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Symptom reporting after the introduction of a new high-voltage power line: A prospective field study

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ABSTRACT

Background: There is public concern about the potential health effects of exposure to extremely low frequency electromagnetic fields (ELF-EMF) of high-voltage power lines (HVPLs). Some residents living near HVPLs believe ELF-EMF might cause non-specific health complaints.
Objectives: The present study is the first to prospectively investigate whether self-reported health complaints and causal beliefs increase after the construction of a new power line.
Methods: We used a quasi-experimental design with two pretests before and two posttests after a new HVPL was put into operation. Residents living near (0–300 m, $n=229$; 300–500 m, $n=489$) and farther away (500–2000 m, $n=536$) participated in the study. Linear mixed models were fitted to test whether symptom reports and beliefs that power lines caused health complaints increased more in residents living close to the new line compared to residents living farther away.
Results: A significantly ($p<.05$) larger increase from baseline in symptom reports and causal beliefs was found in residents living within 300 m from the new power line when compared to residents living farther away. While symptom reports did not differ at baseline, the belief that a power line could cause these symptoms was at baseline already stronger for residents living close compared to residents living farther away.
Conclusions: We found a negative impact of a new HVPL on health perceptions of nearby residents, even before the line was put into operation.

1. Introduction

The potential health effects of exposure to extremely low frequency (ELF) electromagnetic fields (EMF) from nearby high-voltage power lines (HVPLs) are the subject of a longstanding debate in environmental health. In contrast to high frequency ionizing radiation (e.g. X-rays), no plausible biophysical mechanisms are known for ELF-EMF to cause health effects in humans under the current exposure standards. Several epidemiological studies investigated the potential effects of ELF magnetic fields emitted by power lines on a wide variety of health outcomes, such as brain tumors (Klaeboe et al., 2005), Alzheimer's disease (Huss et al., 2009), and non-specific health complaints such as headaches (Poole et al., 1993). For most outcomes the World Health Organization judged the evidence indicative of no relationship with magnetic fields (World Health Organization, 2007). Only for childhood leukemia was the evidence deemed to be sufficiently strong to remain a concern based on pooled analyses of observational studies (e.g. Ahlbom et al., 2000).

The evidence of a relationship between ELF-EMF and non-specific health complaints is considered weak. However, between 1.5% and 13.4% of the general population attributes health complaints, such as fatigue and concentration problems, to exposure from EMF emitted by various electrical sources such as mobile phones and power lines (Baliatsas et al., 2012). A review of experiments exposing participants to real radiofrequency or ELF fields and sham EMF indicate no effects of EMF exposure on symptom reports or on the ability to distinguish between real and sham EMF (Rubin et al., 2010). However, sham EMF exposure resulted in increased symptom reports in healthy participants who were told that they were exposed to EMF from visibly present

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electrical equipment (Szemerszky et al., 2010; Witthoft and Rubin, 2013). These findings suggest that health responses to HVPLs could occur through other psychological pathways unrelated to EMF exposure.

In the medical field an increase in symptom reports after exposure to an inert treatment is described as a nocebo response (Tracey, 2010). Nocebo responses are likely to occur when people hold negative expectations of a treatment (Faasse and Petrie, 2013). Nocebo-like responses are also found with environmental exposures such as wind turbines (Crichton et al., 2014) and mobile phone base stations (Danker-Hopfe et al., 2010). Research on nocebo responses to HVPLs is limited, but studies suggest that people hold negative health expectations of exposure to ELF-EMF from power lines (Morgan et al., 1990; TNS Opinion and Social, 2010; Visschers et al., 2007).

When negative health expectations of living near a power line are prevalent, one may expect to find higher symptom reports in people living closer to a HVPL. Only a few HVPL health studies have examined effects of distance on non-specific health complaints. McMahan and Meyer (1995) for instance, found no differences in symptom reports between residents living on the easement of a HVPL or one block away. However, residents who worried more about overhead transmission lines were more likely to report symptoms and this effect was stronger for those living on the easement. A more recent general population study did not find an association between distance to HVPLs and symptom reports (Baliatsas et al., 2011), but they did find a relationship between perceived proximity of power lines and reporting symptoms, suggesting the potential importance of the perception of proximity for health responses to occur.

The current study is, to our knowledge, the first to prospectively assess health responses to the introduction of a new HVPL. New HVPLs are being introduced into the environment as a result of the increasing demand for reliable and renewable energy supplies (Devine-Wright and Batel, 2013; Kheifets et al., 2010). Currently a project is being carried out in the Netherlands investigating health responses to a new HVPL route (Porsius et al., 2014). In this paper we report the main results of the project. The research question that we address here is whether symptom reports increase more for residents living near a new power line route after it has been put into operation, compared to residents living farther away. In addition, we investigate the effect of proximity to the new line on the belief that reported symptoms are caused by a power line.

2. Methods

For full details about the design and rationale of the study we refer to the published study protocol (Porsius et al., 2014).

2.1. Setting

The Zuidring is the first 380 kV power line route being introduced in the Netherlands as part of a large infrastructural operation resulting in 350 km of new HVPLs. The Zuidring consists of two overhead parts (i.e. Zuidring-West and Zuidring-East) of 10 km in total.

2.2. Design and study population

We used a quasi-experimental design with two pretests (T1, T2) during construction of the Zuidring and two posttests (T3, T4) approximately 2 and 7 months after the line had been put into operation. At T1 major construction work was carried out, while at T2 the power line route was visibly finished but not yet operational. We collected data within an 18 months' time frame. Geographical information about the new power line route was provided by national grid operator TenneT. Distance to the nearest overhead part of the Zuidring was calculated with ArcGIS 9.3.1 software. All households within 500 m of the Zuidring-West ($n=1057$) and Zuidring-East ($n=1322$) area were included. A random stratified sampling strategy was used to include the same number of households residing within 500–2000 m of the overhead parts of the Zuidring (see Porsius et al. (2014)). All available addresses were stratified for area (Zuidring-West and Zuidring-East), distance (500–1000 m, 1000–1500 m, 1500–2000 m) and degree of urbanization (less than 1000 and 1000–2500 addresses per km^2). We drew random samples (using SPSS random number generator) from these strata matching the proportion of addresses in rural and urban areas of the households within 500 m of the Zuidring.

2.3. Procedure

All households received a postal letter invitation for one member of the household older than 18 years to participate in a longitudinal questionnaire-based environmental health study relating changes in the environment to changes in health. To reduce potential response bias the letter did not mention the study was about power lines. In the letter we provided a hyperlink to a digital questionnaire with a personal login and password. On request, residents were able to participate through receiving paper versions of the questionnaires. Informed consent was implied through filling out the questionnaire online or by returning the paper questionnaire. Invitations for follow-up were sent through e-mail addresses collected at the first measurement. In case an e-mail address was invalid or missing, invitations were sent through postal mail. The Medical Ethics Committee of the VU University Medical Center Amsterdam approved the study protocol.

Because the response rate at T1 was lower than the anticipated 30%, all residents who did not respond at T1 were invited again at T2 to participate. Onwards from T3 only residents who participated in at least one of the pretests were invited by e-mail and postal letter to fill out a questionnaire. A maximum of three reminders was sent at each measurement wave. Fifty euro gift certificates were randomly awarded to ten participants who filled out a questionnaire.

2.4. Outcomes

We used the somatization scale of the Dutch 4DSQ (Terluin et al., 2006) to measure non-specific somatic health complaints. The scale consists of 16 non-specific somatic symptoms commonly reported in general practitioner practices such as headaches, dizziness, and low back pain. For each health complaint, participants indicated whether they were bothered by it during the previous week on a 5-point scale (ranging from no, through to constantly). Following instructions (see Terluin et al. (2004)) scores were trichotomized and summed resulting in a minimum score of 0 and a maximum score of 32.

Non-specific cognitive health complaints were assessed with a Dutch translation (Gehring et al., 2009) of the MOS Cognitive Functioning Scale (Stewart et al., 1992). The scale consists of six items tapping the domain of general cognitive functioning (e.g. forgetfulness, difficulty concentrating, trouble maintaining attention). On a 6-point scale (ranging from all of the time, through to none of the time), participants indicated how often they experienced a specific cognitive problem during the previous week. Scores were recoded and an average score was calculated, resulting in a score between 1 and 6. For both cognitive and somatic