



Study of the influence of electromagnetic fields on Human well-being in buildings of the urban area of Annaba (Algeria)

Bouslama Amina^{*1}, Boukhemis Kaddour¹, Abdelmelek Hafedh²

¹Laboratory of Architecture and Urbanism, Faculty of Earth Sciences, Annaba Badji Mokhtar University, Sidi Amar, Annaba, Algeria

²Laboratory of Integrated Physiology, Faculty of Sciences, University of Carthage, Jarzouna, Bizerte, Tunisia

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Abstract

In nowadays, wireless communication technologies (Wi-Fi, mobile phone, relay antennas...) have become part of the city's structure and have shaped a new image of our towns. Although, wireless communication played a leading role in the development of cities and smart-cities around the world. The present study based on a survey evaluating of Human well-being related to electromagnetic fields pollution (EMFP) in the urban area of Annaba (Algeria). A sociological survey conducted on 227 citizens (between 18- 39 years old). The most important results of our investigation demonstrated a correlation between EMFP exposure and Human well-being. In addition, EMFP disrupt physiological parameters leading to tiredness on waking, migraines, insomnia and stress. In conclusion, the EMFP could have a negative impact on Human well-being related to building architecture in Annaba urban area.

*Corresponding Author: Bouslama Amina ✉ bouslama.amina@yahoo.fr

Introduction

Living systems could be influenced by natural electromagnetic field (EMF_{nat}) (like sunlight) and/or artificial field (EMF_{art}) (emitted by relay antennas, mobile phone, Wi-Fi.), leading to many biological disruptions (Saili *et al.*, 2015; Ammari *et al.*, 2017; Othman *et al.*, 2017).

Previous studies showed different benefits of EMF_{nat} on Human and animal health. Interestingly, several studies showed a negative bioeffects of EMF_{art} on animal health (Ghodbane *et al.*, 2013; Saili *et al.*, 2015). Previous works showed the induction of stress, hypoxia and diabetes-like status under EMF_{art} (Chater *et al.*, 2005; Abdelmelek *et al.*, 2006). Furthermore, Saili *et al.*, (2015) demonstrated that radio frequencies (RF) reduce the efficacy of drugs. Moreover, Othman *et al.*, (2017) observed that RF induce neurological effects in the offspring of female rats.

Different studies point that EMF_{art} could influence animal and human behavior, but there are only few studies discussing the effects of this pollution on Human well-being. However, the World Health Organization (WHO) has already defined health since 1946 as « a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity » (Frank, 2002).

In addition, in the near future we will observe the increase of smart-cities number in the world. These smart-cities will have more electromagnetic pollution (EMFP) than our traditional cities (Batty *et al.*, 2012), thus justifying research on the harmful bioeffects of EMF on citizen living in different architectural design of buildings. The aim of the present investigation was to demonstrate the implication of EMF emitted by relay antenna or Wi-Fi on Human well-being in the Annaba urban area (Algeria).

Material and methods

Study zone

The city of Annaba is located 600 km from Algiers the capital Algeria, in the far Northeast of the country, open on the Mediterranean coast.

The present study was carried out on a sample of the population of Annaba, a city situated at 36°54'15"N of latitude and 7°45'07"E of longitude. (Fig. 1).

Studied population

Respondents (227-citizen aged between 18 – 39 years old and living in Annaba city) asked on a number of frequently questions related to electromagnetic fields pollution and well-being in buildings. Additionally they were asked to suggest factors that 'gave them well-being or ill-being like horizontal or vertical building and the nature of walls.

For the present investigation, we have prepared a survey that includes twenty two (22) questions divided into three sections; i) the first contains nine questions about the respondents; ii) The second part aim contain six questions in order to evaluate the citizen well-being; iii) The last section aim to evaluate the bioeffects of electromagnetic pollution (seven questions).

Citizen were chosen at random and objectively, making sure to cover all sectors of Annaba.

Statistical analysis

The data collected were processed statistically with the software "Statistical Package for the Social Sciences" also called "IBM SPSS 20" with a significance level of 0,05. For a better readability / reading of the results their graphical representation was made by Excel Office 2013. Univariate and bivariate analysis have been established. The latter rely on the calculation of the Pearson Chi-square test (X^2) at the 0,05 threshold to verify the existence of a dependency between the variables.

Results and discussion

Our data reported that our sample was made by about 50,05% men and 49,95% women. Whereas the social category structure of the sample is composed of 65,20% workers, 27,31% students and only 7,49% at home (housewives) (Tab. 1).

Table 1. Distribution sample by sex and social category.

Social category	Men		Women		Total	
	N	%	N	%	N	%
Workers	81		67		148	65,20
Students	25		37		62	27,31
At home (housewives / unemployed)	8		9		17	7,49
All category	114	50,05%	113	49,95%	227	100%

Globally, results demonstrated that ill-being is slightly higher (+52,42%) than well-being in Annaba citizen (Fig. 2). Fig. 3 show that the composition of the ratio of well-being / ill-being do not reveal any significant difference (Ratio = 0,97 during day and Ratio = 1,01 during night). The investigation reported that men have higher values of well-being compared to women (57,89% vs 37,17% ; p= 0,02). Human well-being was correlated to men life style, confirmed by X² values (Fig. 4).



★ Study area



★ Study area

Fig. 1. Location of the study area.

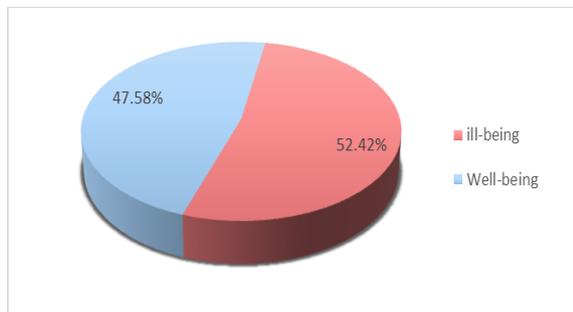


Fig. 2. Evaluation of Human well-being in Annaba citizen (n = 227).

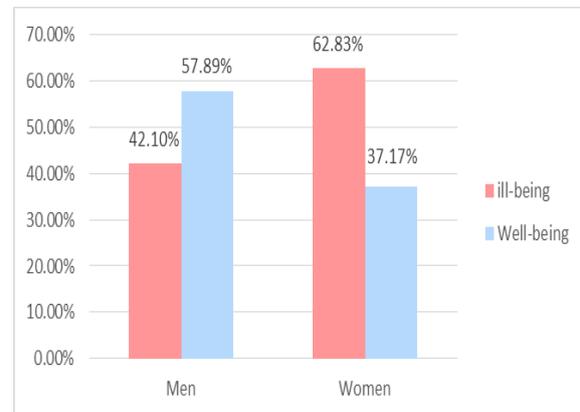


Fig. 4. Evaluation of Human well-being by sex in Annaba citizen (n = 227).

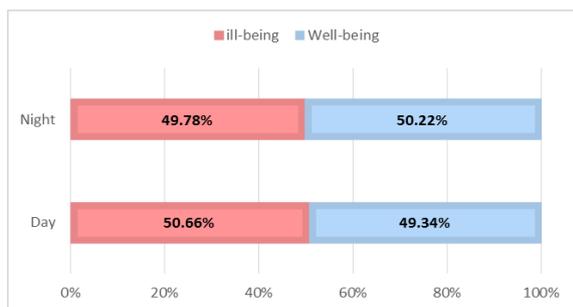


Fig. 3. Evaluation of well-being during day or night in Annaba citizen (n = 227).

Interestingly, Fig. 5 indicated that 63,16% of the total masculine population spend less time than 4 hours in their home during day. While 51,33% the total female population spent between 4 and 8 hours, and 6,19% spent time between 8-12 hours. Therefore the presence of a correlation of average size between sex and time spent at home (p= 0,02) is affirmed.

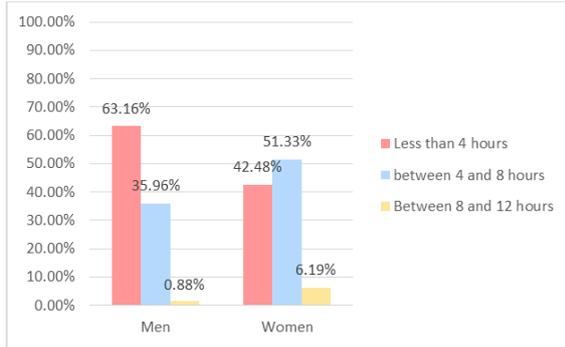


Fig. 5. Evaluation of time spent at home by sex (n=227).

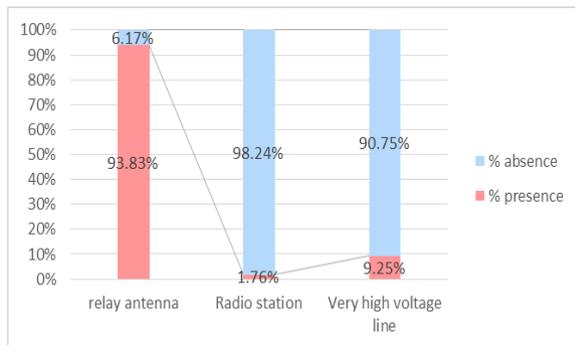


Fig. 6. Evaluation of electromagnetic fields sources in urban area of Annaba.

Fig. 6 indicates a high occurrence of relay antennas with about 93,83% of cases in the urban area of Annaba. Our study demonstrated in fig. 7 the presence of negative correlation between well-being and the existence of relay antenna (with $X^2 = 8.701$, dof= 1, $p = 0,03$). Our data point to the presence of negative correlation between well-being and distance (absent, above and more than 300m) By contrast, we observe a correlation of ill-being with distance (between 150 and 300m and less than 150m) (with $X^2 = 112,359$, dof= 4, $p = 0.000$). (Fig. 8).

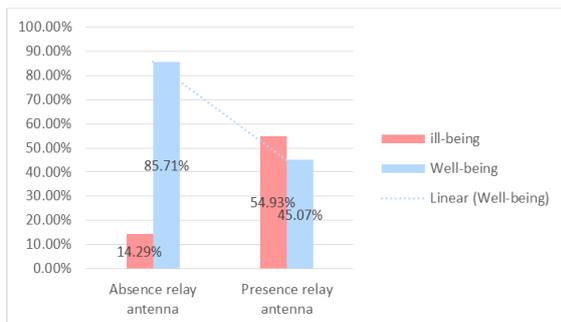


Fig. 7. Evaluation of link between Human well-being and the presence of relay antennas (n=227).

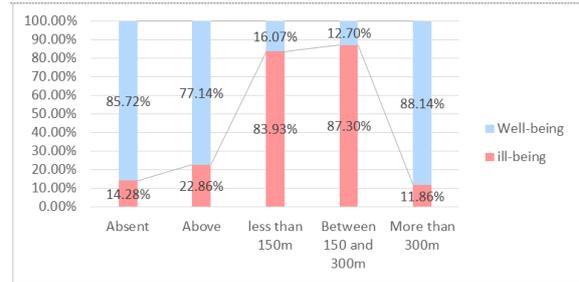


Fig. 8. Study of well-being by distance from relay antenna.

The analysis of the survey shows clearly that many health effects of EMF was observed in the house urban of Annaba like tiredness on waking, migraines, insomnia and stress (Fig. 9). Our results reveal in Fig. 10 the existence of negative correlation between well-being and distance from modem Wi-Fi to the room (with $X^2 = 27,565$, dof= 3, $p= 0,000$). Our data demonstrated the presence of significant correlation between well-being and floor number in which citizen live. The correlation is negative in the second, third and fourth floor, and positive in the rest of floors. ($X^2 = 32,904$, dof= 6, $p=0,000$) (Fig. 11). The results of fig.12 prove that there is a correlation between well-being and building materials (with $X^2 = 20,224$, dof=1, $p=0,000$).

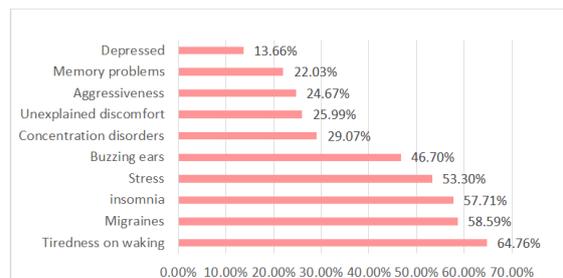


Fig. 9. Investigation of symptoms felt.

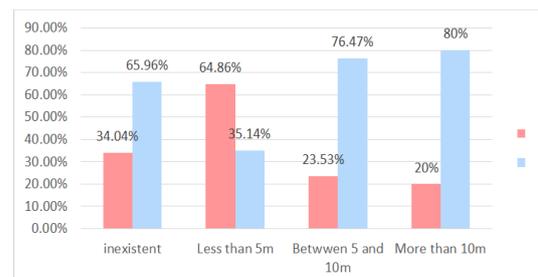


Fig. 10. Evaluation of well-being by Distance from the modem Wi-Fi to the room.

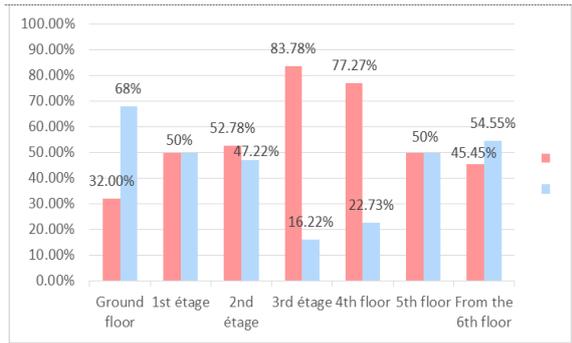


Fig. 11. Evaluation of well-being by floor (level) of dwelling (n=227).

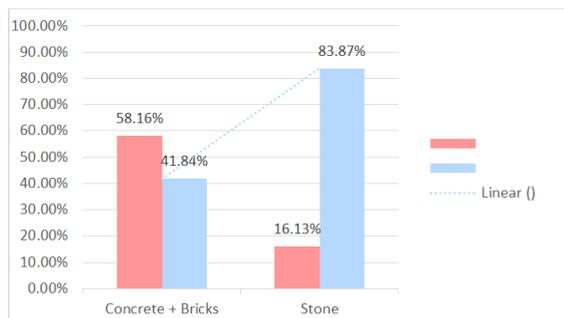


Fig. 12. Evaluation of well-being by exterior wall construction material (n=227).

Discussion

Our investigation demonstrated for the first time, as far as we know, that ill-being is higher than well-being in Annaba (Algeria) probably correlated to electromagnetic pollution (EMFP).

In different towns in the world, thousands of citizen people are exposed to natural electromagnetic fields from sun and nowadays they live under an electro-smog (radio frequencies from relay antennas, Wi-Fi..) or EMFP (Adey, 1993). Interestingly, literature points to the existence of natural bioeffects of electromagnetic fields on plants, animals and Human physiology and metabolism (Vian *et al.*, 2016; Maffei, 2014; Adey, 1993). Natural electromagnetic fields modulate in Human and animal different hormones like melatonin and different neurotransmitters (like dopamine) implicated in well-being. (Mead, 2008; Tsai *et al.*, 2011).

In accordance to the natural bioeffects of light, we suppose that artificial electromagnetic fields could

interact with the same biological pathways in order to disturb neurological and biological process in Human and animal cells as previously demonstrated by different authors including Chater *et al.*, 2005; Abdelmelek *et al.*, 2006; Brillaud *et al.*, 2007; Ammari *et al.*, 2008; Ben Salah *et al.*, 2013; Sali *et al.*, 2015, Ammari *et al.*, 2017 and Othman *et al.*, 2017).

The analysis of well-being in Annaba reveals that men have a higher well-being compared to women. In order to explain this data, we have to compare time spent by women and men at home. Our investigation showed no difference of well-being between day and night; indicating that the artificial electromagnetic fields have a pronounced bioeffects compared to natural electromagnetic fields. Given that, ill-being of women was correlated to time exposure to artificial electromagnetic fields, confirmed by the presence of relay antennas (fig. 6). Interestingly, modulation of well-being is function of distance (the inverse square law: intensity = 1/distance²) (Röösli, 2014). Our investigation demonstrated the artificial electromagnetic fields decrease well-being between 150 – 300 meters and less than 150 meters. This supports the results of Viel *et al.*, (2005), who states that the intensity of exposure to radiofrequency waves emitted by the relay antennas in urban areas peaks around 280m. Well-being was observed in white spaces (near zero field EMF), in the floor of house or building and with a distance higher than 300 meters. Finally, the ill-being could be explained by different confirmed bioeffects or symptoms like tiredness on waking, migraines, insomnia and stress (Fig. 9).

In addition, we can evaluate the bioeffects or observed symptoms of radio frequencies in houses or buildings by EMF generated by Wi-Fi (2,45 GHz). Previous studies reported behavioral and biological disruptions (Sali *et al.*, 2015; Othman *et al.*, 2017; Pall, 2018). Our data confirmed that the bioeffects of Wi-Fi is function of distance as previously demonstrated with relay antennas. The pronounced bioeffects on Human well-being of Wi-Fi is less than 5 meters.

The bioeffects (tiredness on waking, migraines, insomnia and stress) depend on the nature of building:

horizontal building (house) or vertical building. We note that the most important bioeffects was observed in third and fourth floors. Moreover, the bioeffects of EMFP could be modulated by the nature of the wall (stone or concrete and bricks). The well-being was observed with walls designed with stones.

Conclusion

In conclusion, our investigation demonstrates clearly that well-being is correlated to distance of building to the relay antennas and time spent at home. In addition, the nature of wall especially stone plays a key note in order to reduce the impact of radiofrequencies on human comfort.

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