

Quality of Life of Individuals with Electromagnetic Hypersensitivity: A Targeted Review of Literature

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BACKGROUND

- Electromagnetic hypersensitivity (EHS), also known as electro sensitivity, is characterized by a variety of non-specific symptoms such as fatigue, lack of concentration, dizziness, nausea, heart palpitations, and burning sensations in the facial area¹
- These symptoms may be mild in some individuals and can be dealt with efficiently by limiting the exposure to electromagnetic radiations, while in others, the symptoms may be severe and may affect the lifestyle of the individuals²
- EHS prevalence is highly variable in the general population: ranges from 3.2% (California, 1998) to 13.3% (Taiwan, 2007)^{2,3}
- Although the European Academy for Environmental Medicine (EUROPAEM) electromagnetic field guidelines (2016) identifies EHS as a serious health concern,⁴ currently, there is no specific diagnosis and treatment for EHS globally
- This targeted review of literature assessed the quality of life (QoL) of individuals with EHS

METHODS

Search Strategy

- PubMed and Google databases were searched on 18 October, 2018. No time limits were applied to the search results. Table 1 gives the search strategy for PubMed database

Study Selection

- Identified studies were screened by one researcher. Search hits were screened in two phases:
 - Primary: Using study titles and/or abstracts
 - Secondary: Full-paper screening for relevant records
- Studies reporting information on QoL parameters and symptoms which are known to have an impact on QoL in individuals with EHS were included

Data Extraction

- Information on QoL parameters and symptoms known to impact QoL were extracted
- Outcomes assessing the causality of the observed changes in QoL outcomes with symptoms or the changes in symptoms with electromagnetic exposure were not explored

RESULTS

- PubMed database searches identified 263 studies. Additional two records were identified through a general Google search thus, making a total of 265 studies (Figure 1)
- Individuals with idiopathic environmental intolerance attributed to electromagnetic fields (IEI-EMF) had significantly lower scores in all eight subscales of the 36-item Short-Form survey (SF-36) vs. population-based referents⁵ or non-sensitive controls⁶ (Table 2)
- The overall QoL was also lower in an individual participant with EHS than the population norms⁷ (Table 2)
- Individuals with EHS rated significantly higher (vs. the controls) on the following:
 - Spontaneous, positive, and negative clusters of structural analysis of social behavior (SASB) suggesting that they were impulsive, with both elevated positive and negative self-image⁸ (Table 3)
 - Coping resources inventory-spiritual/philosophical (CRI-SP) subscale suggesting that they were guided by religious, familial or cultural traditions⁸ (Table 3)
- Skin complaints, fatigue, and various eye symptoms were commonly reported in individuals with EHS⁹
- Those with mobile-phone related symptoms (MPRS) exhibited more negative moods vs. controls: they had more tension-anxiety, depression, anger-hostility, fatigue, and confusion, and had less vigor although they did not differ from controls in their ability to detect exposure¹⁰ (Table 3)
- In contrast, one of the studies¹¹ included in a systematic review¹² reported higher levels of pleasure and arousals in mood during the EMF condition (Table 3)
- Individuals with EHS and MPRS scored higher vs. the reference groups on almost all aspects of personality traits and stress¹³ (Table 3)

Table 2: Quality of Life outcomes reported in the included studies

Author, Year	Participants	Study Design	QoL Outcomes
Rubin et al., 2008 ⁸	Individuals with MPRS (n=52), individuals with MPRS and EHS (n=19), and nonsensitive controls (n=60)	Cross-sectional	<ul style="list-style-type: none"> PSF scores poor in individuals with EHS vs. controls and MPRS (P<0.05 for both) Physical and emotional roles limited in individuals with EHS vs. controls and MPRS (P<0.05 for both) Mental health was poor in individuals with EHS vs. MPRS (P<0.05) and vs. controls (P=NS) General health and vitality poor in individuals with EHS vs. controls and MPRS (P<0.05 for both) Bodily pain was higher in individuals with EHS vs. controls and MPRS (P<0.05)
Baliatas et al., 2014 ¹⁴	Non-sensitive individuals' grp: control (n=5073), GES (n=514) and IEI-EMF (n=202)	Epidemiological	<ul style="list-style-type: none"> Individuals with GES and IEI-EMF had higher levels of functional impairment,* symptom scores, negative symptom perceptions, and illness behavior**
Kjellqvist et al., 2016 ⁹	Individuals with IEI-EMF (n=114) and a population-based sample of referents (n=104)	Cross-sectional	<ul style="list-style-type: none"> PSF scores poor in IEI-EMF vs. referents (PF: P=0.035; SF: P<0.001) Physical and emotional roles limited in IEI-EMF vs. referents (P<0.001 for both) General health, vitality, and mental health poor and bodily pain high in IEI-EMF vs. referents (general health: P<0.001 vitality: P<0.001; bodily pain: P<0.001; mental health: P<0.001)
Verrender et al., 2018 ⁷	25 self-diagnosed EHS individuals. Of these, 3 completed the study	Individual cases	<ul style="list-style-type: none"> Participant 1: overall QoL, physical health, psychological health, and overall health scores below the population norms; social relationships and environment scores above the population norms Participant 2: overall QoL, psychological health, social relationships, and environmental scores below the population norm; overall health score and physical health above the population norms Participant 3: overall QoL and health, psychological health, social relationships below the population norms; physical health and environmental scores above the population norms <p>Note: Subjective well-being of individual participant was assessed using WHOQOL-BREF questionnaire</p>

EHS, electromagnetic hypersensitivity; GES, general environmental sensitivity; IEI-EMF, idiopathic environmental intolerance attributed to electromagnetic fields; MPRS, mobile phone related sensitivity; NS, non-significant; PF, physical function; PSF, physical and social function; QoL, quality of life; SF, social function; WHOQOL-BREF, World Health Organization Quality of Life Instrument.

*Functional impairment assessed using general health subscale of RAND-36 Health Survey questionnaire, sleep quality assessed with 10-item version of the Groningen Sleep Quality Scale (GSQS), and psychological distress assessed using the 12-item version of the General Health Questionnaire (GHQ-12). **assessed using Brief Illness Perceptions Questionnaire

Table 3: Studies reporting symptoms and/or behavioral outcomes impacting Quality of Life

Author, Year	Participants	Study Design	Reported Adverse Events and/or Behavioral Symptoms
Bergdahl et al., 1998 ⁹	Individuals with symptoms allegedly caused by electricity or visual display units (n=28)	Survey	<ul style="list-style-type: none"> General: skin complaints (68%), fatigue (46%), and various eye symptoms (32%) Oral: burning mouth (50%), craniomandibular dysfunction (43%), and gustatory disturbance (25%) Mean symptom intensity: eye complaints, dizziness, and pain, along with craniomandibular dysfunction scored highest on VAS
Bergdahl et al., 2004 ⁸	<ul style="list-style-type: none"> EHS individuals (N=344) --VDT (n=200*) --HE (n=50*) Gender and age-matched controls (n=250) 	Case-control	<ul style="list-style-type: none"> CRI-SP scale: VDT+HE group rated significantly higher vs. control (P=0.035). Other CRI scales did not differ between the groups SASB: VDT+HE group scored significantly higher on the spontaneous (P=0.004), positive (P=0.000), and negative (P=0.004) clusters and significantly lower on the controlled cluster (P=0.002) The VDT group rated significantly lower on the controlled cluster and higher on both positive and negative clusters vs. controls (P<0.05 for all)
Rubin et al., 2005 ¹²	EHS individuals	Systematic review of single and double-blind provocation studies	<ul style="list-style-type: none"> SEHS symptoms can be severe and disabling. However, it is difficult to prove under blinded conditions that EMF can cause these symptoms One study reported significantly higher levels of pleasure (P=0.01) and arousal (P=0.05) in EMF (contrary to the self-reports of individuals with EHS)
Mortazavi et al., 2007 ¹⁵	Healthy university students (N=518)	Case-control	<ul style="list-style-type: none"> Headache, fatigue, difficulties in concentration, vertigo/dizziness, attention disorders, nervousness, palpitation, low back pain, myalgia, and tinnitus Symptoms prevalence similar between CRT users and non-users Significant association observed between cordless phone use and difficulties in concentration (P<0.05) or attention disorders (P<0.05). These differences were not significant when data were corrected for gender No association observed between mobile phone use and symptoms No significantly higher prevalence of self-reported symptoms in individuals using mobile phones, VDTs or cordless phones more often vs. others
Furubayashi et al., 2009 ¹⁰	<ul style="list-style-type: none"> MPRS (n=11) Controls (n=43) 	Double-blind, cross-over, provocation study	<ul style="list-style-type: none"> Discomfort was greater for MPRS vs control (P=0.016). However, this was irrespective of EMF and not significant NEO-FFI scores: No significant difference POMS: Significant for all subscores; MPRS individuals had more negative moods and less vigor vs. controls Both groups had significantly higher scores of fatigue and confusion and less vigor post-exposure
Landgrebe et al., 2009 ¹⁶	<ul style="list-style-type: none"> EHS individuals (n=89) Matched controls (n=107) 	Case-control	<ul style="list-style-type: none"> Depression, anxiety, sleep quality: major depression (P=0.0008), anxiety disorder (P=0.029) and somatoform disorders (P=0.0071) common in the EHS group vs. controls EHS group had a higher EMF-complaint level and a worse sleep quality vs. controls Tinnitus: significantly common in the EMF-sensitive group vs. control (P<0.0001); no differences concerning tinnitus duration and severity between groups
Johansson et al., 2010 ¹³	<ul style="list-style-type: none"> Case groups: MPRS (n=45) and EHS (n=71) Reference groups: population-based sample (n=106) and control (n=63) 	Case-control	<ul style="list-style-type: none"> Instruments of personality traits and stress: case groups scored higher vs. reference groups STAI Trait subscale, KSP Psychasthenia subscale, SMBQ tension subscale: significant differences for case vs. the population-based group (P<0.05) EHS group differed from reference in more aspects vs. the MPRS group EHS group scored higher on all scales except the STAI, the KSP subscale Psychic Anxiety, and the SMBQ Tension subscale vs. MPRS group Higher number of both EMF-related and non-related symptoms reported by case vs. reference (P<0.05), and EHS vs. MPRS (P<0.05)
MegTseng et al., 2011 ¹⁷	Individuals selected from a nationwide Computer-Assisted Telephone Interviewing system (N=1251)	Survey	<ul style="list-style-type: none"> More individuals with SREMFs had poor perceived health, inability to work, impairment in daily activities, and psychiatric morbidity vs. those without SREMFs
Roosli and Hug, 2011 ¹⁸	EHS volunteers and individuals (included studies evaluated 11 to 26,039 individuals)	The narrative review included studies on self-reported symptoms and ability to perceive low-level RF-EMF exposure	<ul style="list-style-type: none"> QoL not impacted by EMF exposure Individuals with EHS were not more susceptible to EMF vs. the rest of the population

CRI-SP: coping resource inventory-spiritual; CBT: cognitive behavioral therapy; EHS: electromagnetic hypersensitivity; EMF: electromagnetic field; HE: hypersensitivity to electricity; KSP: Karolinska Scales of Personality; MP: mobile phone; MPRS: mobile phone related symptoms; NEO-FFI: Neo Five Factor Inventory; POMS: Profile of Mood States; RF-EMF: radio frequency electromagnetic field; STAI: State-Trait Anxiety Inventory; VAS: visual analog scale; VDT: visual display terminal

*Number of individuals who returned the questionnaire reported

Additionally, Kjellqvist et al., 2016 study (summarized in Table 2) reported that the IEI-EMF group had significantly higher symptom scores vs. the referents on all subscales of SCL-90 (Symptom Checklist 90), except for the Psychotism subscale, which did not reach statistical significance (P=0.087). Rubin et al., 2008 study (also summarized in Table 2) reported no significant group differences in the percentages of participants classified as psychiatric cases using the GHQ-12 (P=0.24) among electroresistant individuals, mobile phones sensitive individuals and non-sensitive controls. However, there was a significant group difference in PHQ-9 depression scores (P<0.001), with electroresistant participants having a significantly higher level of depressive symptoms vs. control (P<0.002) or mobile phone sensitive participants (P<0.001)

ACKNOWLEDGMENTS & DISCLOSURES: The authors wish to thank ScivocTM Healthcare Pvt. Ltd. for providing editing support for this poster. Both authors are employees of Skyward Analytics Pvt. Ltd.REFERENCES: 1. Baliatas C, et al. BMC Public Health 2012;12:643. 2. WHO - EMF Publications & information resources. Available from: <http://www.who.int/peh-emf/publications/facts/fs296/en/>. 3. Huang P-C, et al. Environ Health 2018;17:1-11. 4. Belyaev I, et al. Rev Environ Health 2016, p. 363. 5. Kjellqvist A, et al. J Psychosom Res 2016;84:8-12. 6. Rubin GJ, et al. J Psychosom Res 2008;64:1-9. 7. Verrender A, et al. Bioelectromagnetics 2004;7:538-42. 8. Bergdahl J, et al. Acta Odontol Scand 1998;56:303-7. 9. Furubayashi T, et al. Bioelectromagnetics 2009;30:100-13. 11. Mueller CH, et al. 3rd International Conference on Bioelectromagnetism, 08-12 October 2000; Slovenia. 12. Rubin GJ, et al. Psychosom Med 2005;67:224-32. 13. Johansson A, et al. J Psychosom Res 2010;68:37-45. 14. Baliatas C, et al. J Psychosom Res 2014;76:405-13. 15. Mortazavi SM, et al. Bioelectromagnetics 2007;28:326-30. 16. Landgrebe M, et al. PLoS One 2009;4:e5026. 17. Meg Tseng MC, et al. J Formos Med Assoc 2011;110:634-41. 18. Roosli M, et al. Wien Med Wochenschr (1946) 2011;161:240-50.

LIMITATIONS

- Due to the exploratory nature of the review, included studies were not appraised for quality
- The review included all type of study designs due to very few number of articles published on the concerned topic
- The review did not aim to identify whether the impact on QoL is due to the symptoms that these individuals experience or due to the condition itself and whether these individuals can perceive EMF exposure any better than the normal individuals
- Caution needs to be exercised in making comparison across studies owing to differences in study design, population, and settings

CONCLUSIONS

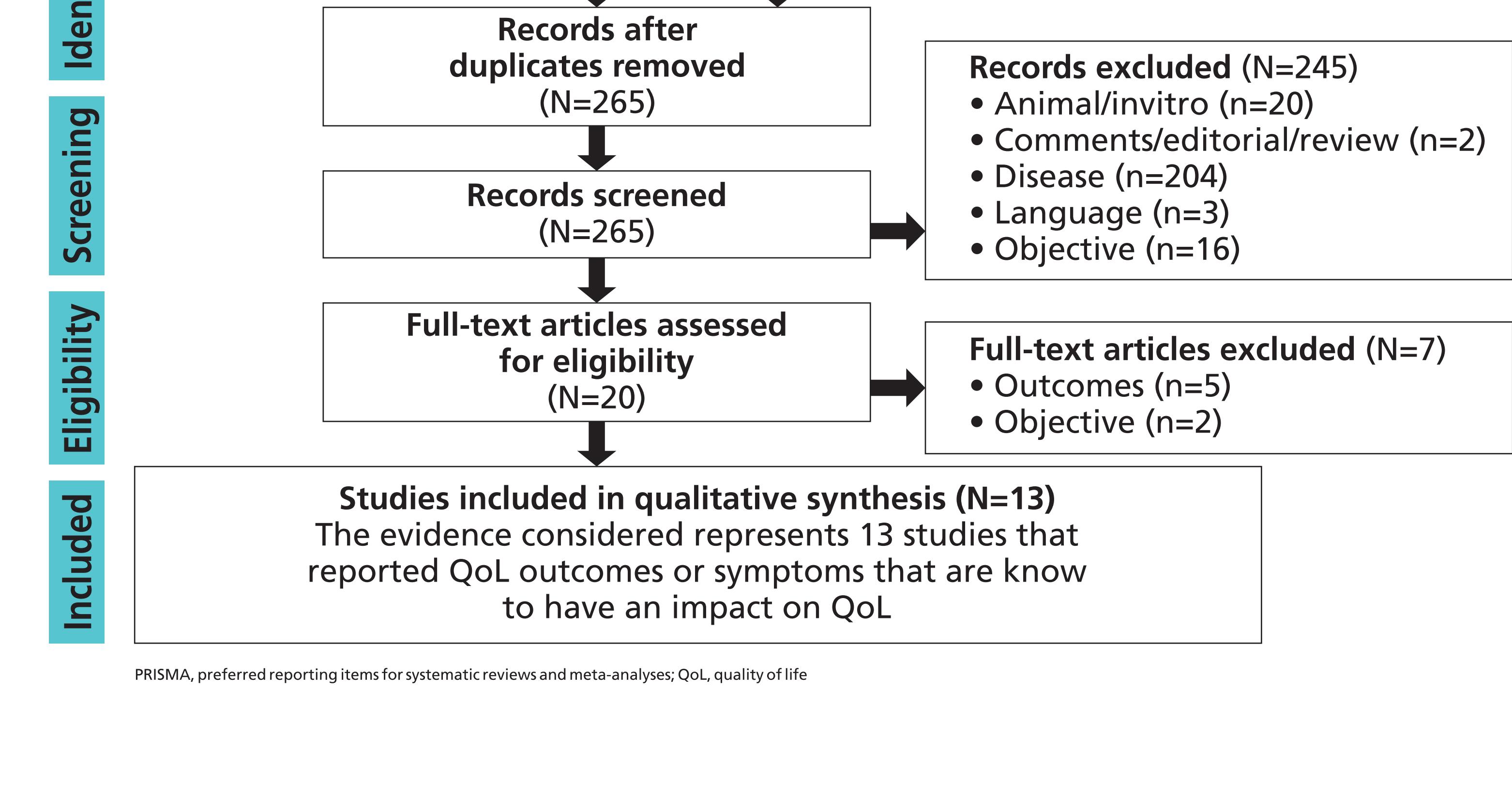
- QoL of individuals with EHS was lower vs. the population referents or controls in included studies
- Individuals with EHS reported a higher incidence of depression, anxiety, somatoform disorders, discomfort, fatigue, and poor sleep quality vs. respective controls
- No definite conclusion can be drawn due to the heterogeneous nature of the included studies

Table 1: Search strategy for the PubMed database

S. No.	Query	Items found
1	Search "electrical sensitivity"	63
2	Search "electromagnetic hypersensitivity"	80
3	Search "electro-smog"	1
4	Search ("mobile phone" or "wi-fi" or "microwave" or computer or "power line")	785050
5	Search (hypersensitivity or allergy or intolerance)	487493
6	Search (#4) AND #5	3563
7	Search "Idiopathic Environmental Intolerance attributed to electromagnetic fields" or IEI-EMF	34
8	Search ((#1 OR #2) OR #3) OR #6 OR #7	3701
9	Search (((QoL) OR (quality of life) OR (value of life) OR (life quality) OR (life qualities) OR (health-related quality of life) OR HRQoL OR HRQL OR EQ-5D OR (euroqol-5d) OR euroqol OR (PRO) OR (patient reported outcome) OR SF-36 OR (Short Form-36) OR SF-6D OR (short-form-6d) OR (Short form) OR (Short-form) OR (health utilities index) OR (health utility index) OR HUI OR (psychological general well-being) OR (psychological well-being) OR (humanistic burden) OR (standard gamble) OR (time trade off) OR (visual analogue scale) OR (visual analog scale) OR VAS))	941493
10	Search (#8) AND #9	263

EO-5D, EuroQoL five dimension scale; HRQoL, health-related quality of life; HUI, health utility index; IEI-EMF, idiopathic environmental intolerance attributed to electromagnetic fields; QoL, quality of life; SF-36, the 36-item Short Form survey; SF-6D, the six-dimensional health state short form; VAS, visual analogue scale

Figure 1: PRISMA diagram



CRI-SP: coping resource inventory-spiritual; CBT: cognitive behavioral therapy; EHS: electromagnetic hypersensitivity; EMF: electromagnetic field; HE: hypersensitivity to electricity; KSP: Karolinska Scales of Personality; MP: mobile phone; MPRS: mobile phone related symptoms; NEO-FFI: Neo Five Factor Inventory; POMS: Profile of Mood States; RF-EMF: radio frequency electromagnetic field; SMBQ: Shiro-Melamed Burnout Questionnaire; SREMF: self-reported electromagnetic field sensitivity; STAI: State-Trait Anxiety Inventory; VAS: visual analog scale; VDT: visual display terminal