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Reporting of subjective symptoms after a specific training intervention on radiofrequency electromagnetic fields exposure in a sample of Italian students using smartphone devices

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Abstract

Several studies investigate effects of problematic smartphone use on non-specific symptoms. These symptoms are not associated to RF-EMF exposure, but can be related to the fatigue caused by the very intense use of the devices. In this study we surveyed a group of university students, grouped according to the reported hours of smartphone use and with respect to a specific training intervention on the recognized biophysical effects of RF-EMF. We tested the reported percentages of ten different symptoms, and their frequency of occurrence in the previous year. Six symptoms were related to different types of sleep problems, then also concentration problems, headache, palpitation and daily tiredness have been investigated. As these symptoms are subjective and related to the different individual perceptions, it was hypothesized that their reporting could be changed when receiving specific information on the effects of RF-EMF exposure from smartphones' use. The results showed that eight out of ten symptoms resulted more frequent in the subgroup of very intense smartphone users in the no-intervention arm compared to very intense users in the post-intervention group, suggesting a possible modification of the subjective reporting after the specific training received by the students.

1. Introduction

Several studies have investigated the possible effects of electro-magnetic fields (EMF) exposure on various non-specific symptoms [1-4]. Recently, a WHO-commissioned systematic review evaluating the evidence arising from observational human studies concluded for a non-association between acute RF-EMF exposure, at levels below the threshold for induction of sensory effects, and symptoms such as headache, sleep disturbances and others [3]. A similar WHO-commissioned systematic review dealing with the results of human experimental studies came to the same conclusions [4]. Nevertheless, RF-EMF exposure may be perceived as hazardous from exposed individuals, such as mobile phone users [1-4]. On the other hand, an intense use of communication devices as smartphones may result in fatigue, concentration problems and lowered sleep quality, as reported in various surveys targeting the problematic smartphone use and the appearance of non-specific symptoms [5].

The objective of the study was to evaluate whether a specific training intervention explaining the biophysical

basis of the RF-EMF effects in human subjects could have an impact on the self-reporting of a group of non-specific subjective symptoms, mainly related to sleep quality, among young mobile phone users.

2. Methods

Through an online survey via Google Forms we evaluated the occurrence of ten different subjective symptoms with respect to the reported hours of mobile phone use in a sample of students from various Courses of the Faculty of Medicine of an Italian University. Six symptoms are related to sleep function, and are the following: Difficulty falling asleep, Awakenings at night, Insomnia, Feeling of unrestful/insufficient sleep, Difficulty waking up and Daytime sleepiness. The other four symptoms are: Palpitations, Tiredness, Headache and Concentration problems. We evaluated their occurrence on a 5-points scale from never/very rarely to (almost)daily, while simultaneously we asked the students to report on their average daily time of smartphone use, in hours per day, during the previous year. We then classified intense users reporting to use the device 5 or more hours/day and very intense users, reporting a utilization of 7 hours or more. We compared these groups with normal users reporting 4 or less hours/day of mobile phone use.

The students have been allocated to two groups, based on a random assignation of their Course to the intervention or non-intervention arm. One group received a specific two hours training intervention on the proved biophysical interaction mechanisms of RF-EMF with biological tissues, with respect to the exposure levels expected during mobile phone use. The students within this group were asked to fill-in the questionnaire two weeks before the intervention and then immediately after the training. The other group of students did not receive the intervention but completed the same survey.

3. Results

Sixty-nine students attending various courses of the Faculty of Medicine participated in the survey and received no intervention. Their mean age is 22.1 (SD=2.2) years old, and they are for the 64% females. Those in the pre-intervention group were 63, with a mean age of 24.5 years old (SD= 2.0) and a percentage of female subjects equal to 60.3%. There were slight differences between the pre-intervention and the post-intervention groups, due to some subjects who were present at the baseline assessment but

were missed at the training and vice-versa. As a whole, in the post-intervention group only 44 subjects were included, with a mean age of 24.3 years old (SD= 2.0) and a percentage of females of the 59.9%.

Considering mobile phone use, intense users were 56.5% in the no intervention group, while 49.2% in the pre-intervention arm and 31.8% in the post-intervention group. Among these subjects, very intense users who reported to use the device 7 or more hours per day were 14.5% in the no intervention arm, while 11.1% in the pre-intervention and the 15.9% in the post intervention groups (Table I). In Table I the prevalence of the symptoms referred to occur on a weekly up to almost daily basis in the previous year is shown. For the no intervention vs. the pre-intervention and the post-intervention arms we compare the prevalence across the three groups of normal users vs. intense and very intense users.

Respondents in the no intervention group are slightly younger and reported a more intense mobile phone use compared to the other groups. Symptoms' frequency ranged from 0% for difficulty falling asleep and insomnia up to 20% for daytime sleepiness and concentration problems among normal users. Excluding palpitations, the reporting of the symptoms was higher on average among intense and very users, ranging from 12.8% for awakenings at night up to 35.9% for difficulty waking up, daytime sleepiness and tiredness, and further increasing to 50% for these three symptoms in the specific subgroup of very intense users (Table I).

When considering the pre-intervention group, symptoms occurrence ranged from 3.1% for palpitations to 25% for tiredness among normal mobile phone users, up to 29% for difficulty waking up among intense users, further increasing to 42.9% for both daytime sleepiness and tiredness in the subgroup of very intense users (Table I).

Finally, for the post-intervention group the frequency of symptoms was low the group of normal users, with 0% for both palpitations and headache and only 3.3% for difficulty falling asleep, awakenings at night and concentrations problems. The prevalence of symptoms increased from 7.1% for palpitations, insomnia and difficulty falling asleep up to 35.7% for tiredness among intense users, with no further increasing observed when restricting the analysis to the subgroup of very intense users (Table I).

When observing the trend of symptoms occurrence with respect to the reported time of mobile phone use, it has been shown that, with the only exception of palpitations, all the symptoms' prevalence increases alongside with the increasing numbers of hours of smartphone use in the no intervention group. In the pre-intervention arm, difficulty falling asleep, insomnia, difficulty waking up and headache are more frequent in the normal users' group compared to the very intense users. After the intervention, all the symptoms, including palpitations, are more frequent within the very intense users' group when compared to normal users, but only in six cases more frequent with respect to intense users.

Table I. Percentage of smartphone users reporting symptoms on a weekly/daily basis in the previous year in the absence of a specific training intervention on EMF effects vs. before and after the intervention, and grouped according to the reported daily hours of smartphone use.

Daily hours of smartphone use	No intervention		
	≤4	≥5	≥7
Difficulty falling asleep	0	20,5	30
Awakenings at night	6,7	12,8	20
Insomnia	0	15,4	20
Feeling of unrestful/insufficient sleep	10	33,3	50
Difficulty waking up	16,7	35,9	40
Daytime sleepiness	20	35,9	50
Palpitations	6,7	0	0
Tiredness	16,7	35,9	50
Headache	3,3	17,9	30
Concentration problems	20	20,5	30
Daily hours of smartphone use	Pre-intervention		
	≤4	≥5	≥7
Difficulty falling asleep	18,8	16,1	14,3
Awakenings at night	12,5	12,9	28,6
Insomnia	9,4	6,5	0
Feeling of unrestful/insufficient sleep	12,5	22,6	14,3
Difficulty waking up	18,8	29	14,3
Daytime sleepiness	18,8	22,6	42,9
Palpitations	3,1	6,5	14,3
Tiredness	25	22,6	42,9
Headache	18,8	6,5	14,3
Concentration problems	15,6	25,8	28,6
Daily hours of smartphone use	Post-intervention		
	≤4	≥5	≥7
Difficulty falling asleep	3,3	7,1	14,3
Awakenings at night	3,3	14,3	28,6
Insomnia	6,7	7,1	14,3
Feeling of unrestful/insufficient sleep	10	21,4	28,6
Difficulty waking up	10	21,4	28,6
Daytime sleepiness	6,7	28,6	14,3
Palpitations	0	7,1	14,3
Tiredness	10	35,7	28,6
Headache	0	21,4	14,3
Concentration problems	3,3	21,4	14,3

4. Discussion

The reporting of non-specific symptoms in the previous year reached quite high percentages among university students with an intense and/or very intense smartphone use (i.e. ≥ 5 hours/day). This is in line with the fact that the problematic use of the devices can have an impact on the attention, as well as on the sleep quality and well-being of smartphones users [5]. Nevertheless, our analysis, in line with recent WHO-commissioned systematic reviews [3, 4], did not support any effects of RF-EMF exposure, as there is no significant increase of the symptoms with the increased reported hours of smartphone use. Moreover, other analysis, not showed here, considered the types of the devices classified according to their SAR levels, the condition of sleeping with a turned-on device placed on the bedside table close to the head and the type of use of the device (i.e. streaming, calling, texting): none of these further sub-analysis suggested any role of RF-EMF exposure.

The hypothesis under study was that students, with a better knowledge on the current absence of any scientific prove supporting the role of RF-EMF exposure in inducing non-specific symptoms, would be less likely to report high percentage of weekly/daily symptoms when comparing very intense vs. intense users. The hypothesis was partially confirmed, as, looking at the group of very intense smartphone users, for 8 out of 10 symptoms the highest percentages of reporting have been found among students who did not receive any intervention. On the other hand, the training seemed not effective in changing the reporting of the symptoms before and after: in four cases the percentages were exactly the same, in three cases the reported percentages were higher in the pre-intervention group, while in other three cases higher in the post-intervention compared to pre-. Another interesting result is that, after the intervention, for four out of ten different symptoms a lower reported percentage has been found within the subgroup of very-intense users vs. intense users. Nevertheless, this proportion was exactly the same in the pre-intervention group, while in the group of those who did not receive any intervention all the symptoms but one (that resulted with the same percentage in the two subgroups) resulted with a higher percentage in the sub-group of very-intense smartphone users compared to intense users.

5. Conclusions

Excessive smartphone use seems associated with an increased self-reporting of various symptoms related to sleep problems, as well as with headache and daily tiredness/fatigue, while not with palpitations. Increased reporting is associated with the problematic long hours daily use of the devices, rather than with proxy indicators of increased RF-EMF exposure levels. Considering the reporting with respect to a specific intervention explaining the mechanisms by which RF-EMF can induce biophysical effects in humans, the percentage of self-reported subjective symptoms resulted higher in very intense

smartphone users who did not receive any training intervention on RF-EMF.

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