

## Neurobehavioral effects among inhabitants around mobile phone base stations

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### Abstract

**Background:** There is a general concern on the possible hazardous health effects of exposure to radiofrequency electromagnetic radiations (RFR) emitted from mobile phone base station antennas on the human nervous system.

**Aim:** To identify the possible neurobehavioral deficits among inhabitants living nearby mobile phone base stations.

**Methods:** A cross-sectional study was conducted on (85) inhabitants living nearby the first mobile phone station antenna in Menoufiya governorate, Egypt, 37 are living in a building under the station antenna while 48 opposite the station. A control group (80) participants were matched with the exposed for age, sex, occupation and educational level. All participants completed a structured questionnaire containing: personal, educational and medical histories; general and neurological examinations; neurobehavioral test battery (NBTB) [involving tests for visuomotor speed, problem solving, attention and memory]; in addition to Eysenck personality questionnaire (EPQ).

**Results:** The prevalence of neuropsychiatric complaints as headache (23.5%), memory changes (28.2%), dizziness (18.8%), tremors (9.4%), depressive symptoms (21.7%), and sleep disturbance (23.5%) were significantly higher among exposed inhabitants than controls: (10%), (5%), (5%), (0%), (8.8%) and (10%), respectively ( $P < 0.05$ ). The NBTB indicated that the exposed inhabitants exhibited a significantly lower performance than controls in one of the tests of attention and short-term auditory memory [Paced Auditory Serial Addition Test (PASAT)]. Also, the inhabitants opposite the station exhibited a lower performance in the problem solving test (block design) than those under the station. All inhabitants exhibited a better performance in the two tests of visuomotor speed (Digit symbol and Trailmaking B) and one test of attention (Trailmaking A) than controls. The last available measures of RFR emitted from the first mobile phone base station antennas in Menoufiya governorate were less than the allowable standard level.

**Conclusions and recommendations:** Inhabitants living nearby mobile phone base stations are at risk for developing neuropsychiatric problems and some changes in the performance of neurobehavioral functions either by facilitation or inhibition. So, revision of standard guidelines for public exposure to RFR from mobile phone base station antennas and using of NBTB for regular assessment and early detection of biological effects among inhabitants around the stations are recommended.

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**Keywords:** Neurobehavioral effects; Mobile phone base stations; Radiofrequency radiations (RFR)

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### 1. Introduction

There is a general concern about the possible hazardous health effects of exposure to radiofrequency radiations (RFR) emitted from mobile phone base station antennas. Disturbance of the nervous system leads to behavioral changes and may serve as an early indicator of disturbances in regulatory functions of many

systems (Lai and Singh, 1994). Exposure of the neural tissue to RFR can cause electrophysiological changes in the nervous system (Navakatikian and Tomashevskaya, 1994; Velizarov et al., 1999). Some studies have suggested that RFR induce tissue heating leads to tissue damage (Gajsek et al., 2002; Preece et al., 1999). Some effects are observed among mobile phone users at low intensity and after repeated exposure (Hyland, 2000). The efflux of calcium ions from brain tissue is an important neurochemical effect of RFR as calcium ion plays an important role in the functions of the nervous system such as the release of neurotransmitters (Dutta et al., 1989). Experimental studies on

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rats indicated that both cholinergic and endogenous opioid transmitter systems inside the central nervous system are involved in the RFR-induced spatial working memory deficit (Lai et al., 1990, 1994). Moreover, RFR activate endogenous opioids in the brain, which in turn cause a decrease in cholinergic activity leading to short-term memory deficit. The stress hormone “corticotropin releasing factor” is also involved (Lai et al., 1994).

The emissions of a mobile phone base station are usually described by its effective radiated power which is given in Watts (W) (Nousir, 2002). The intensity of RFR is called the power density and is measured in ( $\text{mW}/\text{cm}^2$ ). However, the specific absorption rate (SAR) that is measured in ( $\text{W}/\text{kg}$ ) of tissue is a more reliable determinant and index for RFR biological effects than power densities as SARs reflect what is actually being absorbed rather than the energy quotient in space (Lai, 2000).

There are national and international safety guidelines for public exposure to RFR produced by mobile phone base stations. The Egyptian standard follows the ANSI/IEEE (1992), the permissible level of radiation power density is less than  $0.4 \text{ mW}/\text{cm}^2$  (Egyptian Protocol of Criteria for Construction of Mobile Phone Base Stations, 2000).

Increased concern by the public about the safety and potential health effects at the appearance of a multitude of cellular transmitter antennas on the buildings and fear of unknown make it necessary to provide an answer to the question about safety of mobile phone base stations. So this study aimed to identify the possible neurobehavioral deficits among inhabitants living nearby the first mobile base station in Menoufiya governorate. To the best of our knowledge, no similar studies were carried out in Egypt till now, but other studies all over the world were performed mainly about safety of cellular phone use.

## 2. Subjects and methods

This cross-sectional study was conducted during the period from March to December 2003, included inhabitants living in and opposite to the building where the first mobile phone base station was constructed in Shebin El-Kom City (Menoufiya governorate) in 1998 (Fig. 1). The base station consists of three antennas and a shelter which contains an electric power station and the cables for the base station antennas (Fig. 2).

Eighty-five exposed individuals completed the study. Thirty-seven were current inhabitants living under the mobile phone base station antennas, while the other forty-eight were employees and agriculture engineers working in agricultural directorate building approximately 10 m opposite to the station. A control group constituted of 80 employees and engineers of a Shebin El-Kom agricultural administration building located approximately 2 km from the designated mobile phone base station was chosen and completed the study. They were matched for age, sex, occupation (employees and agriculture engineers), education level and mobile phone use. Consent forms were signed by all participants as they were volunteers, they were asked to do their best during testing. Approval and support from the ethical committee at Menoufiya Faculty of Medicine were obtained. None of the participants was informed



Fig. 1. The mobile phone base station antennas upon the building for agricultural professions.

about the purpose of the study so as to exclude any malingering effects. They were informed about the purpose of the study at the end. The average exposure time for RFR was 8 h for employees in the building underneath the antenna and 15 h for inhabitants of the building opposite the antenna. None of the controls lived near an antenna. The exclusion criteria were based on personal and medical histories including those having epilepsy, psychiatric disorders or specific cause of headache. The tools used to collect data were:

- (A) Questionnaire: included data about personal, occupational and medical histories and neuropsychiatric complaints such as headache, irritability, memory changes, tremors, dizziness, blurred vision, and depressive symptoms (sensation of sadness) (Abdel Gawad, 1972). The questionnaire clearly

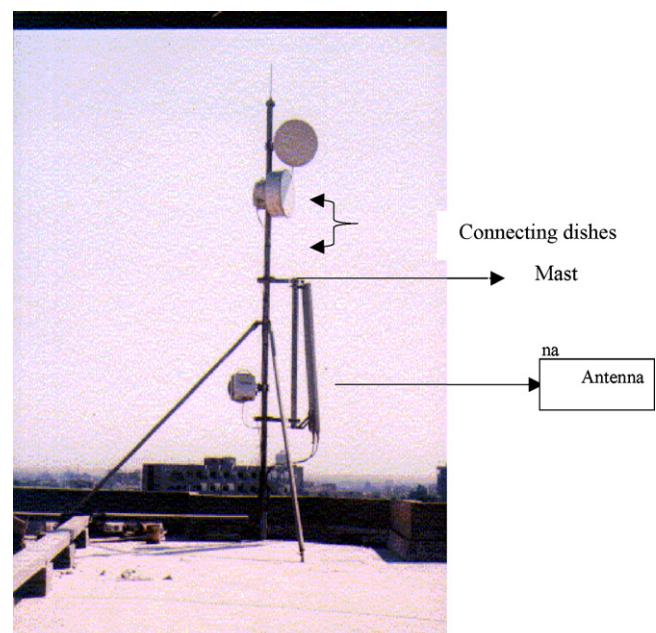


Fig. 2. The antenna of a mobile phone base station upon the building.

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