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Correlation between Base Transceiver Station and the Quality of Sleep and Life of Nearby Residents

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ABSTRACT

Introduction: Electromagnetic waves that are of higher energy than visible light transmit information between mobile phones and antennas BTS (Base Transceivers Station). The increasing use of mobile phones due to the proliferation of antennas is a matter of concern. The present study aimed to investigate the correlation between distance from the BTS antennas and the quality of sleep and life of nearby residents.

Material and Methods: For the assessment of the quality of sleep, the Pittsburgh Sleep Quality standard questionnaire (PSQI) was used. On the other hand, the 12-item Short -Form Health Survey (SF-12) was used to assess the quality of life. This questionnaire contains two parameters: Mental Health Composite Scores (MCS) and Physical Health Composite Scores (PCS).

Results: The analysis of the data obtained from 810 people indicated that the most sleep disturbance and the minimum average MCS score ($p<0.05$) were detected in the residents who were living within 50-100 meters from the antenna. Moreover, it was found that the average PCS score was lower among those residing within 100-200 meters from the antenna, as compared to other residents.

Conclusion: The present study demonstrates that exposure to electromagnetic waves can affect sleep quality, as well as the mental and physical life qualities of the residents depending on the distance from BTS. Antennas implant must be set in patterns that have the lowest intensity in terms of beam convergences for all residents.

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Introduction

Radiofrequency radiation (RFR) emanating from base transceiver stations (BTS) (the antennas which communicate with the mobile phones) is one of the growing concerns about the possible effects of electromagnetic fields on the general health of people [1].

BTS consists of three parts, namely A, B, and C, each of which covers about 120 and totally 360 horizontal degrees [2]. Each BTS supports approximately 30 Kilometers (Km); nonetheless, their functional range varies in open areas. It is estimated at 20 Km with no building or obstacle nearby, whereas it is measured at 2-5 km in urban spaces with many tall buildings [2].

The exposure to these base stations is regarded as low-powered; however, their output is continuous (24 h/day for many years) [3]. This exposure is more powerful at close quarters, while the field intensities rapidly decline with increasing distance from the base of the antenna [1]. The impacts of acute exposure to electromagnetic fields are divided into two major groups: thermal effects generated by high-intensity exposure and non-thermal effects that deal with the low-intensity electromagnetic waves [4]. Waves used for mobile communications have non-thermal effects [4]. As a result of tremendous cell phone users worldwide, the impacts of electromagnetic waves emitted by BTSs on general health have come into the focus of researchers [5]. Jelder et al. have pointed to the effects of electromagnetic fields on oxidative stress indices [5]. In Poland, Bortkiewicz A et al. found a correlation between subjective symptoms and distance from BTSs in the people living in the vicinity of base stations [3]. They indicated that 57% of their study population reported headaches despite the fact that 36.4% of them were 100-150 meters away from the base stations. In addition, 24.4% of people living more than 150 meters away reported memory problems [3, 6].

In the same vein, in Germany, Blentner et al. reported that residents adjacent to a mobile base station (D <500 m), as well as those who are

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concerned about the risks of radiation emitted from mobile stations, made more health complaints, as compared to other participants [6, 7]. Austrian researchers have suggested that it is impossible to determine a threshold at which no effects occur. Moreover, they indicated that for assessing the effects on health, mobile base station power density must be greater than 0.5-1 mW/m2 to observe [6, 8]. Sorgucu and Develi stated that although the radio frequency level of mobile base stations does not exceed the international limit, the exposure to these low-intensity electromagnetic fields for a long time may pose serious risks to general health [6, 9].

In Iran, there are three mobile operators which are servicing their subscribers using their own BTS. With the overwhelming use of mobile phone telecommunication, BTSs antennas can be extensively observed near houses, hospitals, parks, and shopping centers. Although the waves used for mobile communications have non-thermal effects, long-term exposure sometimes over a lifetime can bring about effects that are cumulative with some thermal effects [4]. With this background in mind, the present study was performed to investigate the correlation between distance from the antennas and psychological effects (the quality of sleep and life) on people living near mobile phone BTS Antenna.

Materials and Methods

Study population

The current study was performed on 810 randomly selected inhabitants, including 411 women and 399 men) living near the mobile phone BTS antenna in Arak.

The participants were assigned to five groups according to their distance from the mobile phone BTS antenna (0-50 meters (m), 50-100 m, 100-200 m, 200-300 m, and > 300m). Furthermore, the duration of residence in the region was considered a physical variable to define the exposure condition of subjects (less than 1 year, 1-2 years, 2-5 years, and more than 5 years). To avoid the variability inherent in the study, the individuals with physical and mental illnesses which led to hospitalization and chronic physical and mental illness were excluded. Moreover, participants who continuously and excessively used mobile phones, phones, computers, and microwaves were ruled out.

Pittsburgh Sleep Quality index and SF-12 questionnaire

The sleep quality was measured using the Pittsburgh sleep quality index (PSQI) which is a self-assessed questionnaire evaluating sleep quality. 19 separate items generate seven component scores, namely sleep latency, subjective sleep quality, sleep duration, sleep disturbances, use of sleep medications, habitual sleep efficiency, and daytime functioning disorders. The final score is the summation of these seven components [10]. According to this questionnaire, there is a minimum and maximum possible score for sleep quality (within 0-39). The higher score of sleep quality signifies poor sleep quality. In other words, score 39 indicates the worst sleep quality, while zero shows the best [11]. On the other hand, the 12-item Short Form Health Survey (SF-12) was used to assess the quality of life. It is a multipurpose, generic 12-item questionnaire developed from the 36-Item Short Form Health Survey questionnaire (SF-36) which is widely used to evaluate health status [6, 7]. The SF-12 yields an eight-scale profile of scores, as well as physical and mental health summary measures: physical functioning (PF): two items, role limitations due to physical functioning (role-physical (RP)): two items, bodily pain (BP): one item), general health (GH): one item, vitality (VT): one item, social functioning (SF): one item, role limitations due to emotional problems (role emotional [RE]): two items, and mental health (MH0: two items)[12]. According to this questionnaire, the minimum and maximum possible scores for each dimension of quality of life and total quality of life fall within 0-100. In other words, score 100 indicates the best and zero signifies the worst quality of life [11].

In the present study, the quality of sleep was investigated using the PSQI standard questionnaire. On the other hand, in order to evaluate the quality of life, the SF-12 questionnaire was used which contain two parameters, namely Mental Health Composite Scores (MCS) and Physical Health Composite Scores (PCS). For both Pittsburgh and SF-12 questionnaires, the obtained data from completed questionnaires were converted to 0-39 and 0-100 metric, respectively, and compared between different groups of subjects, according to their distance from the BTS antennae and the length of time living in the vicinity of BTS.

Statistical analysis

Data were analyzed in IBM SPSS Statistics for Windows package (version 16) using Student's t-test and one-way ANOVA to evaluate the differences of sleep qualities among different groups of subjects. Furthermore, to analyze PCS and MCS scores in different groups, one-way ANOVA was performed. Statistical significance was defined at a p-value of <0.05 and the data were expressed as mean±SD.

Results

Out of 810 participants, 411(50.7%) were women and 399 (49.2) were men. The mean scores of PSQI for women and men were obtained at 7.37±3.54 and 6.5±3.20, respectively. No statistically significant difference was found between women and men in seven components of PSQI ($p \geq 0.05$).

Figure 1 depicts the mean scores of different components of PSQI (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction). The t-test revealed no statistically significant differences between women and men in terms of PSQI mean, according to the distance from the BTS antennae. The subjects who were living at the

distance of 50-100 meters from BTSs demonstrated a significant increase in PSQI score (7.80±3.58; P<0.05). Based on the analysis of the SF-12 questionnaire, the average PCS score was lower among those who were living at 50-100 meters from the antennas (44.48±9.04). Moreover, the average MCS score was reported to be lower in subjects residing at the distance of 100-200 meters (42.04±9.13; Table 1).

Inhabitants who were living near the BTS antennae for 1-2 years had a high score of PSQI (7.41±3.88) and a lower score of MCS (42.68±7.56) among other groups. In addition, the average PCS score was lower in subjects living near BTSs for less than 1 year (45.28±8.01; Table 2).

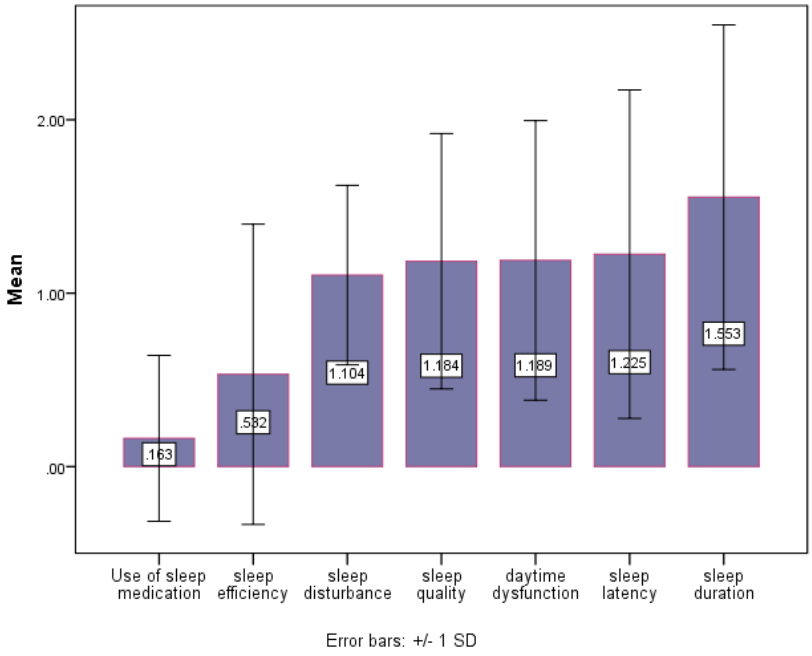

Figure 1. The mean scores of seven components of Pittsburgh sleep quality index (PSQI)

Table 1. Means of Pittsburgh sleep quality index, Mental Health Composite Scores, and Physical Health Composite Scores according to the distance from mobile phone BTS antennae

	Distances from BTS antennae (meter)					
	0-50	50-100	100-200	200-300	>300	P-value *
Total frequency	1621	64	163	143	177	
Pittsburgh sleep quality index (mean±SD)	6.69±3.26	7.80±3.58	7.53±3.30	6.91±3.38	6.87±3.49	P=0.012 F=3.23
Physical Health Composite Scores (mean±SD)	48.32±8.86	44.48±9.04	44.83±8.93	47.06±9.21	49.42±8.86	P=0.000 F=9.46
Mental Health Composite Scores (mean±SD)	46.85±8.23	42.98±9.20	42.04±9.13	45.37±9.13	46.06±8.9	P=0.000 F=8.45

* One-way ANOVA indicating differences between groups

Table 2. Means of Pittsburgh sleep quality index, Mental Health Composite Scores, and Physical Health Composite Scores according to a period of time of living near the mobile phone BTS antennae

Pittsburgh sleep quality index (mean±SD)	Period of time of living near the BTS antennae (year)			
	<1 year	1-2 years	2-5 years	>5 years
	7.21±3.21	7.41±3.88	7.19±3.32	7.23±3.48
Physical Health Composite Scores (mean±SD)	44.72±7.42	45.28±8.01	44.83±8.21	45.33±7.43
Mental Health Composite Scores (mean±SD)	43.28±7.02	42.68±7.56	42.33±8.11	42.83±7.98

Discussion

In recent years, the effects of electromagnetic fields emitted by the mobile stations, laptops, and magnetic resonance imaging (MRI) machines on animals and the general health of people have come into the focus of the researchers. The studies reported that the exposure of humans to high-frequency magnetic fields by mobile stations is two to four times lower than the current valid values [6]. The present study investigated the quality of sleep and life of people who are living near mobile phone BTS antennas. According to the PSQI means, most of sleep disorders were observed in people who were living at 50-100 meters from BTS antennas, while the least disorders were detected in those residing at less than 50 meters distance. Regarding sleep quality, the results indicated that residing within the distance of about 50-200 meters from the BTS antennas can affect sleep quality, as compared to living at less or more than this distance. Moreover, the results of the present study illustrated that the effect of distance of less than 50 m is approximately equal to that of detected in more than 300 m. According to the direction of radiation and spatial coverage of radiation, the highest intensity of waves is at intervals between 50 to 300 m. Nevertheless, the psychological and physiological effects may not obey the inverse square law that exists in radiation physics.

Some studies have demonstrated that the maximum intensity of BTS radiation occurs at 100-200 m distances from the antenna base, according to the direction and the radiation sector [13]. In the present research, the minimum value of the PCS score was related to those residing within this distance.

In addition, the obtained results showed that the length of time living near BTS exerted no effect on sleep quality. SF-12 questionnaire was used for the measurement of quality of life. The residents at the distance of 50-100 m had a minimum average of mental health. Moreover, people who were residing at the distance of 100-200 m had a minimum physical health average. Consistent with the results of a study conducted by H-P Hutter et al., the findings of the current study were indicative of the effects of these waves on such consequences as headache, level of consciousness, as well as factors associated with quality of life [14]. However, the present study did not provide any evidence for the impacts of the antenna on the physical components of quality of life []. In the same vein, Donker et al. stated that the short-term EMF emitted by mobile phone base stations has not any physiological effect on sleep quality[15]; nonetheless, these findings need to be confirmed in further studies.

The present findings in terms of effective factors on quality of life and sleep are in line with symptoms reported by Santini et al. The terms of effective factors on quality of life are including nausea, loss of appetite and visual disturbances for residents at the distance of 10-100 meters away and sleep disturbances for people residing with in the distance of 100-200 meters [16].

Shahabi et al. also reported that the residents in more than 300m from BTS had better health conditions, as compared to those living within less distances. Moreover, they found higher risks of headache and nausea among women residing at a distance of <300, as well as a decrease in libido among men who lived there [17]. In another study, the headache was detected in 57% of residents 36% of whom were living within a distance of 100-150 m [3].

In the present study, the maximum physical factor score of life quality was reported for people who were living in the region for more than 5 years, whereas the minimum score was reported for those who lived there less than 1 year. These findings need to be confirmed in further studies. The electromagnetic waves at the frequency range provided by the BTS antennas are non-ionizing waves. They can cause some biological effects through non-thermal pathways. These effects are more profound, as compared to the direct effects of these waves on clinical symptoms (including physical and mental symptoms). These symptoms reveal a psychological and sometimes non-scientific concern that generates a negative perception of the technology at the community level [7]. In compliance with a study carried out by Sabine et Al., such parameters as those presented in the present study, may not occur due to short-time radiation. Moreover, such effects as sleep disorders, neurological symptoms, nausea, fatigue, and quality of life-related parameters, may not be considered the early effects of exposure to electromagnetic beams of GSM or other modulation of telecommunication signals. Therefore, the occurrence of sleep disorders or psychological stress which was regarded as PCS in the present study is the long-term adverse consequence of residing in the vicinity of BTS [18]. Sorgucu and develi also reported the possibility of serious health problems in people who were exposed to very low levels of electromagnetic fields for very long periods of time [6].

Conclusion

In conclusion, the results of the present study indicated that exposure to electromagnetic waves caused by BTS antennas in terms of distance could affect the quality of sleep and life of individuals in both psychological and physical components. Therefore, it seems that convergence of the waves should be considered to the extent practicable in the setup of these antennas, and the waves should have the least possible intensity.

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