Heliyon 8 (2022) e10646

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Comparison of mobile phone usage and physical activity on glycemic status, body composition & lifestyle in male Saudi mobile phone users

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ARTICLE INFO

Keywords:
Mobile phone
Physical activity
Hazards
Diabetes
HbA1c
Body composition

ABSTRACT

Background: &Objectives: This study aimed to compare the effects of mobile phone usage and physical activity on HbA1c, body composition, and lifestyle among male Saudi Arabian mobile phone users.

Methods: The study was conducted in the Department of Physiology, College of Medicine, King Saud University, Riyadh, Saudi Arabia from July 2020 to July 2021. The study sample consisted of 203 non-smoker male Saudi participants aged from 20 to 60 years who used mobile phones. Personal information was obtained through interviews using a proforma. The participants were divided into three groups according to their daily mobile phone usage: Group (1): less than 2 h, Group (2): 2–3 h, and Group (3): more than 3 h, and according to their physical activities: Group (1): sedentary, Group (2): average, and Group (3): athletes. Glycated Hemoglobin (HbA1c), Bioelectrical Impedance Analysis (BIA), and (SF) 36- items survey was performed.

Results: The mean age of 203 Saudi male adult participants was 28.0 ± 10.4 years. Mobile phone usage in the less than 2 h group was (33.5%), between 2-3 h (22.7%), and more than 3 h (43.8%) respectively. The mean age of Group (3), who used mobile phones for more than 3 h, was the lowest (23.9 ± 5.7). The results showed that HbA1C levels were almost equal in all three groups (5.8 ± 0.4, 5.7 ± 0.4, and 5.7 ± 0.3 respectively). In addition, emotional well-being and social functioning showed insignificant decreases in the more than 3 h group compared to other groups of mobile phone usage (69.3 ± 15.7, 70.9 ± 15.5, 65.2 ± 16.0, $p = .091$ and 82.9 ± 201, 81.2 ± 18.7, 77.6 ± 21.6, $p = .267$) respectively. No effect was detected between groups regarding various body compositions. Regarding physical activity classifications: the sedentary group constituted (36%) of the sample, whereas the average and athlete groups represented (53.7%) and (10.3%) of the total sample respectively. There was a significant decrease in BMI (29.6 ± 7.8, 25.3 ± 5.1,24.7 ± 5.6, $p = .000$), fat mass (24.7 ± 15.0, 17.1 ± 9.1, 15.3 ± 10.6, $p = .000$), and free fat mass (64.0 ± 10.2, 56.8 ± 8.7, 57.5 ± 8.0, $p = .000$) in the average and the athletic groups compared to the sedentary group. No significant difference was found in HbA1c between physical activity groups (5.8 ± 0.4, 5.7 ± 0.4, 5.7 ± 0.4, $p = .218$).

Conclusions: Mobile phone usage does not affect HbA1c and body composition parameters. Furthermore, we found the youngers used mobile phones longer than others. Insignificant decrease in emotional well-being and social functioning parameters of the style of life due to long mobile phone usage which needs more attention.

1. Introduction

A dramatic increase in the usage of mobile phones has been noticed in the last 20 years among individuals of all ages in different sites around the world [1]. Mobile phones have become part of the communication world and part of our social life [2] with more than 7 billion mobile phone users globally [3]. Mobile phone technology involves electromagnetic field radiation [4, 5, 6] and exposes humans to various health effects which have been controversially discussed in the literature [1, 7]. Health issues such as fatigue, headache, dizziness, tension, sleep disturbance [1], and hearing and vision complaints [8] have been positively correlated with electromagnetic field radiation. The exact mechanism behind its effects is not well established. Several mechanisms, however, have been suggested including thermal effects of the radiations on human tissues, non-thermal

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https://doi.org/10.1016/j.heliyon.2022.e10646
Received 14 September 2021; Received in revised form 12 January 2022; Accepted 8 September 2022

effects of the radiations by changing the permeability of the blood-brain barrier, affecting the dopamine-opiate system, the effects of the radiations in the hippocampus, the effects of radiations on rapid eye movement sleep (REM), and on melatonin level [1, 8]. Electromagnetic field radiation has been classified as a possible carcinogenic factor by WHO and the international agency for research on cancer [2, 9, 10, 11, 12]. It is thought that electromagnetic field radiation enhances cell division and inhibits apoptosis [11]. The extensive increase and development of new mobile phone technologies lead to major changes in the exposure to electromagnetic field radiation [12, 13]. Meo et al found that exposure to high radio-frequency electromagnetic field radiation, generated by mobile phone base stations, resulted in an elevation of HbA1c blood levels and hence the prevalence of prediabetes among school students in a study conducted in Saudi Arabia [13]. This has appeared to be another risk factor contributing to high levels of HbA1c and incidence of type 2 diabetes mellitus (DM) [13]. There were no clear reasons that led to these results but a decrease in the secretion of insulin, conformational changes in the molecule of insulin, and reduction of the binding capacity of insulin to the receptors have been suggested as mechanisms of action [13]. Recently, more than 380 million individuals are considered diabetics and the expectation is to reach approximately 600 million by 2035 [14, 15, 16]. The International Diabetes Federation mentioned that Saudi Arabia has the highest rate of DM in the Middle Eastern and North African (MENA) region with a prevalence rate of 17.7% [16] and this number might rise due to lifestyle changes [14, 17]. Not only adults, but electromagnetic field radiation effects on children's behavior and development were also studied in the literature and a positive correlation was found between learning, cognition, attention, and behavioral disorders and exposure to electromagnetic field radiation [18].

On the other hand, different studies gave ambiguous results regarding the effect of electromagnetic radiation on human health suggesting no correlation between electromagnetic radiation and health [19, 20, 21, 22] which encourages the scientific society for more studies in this regard.

Mobile phone addiction may affect the style of life by changing users' attitudes through increasing anger, tension, depression, irritability, and restlessness as observed by some researchers [23].

The prevalence of obesity and related disorders is devastating worldwide and especially in Saudi Arabia [24]. The effect of physical activity on obesity, body mass index (BMI), and body composition is well known [25] and hence can be used as part of the solution in this manner. Studies advocated that body composition parameters such as body mass index (BMI) and fat mass could be used as physical fitness indicators [26]. However, the relationship between HbA1c, body composition, and lifestyle with mobile phone usage is yet to be assessed by validated and measurable methods like Glycated Hemoglobin (HbA1c), Bioelectrical Impedance Analysis (BIA), and 36-Item Short Form Survey Instrument ̋SF36̋. We hypothesized that mobile phone could elevate HbA1c level, and affects body composition and attitude. This study aimed to evaluate the correlation of long usage of mobile with HbA1c, body composition analysis and body fat, and lifestyle of Saudi male mobile phone users and compare it to the effect of physical activity on these parameters.

2. Methods

The present Analytical cross-sectional study was performed in the Department of Physiology, College of Medicine, King Saud University, Riyadh, Saudi Arabia from July 2020 to July 2021. The study sample consisted of 203 nonsmoker male Saudi participants aged from 20 to 60 years using mobile phones who were randomly selected in this study. The volunteers were divided into three groups: Group (1): those who used mobile phones less than 2 h daily, Group (2): those who used mobiles

Table 1. Demographic and clinical characteristics of the study population, N = 203.

Variables	N (%)	Minimum	Maximum	Mean	Std. Deviation
Phone usage time:					
Group (1): <2 h	68 (33.5)				
Group (2): 2–3 h	46 (22.7)				
Group (3): >3 h	89 (43.8)				
Physical activity:					
Group (1): Sedentary	73 (36.0)				
Group (2): Average	109 (53.7)				
Group (3): Athlete	21 (10.3)				
Occupation:					
Employee	74 (36.5%)				
Student	129 (63.5%)				
Age	203	20.0	60.0	28.0	10.4
Height	203	157.0	202.0	171.9	6.1
Weight	203	47	191	79.4	20.0
Body mass index (BMI)	203	15.4	58.8	26.8	6.5
HbA1c	203	4.9	7.0	5.7	0.4
Fat Mass	203	2.4	95.9	19.6	12.3
Free Fat-Mass (FFM)	203	10.0	94.7	59.5	9.8
Total body water (TBW)	203	4.1	69.3	43.3	7.7
Physical functioning	203	5.0	100.0	84.7	21.9
Role limitations due to physical health	203	0.0	100.0	83.2	28.6
Role limitations due to emotional problems	203	0.0	100.0	66.2	42.0
Energy fatigue	203	10.0	100.0	61.8	17.6
Emotional wellbeing	203	16.0	100.0	67.8	15.9
Social functioning	203	.0	100.0	80.2	20.5
Pain	203	45.0	100.0	91.6	13.9
General Health	203	30.0	100.0	71.6	13.9
Health change	203	25.0	100.0	65.0	22.1

Data are presented as number (N), percentage (%), and the mean and standard deviation of participants.

phone between 2-3 h, and Group (3): those who used mobile phones more than 3 h. Mobile phone usage included phone calls, social media interactions, online studying, applications usage, games, etc. In the literature, different studies have different classifications regarding the duration of mobile phone usage, but we used our classifications according to the observed usage in our society. The physical activity classification was: Group (1): sedentary group (no activity at all), Group (2): average group (non-intense activity: 90–120 min/week), and Group (3): athletes (intense activity: more than 120 min/week). We evaluated three dependent variables: HbA1c, Body compositions, and 36-item style of life. This study used Three tools of measurement:

1 Glycated Hemoglobin (HbA1c): detects the mean blood glucose concentration for the last 3 months. We used the Clover A1c system (Inforpia, Kyunggi, Korea an automated boronate affinity to determine the HbA1c percentage in whole blood. World Health Organization, International Diabetes Federation, and the American Diabetes Association have considered HbA1c as a diagnostic marker for diabetes mellitus [27, 28]. Participants were divided into three groups according to the American Diabetes Association classification. Subjects with HbA1c less than 5.7% were considered nondiabetics; HbA1c 5.7%–6.4% were pre-diabetics; and subjects with HbA1c greater than 6.4% were considered diabetics [28].
2 Bioelectrical Impedance Analysis (BIA): is a widely used method to detect body composition, which is a quick, easy, cost-effective test [29, 30]. This method uses a non-detectable, safe low-level current that flows through the body. BIA measures the resistance and impedance of current flows through extracellular and intracellular fluids if body electrolyte status is normal [29, 30]. BIA can provide a detailed measurement of different body composition parameters such as height, weight, BMI, free fat mass, and fat mass.
3 RAND 36-Item Health Survey: is a two-step Scoring process that examines the quality of lifestyle. Health-related quality of life (HRQL) is commonly measured by the 36-item Short Form (SF-36) which has been proven to be a reliable indicator. It was derived from the Medical Outcomes Study or RAND Health Insurance Experiment [31]. It is a short form derived from a larger 149-item instrument and is more precise than its predecessor (SF-20). It has been translated into many languages [31, 32, 33, 34]. The study was approved by the Institutional review board (IRB), College of Medicine, King Saud University (E-20-5373). The confidentiality of all the information related to the participants is of our concern and confirmation that the study complies with all regulations and the rights of the participants, and the purpose of the study was stated in the consent form which was obtained from all the participants.

3. Exclusion criteria

Participants aged above 60 or below 20 were excluded. Mobile phone users who smoke cigarettes or shisha were excluded. Diabetic patients and Blood disease patients were excluded. History of employment in any industrial plant which produces dust or fumes such as (cement, welding, wood, oil, cotton, and flour) were excluded, and a history of psychiatric or hormonal disorders or medications were excluded. Investigators interviewed 203 male volunteers mobile phone users and detailed clinical information was obtained.

4. Statistical analysis

SPSS 24.0 version statistical software was used. We used mean, standard deviation, frequencies, and percentages to express different variables. Analysis of variance (ANOVA) and Post-HOC analysis (HOC) statistical tests was used based on the comparison between different groups. Proportions were compared between different groups with a p-value = 0.05 and 95% CI.

5. Results

Table 1 showed Mobile phone usage selected groups: individuals who used their mobile less than 2 h daily represented (33.5%) of the total sample whereas individuals who used their mobile for 2–3 h and more than 3 h represented (22.7%) and (43.8) respectively. Regarding physical

Table 2. Comparison of demographic variables, HbA1c, and body composition between different mobile phone user groups.

Variable	Group (1) Less than 2 h, n = 68	Group (2) Between 2-3 h, n = 46	Group (3) More than 3 h, n = 89	P-Value
Age (years)	29.9 (±12.2)	33.0 (±11.6)	23.9 (±5.7)**,***	.000
Height (Cm)	171.4 (±6.3)	172.1 (±7.2)	172.2 (±5.3)	.677
Weight (kg)	79.9 (±18.0)	82.5 (±18.5)	77.5 (±23.7)	.595
Body Mass Index (kg/m2)	27.5 (±6.2)	26.5 (±5.9)	26.4 (±7.1)	.541
Hemoglobin A1c (HbA1c)	5.8 (±0.4)	5.7 (±0.4)	5.7 (±0.3)	.426
Free Fat-Mass (FFM)	59.8 (±8.5)	59.6 (±9.3)	59.1 (±11.0)	.899
Fat Mass	21.0 (±10.9)	19.1 (±10.7)	18.9 (±14.0)	.537
Total Body Water	43.0 (±7.5)	43.5 (±6.6)	43.5 (±8.4)	.917

Data are presented as mean and standard deviation. P value is measured by ANOVA, * 2–3 h is significant for Less than 2 h, ** More than 3 h is significant for less than 2 h, *** More than three is significant for 2–3 h by Using the HOC test.

Table 3. Comparison of lifestyle variables between different mobile phone user groups.

Variable	Group (1) Less than 2 h, n = 68	Group (2) Between 2-3 h, n = 46	Group (3) More than 3 h, n = 89	p-value
Physical functioning %	86.5 (±20.2)	81.3 (±25.6)	85.1 (±21.2)	.459
Role limitations due to physical health %	88.4 (±24.2)	77.8 (±33.3)	82.0 (±28.7)	.144
Role limitations due to emotional problems %	70.7 (±40.5)	68.1 (±39.7)	61.7 (±44.2)	.398
Energy/fatigue %	63.5 (±17.3)	63.1 (±18.0)	59.9 (±17.6)	.379
Emotional well-being %	69.3 (±15.7)	70.9 (±15.5)	65.2 (±16.0)	.091
Social functioning %	82.9 (±201)	81.2 (±18.7)	77.6 (±21.6)	.267
Pain %	92.7 (±13.8)	92.0 (±12.2)	90.5 (±14.8)	.589
General health %	70.5 (±15.3)	72.5 (±11.2)	72.1 (±14.9)	.698
Health change %	64.3 (±20.8)	68.3 (±21.5)	63.7 (±23.4)	.514

activity classifications: the sedentary group constituted (36%) of the sample, whereas the average and athlete groups represented (53.7%) and (10.3%) of the total sample respectively. Table 1 also showed that the mean age for the sample size was 28.0 (±10.4), the mean height was 171.9 ± 6.1, the mean weight was 79.7 (±20.4), and the mean BMI was 26.8 ± 6.5. It also showed the mean HbA1c for the sample population was 5.7 ± 0.4. Table 2 shows that the younger participants (23.9 ± 5.7) used mobile phones more than the other groups (less than 2 h: 29.9 ± 12.2, between 2-3 h: 33.0 ± 11.6 with p = 0.000). Also, Table 2 showed no difference in HbA1c between the three groups (5.8 ± 0.4) for less than 2 h, (5.7 ± 0.4) for 2–3 h, and (5.7 ± 0.3) for more than 3 h with p-value = 0.426. In addition, Table 2 showed that Body mass index tended to be insignificantly higher in group one (27.5 ± 6.2) (26.5 ± 5.9) for group two, and (26.4 ± 7.1) for group three with, P-value = .541 which means that people who used mobile for less than 2 h tended to be slightly overweight than those with higher usage. It also shows that there is no difference in Fat-Mass between groups according to mobile phone usage. Table 3 showed that Emotional well-being was lower in mobile phone user group three (65.2 ± 16.0) compared to the other groups (69.3 ± 15.7 and 70.9 ± 15.5) but with no significant difference p = 0.091. It also showed an insignificant decrease in social functioning in group three (77.6 ± 21.6) compared to the other groups (82.9 ± 201, 81.2 ± 18.7) with (p = .267).

Table 4 showed there was a significant decrease in BMI (29.6 ± 7.8, 25.3 ± 5.1,24.7 ± 5.6, p = .000), Fat mass (24.7 ± 15.0, 17.1 ± 9.1, 15.3 ± 10.6, p = .000), and free fat mass (64.0 ± 10.2, 56.8 ± 8.7, 57.5 ± 8.0, p = .000) in average and athletic groups compared to the sedentary group. No significant difference was found in HbA1c between physical activity groups (5.8 ± 0.4, 5.7 ± 0.4, 5.7 ± 0.4 with p = .218). Table 5 showed the effects of the physical activity group on lifestyle variables which showed a positive significant correlation between physical functioning (95.4 ± 10.1 with p = 0.049), Energy/fatigue (67.8 ± 20.7 with p = 0.023), and general health (80.9 ± 10.5 with p = 0.000) variables with athletes' group.

P value is measured by ANOVA, * 2–3 h is significant for Less than 2 h, ** More than 3 h is significant for less than 2 h, *** More than three is significant for 2–3 h by Using the HOC test.

6. Discussion

Electromagnetic Field radiation has been under intense investigation in the literature. The Association of mobile phones and several health issues have been established [35, 36, 37, 38]. In addition, a positive correlation between electromagnetic radiations and infertility of the male reproductive system has been detected by changing the motility and decreasing the number of sperms [39]. On the other hand, other studies gave ambiguous results regarding the effects of electromagnetic radiation on health [19, 20, 21, 22]. The differences in results from various studies could be due to the differences in the frequencies of the electromagnetic radiations between studies, the distances from the source of the radiations, duration of exposure to radiations, and the age of the participants [19, 21, 39, 40]. All these factors could change the outcome of the results and consequently produce various health situations.

When using a mobile phone, three powerful factors might affect human health and attitudes: (1) Electromagnetic radiations that have controversial effects on the human body. In this regard, one should take into consideration the intensity of the radiation, duration of exposure, distance from the source of radiation, and age of the person exposed to the radiation. (2) The time that is spent when using a mobile phone and whether this will distract the users from other aspects of life or not, such as social obligations. 3) The content of media that is directed toward mobile phone users, especially younger users.

According to our results, most of our participants used their mobile phones for more than 3 h (43.8%) which was an expected result these days as mobile phones have become part of our daily life. In addition, younger participants (23.9 ± 5.7) showed an increased usage of mobile phones more frequently than others. Whether this is associated with modern education communication skills or with social interactions

Table 4. Comparison of clinical variables, HbA1c, and body composition between different physical activity groups.

Variable	Group (1) Sedentary, n = 73	Group (2) Average, n = 109	Group (3) Athletes, n = 21	P-Value
Age (years)	24.9 (±7.8)	30.3 (±11.6)*	26.9 (±8.8)	.002
Height (Cm)	173.1 (±6.6)	171.2 (±5.7)	171.5 (±5.5)	.118
Weight (kg)	88.5 (±18.0)	73.5 (±18.5)	71.0 (±23.7)	.595
Body Mass Index (kg/m2)	29.6 (±7.8)	25.3 (±5.1)*	24.7 (±5.6)**	.000
Hemoglobin A1c (HbA1c)	5.8 (±0.4)	5.7 (±0.4)	5.7 (±0.4)	.218
Free Fat-Mass (FFM)	64.0 (±10.2)	56.8 (±8.7) *	57.5 (±8.0) **	.000
Fat Mass	24.7 (±15.0)	17.1 (±9.1) *	15.3 (±10.6) **	.000
Total Body Water	45.6 (±10.0)	42.1 (±5.7) *	42.1 (±5.8) **	.008

Data are presented as mean and standard deviation. P value is measured by ANOVA, * 2–3 h is significant for Less than 2 h, ** More than 3 h is significant for less than 2 h, *** More than three is significant for 2–3 h, by Using the HOC test.

Table 5. Comparison of lifestyle variables between different physical activity groups.

Variable	Group (1) Sedentary, n = 73	Group (2) Average, n = 109	Group (3) Athlete, n = 21	p-value
Physical functioning %	82.2 (±22.5)	84.3 (±22.7)	95.4 (±10.1) **	.049
Role limitations due to physical health %	77.5 (±32.7)	85.0 (±26.4)	93.7 (±19.6)	.050
Role limitations due to emotional problems %	62.5 (±42.6)	67.9 (±41.0)	69.8 (±45.8)	.640
Energy/fatigue %	57.6 (±16.9)	63.4 (±16.9)	67.8 (±20.7) **	.023
Emotional well-being %	64.1 (±15.3)	69.7 (±15.5)	71.6 (±17.7)	.035
Social functioning %	78.5 (±20.8)	80.5 (±20.0)	84.5 (±21.9)	.499
Pain %	89.2 (±16.5)	92.5 (±12.8)	95.4 (±7.0)	.126
General health %	66.3 (±14.5)	73.4 (±12.7) *	80.9 (±10.5) **	.000
Health change %	62.3 (±23.0)	65.9 (±21.1)	69.0 (±23.5)	.379

Data are presented as mean and standard deviation. P value is measured by ANOVA, * 2–3 h is significant for Less than 2 h, ** More than 3 h is significant to less than 2 h, *** More than three is significant to 2–3 h, by Using the HOC test.

should be studied carefully. Regarding physical activity, even though the mean age of our sample size was 28.0 ± 10.4 which is relatively low, approximately 36% lived sedentary life with minimum physical activities which give warning indications that younger people are not aware of the importance of physical activities and its implications in health. We found that the duration of mobile phone usage had no significant effect on HbA1c. This result was different from what Meo et al have found; a positive correlation between radiation emerging from mobile phone towers and elevation of HbA1c in the blood [13]. The difference between our study and Meo et al study could be due to the low-frequency radiations emitted from mobile phones as opposed to mobile phone towers which have been mentioned earlier as an important factor that can affect the result. In addition, we found that there was no difference in Body mass index, fat mass, and free fat mass between mobile phone user groups while physical activity had a significant effect on BMI and various body compositions. The negative correlation between mobile phone usage and body composition may be due to the sedentary lifestyle of individuals which includes other distracting factors such as Television, Computers, social gatherings, and long day's work irrespective of mobile phones.

From our results, it is observed that mobile phone usage has fewer influences on various lifestyle variables, measured by a 36-item health survey, such as physical functioning, pain, general health, and health change as mobile phones have become part of all these aspects of life and hence no difference can be detected between users. On the other hand, our results showed long mobile phone usage has negative effects on emotional well-being, role limitations due to emotional problems, and social functioning (even though it is insignificant) which need more concern and further attention. One possible reason that could explain the negative effect of mobile phones on emotional well-being and social functioning is the content of social media applications and their influences on the younger generation. On the other hand, physical activities have well-known positive effects on physical functioning, energy/fatigue, and general health variables.

Due to its high exclusion criteria: female participants (to eliminate any hormonal influences if any for the time being [41, 42], and to have more control on variables), nonsmokers, and used validated measures, the sample size was small in our study. In addition, it was difficult to find a control group who do not use mobile phones and was also difficult to find less than 2 h mobile phone users. On the methodology, there was a limited resource for specific measurements of Visceral fat.

7. Conclusions and recommendations

We concluded that mobile phone usage does not affect HbA1c and body composition parameters. Also, youngers were found to use mobile phones more than others. This should increase public awareness about the long usage of mobile phones among society members. More attention should be directed toward teenagers to eliminate the effects of mobile phones on emotions and social functioning. Further study on a large sample size including different age groups, long mobile phone usage, and female gender is highly recommended. The effect of mobile phone usage on visceral fat is of great value to be studied. A well-controlled study that compares differences in the frequency of radiation, exposure time, distance from the source of the radiation, and its effects on age should be carried out, supported, and funded to evaluate the exact effect of Electromagnetic Field Radiation.

Declarations

Author contribution statement

Thamir Al-khlaiwi: Conceived and designed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Syed Shahid: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Mohammed Alshalan, Mohammed Al-qhatani, Sultan Alsowiegh, Saud Queid, Omar Alyabis, Huthayfah Al-khliwi: Performed the experiments.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability statement

The data that has been used is confidential.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Acknowledgements

We would like to thank the College of Medicine Research Center (CMRC), Deanship of Scientific Research, King Saud University, Riyadh, Saudi Arabia for their valuable support and courage.

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