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Novaes Lipp, Marilda Emmanuel; Barbieri, Flavio Eitor; Santánnia, Leonel; Justo, Ana Paula; Cabral, Ana Carolina; Urbini dos Santos, Flavia; Gallo, Sabrina; Kheifets, Leeka
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Perception of risk from electric and magnetic fields: Stress effects and psychological aspects

Percepção de risco de campos elétricos e magnéticos: efeitos do estresse e outros aspectos psicológicos

Marilda Emmanuel Novaes **LIPP**¹

Flavio Eitor **BARBIERI**²

Leonel **SANTÁNNA**²

Ana Paula **JUSTO**³

Ana Carolina **CABRAL**¹

Flavia Urbini dos **SANTOS**¹

Sabrina **GALLO**¹

Leeka **KHEIFETS**⁴

Abstract

The present study aimed to investigate the perception of risk in the Brazilian population related to electric and magnetic fields. Six hundred adults were recruited from the surrounding communities. Three hundred of them lived in large cities and an equal number lived in small towns. A short questionnaire was constructed to assess risk perception, trust in government to control risk exposure, level of comfort with exposure to extra-low-frequency electromagnetic fields, measures perceived as necessary to reduce emotional discomfort, and trust in the regulatory agencies. The Lipp Inventory of Stress Symptoms for Adults was applied to assess stress levels. Findings indicate that the majority of the participants in this study did not trust the Government to provide protective measures from exposure to electric and magnetic fields, did not trust the regulatory agencies, felt that there is no adequate risk control and thought about it frequently, and some felt that line installations were being performed in excess and that this should be stopped. Results endorse the need for risk education and indicate that risk perception and feelings should be considered before starting new line installations. Risk communication should incorporate knowledge regarding social cognition since a large proportion of the people were concerned about electric and magnetic fields. Lack of communication can lead to a rejection of necessary transmission line installation, and to unnecessary or exaggerated fear.

Uniterms: Electromagnetic fields; Risk perception; Stress.

Resumo

O estudo teve como objetivo investigar a percepção de risco relacionada a campos eletromagnéticos de baixa frequência na população brasileira. Participaram seiscentos adultos, sendo metade constituída por habitantes de cidades grandes e a outra metade por

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¹ Instituto de Psicologia e Controle do Stress. R. Tiradentes, 289, Conj. 91, Guanabara, 13023-190, Campinas, SP, Brasil. *Correspondência para/Correspondence to:* M.E.N. LIPP. *E-mail:* <mlipp@uol.com.br>.

² Associação Brasileira de Compatibilidade Eletromagnética. São Paulo, SP, Brasil.

³ Pontifícia Universidade Católica de Campinas, Centro de Ciências da Vida, Programa de Pós-Graduação em Psicologia. Campinas, SP, Brasil.

⁴ University of California at Los Angeles, School of Public Health. Los Angeles, CA, United State.

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habitantes de cidades pequenas. Um breve questionário foi utilizado para avaliar: (1) percepção de risco associada aos campos eletromagnéticos; (2) confiança no governo para proteger o povo do risco de exposição; (3) nível de conforto emocional frente à exposição às linhas de transmissão elétrica; (4) medidas percebidas como capazes de reduzir desconforto emocional; e (5) confiança nas concessionárias. Adicionalmente, foi aplicado o Inventário de Sintomas de Stress de Lipp, com o intuito de identificar o nível de estresse dos respondentes. Os dados indicaram que a maioria dos participantes (51,59%) deste estudo não confia que o governo tome as medidas necessárias para controlar os riscos; 28,05% não confiam nas concessionárias quanto ao controle de exposição excessiva; 33,0% sentem que não há um controle adequado do risco; e 17,00% pensam que a instalação de linhas de transmissão é excessiva, devendo-se parar com sua colocação. Os dados mostram a necessidade de se implementar um programa de educação quanto aos riscos reais, que leve em consideração o modo de pensar e sentir do povo brasileiro, antes de se instalar novas linhas de transmissão. A falta de comunicação pode levar o povo a rejeitar a instalação de linhas de transmissão necessárias e criar um medo desproporcional quanto a este assunto.

Unitermos: Campos eletromagnéticos; Percepção de risco; Estresse.

Since around 1890, when hotels and public places began to use electricity for lighting, public concern over potential health effects of Extra-Low-Frequency (ELF) electromagnetic fields from transmission lines has become an important issue to consider. This issue gained momentum with Wertheimer and Leper's study published in 1979 that indicated a correlation between childhood cancer and proximity to distribution and transmission lines. Since then numerous studies have investigated a wide range of possible adverse effects from exposure to ELF. The findings of the initial studies were challenged on methodological grounds. With time, the overall quality of the studies improved. The majority of reviews (National Institute of Environmental Health Sciences (NIEHS), 1999; International Agency for Research on Cancer - IARC, 2002) have classified magnetic fields as "possibly carcinogenic" based on studies of childhood leukemia and negative animal data. For other outcomes, and particularly for breast cancer (Davis, Mirick & Stevens, 2002) and cardiovascular disease (Hakansson, Gustavsson, Sartre & Floderus, 2003) the evidence is more consistently negative.

Avoiding exposure to Electric and Magnetic Fields (EMF) is almost impossible, as these fields are present whenever electricity is used or produced. The strength of a typical man-made field is lower than that of the earth (note however, that the first is at power frequency, where as the earth's field is static). Established guidelines (International Commission on Non-Ionizing Radiation Protection (ICNIRP), 2008) are based on acute effects, while the public is concerned with possible long-term effects.

Concerns aroused by modern technology are not always unreasonable, and it is important to consider

the positive effects of risk perception in a community as far as preventive measures are concerned (Albuquerque Navarro & Cardoso, 2005). As pointed out by Renn (2004), risk perception can be seen as a mental instrument that allows the prediction of future hazards and facilitates risk reduction measures. The upsurge in public and media concern related to the possible effects of ELF exposure and the need to clarify the degree to which this concern is proportional to the real risks involved have been the focus of several investigations. Risk perception is a complex question and for most people it is more subjective and qualitative, with perceived risk having little correlation with actual risk (Beecher et al., 2005; Petts, 1998; Schütz & Wiedemann, 2008). In the case of electromagnetic fields, personal beliefs and values seem to play an even greater role because of fear of cancer and because exposure is often involuntary. Another important factor is the poor understanding that most people have about electricity and radiation, as well as the fact that the agent is invisible and not perceptible. The degree of trust that a person has in the risk regulators also seems to be a very important factor in determining risk perception. The role of trust as a mediator has been the focus of many authors (Beecher et al., 2005; Walls, Pidgeon, Weyman & Horlick-Jones, 2004), who believe that trust plays a critical role in driving risk perception and that distrust contributes to opposition to proposals for activities perceived as risky (Walls et al., 2004). However, the binary opposition of trusting or not trusting is inadequate for understanding risk perception, the same way that to be well-informed about the real risks does not always seem to reduce personal bias in risk evaluation. In this respect, studies (Beecher et al., 2005) have attempted to verify whether increasing the

technical information provided to lay people would affect risk perception. Although this issue has been dealt with by the various governments who have tried to promote better risk communication and enhanced public participation in decisions on the siting of electrical installations (Mattos, Sauaia & Menezes, 2002), it remains a sensitive question (Wiedemann & Schütz, 2005). Some authors feel that public risk perception must be recognized as a factor in the decision to apply precautionary measures and that the public should always be informed. However, few studies have attempted to investigate the effect of precautionary measures to reduce public fear about EMF. Wiedemann and Schütz (2005) investigated whether the communication of precautionary measures influences risk perception. Their findings indicate that under some circumstances, communication of precautionary measures can amplify perception of a risk showing the need for special care in the implementation of such measures. One consideration is the assessment of the perception of risk prior to the adoption of any social measures. This is always difficult because the public differ in their beliefs from many experts. However, it is essential to investigate the risk perception each community has to improve social communication and reduce unnecessary concerns.

Another factor that seems important to consider, in a stressful society such as ours, is a possible association between emotional stress and risk perception, especially considering that excessive stress is known to give rise to emotional responses (Everly Jr, 1989). It is not yet known if a high level of stress would lead a person to be more emotional and to consistently overestimate the risks or if a high level of stress would lead to less careful assessments of situations not directly related to the source of stress.

Risk perception is likely influenced by personal values, attitudes and feelings. Thus any measures attempting to deal with ELF risk perception and fear in the population should, as recommended by Renn and Rohrmann (2001), consider the culture of the people involved and their levels of stress.

The aim of the present study was to investigate the risk perception related to electric and magnetic fields in the Brazilian population as a function of (1) living in a large city or small town, (2) the respondents' stress

levels, (3) the level of trust in the risk regulators, and (4) the level of control that respondents feel should be exercised in this area. We hope that our results can contribute to improved risk evaluation by lay people and thus reduce unnecessary or exaggerated fear, in connection with exposure to ELF electromagnetic fields.

Method

The respondents were 600 adults evenly recruited from the surrounding communities, with three hundred from large cities and an equal number from small towns.

Measures

A short questionnaire was constructed to assess (1) risk perception, (2) trust in government to control risk exposure, (3) level of comfort with exposure to extra-low-frequency electromagnetic fields, (4) measures perceived as necessary to reduce emotional discomfort, and (5) trust in the regulatory agencies, that is, in the companies that supply electricity and which are responsible for controlling risks under the inspection of the Government. Two statements each were written for factors 1, 2 and 3 above: one positive and one negative. Block randomization of the statements was used to ensure that two statements about the same issue were not presented in any particular sequence. An open-ended question was added to allow the participants to freely express feelings about exposure. The questionnaire (Chart 1) includes a total of six statements plus the open-ended question. Items 2 and 6 are intended to cover risk perception; items 1 and 5 cover the level of trust in regulatory agencies, and items 3 and 4 investigate the level of comfort to exposure. The possible answers to the questionnaire are: I totally agree, I mostly agree, I somewhat agree, I disagree, I completely disagree.

Stress levels and associated symptomatology were assessed using the Lipp Inventory of Stress Symptoms (LISS) for Adults. The LISS (Lipp, 2000; Lipp & Anderson, 1999) is an instrument validated in Brazil, composed of different sets of symptoms in accordance with Lipp's (2000) four-stage model (alert, resistance, quasi-exhaustion and exhaustion). The LISS enables the

assessment of both cognitive and somatic stress symptoms in terms of the four stress phases. The respondent is asked whether he or she has had a stress symptom (as specified in each chart) in the past day, week, or month. Each of the first two sets (alert and resistance) contains 15 items. The third chart, which assesses stress in the exhaustion phase, contains 23 items. Assessment is made in terms of the percentage tables of the test.

Four Master's-level clinical psychologists conducted the interviews under the guidance of the first author.

Procedures

The ten sites for data collection were selected by the agencies that study risk control in the city of *São Paulo*, Brazil, to ensure that the selected cities had exposure to extremely-low-frequency electromagnetic fields; five of them were small towns and five were considered large cities. Opportunity samples were selected from adults attending churches, clubs or other group activity centers and residing in the target area. As highlighted by Bostrom, Morgan, Adams and Nair (1994), the use of such opportunity samples is quite common practice in studies of risk perception and makes it feasible to interview a large sample for the study.

After establishing contact with a local collaborator, such as the directors of fitness academies, hair salon owners, coordinators of adult education classes, neighborhood associations and shopping center administrators, who helped the interviewers gain access to the potential participants, the four interviewers went to the target cities and talked to the people present, either individually or in groups, and explained the objective of the study and requested their participation. The criteria for inclusion were: to live in the target areas, to be able to understand the questions, to voluntarily agree to participate in the study and to sign the terms of free prior informed consent approved by the ethics committee. In exchange for participation, respondents received a brochure containing simple suggestions on stress management.

The terms of free prior informed consent was signed by each participant. It contained a brief

explanation of the study, advised the respondents that they could terminate the interview at any time they wished and that their names would be kept totally confidential, as approved by the Ethics Committee. Acceptance was greater in the small towns, where people were eager to express themselves. In the larger cities, some people were hesitant and did not want to give their names or ID numbers or simply refused to participate due to lack of time to answer the questions.

Data analysis

The Chi-square test was used to compare the categorical variables between the groups, with Fisher's exact test used for values below five. The Mann-Whitney test was used to compare the numerical variables between the groups and the Kruskal-Wallis analysis of variance was performed with more than two variables, followed by the Dunn's multiple comparison test. To assess the relationships between the main variables and risk perception, the study used logistic regression analysis (univariate and multivariate models with stepwise selection of variables). To assess the joint relationship between the main variables and profile formation, a cluster analysis was used. For the multiple regression analyses of risk perception, data was adjusted for age, gender, education and the size of the city where the data was collected.

Results and Discussion

Demographic data

Females comprised sixty-two percent of the sample while 38% were male. There was no significant difference between large cities and small towns in relation to the sample's gender distribution ($\chi^2=0.04$; $GL=1$; $p=0.841$). The age range was from 19 to 81 years with a mean age of 35 years ($SD=14$). A significant age difference was found between the two types of locations, with the small towns ($M=32.26$ years, $SD=12.08$) showing a higher number of participants in the under-39 age range and the large cities ($M=37.32$ years, $SD=15.22$) having more participants aged forty or older ($\chi^2=25.69$; $GL=3$; $p<0.001$). Almost half of the sample was married (47%). Forty-eight percent of the

participants had received college education, 37% had finished high school, and the remaining 15% had only completed elementary school, with no significant difference between large and small cities ($\chi^2=4.35$; $GL=2$; $p=0.114$). A significant difference was found in education levels between male and female subjects ($\chi^2=6.07$; $GL=2$; $p=0.048$) where more men than women had received college education.

Analyses were performed on the association of stress, educational level, marital status, age, gender, and the size of the city according to risk perception. Age and marital status had no significant influence on the answers given on the questionnaire ($p>0.05$ for all items).

Incidence of stress and symptomatology

The percentage of participants with symptoms of stress was high (55%), indeed higher than expected, since the incidence of stress in Brazil has been found to be between 32% and 37% (Lipp, 2008). Considering only the participants that showed symptoms of stress, approximately 6% of them were in the initial stage (alert), 10% were in the advanced stage (quasi-exhaustion/exhaustion), and thirty-nine percent of them were in the resistance stage of the stress process. Typically, when the stress develops into the resistance stage, the person feels tired and needs to make a special effort to deal with the cumulative stressors present in life. This leads to self-centered decisions and attitudes due to the need to direct energy towards dealing with the challenges involved. Psychological symptoms were most frequently mentioned (35%), such as mental tension, difficulty in concentrating and anxiety.

Analysis of the percentages of participants with stress according to the stage of the stress process and gender revealed that there were more women (62.90%) reporting stress symptoms than men (40.90%). The difference was significant ($\chi^2=24.82$; $GL=1$; $p<0.001$). When the severity of the stress symptoms was compared between men and women, a significant difference was found, with men consistently reporting less stress ($\chi^2=35.02$; $GL=4$; $p<0.001$). This data is compatible with other research in Brazil showing that, in a given group, typically more women are found to have symptoms of stress (Lipp, 2008). This is usually

attributed to the responsibilities women have as professionals and homemakers.

The incidence of stress was not significantly different when small and large cities were compared ($\chi^2=4.74$; $GL=4$; $p=0.315$). This result confirms previous research (Lipp, 2000) that shows that, regardless of the city size, stress can manifest itself, even though it may originate from different types of stressors in each location.

Risk perception

To assess the relationships between the main variables and risk perception, the study used logistic regression analysis (univariate and multivariate models with stepwise selection of variables). Values of 1 to 5 were assigned to possible answers to the first seven items in the questionnaire, ranging from 1, the option "I completely disagree" to 5, where the answer was "I totally agree". The answers to the negative items 4, 5 and 6 were inverted to permit analysis. The other two items included in the questionnaire were open questions and were analyzed in categories.

Using the items from Chart 1 as a basis, which provides a translation for the questionnaire used in the research, and after inverting the values given to the negative items 4, 5 and 6, a measure of risk perception was created by calculating the mean of values given by the respondents to items 2 and 6. A score for the level of trust in the regulatory agencies was obtained from the means of the values given to items 1 and 5; and a score, for the level of emotional comfort the respondents felt with regard to EMF exposure, was obtained from the means of items 3 and 4. The value given to item 7 was considered to be the score for trust in Government.

Table 1 shows the percentages of respondents who gave each type of answer to the first seven questions included in the questionnaire. It can be seen that 28.05% of the respondents did not feel that the regulatory agencies could be trusted to control risk, and 51.59% did not feel that the Government does a trustworthy job in controlling and inspecting electric transmission lines.

When analyzing trust in the risk regulatory agencies and in the Government, care must be taken

Chart 1

The English translation of the Questionnaire Used

Name: _____ ID: _____

Sex: _____ Age: _____ Date of birth: _____

Marital status: _____ Occupation: _____

Instructions: Please answer the questions that will be read to you as sincerely as you can, do not spend too much time thinking about them, simply give the first answer that occurs to you. Please indicate:

I totally agree,
 I mostly agree,
 I somewhat agree,
 I disagree,
 I completely disagree.

1. The regulatory agencies do a very trustworthy job regulating risk exposure to electromagnetic fields so that people are well protected.
2. One has to worry all the time thinking about the risk to health posed by the electromagnetic fields.
3. Progress demands that transmission lines be placed everywhere and the benefits make it all worth the risk involved.
4. I think that we should stop completely placing transmission lines in our community because they can be dangerous to health
5. I do not trust that there is good control of the risk of exposure to electromagnetic fields in my community.
6. Many times I do not even remember that there are transmission lines near where I live.
7. It is possible to trust Government control and inspection of electric transmission lines.
8. In your opinion, for people to feel comfortable, what could be done in relation to wires and electric and magnetic fields near houses and constructions?
9. If wires or transmission lines were no longer installed, how would people's daily life be affected?

Table 1

Percentages of answers given to the items in the risk perception questionnaire

Item \ Answer	I totally agree	I mostly agree	I somewhat agree	I disagree	I completely disagree
1	7.35	20.70	34.89	20.87	16.19
2	11.69	20.37	24.74	12.35	30.55
3	4.34	5.68	20.53	17.36	52.04
4	33.89	29.88	18.86	6.34	10.52
5	13.19	29.38	24.37	12.52	20.53
6	16.53	26.88	19.37	10.02	27.21
7	23.54	23.05	30.05	11.02	7.35

Note: Item 1) The regulatory agencies do a very trustworthy job regulating risk exposure to electromagnetic fields so that people are well protected.

Item 2) One has to worry all the time thinking about the risk to health posed by the transmission lines.

Item 3) Progress demands that transmission lines be placed everywhere.

Item 4) I think that we should completely stop placing transmission lines in our community because they can be dangerous to health.

Item 5) I do not trust that there is good control of the risk of exposure to electromagnetic fields in my community.

Item 6) Many times, I do not even remember that there are transmission lines near where I live.

Item 7) It is possible to trust government control and inspection of electric transmission lines.

not to confuse lack of trust in the authorities in general and the lack of trust with regard to risk exposure in particular. It is possible that the high level of mistrust (51.59%) relates to this general feeling, especially considering the much lower level of mistrust found with the regulatory agencies, which indicates that the respondents trust the supply companies more than the Government to control exposure risks.

Ten percent of the respondents felt that for progress there is no need for so much installation of electric wires in the neighborhoods, 17% thought that such installations should stop completely, and 33% consider that there is no appropriate risk control in their community. The answers show the need for educational campaigns that could quell some of the unrealistic doubts lay people have, especially considering that 17%

of the respondents felt that the installation of new lines should stop.

Table 2 shows the descriptive analyses of the answers given and the scores for risk perception, trust in regulatory agencies, emotional comfort with regard to EMF, and trust in Government to enforce the necessary measures to protect people from unnecessary risk, calculated on the basis of the answers given by the respondents. The scores were similar, with the highest mean score for emotional comfort ($M=3.88$, $SD=0.89$), and the lowest for Government trust ($M=2.51$, $SD=1.18$). The mean risk perception score, for the entire group, was 3.12 ($SD=1.09$), indicating that, on average, respondents *somewhat agree* that there is an appropriate control of risk and feel somewhat comfortable about it.

Risk perception and stress

Regarding the association between the stage of stress and risk perception, the Dunn *post-hoc* test, performed after the multiple comparison Kruskal-Wallis test, showed that the stress level significantly affected risk perception in that it served as a buffer, reducing risk perception ($p=0.003$) and increasing emotional comfort in relation to EMF ($p=0.037$). People in the alert stage had less risk perception (risk perception score = 2.51, $SD=1.07$), that is, they seem to worry less about risks

than people without stress, who presented a risk perception score of 3.18 ($SD=1.09$).

Risk perception and level of education

The associations between the level of education and risk perception, and between education and emotional comfort were significant, with the more educated participants showing a smaller risk perception score (Dunn *post-hoc* test, $p=0.034$) and a higher emotional comfort score (Dunn *post-hoc* test, $p<0.001$). More of the college educated participants disagreed that we should stop installing transmission lines (Dunn *post-hoc* test, $p=0.043$) and thought that people should not constantly worry about this subject (Dunn *post-hoc* test, $p<0.001$).

Risk perception and size of city

Results showed that the respondents from small towns had a more positive view of the electric transmission lines (trust score=3.61, $SD=0.83$) than the people from large cities (trust score=2.68, $SD=0.95$). Comparing the two types of location, it was found that the differences were significant in terms of trust in the regulatory agencies ($p=0.001$), feelings that the benefits of installing more lines compensate the risks ($p=0.002$), emotional comfort ($p=0.001$), not wanting to interrupt the electricity services ($p=0.001$), and feeling that the government exercises adequate risk control.

Table 2

Numerical analyses of answers to the questionnaire and calculated scores for risk perception, trust in regulatory agencies, emotional comfort, and trust in Government

	N	Mean	Standard Deviation	Median
<i>Questions</i>				
Q1	599	3.18	1.15	3.00
Q2	599	3.29	1.39	3.00
Q3	599	4.07	1.16	5.00
Q4	599	2.30	1.29	2.00
Q5	599	2.98	1.33	3.00
Q6	599	3.05	1.46	3.00
Q7	599	2.51	1.18	2.00
<i>Mean scores</i>				
Risk perception		3.12	1.09	3.00
Trust in agencies		3.10	0.96	3.00
Emotional comfort		3.88	0.89	4.00
Trust in government		2.51	1.18	2.00

Risk perception and gender

The Mann-Whitney test revealed no significant difference in risk perception scores for men and women ($p=0.923$). The mean risk perception score was 3.12 (SD=1.11) for female and 3.13 (SD=1.07) for male subjects.

To search for possible variables influencing risk perception, Spearman's correlation coefficient was calculated for all relevant variables. Trust in regulatory agencies ($r=-0.129$; $p=0.0016$; $n=599$) and emotional comfort ($r=-0.234$; $p<0.0001$; $n=599$) showed a significant correlation with risk perception.

Table 3 shows the results of the multiple regression analyses for risk perception, adjusted for age, gender, education and the size of the city where the data was collected. It can be seen that, after data adjustments, the variables emotional comfort, stress

stage, and trust in the regulatory agencies were, together, found to be significant as associated factors related to risk perception. Participants with higher risk perception scores were the ones with less emotional comfort, no stress and with lower scores in trust in the regulatory agencies.

Cluster analysis was performed for the principal variables in the study such as gender, age, education, marital status, size of the city, stress, risk perception score (calculated from the mean value of items 2 and 6), trust in the agencies (score for level of trust in the regulatory agencies was obtained from the mean value of items 1 and 5) and government (the value given to item 7 was considered to be the score for trust in Government), and emotional comfort (the level of emotional comfort the respondents felt in regard to EMF exposure was found from the mean score of items 3 and 4 through the use of the partition method for two groups). Cluster

Table 3

Results of Multiple Regression Analyses for risk perception, adjusted for (a) age, gender, and (b) the size of the city where data was collected and (c) educational level

Results of Multiple Regression Analyses for risk perception, adjusted for age and gender				
Variables	Categories	Beta (SE)*	p-Value	Partial R ^{2**}
Emotional comfort	Score	-0.25 (0.05)	<0.001	0.0503
Stress stage	Alert	-0.61 (0.20)	0.002	
	Resistance	-0.12 (0.10)	0.208	0.0171
	Quasi exhaustion or exhaustion	0.04 (0.16)	0.804	
Trust in regulatory agencies	Score	-0.09 (0.05)	0.048	0.0063
Results of Multiple Regression Analyses for risk perception, adjusted for age, gender and the size of the city where data was collected				
Variables	Categories	Beta (SE)*	p-Value	Partial R ^{2***}
Emotional comfort	Score	-0.25 (0.05)	<0.001	0.0489
Stress stage	Alert	-0.61 (0.20)	0.002	
	Resistance	-0.12 (0.10)	0.223	0.0172
	Quasi exhaustion or exhaustion	0.04 (0.16)	0.798	
Trust in regulatory agencies	Score	-0.10 (0.05)	0.035	0.0072
Results of Multiple Regression Analyses for risk perception, adjusted for age, gender, the size of the city where data was collected and education				
Variables	Categories	Beta (SE)*	p-Value	Partial R ^{2***}
Emotional comfort	Score	-0.24 (0.05)	<0.001	0.0416
Stress stage	Alert	-0.59 (0.20)	0.003	
	Resistance	-0.13 (0.10)	0.182	0.0163
	Quasi exhaustion or exhaustion	0.02 (0.16)	0.880	
Trust in regulatory agencies	Score	-0.10 (0.05)	0.031	0.0075

Note: *Beta: Estimated value or angular (slope) coefficient in the regression line, SE: Standard Error of beta. R²: coefficient de determinacion. Criteria: Stepwise of variable selection. Total R^{2**}: 0.0737, Intercept (SE): 4.39 (0.24), $p<0.05$; Total R^{2***}: 0.0733, Intercept (SE): 4.47 (0.26), $p<0.001$; Total R^{2****}: 0.0654, Intercept (SE): 4.44 (0.29), $p<0.001$.

1 was composed primarily of college educated males, from small towns, without stress, with lower score in the questions related to risk perception, higher score in the question related to trust in regulatory agencies and the government, and with more emotional comfort. Cluster 2 included high school educated females, from large towns, with stress symptoms, higher risk perception, lower trust in regulatory agencies and the government, and with less emotional comfort. Significant differences between the two groups were found for risk perception ($p=0.009$), trust in agencies ($p<0.001$), emotional comfort ($p<0.001$) and trust in government ($p<0.001$). Women, in general, did not differ significantly from men in risk perception, as mentioned earlier in this article, however when the level of educational and the size of the city they reside in were taken into consideration, differences were detected, showing that women with low formal education, living in large cities, tended to have less trust in risk control by government and agencies, feel less emotional comfort, and have a higher risk perception. Educational campaigns about EMF should target this population in a more direct way.

The questionnaire also included two open-questions as shown in Chart 1. The answers to question 8, regarding what needs to be done so that people could feel comfortable in relation to power lines and electric and magnetic fields near houses and constructions, were mostly distributed into four categories, namely: (a) 41% felt that "Government and regulatory agencies should exercise more control"; (b) 47% of the respondents suggested placing all power lines underground ("underground installations seem safer"); (c) 6% felt that it is all right as it is ("I think that the installations are all right, no problem") and (d) 6% felt that there is need for more information to be made available to people.

These results are consistent with the finding that a large number of respondents (approximately 59%) did not trust the authorities in relation to risk control. If there is no trust, then it would be expected that more control would be a desired and designated measure. The lack of knowledge about EMF is apparent in the answers, yet only 6% of the participants felt the need for more information.

Answers to question 9 (If wires or transmission lines were no longer installed, how would people's daily lives be affected?) were mostly distributed into three categories: (1) 73% of the respondents stressed the negative consequences for society ("people would not be able to use computers any more," "it would be chaos"; "people would feel desperate, frustrated"); (2) 12% of them mentioned personal consequences and feelings ("I would not be able to listen to my programs" or "I would feel depressed because it would be dark at night"); and (3) 15% expressed the opinion that "life would be better". The simplicity of the answers obtained revealed that most of the sample's participants had not thought carefully about the possible consequences the world would face without the installation of transmission lines; some of the answers were very much focused on personal situations and losses and not on society as a whole. This indicates that any educational campaigns in this area should consider this tendency.

Approximately 43% of the participants worried about EMF risks. This finding is compatible with those of Schreier, Huss and Röösl (2006) in Switzerland, showing that 53 percent of their 2,028 adult respondents were worried about adverse health effects from EMF. As mentioned by Schütz and Wiedemann (2008), one may speculate that, when an individual's knowledge about technology is lacking, people use more familiar aspects from the social context as cues for their risk evaluation.

Taken together, our findings indicate that the majority of the participants in this study did not trust the Government to take protective measures, some did not trust the regulatory agencies, a great number felt that there is no adequate risk control and thought about it frequently, and some felt that power lines were being installed unnecessarily. Even though a consensus society is neither possible nor desirable, results endorse the need for risk education to be implemented and indicate that risk perception and feelings should be considered before starting new line installations. Risk communication should incorporate knowledge about social cognition since the large proportion of people concerned about EMF may cause social conflict given the ubiquity of EMF in our everyday lives.

Study limitations

As with any research, there are limitations that need to be discussed. One limitation is that the data came from opportunity samples selected from adults attending churches, clubs or other group activity centers and residing in the target area. Although the use of such opportunity samples is a common practice in studies of risk perception and its use made it feasible to interview a large sample for the study, there was no uniformity in the subjects' characteristics which should be taken into consideration in the analysis of the results.

Conclusion

Data from this study indicate that risk perception depends on many factors that determine how a person will process the danger that might exist. Among these factors it was concluded that emotional stress has a significant impact in risk perception. When the person is under stress, the attention is focused on the stressors that need to be faced, and little attention is given to other stimuli that are present at that time. Another relevant factor to be considered is the amount of information that a person has about a particular technical situation, the less is known, the more probable it will be that the individual fills the blank with socially desirable beliefs. To avoid unnecessary worries, it is concluded that public education is essential when new transmission lines are installed in a neighborhood.

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