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## Review Paper

# The health impacts of windstorms: a systematic literature review



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## ABSTRACT

**Introduction:** This systematic literature review aims to identify documented impacts that windstorms have on human health. Windstorms occur frequently and some researchers have predicted an increase in severe gales in the future, resulting in an urgent need to understand the related patterns of morbidity and mortality.

**Study design:** Systematic literature review.

**Methods:** A systematic literature review of international evidence on the impacts of windstorms on human health was conducted in May 2012.

**Results:** This review of published evidence demonstrates that human health can be severely affected by windstorms. Direct effects occur during the impact phase of a storm, causing death and injury due to the force of the wind. Becoming airborne, being struck by flying debris or falling trees and road traffic accidents are the main dangers. Indirect effects, occurring during the pre- and post-impact phases of the storm, include falls, lacerations and puncture wounds, and occur when preparing for, or cleaning up after a storm. Power outages are a key issue and can lead to electrocution, fires and burns and carbon monoxide poisoning from gasoline powered electrical generators. Additionally, worsening of chronic illnesses due to lack of access to medical care or medication can occur. Other health impacts include infections and insect bites.

**Conclusion:** Public health advice can reduce morbidity and mortality from windstorms. Findings from this review will provide material for increased awareness and education amongst the public and healthcare professionals to prevent and prepare for these health impacts. Nevertheless, more research is needed to identify more specific patterns of health impacts and how these could be reduced in the future.

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<sup>e</sup> Until 31st March 2013 Public Health England was known as the Health Protection Agency, HPA.

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## Introduction

Windstorms, in the forms of cyclones (including tropical, sub-tropical extra-tropical storms and polar lows), local windstorms (such as tornadoes), and downslope windstorms, occur worldwide, and events such as Hurricane Katrina and Hurricane Sandy have emphasized the high impact these events can have on public health.<sup>1–3</sup> Hurricanes, tropical storms and tropical cyclones occur infrequently in Europe. However, Europe is not immune from natural disasters of this sort, given that wind speeds in extra-tropical cyclones can reach ‘hurricane force’ according to the Beaufort wind scale. Although both the Special Report on Managing Risks of Extreme Events and Disasters to Advance Climate Change Adaptations<sup>4</sup> and the Climate Change Risk Assessment for the UK<sup>5</sup> are inconclusive with regards to the trend in frequency and intensity of windstorms in the UK, these events exist and have significant health impacts. According to the Department of Health,<sup>6</sup> ‘floods and windstorms are a regular occurrence in the UK’. Baker and Lee<sup>7</sup> considered that over the last 18 years, windstorms had a greater impact in the UK than flooding.

The health impacts of windstorms have been discussed extensively with reference to developing countries<sup>4</sup> and the USA.<sup>8–13</sup> These impacts are generally separated into direct and indirect health impacts, thereby referring to the primary effect of the impact of the storm, causing injury and death, and the secondary effects of the impact, through the breakdown of infrastructure.<sup>9,14</sup> These health impacts can be severe,<sup>15</sup> and their effects on human health could be significantly reduced by a better understanding of their patterns, which would allow appropriate preparation, emergency planning and public education.<sup>16</sup> This paper is a response to the severe lack of peer-reviewed data in relation to events in the UK, where the majority of information is presented by the media,<sup>17</sup> rather than evidence-based research.

### Definition of windstorm

An issue when researching the health impacts of windstorms is the lack of a consensus or consistent use of the definition of a windstorm. In this paper the following definitions are used:<sup>18</sup>

- **Wind:** motion of the air, described by the average motion over 10 minutes, in metres per second, miles per hour, kilometres per hour, knots (kn: nautical miles per hour) or Beaufort Force. Gale force is a wind speed of more than 34 kn (63 km/h). Storm force is a wind speed of more than 56 kn (103 km/h) (Box 1).
- **Storm:** a disturbed state of the atmosphere of sufficient intensity to present a hazard – always involves wind, but may also involve other weather phenomena.
- **Windstorm:** a storm in which the primary hazard comes from the wind speed. Three main categories may be identified: cyclones (including tropical and extra-tropical storms and polar lows), local windstorms (such as tornadoes) and downslope windstorms.

Box 1 Wind speed conversions.

Wind speed (ws) mph (miles per hour)	(ws) km/h (kilometres per hour)	(ws) m/s (metres per second)	(ws) knots
1	1.609	0.447	0.869
0.621	1	0.278	0.540
2.240	3.6	1	1.944
1.151	1.852	0.514	1

### Wind and wind speed

Looking specifically at the correlation between wind and health impacts, it is useful to consider the scales used to classify windstorm events. They demonstrate the link between wind speeds and the effects on the environments (see Appendix 1–3) which in turn can have direct and indirect effects on human health. The impact of the wind force on building structures, for instance, will affect whether a person needs to leave their home.

### Separating windstorm variables

In most windstorms the hazard does not come exclusively from the wind: much of the data in the literature incorporates the effects on humans caused by storm surges and subsequent flooding. The impacts would be more easily measured if the wind variable occurred in isolation during a windstorm, but this is unfortunately rarely the case. Two hurricane events, however, Ike (2008) and Andrew (1992) have frequently been singled out as predominantly ‘dry’ hurricanes. Thus, the conclusions drawn from these events are particularly pertinent to this paper.

### Aim

This paper aims to identify and review current evidence of the impacts of windstorms on human health to support planning, preparation and education of the public and health professionals so as to reduce the adverse impact on health.

### Objectives

The objectives of this paper are to

- identify and present evidence of the impacts of high winds on human health;
- provide evidence for reducing these impacts and making recommendations for planners and healthcare professionals; and
- document key themes and areas requiring further work.

### Methods

A search strategy was developed to identify published literature relevant to the potential health impacts of windstorms.

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