

Burgeoning Rise In Smartphone Usage among School Children In Saudi Arabia: Baseline Assessment of Recognition and Attention Skills Among Users and Non-Users Using CANTAB Tests

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Background: The use of smart phones and other internet based smart devices by children is on the rise. The aim of the present study was to determine the prevalence and pattern of smart device use and to conduct the baseline assessment of speed, memory and accuracy skills of the users.

Method: A cross sectional study was done on 177 school children aged between 12 to 16 years studying in the intermediate schools of Riyadh city. The survey tool was interviewer administered and cognitive function assessment was done by CANTAB battery testing.

Results: The most common smart device used by children was smartphone (85%). Boys showed a higher prevalence of usage of smartphone compared to girls (93% vs 74%; $p < 0.001$). Smartphone showed highest duration of mean usage of 28.5 ± 27 h per week, followed by tablets 7.5 ± 15 h per week and laptop 3 ± 7.4 h per week. All three gadgets together were used by 44% of the children with 35 median hours of usage per week. The most common activity performed was social networking (72%). CANTAB results showed that the speed, memory and accuracy (recognition) skills of the group-II (heavy users) were better than the group-I and the non users though not significant. Thus the use of smart devices among young children has become rampant.

Conclusion: There are signs of children developing internet dependency and addiction towards smartphone use. Follow up studies are recommended to determine the cognition skills of long term users.

Keywords: Smartphone use, internet addiction, memory, speed skills, schoolchildren, saudi arabia

Introduction

The use of wireless internet devices has become ubiquitous in the present world making man an inadvertent slave of 'digital machines' (1). With the advent of 21st century, technology has produced an incredible boom of internet devices like smartphone, laptops, notebooks and tablets (2). Affordability and

unlimited accessibility of internet has led to widespread use of these devices intended for calling, playing games, chats and social media, browsing contents and downloading apps leading to complete reliance on these devices (3). A report from Of-com, Communication Market, United Kingdom stated that 46% of mobile users in 2011 were smartphone users

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which escalated to 71% in 2015, while internet usage both fixed and mobile corresponded to 131 per 100 population (4,5). Interestingly Saudi Arabia ranks third in global ranking, with 72.8% in smartphone penetration rate indicating a high potential market growth (6). The Kingdom of Saudi Arabia showed alarming statistics of mobile communication market where the use increased from 12% in 2001 to 153% in third quarter of 2016 (7).

Smartphones which use advanced version of operating systems is the easiest device to use and its usage has witnessed remarkable increase over the couple of years (8,9). Addiction or irrational use of smartphones and other devices is being documented and is a matter of growing concern (10). Research has established significant association between constant smartphone use with obesity, psychological trait, compulsive behavior, anxiety, stress and depression (11-14). Studies have also reportedly linked its usage with headaches, vision related temporary disturbances, musculoskeletal disorders (15-17).

Use of these devices is increasing among children and adolescents. An exhaustive report published by Global System for Mobile communication (GSM) shows many interesting and shocking facts on mobile usage among children from five countries - Japan, India, Indonesia, Egypt and Chile. These studies have reported the age of initiation of mobile phone use to be around 7-8 years and 95% of the children by the age of 18 years become constant users. 18The modern world is facing yet another new epidemic of addiction to smart devices leading to minimized outdoor activities resulting in isolation and internet dependence (19). This raises the issue of how does it affect the cognitive behavior of children in terms of speed,

accuracy and memory. Much of the literature with empirical evidence suggests about physical or psychosocial effects but literature on cognitive effects is relatively sparse and nevertheless it is exceptionally scarce in the region of Saudi Arabia. Results from multiple studies have been inconsistent where some suggest that constant use may affect cognition in adults while others found no effect (20, 21). Studies investigating cognitive functions in children are rare hence, in addition to investigating the prevalence and pattern of smart device use, the current study also aimed to find the baseline assessment of attention and recognition skills of users.

Material and Method

A cross sectional study was conducted across the private and governmental schools of Riyadh region during the period April to December 2015. Children and adolescents in the age group of 12 to 16 years were taken as study subjects. Ethical clearance was obtained from Institutional Ethical Review Board and permission to conduct the study in the schools was obtained from the Ministry of Education.

The sample size was calculated as 159 based on prevalence of 90% mobile phone usage among children and adolescents (22). Assuming 10% drop out rate, it was further increased to 175 subjects. Multistage cluster random sampling was done to select the schools from five zones of Riyadh (East, West, North, Central and South) and subjects were enrolled from the selected school using random sampling process by random number generator software (23) after obtaining students list from schools. Data were collected with help of well-trained male and female medical students.

A well-structured precoded questionnaire was used for collecting data on demographic con-

tents, details of smartphone and other electronic devices usage, and knowledge about perceived health hazards of smartphone use. Neuropsychological testing was performed by computerized cognitive test battery using CANTAB research suite software (version 6.0.37, Cambridge cognition). CANTAB research software is a highly sensitive and advanced tool for measuring cognitive functions which uses wide range of tests to assess brain functions (24). Memory test and attention test refer to cognition testing skills and hence were adopted in the current study. Attention is the ability of child to remain focused. It can be defined with psychological perspective as; "the element of cognitive functioning in which mental focus is maintained on specific issue, object or activity". (Mosby's Dictionary) Memory can be defined as; "the mental faculty that enables one to retain and recall previously experienced sensations, impressions and ideas" (Medical Dictionary).

The first task was Pattern Recognition Memory (PRM), which assessed the visual pattern recognition memory where the participant is made to choose between the patterns they have already seen amidst newer patterns. The outcome of the pattern recognition memory test was percentage of correct trials and latency of speed of the participant's responses. Mean latency, which gives the measure of aggregate of response time for right answers was computed as the average of the mean correct latency, mean correct latency congruent, mean correct latency incongruent, mean correct latency blocks35 non-switching blocks and mean correct latency block7 switching block. The second task was Attention Switching Task (AST). The tasks included responding quickly to a series of visual patterns on the computer screen by measuring the latency, correct and incorrect

responses, commission errors, omission errors, switch cost and congruency cost (24). The entire battery took 13–18 minutes to complete the tests. All the tests were conducted after a practice session by the children. More detailed information on the battery test can be obtained from CANTAB website; <http://www.cambridgecognition.com/cantab/cognitive-tests>. Descriptive and inferential statistics were computed using SPSS ver 21 mean and standard deviation was derived for all the outcome variables stated in the memory recognition and attention deficit tasks. The total number of hours of usage of the three devices – smartphone, laptop and tablet was computed for one week and its median was considered. Further analysis was done for two groups categorized on the basis of median of total hours of the smart gadgets use.

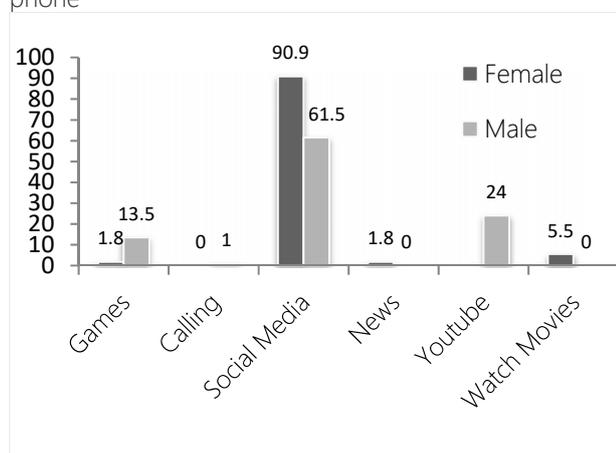
The difference in means of the outcome variables was tested by one-way ANOVA to compare the cognitive functions between smartphone users, non-users. Chi square test was used to test the association between categorical variables. *P* value of <0.05 was set for the statistical significance.

Results

The Cambridge Neuropsychological Test Automated Battery (CANTAB battery test) was completed by 177 students (103 boys and 74 girls). The prevalence of smartphone use among the study sample was 85.3%. The prevalence was higher among boys (93%) than girls (74%). The mean age of the students was 14 years. Smartphone was the most common gadget in use followed by tablets and laptops. Children used smartphone for average of 4.5 ± 4.4 hours daily while tablets were used for 1.4 ± 2.4 hours and laptops for 1 ± 1.6 hours.

On assessing the length of ownership of the smartphone, the study showed that 62% of the smartphone users were using the smartphone for more than two years. Figure 1 shows gender wise depiction of various activities performed on the smartphone. The most common type of activity performed on the smartphone was communication by social media and interestingly, use of smartphone for calling was found to be near zero among children.

Figure-1. Listed below in the figure is gender wise depiction of activities performed by children on smart phone



*Data is reported in percentage.

The perception of children on health effects due to constant smartphone use was assessed. It was interesting to note that 70% of the students were aware that smartphone usage for more than 2 hours per day may cause health problems. Table-1 demonstrates the perceived health effects of smartphone use between the two groups categorized based on median hours of usage per week. Among the reported disorders, vision disturbance, headache and sleep disturbance were more among the group-II (smartphone users >28 hours/week) on comparison with the group-I (smartphone users ≤28 hours/week) but not reaching to the level of statistical significance.

Table 1: Perception of health effects on constant smart phone usage and details of health of children using phone

Health effects	Smartphone users ≤28 hours/week (n=80)	Smartphone users >28 Hours/week (n=71)	P
>2 hrs/ day usage may cause ill effect on health (YES)	55 (68.8)	50 (70.4)	.861
Health effect on study subjects: No health effect	45 (56.3)	52 (73.2)	.041
• Memory	6 (7.5)	9 (12.7)	.415
• Vision	30 (37.5)	30 (42.3)	.618
• Sleep	16 (20)	20 (28.2)	.257
• Concentration	11 (13.8)	15(21.1)	.282
• Headache	21 (26.3)	21 (29.6)	.717

* From the total sample of 177 subjects, 26 were non smartphone users and excluded from above analysis. Classification done on basis of 50th percentile (median) of number of hours of smartphone usage centered on 28 hours per week of usage.

Table 2: Attitude of children towards smartphone use

Attitude	Male (103)	Female (74)
Cannot live without smartphone	27(26.2)	21(28.4)
Can live without a smartphone	49(47.6)	27(36.5)
Check Soon After Waking Up		
Always	33(32)	21(28.4)
Sometimes	40(39)	26(35)
Never	23(22.3)	8(10.8)
Check Before Sleeping		
Always	57(55.3)	33(44.6)
Sometimes	27(26.2)	16(21.6)
Never	12 (11.7)	6(8.1)
Check After School		
Always	58(56.3)	36(48.6)
Sometimes	21(20.4)	15(20.3)
Never	17(16.5)	4(5.4)

Attitude and addictive behavior towards smartphone use showed similar results between boys and girls. About 28% girls and 26% boys showed tendency towards smartphone addic-

tion as they reported to have said that they can not live without it while 15% girls and 28% boys said they have to check it all the time. The attitude of children displayed a growing favoritism for smartphone as the results showed that most of the children reported to have been always checking the phone after school hours.

Table-3. Cognitive function (speed, memory and accuracy skills) among non-smartphone users, smartphone users for ≤ 28 Hours/day and phone users for >28 Hours/day.

Cognitive tasks	Non-users	Group-I	Group-II	P value
	(n=26)	<28 Hours /week (n=80)	>28 Hours /week (n=71)	
PRM % Correct	81.5 (11)	79.4 (13.6)	82.4 (11.5)	0.161
AST % Correct	87.2 (10.2)	85.2 (10.3)	85.7 (11.5)	0.78
Switching Cost Mean Correct	213 (116.4)	200.3 (151.7)	204.1 (163.9)	0.88
Mean Latency Millisec	913.1 (225.3)	858.5 (171.8)	823 (186.8)	0.22
Mean Correct Latency	910.2 (223.9)	859.3 (167)	825.1 (187.6)	0.23
Mean Correct Latency Congruent	882.5 (222.5)	831.4 (163.5)	799.3 (192.6)	0.27
Mean Correct Latency Incongruent	944.3 (233)	879.8 (205.6)	847.6 (217.4)	0.35
Mean Correct Latency Blocks35 Non-Switching Blocks	813.2 (195.8)	762.7 (174.2)	732.3 (209.1)	0.33
Mean Correct Latency Block7 Switching Block	1015.3 (268.4)	959.5 (199.6)	911 (224.9)	0.162

All values are in Mean(SD). Significance testing was done by Analysis of variance. $P < 0.05$ shows significance.

Male children showed a greater predilection towards constant use than the female children. Table-2 presents details of attitude of children towards frequency of checking of smartphone.

Furthermore, the attention and recognition skills were assessed by the CANTAB tests and compared among the users and the non users. The smartphone users were further categorized into group I and II based on median time of total hours of smartphone usage per week obtained as 28 hours as shown in Table-3. The PRM tests for memory and AST tests for speed and accuracy were higher in the non users and among the group-I compared to the group-II although not reaching to the level of statistical significance.

Discussion

Owing to scarcity of data from the Saudi Arabian region, the present study has attempted to provide useful information on the new and burgeoning crisis of smart devices usage among children and adolescents. To present the results in a concise manner, the main findings of the study suggest that there is an increase in smartphone use among children and adolescents in Saudi Arabia, with boys showing significantly higher usage than girls. The major activity performed was interaction through social media and internet browsing and with regard to cognitive skills, the study found the heavy users to be faster and quicker in recognition and attention performance tasks.

Epidemiological studies have been on-going to investigate the effect of the radio waves on developing brain tissues, cognition skills, sleep, and its effects on heart and body weight (25, 26). Research studies are unable to establish consistent evidence on the harmful role of radiofrequency waves from mobile phones during voice calling on the cognitive behavior of the children (27, 28). Since World Health Organization has been constantly encouraging and promoting research in this field with a spe-

cial focus on children, our rationale was to determine the smartphone use among school children and to assess the speed, memory and accuracy skills of smartphone users and non users. The present study found that measures of cognition skills like memory, speed and accuracy differed across the groups of users and nonusers. Children using smart phones for longer hours performed slightly better than the rest, since their latency values were lower indicating quicker response time for AST tests. They also displayed precision in recognition reflecting better memory and accuracy skills than their non user counterparts. The results of the CANTAB tests for accuracy, speed and memory were re-analyzed for different groups based on smartphone usage per day (median as 4.5 hours) and all gadget users for one week (median as 35 hours). However the analysis did not show any significant difference in performance of children between the groups (data not shown).

Research in this field is relatively new and studies have been carried out over the last two decades resulting in inconsistent findings. Barth and his team performed metaanalysis of 19 studies published between 1999 and 2007, investigating the effects of electromagnetic fields from mobile phones on cognition function (29). He summarized that most of the cognitive skill tests showed normal results suggesting no association except two cognitive areas, memory and attention, with slight variation but however concluded that the effects were too small for implications.

An Australian cohort study in 2009 reported that children with more voice calling and texting showed slower response time for the two back task but however did not relate it to the significant exposure (30). Lack of published data

from region of Saudi Arabia on this topic limits the discussion on comparing our results with regional studies.

The other findings of the present study point towards children at high risk for smartphone addiction and internet dependency. Rise in internet abuse is an issue of growing concern especially with children being prime targets. One recent study in 2016, from the central region of Saudi Arabia reported 48% smart phone addiction among university students (31). These results point towards increasing addictive behavior among children and adolescents towards cell phone use displaying a shift towards sedentarism (32). Isolation and certain psychosocial traits affecting the children's academic performance (33). UK COSMOS, largest and ongoing cohort study investigating effects of mobile phones on health linked mobile phones with obesity (34). The increase in usage of wireless internet technology thus has several potential implications on children. It is the collective responsibility of the parents and school authorities to restrict the use of smart phones and other internet devices and instead children must be encouraged to perform group activities and outdoor games. It is important that the Ministry of Education formulates suitable guidelines for smartphone use in children and promulgate its implementation through school authorities.

More elaborate studies are needed in different regions of Saudi Arabia to facilitate comparison in prevalence and pattern of use. Long term cohort studies must be undertaken to effectively determine the role of internet devices on cognition functions of children. The current study being cross sectional cannot determine the risk. However it has contributed substantially to highlight the existing situation in Saudi

Arabia providing a platform to conduct further research.

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Conflict of Interest

The authors state that there is no potential conflict of interest.

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