Effect of Mobile Phone Radiofrequency on Cognitive Abilities between Adolescent Users and Nonusers

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Abstract

Mobile phone use is increased worldwide, most of mobile phone users are from the young age, our study is carried out to explore negative effects of mobile phone radiofrequency (MPRF) on cognitive abilities of the children. The study is a (case-control) study on 30 children as users (cases) 12-18 years old, and 30 age matched nonusers (controls). We used Stanford Binet intelligence scale for assessment of cognitive abilities. The users were found to be negatively affected in comparison to nonusers in items of shared cognitive abilities; Visual motor ability, abstract Conceptualization, understanding long question, high performance under time pressure, acquired knowledge**.** The shared cognitive abilities predict learning disabilities and ADHD in teens that are frequently using mobile phones for calling.

Keywords: *Shared cognitive abilities, adolescents, MFRF, Stanford Binet intelligence scale.*

Introduction

There are 5.11 billion unique mobile users in the world today, up 100 million (2 percent) in the past year[(1)] and youth represent a large sector of this quantity[(2)]. This worldwide use of radiofrequency (RF) generating devices raised the concerns about possible hazardous health effects from exposure to RF radiation. Given the fact that children and adolescents are still in the developmental process, there is concern over the question of whether children are more sensitive to electromagnetic fields (EMF) than adults[(3)]. Neurological functions are of special concern as the brain is heavily exposed while calling with a mobile or cordless phone[(4)]. Present-day adolescents will likely have higher cumulative life time exposure to RF-EMF, and the developing brain might be particularly susceptible to RF-EMF–induced alterationsupto 15y of age[(5)]. Scientists from around the world agree that the head and brain of a child absorb significantly more radiation than those of an adult[(6)]. In the present study we aimed to explore whether the exposure to mobile phone radiofrequency is associated with changes in shared cognitive abilities in adolescents which would predict learning disabilities and ADHD with mobile phone (MP) use if present.

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Subjects and Method

This pilot (case-control) study was conducted inpediatrics outpatient clinic at Minia university hospital, Egypt, during the period from June 2016 to July 2017 on 60 children of different socioeconomic status, 30 users (cases) aged from 12–18 years and 30 age matched nonusers (controls). Written informed consent was taken from parents of all enrolled children after clarifying the aim and all steps of the study to them. Children with psychiatric disorders or suffering from any chronic illness or receiving any medicine known to affect cognitive function were excluded from the study. Detailed history taking, with fulfillment of the questionnaire about RF-EMF exposure and pattern of

mobile phone use were taken. The participating children were subjected to the Stanford Binet 5th edition (SB5) intelligence scale.(7)

Results

Concerning the demographic data between mobile phone nonusers and users, there is no significant difference regarding age, gender, urbanity and type of education between them. Prevalence of children using MP in urban areas (93.3%) is higher than nonusers (83.3%). Regarding type of education it was noticed more prevalence of MP users in private schools (20%) rather than nonusers (10%).

Regarding to the exposure to radiofrequency and effects on cognitive function: we noticed that the teens used their mobile phone forabout 5 calls per day with mean duration about 5.3 min per call,31 calls per week and with 3 years duration of ownership and use. Regarding laterality the results showed that 100% of the children in this age group were using the same side of the head during active call operation. In comparing users and non-users, significant differences were observed in the items of shared cognitive abilities with lower values in the users including;Visual motor ability p=0.005, Abstract Conceptualization p=0.012, Understanding Long Question p=0.015, Performance Under Time Pressure p=0.040, High Performance Under Time Pressure p=0.039, Cultural Knowledge p=0.019, Acquired Knowledge p=0.011. On applying binary logistic regression analysis to detect which previous effect is related to the exposure, we found;.Visual motor ability OR=1.06, 95% CI=1.01-1.1, p=0.01, Abstract Conceptualization OR=1.05, 95% CI=1.01-1.09, p=0.02, Understanding Long Question OR=1.05, 95% CI=1.01-1.1 p=0.02, High Performance Under Time Pressure OR=1.05, 95% CI=1.01-1.1 p=0.04, Acquired Knowledge OR=1.04, 95% CI=1.004-1.08, p=0.03 were significantly affected by the MP use.

Table (1) Demographic and clinical data of the studied children:

Variables		Controls	Cases	P value
		N=30	N=30	
Age	Mean ±SD Range	13.9±1.3 (12-17.9)	14.7±2 (12-17.9)	0.09
Sex	Male Female	15(50%) 15(50%)	14(46.7%) 16(53.3%)	0.796
Residence	Urban Rural	25(83.3%) 5(16.7%)	28(93.3%) 2(6.7%)	0.424
School	Governmental Private	27(90%) 3(10%)	24(80%) 6(20%)	0.472

*: Significant difference at P value < 0.05

Table (2) Descriptive data of the pattern of mobile phone use among cases:

Age Group (12-18 years)		Cases
		N=30
Number of call/day	Mean ±SD (Range)	±2.7 (5-15)5.067
Number of call/week	Mean ±SD (Range)	31±17.4 (10-100)
Duration of call by minutes/day	Mean ±SD (Range)	5.3±4.3 (1-15)
Duration of use/years	Mean ±SD (Range)	3±1.2 (1.5-5)
Laterality	RT LT Both	97% 3% 0%

Table (3) Comparison between mobile phone nonusers (controls) and users (cases) adolescents as regard shared cognitive abilities:

Vaiables	Controls	Cases	P value
	N=30	N=30	
Planning ability	107.4/(97.7-120.6)	98.7/(90.9-112.8)	0.053
Problem solving	102.9/(94.4-111.5)	98.7/(88.7-105.8)	0.168
Visual motor ability	104.1/(98.1-110.1)	97.1/(88-104.6)	0.005*
Abstract Conceptualization	110.2/(98.2-121)	99.9/(91-110.6)	0.012*
Understanding Long Question	102.4/(94.9-113.1)	94.9/(85.6-104.2)	0.015*
Attention Concentration	106.4/(99.8-116.2)	100.2/(95.5-111.1)	0.116
Performance Under Time Pressure	105.4/(100.3-113.1)	102.4/(93.6-110.6)	0.040*
High Performance Under Time Pressure	106.3/(100.5-113.1)	100/(92.8-110)	0.039*
Cultural Knowledge	101.2/(92.9-110.7)	91/(84.7-107.4)	0.019*
Acquired Knowledge	104.5/(94.5-114.9)	91.2/(84.2-106)	0.011*

Data expressed by median/IQR

- Mann Whitney test for non-parametric quantitative data between the two groups

*: Significant difference at P value < 0.05

Table (4) Binary logistic regression analysis for prediction of shared cognitive abilities between mobile user (cases) and nonusers (controls) adolescents:

	OR	95% CI	P value
Planning ability	1.03	0.9-1.07	0.07
Problem solving	1.3	0.9-1.08	0.1
Visual motor ability	1.06	1.01-1.1	0.01*
Abstract Conceptualization	1.05	1.01-1.09	0.02*
Understanding Long Question	1.05	1.01-1.1	0.02*
Attention Concentration	1.03	0.9-1.08	0.1
Performance Under Time Pressure	1.05	1-1.1	0.05
High Performance Under Time Pressure	1.05	1.01-1.1	0.04*
Cultural Knowledge	1.02	0.9-1.06	0.1
Acquired Knowledge	1.04	1.004-1.08	0.03*

OR: Odds Ratio

- CI: Confidence Interval
- *: Significant level at P value < 0.05

Discussion

This is a pilot case-control study to demonstrate the effects of mobile phone radiofrequency (MPRF) on shared cognitive abilities of adolescent users. Shared cognitive abilities obtained from Stanford Bienet scale 5th edition mostly used as a predictor for learning disabilities and ADHD. Our study found that, MPRF exposure has negative effects on Visual motor ability, abstract conceptualization, understanding long question, high performance under time pressure, acquired knowledge. Leung et al., (2011) provided support for an effect of 2G and 3G exposure on human cognitive function, especially in adolescents [8].Thomas (2010)in their study found 7% of children and 5% of adolescents using mobile phones showed behavioral problems the

higher the exposure the higher the risk of problems[9]. A Spanish study carried on adolescent boys found a significant association between higher background radiofrequency exposures in the home and anxious/ depressed behaviors, social problems, rule breaking, aggressive behavior, internalizing, total behavioral problems, anxiety and conduct problems, obsessive compulsive disorder and ADHD[10]. Children living near a radio transmitter were found to have reduced memory and attention as well as slower reaction times[11]. On explaining how MPRF could affect cognition, researchers found that mobile phone, Wi-Fi and other radiofrequency signals alter electrical brain activity[12]. The radiofrequency microwave radiation thus has the potential to be far more disruptive to the biological processes going on in the child's growing and developing brain and nervous system. Motawi et al., (2014)found that mobile phone radiation affected the relative brain weight of young rats and histopathological examination reinforced the neuronal damage [13]. Dark neuron degenerative changes were found in the brains of rats exposed pre- and postnatally to 900 MHz radiation[14]. Compromised learning behavior was also determined in the EMF group rats studied by Şahin et al (2013), their results show that the application of a 900 MHz EMF in the prenatal period adversely affected female pups' learning behavior and also resulted in histopathological changes appearing in the hippocampus. Pyramidal neuron loss and histopathological changes in the cornu ammonis of 8-week-old male rats may be due to the 900-MHz EMF exposure [15].

Conclusion

This study found negative effects of MPRF on shared cognitive abilities which predict presence of learning disabilities and ADHD in teens with frequent mobile phone use.

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Ethical Clearance: Taken from faculty of medicine–Minia University Committee.

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