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Original Article

The Effect of Screen Addiction and Attention-Deficit Hyperactivity Disorder on Insulin Resistance in Children

Çocuklarda Ekran Bağımlılığı ve Dikkat Eksikliği ve Hiperaktivite Bozukluğunun İnsülin Direnci Üzerine Etkisi

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ABSTRACT

Objective: Among screen-addicted children, there is a risk of insulin resistance (IR), obesity, hypertriglyceridemia and diabetes mellitus type 2 due to decreased physical activity and irregular eating habits. Most recently, relations of screen addiction (SA) and attention-deficit hyperactivity disorder (ADHD) with obesity have been reported. Herein, we aimed to investigate the presence of IR and dependent factors in screen-addicted children with and without obesity.

Method: A total of 108 children in the age range of 11-17 years were included in the study. Cases were divided into three groups according to ADHD and SA scale scores. In these three groups, there were equal numbers of obese and non-obese patients. Homeostasis model assessment for insulin resistance (HOMA-IR) of the patients was assessed at baseline. Body fat analysis was performed with TANITA BC-420 MA body composition analyzers. All cases wore pedometers for 3 days to determine their basal metabolic rates (BMR) during active and sedentary periods. Carbohydrate, fat and calorie consumption was calculated using a professional nutrition program.

Results: There were no statistically significant differences between the SA and non-SA groups on the energy consumption, BMR and fat mass and dietary contents. There was no effect of ADHD and SA on HOMA-IR values.

Conclusion: We did not find any association between SA and IR. Also dependent factors were similar between groups. New studies are needed to determine how SA affects obesity.

Keywords: Insulin resistance, screen addiction, attention deficit hyperactivity disorder, HOMA-IR

ÖZ

Amaç: Ekran bağımlılığı (EB) olan çocuklar, azalmış fiziksel aktivite ve bozulmuş beslenme düzenine bağlı olarak insülin direnci (İD), obezite, hiperlipidemi ve tip 2 diabetes mellitus açısından yüksek risk altındadırlar. Yakın zamanda yapılan çalışmalarda EB ve dikkat eksikliği hiperaktivite bozukluğunun (DEHB) obezite ile ilişkisi gösterilmiştir. Bu çalışmamızda, EB olan çocuklarda (obez olan veya olmayan) İD varlığını ve etkili faktörleri göstermeyi amaçladık. DEHB, EB ile birliktedir. EB olan çocuklarda aktivite azalmıştır ve buna bağlı olarak İD vardır.

Yöntem: Çalışmaya 11-17 yaş aralığında 108 çocuk alındı. Olgular DEHB ve EB açısından ölçekler ile değerlendirilerek üç gruba ayrıldı. Bu üç grupta eşit sayıda obez ve obez olmayan olgu bulunmaktaydı. İD'yi değerlendirmek için insülin direncinin homeostatik modeli değerlendirmesi (HOMA-IR) değerleri hesaplandı. Vücut yağ analizleri TANITA BC-420 MA vücut kompozisyon analizatörü ile yapıldı. Tüm olgulara 3 gün süre ile "Armband Sense Wear" pedometer takılarak bazal metabolik hız (BMH), aktivite ve istirahat süreleri kaydedildi. Karbonhidrat, yağ ve kalori tüketimi özel beslenme programı (BEBIS) ile hesaplandı.

Bulgular: Ekran bağımlılığı olan ve olmayan gruplar arasında enerji tüketimi, BMH ve vücut yağ kitlesi ve diyet içeriği benzerdi. DEHB ve ekran bağımlılığının, HOMA-IR üzerine etkisi saptanmadı.

Sonuç: EB ile İD arasında ilişki saptanmadı. Bağımlı faktörler gruplar arasında benzerdi. Ekran bağımlılığının obezite ile ilişkisini ve nedenlerini ortaya koymak için daha çok çalışmaya ihtiyaç vardır.

Anahtar kelimeler: İnsülin direnci, ekran bağımlılığı, dikkat eksikliği ve hiperaktivite bozukluğu, HOMA-IR

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INTRODUCTION

Screen addiction (SA) is the limitless and uncontrolled use of television, computer, smart phone and the other screen devices. It is more comprehensive version of the internet addiction that is under discussion all over the world. A large body of evidence shows that SA is always comorbid with other psychiatric conditions, especially attention-deficit hyperactivity disorder (ADHD) [1]. Among screen- addicted children, there is a risk of insulin resistance (IR) and IR related conditions i.e. obesity, hypertriglyceridemia and diabetes mellitus (DM) type 2 due to decreased physical activity and irregular eating habits [2,3]. Numerous studies have examined the relationship between sedentary lifestyle and obesity. Usage of screen devices and screen time are thought to be associated with obesity and long-term health problems [3].

IR, is defined as decreased tissue response to insulin-mediated cellular actions. The term "IR" as generally applied, refers to whole-body reduced glucose uptake in response to physiological insulin levels and its consequent effects on glucose and insulin metabolism.

The major acquired factors leading to IR are sedentary lifestyle brought about by industrialization and innovations in technology, unhealthy eating habits, and obesity. The most widely diagnostic method in clinical practice is homeostasis model assessment for ınsulin resistance (HOMA-IR) [4-6].

Our study aims to investigate the presence of IR and its possible causes in screen-addicted children.

MATERIALS and METHODS

The study was conducted between March 2013 and August 2014 with 36 pubertal children between 11-18 years of age, and diagnosed as SA and ADHD (group 1) by the department of child and adolescent psychiatry. Children with a chronic illness or those taking any medication(s) were excluded from the study. The control group consisted of children and adolescents with non-screen- addicted ADHD (group 2) and those that did not receive the diagnoses of ADHD and SA (group 3). Each group contained equal numbers of obese and non-obese children.

The study was approved by the Ege University Faculty of Medicine Ethics Committee (approval number: 13-2/47, date: 20.02.2013). Written informed consent was obtained from all participants and their parents. Clinical examination, weight and height measurements of the cases were performed by the same investigator. Height was measured to the nearest centimeter using a rigid stadiometer. Weight was measured unclothed to the nearest 0.1 kg using a calibrated balance scale. Body mass index (BMI) was calculated by dividing the weight in kilograms by the square of the height in meters (m^2). Percentiles and Z-scores of weight, height and BMI were determined by using data of Turkish children according to their age and sex [7]. The children with a BMI equal or greater than the +2 standard deviations (SD) for age and sex were considered as obese.

Participants' activity and duration of their resting periods were recorded with the "Armband Sense Wear", body fat-muscle-bone analysis was done using TANITA BC-420 MA Body Composition Analyzer. Participants' food intake for 3 consecutive days was recorded by themselves. Energy, protein, fat and carbohydrate intake were analyzed using a professional nutrition information program, BEBIS. IR was evaluated by HOMA-IR (calculated based on preprandial blood glucose and insulin levels). Acceptable range of HOMA-IR is below 2.7 and any level greater than 2.7 was considered as presence of IR [5,8].

Statistical Analysis

Statistical analyses of the data were performed using SPSS v20.0 for Windows (IBM Corp., Armonk, NY, USA). Distribution of data was evaluated using the Kolmogorov-Smirnov test. For comparison of more than two groups, one-way ANOVA or Kruskall-Wallis test was used according to normal or non-normal distribution of the data. If a significant difference was found in the comparison of more than two groups, Mann-Whitney U test with Bonferroni correction or post-hoc Tukey test was performed to determine where the differences truly originated from. Numerical data were expressed as median (25-75th percentile) or mean ± SD based on 95% confidence interval. The value of $p<0.05$ was considered to be statistically significant.

RESULTS

Mean age of the patients was 13.7±1.95 years. Mean weight, weight SDS, height and height SDS of the patients were 66±21 kg (30-120 kg), 1.2±1.8 (-3.3-+4.6), 159.3±9.9 cm (141.5-184 cm), 0.11±1 (-2.3-+2.5), respectively. Mean BMI, and BMI SDS of all cases were 25.8±7 kg/m^2 (14.9-40 kg/m^2) and 1.17±1.88 (-3.49-3.81), respectively. There were equal number of obese and non-obese children in all of these three groups. Anthropometric data and results of body fat analysis of all participants are given in Table 1. Family history of IR and its complications (obesity, hypertension, DM type 2) was revealed in 41 cases. In the obese cases, the incidence of familial IR was significantly higher ($p<0.05$). Body fat composition was higher in the obese group as expected. There was no significant difference among the groups as for body fat composition (Table 1).

Basal metabolic rates (BMR), energy consumption, number of steps per day, activity, resting and sleeping periods and nutrient intakes of all the groups are shown in Table 2. Mean BMR of obese and non-obese cases were 1.5±0.3 and 1.74±0.27, respectively ($p<0.05$). There was no significant difference among three groups in terms of BMR, daily energy consumption, number of steps, resting, sleeping and activity durations (Table 2). Daily active energy consumption was lower in group 3.

Eighty-nine participants had completed the dietary list. Carbohydrate, fat, protein and energy intakes

Table 1. Anthropometric data and body fat analysis of participants

Parameters	Group 1 SA (+) ADHD (+)	Group 2 SA (-) ADHD (+)	Group 3 SA (-) ADHD (-)	p
Sex (n)	36	36	36	0.017[a]
Male	27 (75%)	25 (69.4%)	16 (44.4%)	
Female	9 (25%)	11 (30.5%)	20 (55.5%)	
Age (years)	13.51 (12.5-14.5)	13.80 (11.9-16.2)	13.86 (11.6-16.1)	0.723[b]
Weight (kg)	67.9±22.7	64.3±21.1	66.9±20	0.764[b]
Height (cm)	160.3±8.4	160.2±11.3	157.5±9.8	0.394[b]
Weight SDS	1.26±1.73	1.12±1.89	1.4±2.09	0.818[b]
Height SDS	0.12±0.86	0.24±1.06	-0.02±1.07	0.526[b]
BMI SDS	1.76 (-0.49-2.51)	1.43 (-1.18-2.65)	1.74 (0.53-2.85)	0.511[c]
Body fat ratio (%)	30.6 (13.7-36.4)	23 (11-39.5)	33.3 (15-42.8)	0.464[c]
Body fat mass (kg)	21.9 (2.1-30)	19.2 (2.5-30.1)	19.1 (1.5-36.6)	0.716[c]

ADHD: Attention-deficit hyperactivity disorder, SA: Screen addiction, Data were presented as mean ± SD or median (25-75th percentiles), [a]chi-square, [b]One-way-ANOVA, [c]Kruskal-Wallis

Table 2. BMR, activity and resting periods and nutrient intakes of the subgroups

	Group 1 SA (+) ADHD (+)	Group 2 SA (-) ADHD (+)	Group 3 SA (-) ADHD (-)	p
BMR	1.6 (1.4-2)	1.5 (1.4-1.7)	1.4 (1.3-1.5)	0.080[b]
Energy consumption (kcal)	2,399±895	2,450±1,003	2,385±567	0.585[a]
Number of steps	8,926±3,804	8,273± 3,669	8,989±3,499	0.579[a]
Resting duration (hr)	8.9 (7-9.6)	8.9 (7.6-9.5)	8.1 (7-9.1)	0.953[b]
Sleep duration (hr)	7.1 (5.5-7.8)	7.1 (6.5-7.9)	6.9 (5.7-7.7)	0.455[b]
Daily active energy consumption (kcal)	576 (356-976)	422 (298-666)	356 (251-636)[cf]	0.037[b]
Duration of physical activity (hr)	1.77 (1.2-4)	1.49 (1-2.2)	1.15 (0.8-1.9)	0.061[b]
Energy intake (kcal)	1,870 (1,720-2,223)	1,732 (1,431-2,237)	1,839 (1,335-2,125)	0.334[b]
Protein intake (g)	74 (55.9-85.2)	66.6 (54.3-81.6)	55 (47.3-79.3)	0.052[b]
Fat intake (g)	77.1 (62.3-101.9)	69.9 (57.4-104.2)	70.3 (59.7-93.4)	0.407[b]
Carbohydrate intake (g)	210 (181-309)	197 (161-241)	214 (139-268)	0.440[b]
Energy intake per weight (kcal)	28.8 (21.7-42.7)	28.3 (19-49.3)	25 (16.3-31.5)	0.223[b]
Protein intake per weight (g)	1.07 (0.74-1.43)	1.12 (0.78-1.93)	0.84 (0.60-1.23)[cf]	0.026[b]
Fat intake per weight (g)	1.17 (0.76-1.52)	1.14 (0.74-2.33)	1.06 (0.80-1.33)	0.333[b]
Carbohydrate intake per weight (g)	3.17 (2.27-5.93)	3.18 (2.51-4.83)	2.92 (1.75-3.53)	0.230[b]

SA: Screen addiction, ADHD: Attention-deficit hyperactivity disorder, kcal: kilocalorie, g: grams, hr: hours, Data were presented as mean ± standard deviation or median (25-75th percentiles), [a]One-Way-ANOVA, [b]Kruskal-Wallis test, [c]Mann-Whitney U test with Bonferroni correction ($p<0.017$), post-hoc test to determine the predominance for non-parametric three group comparisons of 89 participants are shown in Table 2. There was no significant difference between total nutrient intakes of the groups. Energy, fat and carbohydrate intake per weight were similar between groups, on the other hand, protein intake per weight was lower in the group 3.

Mean HOMA-IR of the patients was 3.45±2.71 (0.62-16.46). Median HOMA-IR values of the groups were similar (Table 3).

DISCUSSION

Most recently relations of SA and ADHD with obesity have been reported. To our knowledge, this is the first study that investigates the association between SA and IR and the dependent factors.

BMR is the energy consumption at resting. BMR increases with physical activity, weight loss and healthy eating while decreases with sedentary lifestyle, aging and obesity. Recent studies in obese children suggest that BMR is negatively correlated with obesity [9]. Klesges et al. [10] showed that BMR was lower while watching TV rather than resting. Also recent studies have shown that BMR is lower in girls [9,11]. Contrary to these evidence, we have shown that ADHD and SA did not significantly affect BMR. These results should be considered along with the gender difference between the subgroups.

According to some authors, more frequent use of internet may cause lower physical activity and higher rates of overweight [12]. In another study, Mihrshahi et al. [13] has shown that the association between screen time and obesity also concerns decreased physical activity. In addition, many studies have shown that decreased physical activity and increased ST induce overweight [14]. Ebenegger et al. [15] has shown that ADHD rating scale scores were related to higher physical activity and prolonged screen time. In support of their findings, in our study, the active energy consumption was higher in ADHD cases regardless of the presence of SA.

There are numerous studies about the effects of screen time on sleep. According to these studies, screen time reduces the duration and quality of sleep and it is a risk factor for obesity [13,16-19]. However, in our study, there was no significant difference in sleep durations among the groups. The number and gender difference between subgroups may reveal this result. In addition, numerous studies examining the lifestyle of children with ADHD have shown that children with ADHD sleep less at night [20,21]. Various studies have revealed that obesity is related with decreased sleep duration and poor sleep quality [22]. Buxton and Marcelli [23] demonstrated that sleeping less than 7 h per night causes 6% increase in obesity risk of adults. However, psychopathologies or other factors that may lead to sleep disorders have not been analysed.

Obesity is a clinical situation that manifests with increased fat mass due to higher energy intake than consumed. Clinical studies have shown the existence of an association between obesity and higher fat and carbohydrate consumption [24,25]. In our study energy, carbohydrate, fat, protein intake per kg were observed lower in obese group. It was thought that this may be due to lower food intake with auto-control and/or showing less food intake with guilt/shame. This is in agreement with some other studies indicating that self-recorded dietary lists can not reflect the reality [26,27].

Epidemiologic studies have revealed that eating disorders of the children with ADHD lead to obesity in despite their increased physical activities [28-30]. As important etiologic factors in obesity, skipping meals, binge eating, higher intake of fast-food, and calorie-rich foods are frequently observed in ADHD children due to impulsitivity [2,31]. In our study; energy, fat and carbohydrate intakes of the groups were similar. Protein intake per weight of the group 3 was at the lowest level.

Current evidence suggests that screen media exposure leads to obesity in children and adolescents through overeating in front of the screen, exposure to low nutrient food with high calorie intake, and consumption of various beverages [32]. Epidemiologic studies reveal that children who consume more screen media also consume fewer fruits and vegetables and more energy dense snacks, drinks and fast food [33,34]. A number of studies showed that SA children receive higher percentage of their energy from fats and have a higher total energy intake [35-37]. There was no difference

Table 3. HOMA-IR values of the groups (median + IQR)

	Group 1 SA (+) ADHD (+)	Group 2 SA (-) ADHD (+)	Group 3 SA (-) ADHD (-)	p
HOMA-IR	2.66 (1.64-5.06)	2.14 (1.21-3.27)	3.45 (1.72-5.62)	0.081

HOMA-IR: Homeostasis model assessment for insulin resistance, IQR: Interquartile range, SA: Screen addiction, ADHD: Attention-deficit hyperactivity disorder, Data were presented as median (25-75th percentiles), Kruskal-Wallis test in terms of dietary habits between groups in this study. As a limitation, we did not analyze the dietary lists of the patients in terms of their fruit, vegetable and snack contents.

Inheritance, metabolism, eating habits and physical activity affect the body fat composition. It has been observed in reviews that body fat composition of the children is affected by gender and age [38]. In a national study, relatively higher body fat composition was found in girls and at postpubertal ages which was also positively corelated with weight. Must and Tybor [39] showed that sportive activities decreases the body fat mass. Similarly, in numerous studies no association can be found with screen time and body fat mass [40-45]. In our study, body fat composition was significantly higher in obese group as expected but there was no significantly difference between three groups. Our results have shown that SA and ADHD does not affect the body fat composition which can be also related to the similar number of obese children in the groups.

HOMA-IR values increase in line with obesity and sedentary lifestyle [46]. Our results confirm the presence of higher HOMA-IR values in the obese group. To our knowledge, the relation between SA and IR has not been investigated yet, but a study about screen time and HOMA-IR showed increases in HOMA-IR values with screen time [2]. While the comorbidity between ADHD and obesity has been extensively studied [47-49], the possible association with IR has received less attention. We could not find any affect of SA and ADHD on HOMA-IR which can be due to the differences between subgroups in terms of number/gender/pubertal stages or similar BMI values between the groups.

Study Limitations

Our study has some limitations. Firstly, this study included a small number of subjects and therefore our results require confirmation in a larger cohort. Secondly, HOMA-IR levels may vary due to gender differences between the groups. Likewise, pubertal stages of the subjects may affect the HOMA-IR levels but we did not evaluate the pubertal stages of the study participants. Thirdly, in our study there was similar number of obese children in the groups. The other limitation was that HOMA-IR values were used as surrogate measures of insülin resistance Still, though impractical more sensitive measures of insülin resistance could be used instead.

CONCLUSION

We did not find any association between SA and IR. Also dependent factors were similar between groups. Further studies are needed to determine the effects of SA on obesity.

Ethics

Ethics Committee Approval: The study was approved by the Ege University Faculty of Medicine Ethics Committee (approval number: 13-2/47, date: 20.02.2013).

Informed Consent: Written informed consent was obtained from all participants and their parents.

Peer-review: Externally peer-reviewed.

Author Contributions

Surgical and Medical Practices: Ö.K., E.Ş., S.Ö., Concept: Ö.K., Ş.D., B.Ö., Design: Ö.K., Ş.D., B.Ö., Data Collection and/or Processing: Ö.K., E.Ş., Analysis and/or Interpretation: Ö.K., Y.A.A., S.Ö., D.G., Literature Search: Ö.K., Ş.D., D.G., Writing: Ö.K., Ş.D., D.G.

Conflict of Interest: The authors have no conflict of interest to declare.

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