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Longitudinal associations between risk appraisal of base stations for mobile phones, radio or television and non-specific symptoms

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ABSTRACT

Introduction: Studies found that higher risk appraisal of radiofrequency electromagnetic fields is associated with reporting more non-specific symptoms such as headache and back pain. There is limited data available on the longitudinal nature of such associations and what aspects of risk appraisal and characteristics of subjects are relevant.

Objective: To examine cross-sectional and longitudinal associations between risk appraisal measures and non-specific symptoms, and assess the role of subject characteristics (sex, age, education, trait negative affect) in a general population cohort.

Methods: This study was nested in the Dutch general population AMIGO cohort that was established in 2011/2012, when participants were 31–65 years old. We studied a sample of participants (n = 1720) who filled in two follow-up questionnaires in 2013 and 2014, including questions about perceived exposure, perceived risk, and health concerns as indicators of risk appraisal of base stations, and non-specific symptoms.

Results: Perceived exposure, perceived risk, and health concerns, respectively, were associated with higher symptom scores in cross-sectional and longitudinal analyses. Only health concerns (not perceived exposure and perceived risk) temporally preceded high symptom scores and vice versa. Female sex, younger age, higher education, and higher trait negative affect were associated with higher risk appraisal of mobile phone base stations.

Discussion: The findings in this study strengthen the evidence base for cross-sectional and longitudinal associations between higher risk appraisal and non-specific symptoms in the general population. However, the directionality of potential causal relations in non-sensitive general population samples should be examined further in future studies, providing information to the benefit of risk communication strategies.

1. Introduction

On average, people report more non-specific symptoms such as headache or dizziness when they think they are exposed to radiofrequency electromagnetic fields (RF-EMF) from base stations for mobile phones, radio or television, regardless of actual level of exposure [1–5]. Several studies examined the underlying psychosocial mechanisms in experimental studies with sham exposure [2, 5–8]. However, there is a need for more prospective population studies to gain insight in the long term direction(s) of associations in a general population context.

People form mental models of base stations in their living environment [9]. These internal representations of the external reality shape reasoning, decision making, and behavior and can play a role in individual health responses to the environment [10, 11]. Mental models of base stations can include beliefs about exposure and potential health

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risks, which often do not correspond with the view of experts [12, 13]. For example, there are low correlations between perceived RF-EMF exposure levels on one hand and measured or modelled exposure levels on the other hand [3, 4, 14–16]. At the same time, many people are concerned about potential health risks from EMF [3, 17–19]. They associate EMF exposure with perceived health risks such as cancer, but also with non-specific symptoms such as dizziness or concentration problems, and with sleep disturbance [1, 18, 20–22]. These concerns do not match the results of epidemiological research, which does not indicate clear adverse health effects of RF-EMF exposure from base stations at every day levels of exposure [4, 23–25]. If health effects exist at every day exposure levels, these are likely to be small, and to occur in small (sensitive) groups that have not been identified yet. We will use the term risk appraisal as an overarching term for individual perceptions about personal exposure, health risks, and concerns for personal health. These perceptions can play a role in individual health responses to a potential health hazard [26, 27], regardless of any disparities with epidemiological findings.

A number of studies, mostly experimental studies and studies with electro hypersensitive participants, have examined the link between risk appraisal and increased symptom reporting. There is evidence that nocebo effects can occur, especially in situations with sham EMF exposure [2, 16, 28, 29], or when there is a visible change in the environment such as the placement of a new base station or power line [27, 30]. A nocebo response is the counterpart of placebo, i.e. an adverse health response after a treatment or exposure that is not a direct result of this exposure [29, 31–34]. There is a large overlap in reported symptoms between electrohypersensitivity and other environmental intolerances (multiple chemical sensitivity and infrasound hypersensitivity), and these syndromes share the absence of an established link with actual exposure levels (under blinded conditions) [35]. For each of these syndromes, there is evidence that psychological and behavioral processes play a role. Based on studies with participants who report electro hypersensitivity [6, 36] or idiopathic environmental intolerance [37] there is evidence of a circular process where somatosensory amplification plays a role in amplifying symptoms and risk perception. Other processes may also be important, for instance people who experience many symptoms may be more likely to attribute their symptoms to exposures to an environmental exposure, and become more aware of, and concerned about environmental exposures including EMF [39]. This increased awareness has been described as environmental monitoring [38]. Although experimental studies are important for understanding which psychosocial mechanisms could explain the link between risk appraisal and increased symptom reporting, there is a need for more prospective studies in the general population. With prospective studies it may be possible to gain insight in the direction(s) of associations and the relative importance of mechanisms such as nocebo and incorrect attribution in the general population. This insight is important for the development of adequate risk communication strategies, as well as for the interpretation of possible indirect health effects of exposure, or exposure sources, through risk appraisal. For example, the placement of a new base station could have a negative impact on symptom experiences through increases in perceived exposure [4], but this phenomenon is difficult to disentangle from incorrect attribution of existing or new symptoms to this new exposure source.

Subject characteristics such as sex, age, education, and trait negative affect have been shown to influence both symptom scores and risk appraisal [26]. For example, women consistently report higher risk appraisal and more symptoms than men [40, 41]. As a trait, higher negative affect is associated with higher levels of risk appraisal as well as with reporting more symptoms [37, 42–45]. For other subject characteristics (f.i. education level, race, age) the results regarding risk appraisal are inconsistent across studies, different measures, and type of risks [1, 41, 46–52]. For example, education was associated with higher risk appraisal of mobile phone base stations [52] and smoking [53] but negatively with risks in general [47, 50]. The inclusion of the role of subject characteristics in this prospective study will achieve a more comprehensive understanding of risk appraisal of base stations and its link with symptom reporting.

The first objective of this study was to examine cross-sectional and longitudinal associations between risk appraisal of RF-EMF exposure from base stations for mobile phones, radio, or television, and the experience of non-specific symptoms in a prospective general population cohort. We considered different aspects of risk appraisal with respect to RF-EMF from mobile phone base stations, namely perceived personal exposure in the residential environment, perceived risk that exposure could be a health risk in general, and concerns regarding personal health risks. Secondly, we examined the influence of a number of subject characteristics (sex, age, education, and trait negative affect) on risk appraisal and symptom score.

2. Method

2.1. Population

This study is nested in the AMIGO cohort, which was setup in 2011/2012 (defined here as T0, n = 14,829) to study environmental and occupational determinants of diseases and symptom reporting in the general population (see [54] for a full description). The participants were not specifically recruited for EMF related topics. We studied a follow-up sample of the cohort that participated in two additional questionnaires (in 2013 (defined here as T1) and 2014 (defined here as T2). The selection strategy for the invitations to participate in the follow-up sample is described in detail elsewhere [4]. In short, the purpose of this selection was to achieve contrast in both actual and perceived exposure to RF-EMF from mobile phone base stations, where actual exposure was assessed with the validated 3D geospatial model NISMap [55, 56]. NISMap models exposure at the home address, using data about the position and characteristics of antenna's, elevation and buildings. The selection was achieved by oversampling subjects with high modelled, and/or high perceived exposure at T0. Only participants who answered all questions regarding symptoms, concerns, risk perception, perceived exposure, at both T1 and T2, and trait negative affect at T2, were included in this study (n = 1720). This resulted in the exclusion of n = 484 participants who participated at T1 but not at T2, and the exclusion of an additional n = 24 participants with missing responses on one or multiple key variables.

2.2. Non-specific symptoms

At T1 and T2 we assessed the total symptom score with the somatization scale of the 4 dimensional symptom scale (4DSQ-S), which consists of 16 non-specific somatic symptoms commonly reported in general practices (e.g. headaches, low back pain, and dizziness). According to the 4DSQ manual [57], participants indicated for each symptom whether they were bothered by it during the previous week on a 5-point scale (ranging from no, through to constantly). The scores per symptom were trichotomized and then summed over the symptoms to obtain a total score (no = 0; sometimes = 1, regularly/often/constantly = 2).

2.3. Risk appraisal of RF-EMF exposure to base stations for mobile phones, radio, or television

We assessed risk appraisal of RF EMF from base stations at T1 and T2 with three separate items: 1) Perceived exposure: “To what extent do you think are you exposed to (electromagnetic fields/radiation from) base stations for mobile phones, radio or television (scale of 0-6 where 0 = not at all, 6 = very much)?”. 2) Perceived risk: “To what extent do you think that (electromagnetic fields/radiation from) base stations for mobile phones, radio or television can be a health risk in everyday