cited by different organization types, and how the organizations relate to each other and the evidence. The major limitations of the thesis include the lack of data from the additional organizations and evidence sources about their ties to each other and to the 67 included organization websites, the exclusion of social media and specific other organization types from the analysis, and difficulties with characterizing evidence quality and the adequacy of the peer-review process. Future research could address some of the limitations of the thesis.

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# Appendices:

## Appendix 1: Identified Website Characteristics Data Collection Tool

| Unique ID | Organization Name | Organization Type | Position on Wind Turbines and human health | Website URL | Date of Creation | Date of Last Update | Date Reviewed | Subsection on Health present | Noise Subsection present | EMF/Infrasound Subsection present | blogs cited | Peer-reviewed Articles cited | Grey literature cited | News cited |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | |

| video/documentary evidence links | Personal account/testimony of impact of wind turbines on human health present | News section present | Social Media Component Present (Y/N) | Facebook | Twitter | Instagram | Tumblr | Other social media platform | Links to other organizations | Contact Address |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

## Appendix 2: Cited Evidence Source Data Collection Tool

| A | Citation name | URL | Reference (APA style) | Category of evidence | Peer-reviewed | Predatory Journal | Publication Quality Concerns Present | Grey Literature Type | Consultant report |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

## Appendix 3: Cited Website Data Collection Tool

| Host Organization Unique ID | Host Organization Name | Linked Organization Unique ID | Linked Organization Name | Website URL (top-level domain) | Cited as supportive evidence for position | Included as allied organization | Linked Organization Type | Non-Canadian Organization | Dead Link | Wrong link |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

## Appendix 4: Data Dictionary for Website Characteristics Data Collection Tool

| Field Name | Type | Description | Possible values |
|---|---|---|---|
| Contact address | Open text | Lists contact postal address, if available | Open text or 99999 if unclear or unavailable |
| Date of creation | Numeric; MM/YYYY or YYYY | This field lists the date the website states it was created or the date content was first published, if listed chronologically by year, including month if present | Date, unclear =999999, include year |
| Date of last update | Numeric | Date that the website lists for last update, or last date that content was published, if listed chronologically, if available | Date, unclear=999999, include year of last update |
| Date Reviewed | Numeric | This lists the date the website was reviewed during assessment | Date |

| | | | |
|---|---|---|---|
| EMF/Infrasound Subsection present | Categorical | This field identifies whether the website has a specific subsection on the potential health effects associated with EMF radiation or infrasound | Categories: yes, no |
| Facebook | Categorical | Identifies whether the website includes links to its own Facebook page | Categories: yes, no |
| Grey literature cited | Categorical | Identifies whether the website has cited 'grey literature' which are defined as evidence sources that do not appear in peer-reviewed publications as governmental reviews, working documents or self-published reports | Categories: yes, no |

| | | | |
|---|---|---|---|
| Instagram | Categorical | Identifies whether the website includes links to its own Instagram page | Categories: yes, no |
| Links to other organizations | Categorical | Identifies whether the website includes links to other websites (either as a distinct list or throughout their text) | Categories: yes, no |
| News Cited | Categorical | Identifies whether the website cites news articles (i.e., online news, newspaper or tv stories) as evidence of wind turbines' impact on human health | Categories: yes, no |
| News Section Present | Categorical | Identifies whether the website has its own 'news' section | Categories: yes, no |
| Noise Subsection present | Categorical | identifies whether the website has a section | Categories: yes, no |

| | | | |
|---|---|---|---|
| | | specifically on wind turbine noise | |
| Peer-reviewed Articles cited | Categorical | Identifies whether peer-reviewed articles cited--includes articles published in predatory or low quality journals, as well as conference abstracts | Categories: yes, no |
| Personal account/testimony of impact of wind turbines on human health present | Categorical | Identifies whether personal account or testimony of impact wind turbines on human health is present on the website, defined as content that provides a written or video narrative account of a personal experience related to wind turbines and health | Categories: yes, no |

| | | | |
|---|---|---|---|
| Position on Wind Turbines and human health | Categorical | Website presents explicit position on whether wind turbines are harmful or not to human health--where position is defined by overarching statements on the health impacts of wind turbines. Harmful includes references to wind turbines causing humans to experience 'pain, suffering, sickness, illness, disease or distress' and 'not harmful' includes reference to wind turbine exposure being 'safe; no health impacts' or 'annoyance or sleep disruption only', 'unclear' means no definitive | Categories: Harmful, not harmful, unclear |

| | | | |
|---|---|---|---|
| | | statement on health impact can be found or the messaging is mixed, or states that it is unclear/further research needed to determine | |
| Organization name | Open Text | The field provides the name of the organization as listed on its webpage | Open text |
| Organization type | Categorical | States the type of organization-- where 'community group' describes an organization on a municipal, regional or national level which represents Canadians and has a position on wind turbines; 'public health organization' describes an | Categories: Community group, public health organization, environmental non-governmental organization, academic organization |

| | | | |
|---|---|---|---|
| | | organization that is either a formal governmental body or a non-governmental organization that focuses its work on public health; environmental non-governmental organization is a body that focuses on environmental issues but includes a stated position on wind turbines and human health; academic organization is a university or research-focused body that has a position on the impacts of wind turbines on human health; and other describes organizations | |

| | | | |
|---|---|---|---|
| | | that do not meet the above criteria (excluding industry or commercial organizations) | |
| Other social media platform | Categorical | Identifies whether social media posts that are not Facebook, Tumblr, Twitter, or Instagram are cited by the website | Categories: yes, no |
| Social Media Component Present | Categorical | States whether social media components are present on the website (Facebook, Instagram, Twitter, Tumblr, or Other Social Media Platform) | Categories: yes, no |
| Subsection on Health Present | Categorical | Identifies whether a specific page on health impacts of wind turbines present— | Categories: yes, no |

| | | | |
|---|---|---|---|
| | | defined as a page that specifically describes potential illness, disease, sickness or other adverse health effects—or describes the lack of adverse health effects—related to wind turbine exposure | |
| Tumblr | Categorical | Identifies whether the website contains links to its own Tumblr page | Categories: yes, no |
| Twitter | Categorical | Identifies whether the website contains links to its own Twitter page | Categories: yes, no |
| Unique ID | Numeric | Unique identifying number assigned to the website for consistency | Numeric |
| Website URL | Text field | URL for top level website (if health a | Open text |

| | | | |
|---|---|---|---|
| | | subsection, include subsection URL) | |
| video/documentary evidence links | Categorical | Identifies whether website includes video evidence for health impact of wind turbines (e.g. Youtube, embedded interviews) | Categories: yes, no |

## Appendix 5: Data Dictionary for Website Citation Details (Peer-reviewed or Grey Literature Evidence)

| **Field Name** | **Type** | **Description** | **Possible values** |
|---|---|---|---|
| Attitude to evidence | Categorical | This field describes the organization's attitude to specific evidence sources when additional adjectives or explanatory test is present detailing the evidence source, where positive entails the use of descriptors indicating the cited evidence source is of good quality (e.g. good, high quality), | Categories: Positive, negative, neutral |

| | | | |
|---|---|---|---|
| | | negative entails the use of descriptors indicating that the cited evidence source is of poor quality (e.g. low quality, conflicts of interest, errors present) and neutral otherwise | |
| Citation number | Numerical | Unique number assigned to individual citation with prefix A (i.e., A1, A2, etc). NOTE: For organization websites whose content is solely a publication (e.g. grey literature), the document will be listed in this section as an evidence source | A1, A2, etc |
| Citation Name | Open text | This provides the title of the article or evidence source as listed in its reference | Open text |
| Consultant Report | Categorical | This field details whether a grey literature report is listed as written by a consultant, as defined by wording indicating that the document was prepared for the | Categories: yes, no, unclear |

| | | | |
|---|---|---|---|
| | | organization by the consultant, or that the authorship of the grey literature document was from individuals outside of the organization | |
| Evidence type | Categorical | States the type of evidence by category as determined through review of the evidence sources methods and or structure | Categories: book, Book Chapter, case control study, case report, Cohort Study, conference paper, cross-sectional survey, Editorial, experimental study with controls, experimental study without controls, Grey-literature, Letter, observational study with controls, observational study without controls, Review, Thesis |
| Grey Literature Type | Categorical | Lists the type of organization that authored the cited grey literature document | Categories: Community Group, Public Health Organization, Environmental NGO, |

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| | | | Academic Organization, Industry, Government, Health NGO, Unclear |
| Peer-reviewed | Categorical | This variable whether source is peer-reviewed, as determined through a review of the document and its publisher | Categories: yes, no, unclear |
| Predatory Journal | Categorical | Is source in a known predatory journal (as per Beall's List of Predatory Journals and Publishers https://beallslist.weebly.com/ ) | Categories: yes, no, unclear |
| Publication Quality concerns present | categorical | Are quality concerns found with Internet search of "[publication title] AND quality" and scanning first 30 results | Categories: yes, no, unclear |
| Reference | Open text | Reference as per APA format | Open text |

## Appendix 6: Data Dictionary for Website Citation Details Tool (Other Organization)

| **Field Name** | **Type** | **Description** | **Possible Values** |
|---|---|---|---|
| Cited as supportive | Categorical | Other organization website cited as | Categories: yes, no, unclear |

| | | | |
|---|---|---|---|
| evidence for position | | supportive evidence for human health impact of wind turbines | |
| Dead Link | Categorical | Identifies whether the organization URL is a dead link (link does not work or indicates that the website is no longer functional) | Categories: yes, no |
| Included as allied organization | Categorical | Other organization website cited as allied organization (as linked organization but not explicitly for information on human health impact of wind turbines), defined as being listed in a series of allied organizations on the website, mentioned explicitly as an allied or sister organization, or as a | Categories: yes, no, unclear |

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| | | partner organization | |
| Host organization name | Open text | Name of organization whose website was assessed for additional organization links | Open text |
| Host Organization Unique ID | Numeric | Unique Identifying Number of organization page assessed, assigned in the website characteristics tool | Numeric |
| Linked organization name | Open text | Name of organization whose website was linked from the host website | Open text |
| Linked Organization type | Categorical | Type of organization linked | Categories: Community group, governmental (non-public health), public health organization, environmental NGO, health NGO, industry group, academic organization, unclear |

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|---|---|---|---|
| Linked Organization Unique ID | Numeric | Unique Identifying Number (continues consecutively from website list if not previously assigned number, beginning with Z) | Numeric starting with Z |
| Linked Organization URL | Open text | URL for organization (note if linking to multiple different pages for same organization, include only one URL for the top-level domain) | Open text |
| Non-Canadian Organization | Categorical | Identifies whether the organization is based outside of Canada (found by looking at contact/about details) | Categories: yes, no, unclear |

## Appendix 7: Most Frequently Cited Evidence Sources by Organization Websites with Content on Wind Turbines and Human Health Overall and by Organization Type

| Overall count (n) | Reference (APA style) | Category of evidence | Public Health Organization Count | Reference (APA style) | Category of evidence | Community Group Count | Reference (APA style) | Category of evidence |
|---|---|---|---|---|---|---|---|---|
| 20 | Pierpont, N. (2009). Wind turbine syndrome. K-Selected Books. | Grey-literature | 10 | Chief Medical Officer of Health Ontario. (2010). The potential health impact of wind turbines. | Grey-literature | 13 | Pierpont, N. (2009). Wind turbine syndrome. K-Selected Books. | Grey-literature |
| 19 | Salt, A. N., & Hullar, T. E. (2010). Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing research, 268(1), 12-21. | Review | 6 | Pedersen, E., & Persson Waye, K. (2004). Perception and annoyance due to wind turbine noise—a dose–response relationship. The Journal of the Acoustical Society of America, 116(6), 3460-3470. | Cross-sectional survey | 9 | Nissenbaum, M. A., Aramini, J. J., & Hanning, C. D. (2012). Effects of industrial wind turbine noise on sleep and health. Noise and Health, 14(60), 237. | observational study with controls |
| 11 | Møller, H., & Pedersen, C. S. (2011). Low-frequency noise from large wind turbines. The Journal of the Acoustical Society of America, 129(6), 3727-3744. | Cross-sectional survey | 6 | Jakobsen, J. (2005). Infrasound emission from wind turbines. Journal of low frequency noise, vibration and active control, 24(3), 145-155. | Review | 8 | Phillips, C. V. (2011). Properly interpreting the epidemiologic evidence about the health effects of industrial wind turbines on nearby residents. Bulletin of Science, Technology & Society, 31(4), 303-315. | Review |

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| 11 | Krogh, C. M., Gillis, L., Kouwen, N., & Aramini, J. (2011). WindVOiCe, a self-reporting survey: adverse health effects, industrial wind turbines, and the need for vigilance monitoring. Bulletin of Science, Technology & Society, 31(4), 334-345. | Cross-sectional survey | 5 | Pierpont, N. (2009). Wind turbine syndrome. K-Selected Books. | Grey-literature | 8 | Paller, C., Sh, M., Law, J., & Christidis, T. (2013). Wind turbine noise, sleep quality, and symptoms of inner ear problems. In Toronto (ON): Symposia of the Ontario Research Chairs in Public Policy (p. 17). | conference paper |
| 10 | Colby WD, Dobie R, Leventhall G, Lipscomb DM, McCunney RJ, Seilo MT, et al. Wind turbine sound and health effects. An expert panel review: American Wind Energy Association & Canadian Wind Energy Association; ; 2009. | Grey-literature | 5 | Colby WD, Dobie R, Leventhall G, Lipscomb DM, McCunney RJ, Seilo MT, et al. Wind turbine sound and health effects. An expert panel review: American Wind Energy Association & Canadian Wind Energy Association; ; 2009. | Grey-literature | 7 | McMurtry, R. Y., & Krogh, C. M. (2014). Diagnostic criteria for adverse health effects in the environs of wind turbines. JRSM open, 5(10), 2054270414554048. | Review |
| 10 | Pedersen, E., van den Berg, F., Bakker, R., & Bouma, J. (2009). Response to noise from modern wind farms in The Netherlands. The Journal of the Acoustical Society of America, 126(2), 634-643. | Cross-sectional survey | 5 | Pedersen, E., & Waye, K. P. (2007). Wind turbine noise, annoyance and self-reported health and well-being in different living environments. Occupational and environmental medicine, | Cross-sectional survey | 7 | Punch, J. L., & Jamesii, R. R. (2016). Wind Turbine Noise and Human Health: A Four-Decade History of Evidence that Wind Turbines Pose Risks. | Grey-literature |

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| | | | | 64(7), 480-486. | | | | |
| 10 | Pedersen, E. (2007). Human response to wind turbine noise-perception, annoyance and moderating factors. Inst of Medicine. Dept of Public Health and Community Medicine. | observational study with controls | 5 | Møller, H., & Pedersen, C. S. (2011). Low-frequency noise from large wind turbines. The Journal of the Acoustical Society of America, 129(6), 3727-3744. | Cross-sectional survey | 7 | Thorne, B. (2011). The problems with "noise numbers" for wind farm noise assessment. Bulletin of Science, Technology & Society, 31(4), 262-290. | Review |
| 9 | Pedersen, E., & Persson Waye, K. (2004). Perception and annoyance due to wind turbine noise—a dose–response relationship. The Journal of the Acoustical Society of America, 116(6), 3460-3470. | Cross-sectional survey | 4 | World Health Organization, & World Health Organization. (1999). Guidelines for community noise. WHO, Geneva. | Grey-literature | 7 | Harrison, J. P. (2011). Wind turbine noise. Bulletin of Science, Technology & Society, 31(4), 256-261. | Review |
| 8 | World Health Organization, & World Health Organization. (1999). Guidelines for community noise. WHO, Geneva. | Grey-literature | 4 | National Research Council Committee on Environmental Impacts of Wind-Energy Projects. Environmental impacts of wind-energy projects. Washington, D.C.: National Academies Press; 2007. | Grey-literature | 7 | Krogh, C. M., Gillis, L., Kouwen, N., & Aramini, J. (2011). WindVOiCe, a self-reporting survey: adverse health effects, industrial wind turbines, and the need for vigilance monitoring. Bulletin of Science, Technology & Society, 31(4), 334-345. | Cross-sectional survey |
| 8 | Pedersen, E., & Waye, K. P. (2007). Wind turbine noise, annoyance and self-reported health and well-being in | Cross-sectional survey | 4 | Pedersen, E., & Waye, K. P. (2008). Wind turbines—low level noise sources | Cross-sectional survey | 7 | Arra, I., Lynn, H., Barker, K., Ogbuneke, C., & Regalado, S. (2014). Systematic Review 2013: Association | Review |

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| | different living environments. Occupational and environmental medicine, 64(7), 480-486. | | | interfering with restoration?. Environmental Research Letters, 3(1), 015002. | | | between wind turbines and human distress. Cureus, 6(5). | |
| 8 | Salt, A. N., & Kaltenbach, J. A. (2011). Infrasound from wind turbines could affect humans. Bulletin of Science, Technology & Society, 31(4), 296-302. | Review | 4 | Leventhall, G. (2006). Infrasound from wind turbines-fact, fiction or deception. Canadian acoustics, 34(2), 29-36. | Review | 6 | Jeffery, R. D., Krogh, C., & Horner, B. (2013). Adverse health effects of industrial wind turbines. Canadian Family Physician, 59(5), 473-475. | Review |
| 8 | Thorne, B. (2011). The problems with “noise numbers” for wind farm noise assessment. Bulletin of Science, Technology & Society, 31(4), 262-290. | Review | 4 | Keith, S. E., Michaud, D. S., & Bly, S. H. (2008). A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Journal of Low Frequency Noise, Vibration and Active Control, 27(4), 253-265. | Review | 6 | Shain, M. (2011). Public health ethics, legitimacy, and the challenges of industrial wind turbines: the case of Ontario, Canada. Bulletin of Science, Technology & Society, 31(4), 346-353. | Review |
| 8 | Harrison, J. P. (2011). Wind turbine noise. Bulletin of Science, Technology & Society, 31(4), 256-261. | Review | 4 | Pedersen, E., van den Berg, F., Bakker, R., & Bouma, J. (2009). Response to noise from modern wind farms in The Netherlands. The | Cross-sectional survey | 6 | Krogh, C. M. (2011). Industrial wind turbine development and loss of social justice?. Bulletin of Science, Technology & Society, 31(4), 321-333. | Review |

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| | | | | Journal of the Acoustical Society of America, 126(2), 634-643. | | | | |
| 8 | Shepherd, D., McBride, D., Welch, D., Dirks, K. N., & Hill, E. M. (2011). Evaluating the impact of wind turbine noise on health-related quality of life. Noise and Health, 13(54), 333. | Cross-sectional survey | 3 | van den Berg F, Pedersen E, Bouma J, Bakker R. WINDFARM perception. Visual and acoustic impact of wind turbine farms on residents. 2008 [cited 2009 Aug 27]; FP6-2005-Science-and-Society-20, Specific Support Action, Project No. 044628. | Grey-literature | 6 | McMurtry, R. Y. (2011). Toward a case definition of adverse health effects in the environs of industrial wind turbines: facilitating a clinical diagnosis. Bulletin of Science, Technology & Society, 31(4), 316-320. | Review |
| 8 | Phillips, C. V. (2011). Properly interpreting the epidemiologic evidence about the health effects of industrial wind turbines on nearby residents. Bulletin of Science, Technology & Society, 31(4), 303-315. | Review | 3 | Berglund, B., & Lindvall, T. (Eds.). (1995). Community noise. Stockholm: Center for Sensory Research, Stockholm University and Karolinska Institute. | Grey-literature | 5 | Chief Medical Officer of Health Ontario. (2010). The potential health impact of wind turbines. | Grey-literature |
| 8 | Paller, C., Sh, M., Law, J., & Christidis, T. (2013). Wind turbine noise, sleep quality, and symptoms of inner ear problems. In Toronto (ON): Symposia of the Ontario Research Chairs in Public Policy (p. 17). | conference paper | 3 | Smedley, A. R., Webb, A. R., & Wilkins, A. J. (2010). Potential of wind turbines to elicit seizures under various meteorological conditions. Epilepsia, 51(7), | observational study without controls | 5 | Salt, A. N., & Kaltenbach, J. A. (2011). Infrasound from wind turbines could affect humans. Bulletin of Science, Technology & Society, 31(4), 296-302. | Review |

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| | | | | 1146-1151. | | | | |
| 8 | Howe, B. (2010). Low frequency noise and infrasound associated with wind turbine generator systems: a literature review. Ontario: Ministry of the Environment RFP, (2010). | Grey-literature | 3 | Hurtley, C. (Ed.). (2009). Night noise guidelines for Europe. WHO Regional Office Europe. | Grey-literature | 5 | Shepherd, D., McBride, D., Welch, D., Dirks, K. N., & Hill, E. M. (2011). Evaluating the impact of wind turbine noise on health-related quality of life. Noise and Health, 13(54), 333. | Cross-sectional survey |
| 8 | Olson, H. F. (1972). The measurement of loudness. Audio Magazine, 18-22. | Grey-literature | 3 | Rideout, K., Copes, R., & Bos, C. (2010). Wind turbines and health. National Collaborating Centre for Environmental Health. | Grey-literature | 5 | Nissenbaum, M., Aramini, J., & Hanning, C. (2011, July). Adverse health effects of industrial wind turbines: a preliminary report. In Proceedings of 10th International Congress on Noise as a Public Health Problem (ICBEN) (pp. 1-6). | Cross-sectional survey |
| 7 | Jeffery, R. D., Krogh, C., & Horner, B. (2013). Adverse health effects of industrial wind turbines. Canadian Family Physician, 59(5), 473-475. | Review | 3 | Pedersen, E., & Larsman, P. (2008). The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines. Journal of Environmental Psychology, 28(4), 379-389. | Cross-sectional survey | 5 | Bronzaft, A. L. (2011). The noise from wind turbines: potential adverse impacts on children's well-being. Bulletin of Science, Technology & Society, 31(4), 291-295. | Review |
| 7 | van den Berg F, Pedersen E, Bouma J, Bakker R. WINDFARM perception. Visual and acoustic impact of wind turbine farms on residents. 2008 [cited | Grey-literature | 3 | Harry A. Wind Turbines, Noise and Health [Internet]. 2007 Feb | Grey-literature | 5 | Hanning, C. D., & Evans, A. (2012). Wind turbine noise. BMJ: British Medical Journal, 344(7853), 12-12. | Editorial |

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| | 2009 Aug 27]; FP6-2005-Science-and-Society-20, Specific Support Action, Project No. 044628. | | | | | | | |
| 7 | Guest, H. (2003). Inadequate standards currently applied by local authorities to determine statutory nuisance from LF and infrasound. Journal of low frequency noise, vibration and active control, 22(1), 1-7. | Review | 3 | Krogh, C. M., Gillis, L., Kouwen, N., & Aramini, J. (2011). WindVOiCe, a self-reporting survey: adverse health effects, industrial wind turbines, and the need for vigilance monitoring. Bulletin of Science, Technology & Society, 31(4), 334-345. | Cross-sectional survey | 5 | Council of Canadian Academies, 2015. Understanding the Evidence: Wind Turbine Noise. Ottawa (ON): The Expert Panel on Wind Turbine Noise and Human Health, Council of Canadian Academies | Grey-literature |
| 7 | Keith, S. E., Michaud, D. S., & Bly, S. H. (2008). A proposal for evaluating the potential health effects of wind turbine noise for projects under the Canadian Environmental Assessment Act. Journal of Low Frequency Noise, Vibration and Active Control, 27(4), 253-265. | Review | 3 | Pedersen, E. (2011). Health aspects associated with wind turbine noise—Results from three field studies. Noise Control Engineering Journal, 59(1), 47-53. | Cross-sectional survey | 4 | The Acoustics Group. The Results of an Acoustic Testing Program – Cape Bridgewater Wind Farm Energy Pacific (Vic) Pty Ltd. 44.5100.R7:MSC Nov 2014 | Grey-literature |
| 7 | Krogh, C. M. (2011). Industrial wind turbine development and loss of social justice?. Bulletin of Science, Technology & Society, 31(4), 321-333. | Review | 3 | Knopper, L. D., & Ollson, C. A. (2011). Health effects and wind turbines: A review of the literature. Environmental Health, | Review | 4 | Møller, H., & Pedersen, C. S. (2011). Low-frequency noise from large wind turbines. The Journal of the Acoustical Society of America, 129(6), 3727-3744. | Cross-sectional survey |

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| | | | | 10(1), 78. | | | | |
| 7 | Forssén, J., Schiff, M., Pedersen, E., & Waye, K. P. (2010). Wind turbine noise propagation over flat ground: measurements and predictions. Acta Acustica united with Acustica, 96(4), 753-760. | observational study with controls | 3 | Colby, D. (2008). The Health Impact of Wind Turbines: A Review of the Current White, Grey, and Published Literature. Chatam, Ontario: Chatam-Kent Public Health Unit. | Grey-literature | 4 | Salt, A. N., & Hullar, T. E. (2010). Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing research, 268(1), 12-21. | Review |
| 7 | Waye, K. P., Clow, A., Edwards, S., Hucklebridge, F., & Rylander, R. (2003). Effects of nighttime low frequency noise on the cortisol response to awakening and subjective sleep quality. Life sciences, 72(8), 863-875. | experimental study with controls | 3 | Environment Health Division, Minnesota Department of Health. Public Health Impacts of Wind Turbines [Internet]. Minnesota Department of Public Health; 2009 May | Grey-literature | 4 | Pedersen, E., van den Berg, F., Bakker, R., & Bouma, J. (2009). Response to noise from modern wind farms in The Netherlands. The Journal of the Acoustical Society of America, 126(2), 634-643. | Cross-sectional survey |
| 6 | Pedersen, E., & Waye, K. P. (2008). Wind turbines—low level noise sources interfering with restoration?. Environmental Research Letters, 3(1), 015002. | Cross-sectional survey | 2 | Janssen, S. A., Vos, H., Eisses, A. R., & Pedersen, E. (2011). A comparison between exposure-response relationships for wind turbine annoyance and annoyance due to other noise sources. The Journal of the Acoustical Society of America, 130(6), 3746- | Cross-sectional survey | 4 | Horner, B., Jeffery, R. D., & Krogh, C. M. (2011). Literature reviews on wind turbines and health: are they enough?. Bulletin of Science, Technology & Society, 31(5), 399-413. | Review |

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| | | | | 3753. | | | | |
| 6 | Pedersen, E., & Larsman, P. (2008). The impact of visual factors on noise annoyance among people living in the vicinity of wind turbines. Journal of Environmental Psychology, 28(4), 379-389. | Cross-sectional survey | 2 | Berglund, B., Hassmen, P., & Job, R. S. (1996). Sources and effects of low-frequency noise. The Journal of the Acoustical Society of America, 99(5), 2985-3002. | Review | 4 | Frey, B. J. (2012). Wind Turbines and Proximity to Homes: The Impact of Wind Turbine Noise on Health. A review of the literature & discussion of the issues. | Grey-literature |
| 6 | Nissenbaum, M., Aramini, J., & Hanning, C. (2011, July). Adverse health effects of industrial wind turbines: a preliminary report. In Proceedings of 10th International Congress on Noise as a Public Health Problem (ICBEN) (pp. 1-6). | Cross-sectional survey | 2 | Schust, M. (2004). Effects of low frequency noise up to 100 Hz. Noise and Health, 6(23), 73. | Review | 4 | Jeffery, R. D., Krogh, C. M. E. & Brett Horner B. A., (2014). Industrial wind turbines and adverse health effects. Canadian Journal of Rural Medicine, 19(1), 21. | Review |
| 6 | Pedersen, E. (2011). Health aspects associated with wind turbine noise—Results from three field studies. Noise Control Engineering Journal, 59(1), 47-53. | Cross-sectional survey | 2 | Garrad Hassan Canada Inc. Recommendations for risk assessments of ice throw and blade failure in Ontario. Contract report for Canadian Wind Energy Association (CanWEA); 2007 Contract No.: 38079/OR/01 | Grey-literature | 4 | Havas, M., & Colling, D. (2011). Wind turbines make waves: why some residents near wind turbines become ill. Bulletin of Science, Technology & Society, 31(5), 414-426. | Review |
| 6 | Frey, B. J. (2012). Wind Turbines and | Grey- | 2 | Howe, B. (2006). Wind | Grey- | 4 | Rand, R. W., Ambrose, S. E., & Krogh, | Review |

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|---|---|---|---|---|---|---|---|---|
| | Proximity to Homes: The Impact of Wind Turbine Noise on Health. A review of the literature & discussion of the issues. | literature | | turbines and infrasound. | literature | | C. M. (2011). Occupational health and industrial wind turbines: a case study. Bulletin of Science, Technology & Society, 31(5), 359-362. | |
| 6 | Shain, M. (2011). Public health ethics, legitimacy, and the challenges of industrial wind turbines: the case of Ontario, Canada. Bulletin of Science, Technology & Society, 31(4), 346-353. | Review | 2 | Salt, A. N., & Hullar, T. E. (2010). Responses of the ear to low frequency sounds, infrasound and wind turbines. Hearing research, 268(1), 12-21. | Review | 4 | Krogh, C. M., Jeffery, R. D., Aramini, J., & Horner, B. (2012, August). Wind turbines can harm humans: a case study. In INTER-NOISE and NOISE-CON Congress and Conference Proceedings (Vol. 2012, No. 10, pp. 1709-1722). Institute of Noise Control Engineering. | conference paper |
| 6 | McMurtry, R. Y. (2011). Toward a case definition of adverse health effects in the environs of industrial wind turbines: facilitating a clinical diagnosis. Bulletin of Science, Technology & Society, 31(4), 316-320. | Review | 2 | World Health Organisation 2011. Burden of Disease from Environmental Noise: Quantification of Healthy Life Years Lost in Europe. Copenhagen: WHO Regional Office for Europe | Grey-literature | 4 | Krogh, C. M., Jeffery, R. D., Aramini, J., & Horner, B. (2012, August). Wind turbine noise perception, pathways and effects: a case study. In INTER-NOISE and NOISE-CON Congress and Conference Proceedings (Vol. 2012, No. 10, pp. 1683-1697). Institute of Noise Control Engineering. | conference paper |
| 6 | Yamada, S., Ikuji, M., Fujikata, S., Watanabe, T., & Kosaka, T. (1983). Body sensation of low frequency noise of ordinary persons and profoundly deaf persons. Journal of Low Frequency | experimental study with controls | 2 | Copes, R., & Rideout, K. (2009). Wind turbines and health: A review of evidence. Ontario Agency for Health Protection and | Grey-literature | 4 | Krogh, C. M., Jeffery, R. D., Aramini, J., & Horner, B. (2012, August). Annoyance can represent a serious degradation of health: Wind turbine noise: A case study. In INTER-NOISE | conference paper |

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| | Noise, Vibration and Active Control, 2(3), 32-36. | | | Promotion. | | | and NOISE-CON Congress and Conference Proceedings (Vol. 2012, No. 10, pp. 1671-1682). Institute of Noise Control Engineering. | |
| 5 | National Research Council Committee on Environmental Impacts of Wind-Energy Projects. Environmental impacts of wind-energy projects. Washington, D.C.: National Academies Press; 2007. | Grey-literature | 2 | Salt, A. N., & Kaltenbach, J. A. (2011). Infrasound from wind turbines could affect humans. Bulletin of Science, Technology & Society, 31(4), 296-302. | Review | 4 | Krogh C., McMurtry R.Y. (2014) Health Canada and Wind Turbines: Too little too late?. CMAJ Blog | Letter |
| 5 | Harry A. Wind Turbines, Noise and Health [Internet]. 2007 Feb | Grey-literature | 2 | Shepherd, K. P., & Hubbard, H. H. (1991). Physical characteristics and perception of low frequency noise from wind turbines. Noise control engineering journal, 36(1), 5-15. | Review | 4 | Punch, J., James, R., & Pabst, D. (2010). Wind turbine noise: what audiologists should know. Audiology today, 22(4), 20-31. | Grey-literature |
| 5 | Horner, B., Jeffery, R. D., & Krogh, C. M. (2011). Literature reviews on wind turbines and health: are they enough?. Bulletin of Science, Technology & Society, 31(5), 399-413. | Review | 2 | Lee, S., Kim, K., Choi, W., & Lee, S. (2011). Annoyance caused by amplitude modulation of wind turbine noise. Noise Control Engineering Journal, 59(1), 38-46. | observational study with controls | 3 | Vanderburg, W. H. (2011). Assessing Our Ability to Design and Plan Green Energy Technologies. Bulletin of Science, Technology & Society, 31(4), 251-255. | Review |

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|---|---|---|---|---|---|---|---|---|
| 5 | Bronzaft, A. L. (2011). The noise from wind turbines: potential adverse impacts on children's well-being. Bulletin of Science, Technology & Society, 31(4), 291-295. | Review | 2 | Jung, S. S., Cheung, W. S., Cheong, C., & Shin, S. H. (2008). Experimental identification of acoustic emission characteristics of large wind turbines with emphasis on infrasound and low-frequency noise. Journal of the Korean Physical Society, 53(4), 1897-1905. | experimental study with controls | 3 | Martin, C.L. (2010) Your Guide to Wind Turbine Syndrome... a roadmap to this complicated subject | Grey-literature |
| 5 | Hanning, C. D., & Evans, A. (2012). Wind turbine noise. BMJ: British Medical Journal, 344(7853), 12-12. | Editorial | 2 | Pedersen, E., Van Den Berg, F., Bakker, R., & Bouma, J. (2010). Can road traffic mask sound from wind turbines? Response to wind turbine sound at different levels of road traffic sound. Energy policy, 38(5), 2520-2527. | Cross-sectional survey | 3 | Krogh, C. M. E., Horner B. S. (2011) A Summary of new evidence: Adverse health effects and industrial wind turbines | Grey-literature |
| 5 | Pierpont, N. (2010, November). Wind Turbine Syndrome & the Brain. In First International Symposium on the Global Wind Industry and Adverse Health Effects: Loss of Social Justice (pp. 29- | Grey-literature | 2 | Pedersen, E., Hallberg, L. M., & Waye, K. P. (2007). Living in the vicinity of wind turbines—a grounded theory study. Qualitative | Cross-sectional survey | 3 | Phillips, C. V. (2010) An Analysis of the Epidemiology and Related Evidence on the Health Effects of Wind Turbines on Local Residents | Grey-literature |

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| | 31). | | | Research in Psychology, 4(1-2), 49-63. | | | | |
| 5 | Seong, Y., Lee, S., Gwak, D. Y., Cho, Y., Hong, J., & Lee, S. (2013, September). An experimental study on rating scale for annoyance due to wind turbine noise. In INTER-NOISE and NOISE-CON Congress and Conference Proceedings (Vol. 247, No. 5, pp. 2699-2704). Institute of Noise Control Engineering. | conference paper | 2 | Shepherd, D., McBride, D., Welch, D., Dirks, K. N., & Hill, E. M. (2011). Evaluating the impact of wind turbine noise on health-related quality of life. Noise and Health, 13(54), 333. | Cross-sectional survey | 3 | Pedersen, E. (2007). Human response to wind turbine noise-perception, annoyance and moderating factors. Inst of Medicine. Dept of Public Health and Community Medicine. | observational study with controls |
| 4 | Janssen, S. A., Vos, H., Eisses, A. R., & Pedersen, E. (2011). A comparison between exposure-response relationships for wind turbine annoyance and annoyance due to other noise sources. The Journal of the Acoustical Society of America, 130(6), 3746-3753. | Cross-sectional survey | 2 | Alves-Pereira, M., & Branco, N. C. (2007, September). In-home wind turbine noise is conducive to vibroacoustic disease. In Proceedings of the Second International Meeting on Wind Turbine Noise (pp. 20-21). | conference paper | 3 | McKitrick, R. (2013). Environmental and economic consequences of Ontario's green energy act. The Fraser Institute. | Grey-literature |
| 4 | Windrush Energy. The health effects of magnetic fields generated by wind turbines. Palgrave, ON: Windrush Energy; 2004. | Grey-literature | 2 | Harding, G., Harding, P., & Wilkins, A. (2008). Wind turbines, flicker, and photosensitive epilepsy: Characterizing the flashing | Review | 3 | Wong, R., Smith, E. A., Kirby,D., & Coop, J. (2011) The Ontario Environmental Review Tribunal Decision in Erickson v. Director, Ministry of Environment | Grey-literature |

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| | | | | that may precipitate seizures and optimizing guidelines to prevent them. Epilepsia, 49(6), 1095-1098. | | | | |
| 4 | Pedersen, E., Van Den Berg, F., Bakker, R., & Bouma, J. (2010). Can road traffic mask sound from wind turbines? Response to wind turbine sound at different levels of road traffic sound. Energy policy, 38(5), 2520-2527. | Cross-sectional survey | 2 | Ising, H., & Kruppa, B. (2004). Health effects caused by noise: evidence in the literature from the past 25 years. Noise and Health, 6(22), 5. | Review | 3 | Shepherd, D., & Billington, R. (2011). Mitigating the acoustic impacts of modern technologies: acoustic, health, and psychosocial factors informing wind farm placement. Bulletin of Science, Technology & Society, 31(5), 389-398. | Review |
| 4 | Bakker, R. H., Pedersen, E., van den Berg, G. P., Stewart, R. E., Lok, W., & Bouma, J. (2012). Impact of wind turbine sound on annoyance, self-reported sleep disturbance and psychological distress. Science of the Total Environment, 425, 42-51. | Cross-sectional survey | 2 | Branco, N. C., & Alves-Pereira, M. (2004). Vibroacoustic disease. Noise and Health, 6(23), 3. | Review | 3 | Wolfe, D. (2014) Review of the Health Canada Wind Turbine Noise and Health Study. | Grey-literature |
| 4 | Knopper, L. D., & Ollson, C. A. (2011). Health effects and wind turbines: A review of the literature. Environmental Health, 10(1), 78. | Review | 2 | NHMRC, A. (2010). Wind Turbines and Health–A Rapid Review of the Evidence. July. | Review | | | |
| 4 | Harding, G., Harding, P., & Wilkins, A. (2008). Wind turbines, flicker, and photosensitive epilepsy: Characterizing | Review | 2 | Fortin, P., Rideout, K., Copes, R., & Bos, C. (2013). Wind Turbines and | Grey-literature | | | |

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|---|---|---|---|---|---|
| | the flashing that may precipitate seizures and optimizing guidelines to prevent them. Epilepsia, 49(6), 1095-1098. | | | Health. National Collaborating Centre for Environmental Health at the British Columbia Centre for Disease Control. | |
| 4 | Colby, D. (2008). The Health Impact of Wind Turbines: A Review of the Current White, Grey, and Published Literature. Chatam, Ontario: Chatam-Kent Public Health Unit. | Grey-literature | 2 | Michaud, D. S., Feder, K., Keith, S. E., Voicescu, S. A., Marro, L., Than, J., ... & Lavigne, E. (2016). Exposure to wind turbine noise: Perceptual responses and reported health effects. The Journal of the Acoustical Society of America, 139(3), 1443-1454. | observational study with controls |
| 4 | Environment Health Division, Minnesota Department of Health. Public Health Impacts of Wind Turbines [Internet]. Minnesota Department of Public Health; 2009 May | Grey-literature | 2 | Michaud, D. S., Feder, K., Keith, S. E., Voicescu, S. A., Marro, L., Than, J., ... & Villeneuve, P. J. (2016). Effects of wind turbine noise on self-reported and objective measures of sleep. Sleep, 39(1), 97-109. | observational study with controls |
| 4 | NHMRC, A. (2010). Wind Turbines | Grey- | 2 | Howe, B., Gastmeier, B., & | Grey- |

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|---|---|---|---|---|---|
| | and Health–A Rapid Review of the Evidence. July. | literature | | McCabe, N. (2007). Wind turbines and sound: review and best practice guidelines. Howe Gastermeier Chapnik Limited Engineering. Retrieved, 20(04), 2010. | literature |
| 4 | Jeffery, R. D., Krogh, C. M. E. & Brett Horner B. A., (2014). Industrial wind turbines and adverse health effects. Canadian Journal of Rural Medicine, 19(1), 21. | Review | 2 | Van den Berg, G. P. (2004). Effects of the wind profile at night on wind turbine sound. Journal of sound and vibration, 277(4), 955-970. | observational study with controls |
| 4 | Rand, R. W., Ambrose, S. E., & Krogh, C. M. (2011). Occupational health and industrial wind turbines: a case study. Bulletin of Science, Technology & Society, 31(5), 359-362. | Review | 2 | Brüel & Kjaer (2000). Bruit de l'environnement. Brüel & Kjær Sound & Vibration Measurement A/S, Naerum, Danemark | Grey-literature |
| 4 | Krogh, C. M., Jeffery, R. D., Aramini, J., & Horner, B. (2012, August). Wind turbines can harm humans: a case study. In INTER-NOISE and NOISE-CON Congress and Conference Proceedings (Vol. 2012, No. 10, pp. 1709-1722). Institute of Noise Control Engineering. | conference paper | 2 | Leventhall, H. G. (2004). Low frequency noise and annoyance. Noise and Health, 6(23), 59. | Review |

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|---|---|---|---|---|---|
| 4 | Krogh, C. M., Jeffery, R. D., Aramini, J., & Horner, B. (2012, August). Wind turbine noise perception, pathways and effects: a case study. In INTER-NOISE and NOISE-CON Congress and Conference Proceedings (Vol. 2012, No. 10, pp. 1683-1697). Institute of Noise Control Engineering. | conference paper | 2 | Van den Berg, G. P. (2006). Wind-induced noise in a screened microphone. The Journal of the Acoustical Society of America, 119(2), 824-833. | experimental study with controls |
| 4 | Krogh, C. M., Jeffery, R. D., Aramini, J., & Horner, B. (2012, August). Annoyance can represent a serious degradation of health: Wind turbine noise: A case study. In INTER-NOISE and NOISE-CON Congress and Conference Proceedings (Vol. 2012, No. 10, pp. 1671-1682). Institute of Noise Control Engineering. | conference paper | 2 | Van den Berg, G. P. (2004, August). Do wind turbines produce significant low frequency sound levels. In 11th International Meeting on Low Frequency Noise and Vibration and its Control (pp. 1-8). | conference paper |
| 4 | Arra, I., Lynn, H., Barker, K., Ogbuneke, C., & Regalado, S. (2014). Systematic Review 2013: Association between wind turbines and human distress. Cureus, 6(5). | Review | 2 | Wang, Z. (2011). Evaluation of wind farm noise policies in South Australia: a case study of Waterloo Wind Farm (Doctoral dissertation, Masters dissertation, Discipline of Geography, | Cross-sectional survey |

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|---|---|---|---|---|---|
| | | | | Environment and Population, University of Adelaide, Adelaide | |
| 4 | Fortin, P., Rideout, K., Copes, R., & Bos, C. (2013). Wind Turbines and Health. National Collaborating Centre for Environmental Health at the British Columbia Centre for Disease Control. | Grey-literature | | | |
| 4 | Kugler K, Wiegrebe L, Grothe B, Kössl M, Gürkov R, Krause E, Drexl M. 2014 Low-frequency sound affects active micromechanics in the human inner ear. R.Soc.opensci.1: 140166. | experimental study without controls | | | |
| 4 | Nissenbaum, M. A., Aramini, J. J., & Hanning, C. D. (2012). Effects of industrial wind turbine noise on sleep and health. Noise and Health, 14(60), 237. | observational study with controls | | | |
| 4 | Nussbaum, D. S., & Reinis, S. (1985). Some individual differences in human response to infrasound. University of Toronto. | experimental study with controls | | | |
| 4 | Bolton, R. (2007). Evaluation of Environmental Shadow Flicker Analysis | Grey-literature | | | |

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| | for “Dutch Hill Wind Power Project”. Environmental Compliance Alliance, New York, USA, 30. | |
| 4 | Horne, J. A., Pankhurs, F. L., Reyner, L. A., Hume, K., & Diamond, I. D. (1994). A field study of sleep disturbance: effects of aircraft noise and other factors on 5,742 nights of actimetrically monitored sleep in a large subject sample. Sleep, 17(2), 146-159. | observational study with controls |
| 4 | Broadbent, D. E. (1971). Decision and Stress. London, United Kingdom: Academic Press Inc | book |
| 4 | Hockey, G. R. J. (1997). Compensatory control in the regulation of human performance under stress and high workload: A cognitive-energetical framework. Biological psychology, 45(1), 73-93. | Review |
| 4 | Sygna, K., Aasvang, G. M., Aamodt, G., Oftedal, B., & Krog, N. H. (2014). Road traffic noise, sleep and mental health. Environmental research, 131, 17-24. | observational study without controls |

## Appendix 8: List of Included Canadian Organization Websites with Content on Wind Turbines and Human Health

Alliance to Protect Prince Edward County

BEARAT

Beckwith Responsible Wind Action Group

Bruce Peninsula Wind Turbine Action Group

C.H.A.T. Central Huron Against Turbines

Canada Climate Action Network

CCSAGE Naturally Green

Chatham-Kent Public Health Unit

Chatham-Kent Wind Action Group

CMOH Ontario

Concerned Citizens of North Stormont

CORE

Council of Canadian Academies

David Suzuki Foundation

Dutton Dunwich Opponents of Wind Turbines

Ecology Action Centre

Elgin St Thomas Public Health

Equiterre

Haldimand Norfolk Health Unit

Haliburton, Kawartha, Pine Ridge District Health Unit

Hastings Prince Edward Health Unit

Health Canada

How Green Is This

Huron East Against Turbines (HEAT)

Huron Health Unit

INSPQ

KFL&A

Lambton public health

Leeds, Grenville and Lanark District Health Unit

LSARC

Manitoulin Coalition for Safe Energy Alternatives

Manvers Wind Concerns Kawartha

McMaster Institute of Environment & Health (MIEH)

Middlesex-Lambton Wind Action

Mothers Against Wind Turbines Inc

NCCEH

Niagara Region

North American Platform Against Windpower

North Gower Wind Action Group

Nor'Wester Mountain Escarpment Protection Committee

Ontario Wind Resistance

Ottawa Wind Concerns

Pembina Institute

Peterborough Public Health

Protect Amherst Island

Public Health Grey Bruce

SAFE WIND ENERGY FOR ALL RESIDENTS

Save the Nation

Save the Toronto Bluffs

Sierra Club

Simcoe Muskoka District Health Unit

Smithville Turbines Opposition Party

The Grey Highlands Wind Action Group

The Human Face of Wind Turbines

The Society for Wind Vigilance

Toronto Environmental Alliance

Toronto Public Health

Toronto Wind Action

Wainfleet Wind Action Group

WEPAT

We're Against Industrial Turbines

West Grey Residents Against Industrial Turbines

West Lincoln Glanbrook Wind Action Group

WIND CONCERNS MEAFORD

Wind Concerns Ontario

Wind Resistance of Melancthon

Wind Victims Ontario

## Appendix 9: List of Additional Organizations

Adams County Wind

Adelaide Environmental Protection Authority

Agence Française de sécurité sanitaire de l‟environnement

Alberta Utilities Commission

Allegheny Front Alliance,

Allegheny Highlands Alliance

Allegheny Treasures

Alliance for the Protection of Northumberland Hills

Alliance for Wise Energy Decisions

American Wind Energy Association

Amherst Island Wind Info

Ashfield Colbourne Wawanosh Against Industrial Turbines

Atlantic Alliance Against Wind Power

Barnard on Wind

Better Plan, Wisconsin

Blue Highlands Citizens Coalition

Bluewater Against Turbines (BAT)

British Wind Energy Association

Brookfield Renewable Power Website

Brown County Citizens for Responsible Wind Energy (BCCRWE)

Bruce Peninsula Against Industrial Wind

Bruce Wind Action Group, Kincardine, Ont.

Bureau d'audiences publiques sur l'environnement

Caithness Windfarm Information Forum - CWIF -

Calhan Wind Fraud

Campobello Heritage Protection Society, N.B.

CanWEA

Cavan Monaghan Wind Watch

CCOHS. Noise - basic information.

Central-Bruce Grey Wind Action Group

Citizens Against Lake Erie Wind Turbines

Civilna Iniciativa za Zaščito Senožeških Brd,

Clearview WAIT

Columbia University. (n.d.). Glossary of epidemiological terms.

Concerned Caledon Citizens, Ont.

Country Guardian

CPAI – Coalition to Protect Amherst Island

CREW – Citizens for Responsible energy from Wind

Danish Wind Energy Association

Deep Water Resistance

Delkatla Sanctuary Society, B.C.

Department for Business Enterprise & Regulatory Reform.

East Garafaxa Wind Group, Ont.

East Oxford Community Alliance

Elma-Mornington Concerned Citizens*

Energy Probe

Energy Resources Conservation Board

Environmental Protection Agency (US)

Environmental Registry

EPAW

Epilepsy Canada

Epilepsy Foundation

Ernestown Wind Concerns

Essex County Wind Action Group

EZT Wind Concerns – East Zorra-Tavistock Township

Färingtofta Norra

Forensic Appraisal Ltd

Forest Ecology Group

Friends of Arran Lake, Ont

Friends of Maine's Mountains

Friends of the Tantramar Marsh, N.B.

Friends of Wind

Gegenwind Schleswig-Holstein

Global Wind Energy Council

Government of Prince Edward Island.

Grand Valley Wind Action Group

Great Lakes Wind Truth

Green Energy Act Alliance

Greenpeace

Greenwich Neighbors United

GreyNet International

Haldimand Wind Concerns

HALT-Safe Armow

Healthcare professionals against wind in the Appalachian Mountains

Hong Kong Concern About Wind Power Stations

Howard County Citizens for Safe Energy

Hydro Quebec

IllWind Reporting

Independent Electricity System Operator

Industrial Wind Energy Opposition

Innisfil Wind Watchers

Keep Whitney Wild

Kent's Conservation and Preservation Alliance

Landscape in Norway (LANO)

Landsforeningen Bedre Miljø,

Laurel Mountain Preservation Association

Le ministère du du Développement durable, de l'Environnement et de la Lutte contre les changements climatiques

Madawaska Valley Wind Forum

Manitoba Hydro

Manvers Gone With the Wind

MassDEP Wind Turbine Noise Technical Advisory Group.

Melancthon-Amaranth Citizen's Group

Ministère des Affaires municipales et des Régions du Québec (MAMR)

Ministry of Energy and Infrastructure'

MoE Report on Noise 2007

Mountain Ridge Protection Act

Moygownagh/Kilfian Community and Landscape Protection Group

National Energy Board

National Health Service (UK)

National Wind Watch

No Union Beach Wind Turbine!

Norfolk Victims of Industrial Wind Turbines

Norfolk Wind Concerns

North American Wind Power

North Stormont/Stormont Dundas Glengarry

Northern Ontario for No Wind

Nurses for Safe Renewable Power

Ontario Farmland Preservation

Ontario Ministry of the Environment

Ontario Sustainable Energy Association

Ontario Unwilling Hosts

Ontario Wind Turbines Contracts

Oppose Belwood Wind Farm

ORW – Ontarians for Responsible Wind in Georgian Bay

Ottawa Public Health

Oxford Wind Action Group

pacific hydro

Partnership for the Preservation of the Downeast Lakes Watershed,

Poland National Institute of Public Health – National Institute of Hygiene on wind farms

Preserve Grey Highlands

Prospérité Frontenac

Public Health Agency of Canada

Radiation Safety Institute of Canada

Rangitikei Guardians

Regroupement pour le développement durable des Appalaches,

Renewable Energy Projects Listing

RETA

Ripley Group

Royal Canadian Mounted Police.

S.O.S. Save our Skyline

Safe Green Community Aruba

Saskatoon Wind Turbine Coalition

Saugeen Shores Turbine Operation Policy

Save Coteau Prairie Landscape

Save Ontario's Algoma Region

Save our Allegheny Ridges

Save Our Sherman

Save the South Shore

South Branch Group

South Shore Conservancy

Southgate Community Against Turbines

Speak Out Cavan Monaghan

State Government of Victoria

Stop Ill Wind

Stop Mapleton Wind Farm

Stop the Caw Wind Turbine

Stop Turbines on Maplehill Powassan (STOMP)

Stop Wiatrakom

Swanton Wind

Syndicat des Energies Renouvelables France Énergie Éolienne

The Blue Highlands Citizens Coalition

The Coalition of Residents - Tiny

The WindAction Group

Toronto Hydro

Trees not Turbines

"U.S. Department of Health & Human Services. National Library of Medicine. Environmental Health &Toxicology

Specialized Information Services. IUPAC glossary of terms used in toxicology. "

Union of Nova Scotia Municipalities

United Nations, Environment and Sustainable Development Division.

Vermonters With Vision

Warwick Township

Waubra Foundation

Wayward Wind

West and East Perth Against Turbines

West Elgin Residents Opposing Wind Turbines

Westwind Consulting

WhyWind

Wind Atlas

Wind Aware Ireland

Wind Concerns Bruce

Wind Cows

Wind Energy Concerns About Rural Environment

Wind Farm Action

Wind Farms in Upstate New York

Wind Ontario.ca

wind turbine syndrome

Wind-turbine-models.com

Windwahn

Wolfe Island Residents

World Council for Nature

World Health Organization

World Wind Energy Association

WSIB

Young HEAT – Huron/Perth

Zelená Louka

## Appendix 10: List of Evidence Sources Cited by Included Canadian Organization Websites (in APA Reference format)


Acciona Telecommunication Engineering Projects. (2008). Study of Radioelectric Interferences in the Amherst Wind Farm.

Acoustic Ecology Institute. (2009) Acoustic Ecology Institute Fact Sheet:Wind Energy Noise Impacts

Aguas, A. P., Esaguy, N., Grande, N., Castro, A. P., & Castelo, B. N. (1999). Effect low frequency noise exposure on BALB/c mice splenic lymphocytes. Aviation, space, and environmental medicine, 70(3 Pt 2), A128-31.

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Alves-Pereira M, Castelo Branco NAA. (2007). Public health and noise exposure: the importance of low frequency noise. In: Proceedings of the Inter-Noise Congress

Alves-Pereira M, Castelo Branco NAA. (2007). The scientific arguments against vibroacoustic disease. In: Proceedings of the Inter-Noise Congress

Alves-Pereira, M. A., & Branco, N. A. C. (2009). Sobre o Impacto de Infrasons e Ruído de Baixa Frequência na Saúde Pública-2 Casos de Exposição Residencial/On the Impact of Infrasound and Low Frequency Noise on Public Health-2 Cases of Residential Exposure. Revista Lusófona de Ciências e Tecnologias da Saúde, (2).

Alves-Pereira, M., & Branco, N. A. C. (2007). Vibroacoustic disease: biological effects of infrasound and low-frequency noise explained by mechanotransduction cellular signalling. Progress in Biophysics and Molecular Biology, 93(1), 256-279.

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Ambrose, S. E., (2011) The Bruce McPherson Infrasound and Low Frequency Noise Study Adverse Health Effects Produced By Large Industrial Wind Turbines Confirmed

Ambrose, S. E., Rand, R. W., & Krogh, C. M. (2012). Falmouth, Massachusetts wind turbine infrasound and low frequency noise measurements. Internoise (New York).

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Australian Government National Health and Medical Research Council (2010). Wind Turbines and Health - A Rapid Review of the Evidence.

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