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Prevalence of obesity/hypertension in children and adolescents with ADHD and evaluation of total body composition

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ABSTRACT

Objective: *Attention-deficithyperactivitydisorder (ADHD) is one of the most commonly diagnosed neurobehavioral disorders in childhood. The aim of the present study was to investigate the obesity/hypertension prevalence of children with ADHD at the time of initialdiagnosis, to assessthe total body composition, and also to evaluate the associated risk factors.* ***Methods:*** *The study was carried out with 77 ADHD/100 healthy children and adolescent. All individuals completed a questionnaire form prepared by researchers. The weight, height, and blood pressure (BP) measurements were performed using standardized protocols. Total body composition analysis was performed by 'bioelectrical impedance analysis' method.* ***Results:*** *The obesity/hypertension prevalence in ADHD patients were 16.9%, 13.0%, respectively. The obesity prevalence was more frequent and diastolic BP values were higher in patients than controls. Total body fat (%) was higher in both obese and non-obese patients. In females, sistolic BP and diastolic BP values were higher in ADHD group than control group. In girls sleep duration in weekend-days was shorter in patients. Paternal body mass index was higher in ADHD group. Consumption of chocolate/sugar/chicken/ fish and screen time>1 hour in a day were more common in ADHD patients.* ***Conclusion:*** *The high obesity/hypertension rates in our study emphasize that the assessment of weight/BP should be a part of the ADHD management. The ADHD patients may also have an increased risk of high total body fat even though individuals are not obese. Short sleep duration, consumption of a high amount of chocolate/sugar/chicken/fish, andscreen time>1 hour per day may be a risk factor for ADHD.* ***(Anatolian Journal of Psychiatry 2019; 20(1):93-100)***

Keywords: *attention deficit and hyperactivity disorder, childhood, hypertension, obesity*

DEHB'li çocuk/ergenlerde obezite/hipertansiyon yaygınlığı ve toplam vücut kompozisyonunun değerlendirilmesi

ÖZ

Amaç: *Dikkat eksikliği hiperaktivite bozukluğu (DEHB) çocukluk çağının en sık tanı konulan nöro gelişimsel bozukluklarından birisidir. Bu çalışmanın amacı DEHB'li çocuklarda tanı sırasında obezite/hipertansiyon yaygınlığının araştırılması, toplam vücut yağ içeriğinin belirlenmesi ve ilişkili risk etkenlerinin değerlendirilmesidir.* ***Yöntem:*** *Çalışma 77 DEHB/100 sağlıklı çocuk ve adolesan üzerinde yürütüldü. Çalışmaya katılanlar, araştırmacılar tarafından hazırlanan bir anket formu doldurdular. Boy, kilo ve kanbasıncı (KB) ölçümleri standart protololler gore gerçekleştirildi. Toplam vücut yağ içeriği 'biyoelektrik impedans analiz' yöntemi ile gerçekleştirildi.* ***Bulgular:*** *Hasta grubunda obezite/hipertansiyon oranı %16.9/%13.0 olarak belirlendi. Hastalarda kontrol grubuna göre obezite daha sık görülüyordu ve diyastolik KB değerleri daha yüksekti. Toplam vücut yağı (%) hem obez, hem de obez olmayan hastalarda daha yüksekti. Kızlarda, sistolik ve diyastolik KB değerleri hasta grubunda kontrole göre daha yüksekti. Kızlarda, hafta sonu günlerinde uyku süresi hasta grubunda daha kısaydı. Babaların beden kitle indeksi DEHB grubunda daha fazlaydı. Hastalarda çikolata/şeker/tavuk/balık tüketimi ve günde 1 saatten fazla ekran zamanı daha yaygındı.*

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Sonuç: *Çalışmamızdaki yüksek obezite/hipertansiyon oranları, DEHB hastalarında ağırlık ve KB değerlendirmelerinin DEHB hastalarının izlemlerinin bir parçasının olması gerektiğini vurgulamaktadır. Bu hastalar obez olmasalar bile yüksek toplam vücut yağı açısından risk altındadırlar. Kısa uyku süresi, fazla miktarda çikolata/şeker/tavuk/balık tüketimi ve günde 1 saatten fazla ekran zamanı DEHB gelişimi için risk etkeni olabilir.* ***(Anadolu Psikiyatri Derg 2019; 20(1):93-100)***

Anahtar sözcükler: *Dikkat eksikliği hiperaktivite bozukluğu, çocukluk çağı, hipertansiyon, obezite*

INTRODUCTION

Attention-deficit hyperactivity disorder (ADHD) is a common neurodevelopmental disorder of childhood, estimated prevalence exceeding 5% in childhood.[1,2] It is characterized by persistent patterns of inattention and/or hyperactivity-impulsivity. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria it is divided into three subtypes attending symptomatology: inattentive (IA); hyperactive-impulsive (HA) and combined (C) type.[1-3] Genetic, structural, environmental, neurophysiological factors play roles in the pathogenesis.[1,2,4,5]

Recently, many studies demonstrated a possible association between ADHD and obesity/hypertension in childhood.[1,2,5-8] Obesity prevalence was reported as 9.3%-19.0%, and hypertension prevalence was reported as 12.4%-17.5% in children with ADHD.[5-9] The ADHD may cause obesity with abnormal eating behaviors, or obesity and ADHD may develop as a consequence of differential expression of common neurobiological dysfunctions.[4,5] Hypertension may develop as a secondary health problem of ADHD via obesity or differences in healthy behavior habits like dietary intake/physical activity.[7,8] Also, hypertension may cause inattentive symptoms in children.[8]

The aim of the present study was to investigate the obesity/hypertension prevalence of children with ADHD, total body composition and differences between the study and control groups. It was also aimed to evaluate whether ADHD is associated with socio-economic status, parental obesity, birth weight, breastfeeding duration, initial time of complementary food, physical activity, nutritional behaviors, sleep duration, and screen time (computer usage/television (TV) viewing time).

METHODS

The study was conducted between June 2012 and December 2012.The patient group consisted of 77 children/adolescents diagnosed with ADHD in Gaziantep University Hospital Child and Adolescent Psychiatry Outpatient Clinics according to the DSM-IV diagnostic criteria.[3] The scoring for the ADHD symptoms was performed according to teachers reported symptoms of Turgay DSM-IV-Based Child and Adolescent Disruptive Behavioral Disorders Screening and Rating Scale (T-DSM-IV).[10] Children with comorbid psychiatric disorder excluded from the study according to the Schedule for Affective Disorders and Schizophrenia for School Age Children--Present and Lifetime Version--Turkish Version (K-SADS-PL-T) diagnostic criteria.[11] The control group consisted of 100 healthy children/adolescents admitted to the Well-Child Outpatient Clinic for routine health visits.

The minimum sample size was determined as 73 persons in each group at the 80% power level within α error of 5% with MedCalc (version 11.5.1) program according to the previous literature.[12] The study was approved by the local Ethical Committee of Gaziantep University Faculty of Medicine. Individuals were included in the study if their parents signed informed consent form.

All participants completed a questionnaire form prepared by researchers based on the previous literature.[5,8,13-17] The questionnaire form consists of three parts. The first part included questions about sociodemographic features. The second part included questions about birth weight, exclusively/totally breastfeeding duration, the initial time of complementary food. The final part included questions about physical activity, nutritional behaviors, sleep duration, and screen time.

Anthropometry

The weight/height measurements were performed using standardized protocols. Body mass index (BMI) was calculated as the weight divided by square of height (kg/m^2). International Obesity Task Force's (IOTF) international standards were used to diagnosis of obesity.[18-20] A BMI between 85th and 95th percentile was classified as overweight, above the 95th percentile was classified as obese. Parental obesity was evaluated according to BMI values, ≥25 was accepted as overweight, ≥30 was accepted as obese.

Total body composition (total body fat (%), total body water (%), free fat mass, muscle mass) analysis was performed by bioelectrical imped-

ance analysis (BIA) method with Tanita TBF 300 instrument (Tanita Corporation, Tokyo, Japan). The BIA method is a technique for prediction of body composition based on the difference in electrical conductive properties of various tissue. The accuracy of this method has been proven by comparing magnetic resonance imaging (MRI) and dual-energy X-ray absorptiometry (DEXA) measurements of visceral adipose tissue.[21]

Blood pressure

Measurement was performed according to the recommendations of the American Hearth Association.[22] The population-based age-sex-and-height percentile values provided by Task Force on Hypertension Control in Children and Adolescents were used for evaluation of the systolic/diastolic BP (SBP/DBP) values.[22] Normotension was defined as SBP and DBP<90th percentile, prehypertension was defined as at least one of the SBP or DBP ≥90th and <95th percentile, hypertension was defined as at least one of the SBP or DBP≥95th.[22]

The measurement of weight/height/total body composition/BP values were performed at the time of initial diagnosis in ADHD patients, and the questionnaire form was also completed.

Statistical analysis

All data were analyzed by using the computer software Statistical Package for the Social Sciences for Windows (version 22.0; SPSS). The numeric values were given as mean±SD or percentage (%). The chi-square test was used to determine the relationship between categorical variables. The Pearson's correlation test was used to determine the relationship between pairs of continuous variables. Differences between groups in numeric variables were compared by Mann-Whitney U-test or Student's t test. p<0.05 value were considered as statistically significant.

RESULTS

Sociodemographic features

The mean age of the children was 8.95±2.68 years (range: 5.00-15.00) in ADHD group (61 male/16 female), and 9.68±2.42 years (range: 6.00-14.00) in controls (73 male/27 female). Sibling number was lower in patients (ADHD: 2.80±1.08 (range: 1-6); Control: 3.59±1.60 (range: 1-9); CI 95%=0.38-1.18; p<0.001).

Nutritional history

Exclusively breastfeeding duration was shorter and initial time of complementary food was earlier in patients (p<0.05) (Table 1). Consumption of chocolate/sugar in every day was more common in patients (ADHD: 70, 95.9%; Control: 78, 78.0%; OR=6.58; CI 95%=1.89-22.94; p=0.001). Similarly, consumption of chicken/fish in every day was more common in patients (ADHD: 52, 70.3%; Control: 55, 55.0%; OR=1.93; CI 95%=1.02-3.65; p=0.041).

Sleep pattern

There was no significant difference in sleep duration between ADHD patients and control group (p<0.05) (Table 1). However, in girls sleep duration (weekend-days) was shorter in patients (ADHD: 9.21±1.67 hours (range: 6-12); Control: 10.54±1.50 hours (range: 7-12); p=0.021).

Screen time

In patients TV viewing>1 hour in per day on weekdays was more frequent than controls (p<0.001) (Table 1). Computer usage>1 hour in per day on weekdays/weekend days was more common in patients (p<0.05) (Table 1).

Anthropometric measurements and blood pressure values

While hypertension and obesity prevalence were 9.0%/4.0% in controls, 13.0%/16.9% in patients (Table 2). Obesity was more frequent in patients (p=0.016) (Table 2).Hypertension was more frequent in patients, but not significant (p=0.324) (Table 2). The DBP values were higher in patients (p<0.001) (Table 3). In females, BP values were higher in patients than female controls (p<0.05) (Table 2). In males, only DBP values were higher in patients than male controls (p<0.001) (Table 2). Interestingly, BMI of the patients was positively correlated with paternal BMI (Table 4). Paternal BMI was higher in ADHD group (p<0.001) (Table 3). Paternal overweight/obesity prevalence were more frequent in patients (ADHD: 47, 75.8%; Control: 31, 32.0%; OR=6.67; CI 95%=3.24-13.72; p<0.001).

Total body composition values

Muscle mass/total body water (%) was lower while total body fat (%) was higher in both obese and non-obese patients (p<0.05) (Table 3). In patients, there was a positive correlation between BP values and BMI/total body fat (%)/maternal BMI values (Table 4). But, there was a negative correlation between SBP/DBP and total body water (%) (Table 4).

Subtypes of ADHD patients

The 32.5% (n=25) of the patients was ADHD-IA type, 14.3% (n=11) of them was ADHD-HA type,

Table 1. The comparison of the age, gender, breastfeeding duration, sleep duration, screen time between of the ADHD patients and control group

	ADHD Mean±SD (Min-max)	Control Mean±SD (Min-Max)	CI 95%	p
Age (years)	8.95±2.68 (5.00-15.00)	9.68±2.42 (6.00-14.00)	(-0.03)-(1.46)	0.063
Birth weight (kg)	3.18±0.74 (1.00-4.60)	3.27±0.83 (1.00-5.00)	(-0.16)-(0.34)	0.475
Exclusively breastfeeding duration (month)	4.86±2.22 (0-12)	5.64±2.66 (0-15)	0.02-1.53	0.044
The initial time of complementary food (month)	5.35±1.83 (1-12)	6.87±2.50 (1-15)	0.86-2.17	<0.001
Total breastfeeding duration (month)	12.07±7.70 (0-30)	13.38±7.36 (1-36)	(-0.47)-(-4.05)	0.120
Sleep duration in weekdays (hour)	9.21±1.16 (6.00-12.00)	9.14±1.64 (5.00-13.00)	(-0.50)-(0.37)	0.768
Sleep duration in weekend-days (hour)	9.69±1.60 (6.00-12.00)	9.94±1.83 (5.00-14.00)	(-0.30)-(0.80)	0.372
	n %	n %	OR	p
Gender				
Male	61 79.2	73 73.0	1.41	0.339
Female	16 20.8	27 27.0		
Television viewing time				
>1 hour in per day on weekdays	59 84.3	50 51.0	5.15	<0.001
>1 hour in per day on weekend days	64 90.1	78 80.4	2.23	0.085
Computer usage time				
>1 hour in per day on weekdays	21 60.0	12 21.1	5.62	<0.001
>1 hour in per day on weekend days	31 83.8	33 55.9	4.07	0.005

Table 2. The evaluation of obesity and hypertension status in ADHD patients and control group

	ADHD n %	Control n %		p
Obesity status				0.016
Normoweight	57 74.0	85 85.0		
Overweight	7 9.1	11 11.0		
Obese	13 16.9	4 4.0		
Hypertension status				0.324
Normotensive	55 71.4	81 81.0		
Prehypertensive	12 15.6	10 10.0		
Hypertensive	10 13.0	9 9.0		
	ADHD Mean±SD (Min-max)	Control Mean±SD (Min-max)	CI 95%	p
Females				
Systolic blood Pressure (mmHg)	105.63±10.93 (90.00-120.00)	95.56±17.39 (70.00-140.00)	(-18.79)-(-1.34)	0.015
Diastolic blood Pressure (mmHg)	68.75±8.66 (60.00-80.00)	55.56±11.20 (40.00-80.00)	(-19.82)-(-7.01)	<0.001
Males				
Systolic blood Pressure (mmHg)	102.54±10.97 (85.00-130.00)	101.23±12.46 (70.00-130.00)	(-5.36)-(2.74)	0.520
Diastolic blood Pressure (mmHg)	65.90±8.58 (50.00-90.00)	60.58±9.90 (40.00-80.00)	(-8.38)-(2.06)	<0.001

Table 3. The comparison of the body mass index, blood pressure, and body fat composition values between ADHD and control group

	ADHD Mean±SD	Control Mean±SD	CI 95%	p
Body mass index (BMI) (kg/m^2)	17.83±3.38 (12.80-29.36)	17.74±3.95 (12.70-31.50)	(-1.25)-(1.02)	0.869
Maternal BMI	25.97±4.19 (19.72-39.90)	25.77±4.19 (17.20-38.67)	(-1.56)-(1.11)	0.766
Paternal BMI	27.74±4.11 (19.41-40.40)	24.59±3.47 (16.60-32.87)	(4.35)-(-1.94)	<0.001
Systolic blood pressure (mmHg)	103.18±10.97 (85.00-130.00)	99.70±14.10 (70.00-140.00)	(-7.32)-(0.36)	0.075
Diastolic blood pressure (mmHg)	66.49±8.62 (50.00-90.00)	59.30±10.46 (40.00-80.00)	(-10.10)-(-4.29)	0.075
Total body fat (%)	18.07±6.54 (3.0-40.9)	15.54±7.29 (3.0-45.9)	(-4.63)-(-0.44)	0.018
Fat free mass	25.80±9.75 (13.4-68.6)	29.76±12.99 (3.3-58.3)	(0.58)-(7.35)	0.022
Muscle mass	24.38±9.30 (12.5-65.2)	28.59±11.83 (12.4-55.4)	1.06-7.35	0.009
Total body water	18.88±7.14 (9.8-50.2)	22.18±9.10 (9.7-42.7)	0.88-5.71	0.008
Total body water (%)	60.23±4.98 (43.4-70.9)	61.82±5.34 (39.5-71.1)	0.02-3.15	0.046

Table 4. The relationship between the systolic/diastolic blood pressure and body mass index/parental body mass index/body composition values in ADHD patients

	Systolic blood pressure at the time of initial diagnosis		Diastolik blood pressure at the time of initial diagnosis	
	r	p	r	p
Body mass index of the patients (kg/m^2)	0.485	<0.001	0.459	<0.001
Maternal body mass index	0.289	0.016	0.318	0.008
Total body fat (%)	0.313	0.006	0.304	0.008
Total body water (%)	-0.346	0.002	-0.336	0.003
	Maternal body mass index		Paternal body mass index	
Body mass index of the patients	0.339	0.004	0.323	0.010

while 53.2% (n=41) of them was ADHD-C type. Although there was not statistically significant difference, ADHD-IA type was more frequent in girls than boys (p>0.05). The BMI values was higher in ADHD-IA type patients (p=0.004) (Table 5). There was no significant difference between ADHD subtypes in terms of total body fat (%)/BP/heart rate values (p>0.05) (Table 5). .

DISCUSSION

In recent years, studies suggest that ADHD could be associated with nutritional habits.[5,8,13,14] Similar with our results, previous studies indicate that ADHD patients more likely to consume fatty/sweet foods related to obesity, and increased sugar intake could also play a role in the development of ADHD.[5,8,13,14] The reward deficiency hypothesis in ADHD which is due to the insufficiency of brain dopamine may lead to an increased consumption of fatty/sweet foods.[8] Interestingly, chicken/fish consumption was also more frequent. In recent years, exposure to heavy metal/chemical substances (especially chickens, fish, milk, eggs) due to environmental pollution with nutrition has become an important public health problem.[23] The environmental risk factors (e.g. heavy metals) and chemical material exposures (e.g. lead, mercury, organochlorine, organophosphates, and phthalates) can

Table 5. The evaluation of the differences between BMI, DBP, total body fat (%) values of ADHD-IA type, ADHD-HA type, and ADHD-C type

	ADHD-IA type Mean±SD (Min-max)	ADHD-HA type Mean±SD (Min-max)	ADHD-C type Mean±SD (Min-max)	p
Body mass index (kg/m²)	68.40±9.09* (60-90)	65.45±9.60† (55-80)	65.61±8.07 (50-80)	0.004
Total body fat (%)	18.48±6.34 (3.0-30.3)	14.71±4.57 (9.6-24.6)	18.52±6.96 (4.1-40.9)	0.089
Systolic blood pressure (mmHg)	103.00±11.08 (90.00-120.00)	101.82±13.28 (90.00-120.00)	103.66±10.49 (85.00-130.00)	0.789
Diastolic blood pressure (mmHg)	68.40±9.09 (60.00-90.00)	65.45±9.60 (55.00-80.00)	65.61±8.07 (50.00-80.00)	0.446
Heart rate	69.36±8.92 (55-85)	78.73±10.66 (66-100)	78.37±13.15 (60-120)	0.110

**: Significant ADHD-IA type versus ADHD-HA type; †: Significant ADHD-HA type versus ADHD-C type*

cause predisposition to ADHD.[24] Based on this information, we can only be hypothesized that heavy metal/chemical material exposure with nutrients may play a role in ADHD susceptibility. However, to support our hypothesis, there is a need for experimental animal research for determining the possible effects of exposure to environmental pollution with foods on the development of ADHD.

Sleep disturbances are highly comorbid with ADHD, 25-55% of the children with ADHD experience sleep problems. Sleep difficulties may exacerbate the ADHD symptoms or ADHD-associated disruptive behaviors may also influence sleep pattern. It may be due to genetic links between the ADHD and circadian rhythm disturbance.[1,8,15,16] Short sleep duration was observed in ADHD patients.[13] Females experienced more sleep difficulties[15,16] Similarly, our study indicated that in girls sleep duration was shorter in patients. There is a close relationship between sleep patterns and metabolic regulation, sleep disturbances lead to changes in energy metabolism and may increase the risk of obesity and related comorbidities.[25] When these problems are evaluated together, a good sleep hygiene may prevent chronic complications in ADHD. Therefore, assessment of sleep pattern in children with ADHD should routinely check by health professionals.

Long periods of screen time during childhood could be a risk factor for ADHD.[4] Dysfunctional cognitive hyperstimulation via TV/computer may have a role in the development of ADHD by modulating the intensity of neuronal synapse formation.[4] Previous studies were examined the association between screen time and ADHD, but the results were contradictory. Stevens et al. did not find any association.[17] However, a recent study indicated that screen time was independently associated with ADHD in children.[13] Our study also demonstrated that more than 1 hour screen time was associated with ADHD. The variations between studies could originate from differences in race, socioeconomic, cultural and environmental factors. The American Academy of Pediatrics recommends that maximum screen time should be limited to 2 hours per day in childhood as a preventive measure for related health risks.[26] Even though our results emphasize that restricted screen time under 1 hour may have a preventive role ADHD development, further studies are required to investigate causality and to determine if the short time of screen time could reverse the symptoms of ADHD.

Recent studies suggest that ADHD could be associated with high incidence of obesity.[1,5,8] Obesity can lead to or reveal to ADHD symptoms. Obesity and ADHD can be the different expressions of a common neurobiological dysfunction. The ADHD can contribute to obesity development with abnormal eating behaviors or ADHD specific lifestyle.[1,5] Obesity prevalence was reported between 9.3%-19.0% in children with ADHD.[5,8,9] Our study indicated that obesity prevalence was 16.9% in ADHD patients and more frequent than controls. We also demonstrated that, hypertension prevalence was 13.0% in patients and DBP values were higher than control. Grisaruet al. measured BP using Ambulatory Blood Pressure Monitoring (ABPM) method and they found that children with ADHD

more likely to have abnormally elevated wake systolic loads.[6] Fuemmeler et al. reported that hypertension prevalence was changing between 12.4%-17.5% according to IA/HA symptoms.[7] They concluded that psychosocial factors and health behaviors (e.g. smoking, healthy dietary intake, physical activity, sleep pattern) may mediate developing hypertension in adulthood.[7] But, hypertension is usually secondary due to medical reason in childhood.[8] There has been a significant increase in asymptomatic hypertension prevalence in children.[27] Also, asymptomatic hypertension may cause inattentive symptoms in children.[8] One could be argued that routine BP measurement at the time of initial diagnosis in children with ADHD should be advised. However, this is a preliminary study; further research should be done in large series to validate our results.

To our present knowledge, this study is the first to compare total body composition between ADHD patients and healthy subjects. To date, there is only one study carried out by BIA method in childhood, but the relationship between total body fat and ADHD has not been investigated.[13] Our study demonstrated that total body fat (%) was higher in both obese and non-obese children with ADHD. The ADHD patients more likely to consumption of high calorie foods.[8] Overconsumption of sweet foods could be associated with increasing amounts of body fat even if ADHD patients are not obese. Since increased body fat is associated with elevated BP, clinicians should pay attention to the consumption of sugar during routine follow-up of children with ADHD.[28] There was also a positive correlation between BP values and total body fat (%) in ADHD patients in our study. Our results cannot be generalizable to other populations. Further studies in different sociodemographic groups are needed to confirm our findings.

The main limitation of this study is relatively small sample size. Another limitation is that all measurements of BP were taken on the same day and no follow-up was done to confirm the diagnosis of hypertension. Additionally, the present data were based only on self-reported questionnaires, may not be objective. Despite these limitations, our findings may have potential prevention strategies for the development of obesity/hypertension in children with ADHD. The major strength of this study is that ADHD diagnosis was made by child and adolescent psychiatrists, and other psychiatric comorbidities were eliminated. Further, this study provides additional data about total body composition. Our study also examines the relationship between parental obesity/sleep duration/screen time/dietary habits and obesity/hypertension risk in ADHD patients.

In conclusion, assessment of obesity/hypertension and associated risk factors should be a part of the ADHD management to preventing long-term complications. The ADHD patients may have an increased risk of high total body fat even though individuals are not obese, and body fat is positively associated with BP values. The ADHD may also cause short sleep duration, long screen time and consumption of a high amount of chocolate/sugar/chicken/fish. Clinicians should be aware of the possibility of increased risk of high body fat in children with ADHD. In addition, physicians should also educate these children and parents on unhealthful lifestyle habits. Nevertheless, larger studies are required to expand on our findings.

Authors' contributions: *N.Ç.: conceptualized the study, literature search, performed the measurements of all children, conducted the statistical analysis, drafted the initial manuscript and revised the subsequent drafts; C.G.: performed the ADHD diagnosis, conceptualized the study. B.D.K.: critically reviewed the manuscript; M.K.: performed the ADHD diagnosis.*

REFERENCES

1. *Cortese S, Tessari L. Attention-deficit/hyperactivity disorder (ADHD) and obesity: Update 2016. Curr Psychiatry Rep 2017; 19:14.*
2. *Cortese S, Moreira-Maia CR, St Fleur D, Morcillo-Peñalver C, Rohde LA, Faraone SV. Association between ADHD and obesity: a systematic review and meta-analysis. Am J Psychiatry 2016; 173:34-43.*
3. *American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders, 4th ed. Washington (DC): American Psychiatric Association, 1994.*
4. *Bazar KA, Yun AJ, Lee PY, Daniel SM, Doux JD. Obesity and ADHD may represent different manifestations of a common environmental oversampling syndrome: a model for revealing mechanistic overlap among cognitive, metabolic, and inflammatory disorders. Med Hypotheses* 2006; 66:263-269.

5. Cortese S, Angriman M, Maffeis C, Isnard P, Konofal E, Lecendreux M, et al. Attention-deficit/hyperactivity disorder (ADHD) and obesity: a systematic review of the literature. Crit Rev Food Sci Nutr 2008; 48:524-537.
6. Grisaru S, Yue MW, Mah JC, Hamiwka L. Ambulatory blood pressure monitoring in a cohort of children referred with suspected hypertension: characteristics of children with and without attention deficit hyperactivity disorder. Int J Hypertens 2013; 2013:419208.
7. Fuemmeler BF, Østbye T, Yang C, McClernon FJ, Kollins SH. Association between attention-deficit/hyperactivity disorder symptoms and obesity and hypertension in early adulthood: a population-based study. Int J Obes (Lond) 2011; 35:852-862.
8. Nigg JT. Attention-deficit/hyperactivity disorder and adverse health outcomes. Clin Psychol Rev 2013; 33:215-228.
9. Curtin C, Bandini LG, Perrin EC, Tybor DJ, Must A. Prevalence of overweight in children and adolescents with attention deficit hyperactivity disorder and autism spectrum disorders: a chart review. BMC Pediatr 2005; 5:48.
10. Turgay A. Disruptive behavior disorders child and adolescent screening and rating scales for children, adolescents, parents and teachers. West Bloomfield (Michigan): Integrative Therapy Institute Publication, 1994.
11. Gökler B, Ünal F, Pehlivantürk B, Kültür EÇ, Akdemir D, Taner Y. Reliability and validity of Schedule for Affective Disorders and Schizophrenia for School Age Children--Present and Lifetime Version--Turkish Version (K-SADS-PL-T). Çocuk ve Gençlik Ruh Sağlığı Derg 2004; 11:109-116.
12. Yuca SA, Yılmaz C, Cesur Y, Doğan M, Kaya A, Başaranoğlu M. Prevalence of overweight and obesity in children and adolescents in eastern Turkey. J Clin Res Pediatr Endocrinol 2010; 2:159-163.
13. San Mauro Martín I, Blumenfeld Olivares JA, Garicano Vilar E, Garicano Vilar E, Echeverry López M, García Bernat M, et al. Nutritional and environmental factors in attention-deficit hyperactivity disorder (ADHD): A cross-sectional study. Nutr Neurosci 2017; 11:1-7.
14. Johnson RJ, Gold MS, Johnson DR, Ishimoto T, Lanaspa MA, Zahniser NR, et al. Attention-deficit/hyperactivity disorder: is it time to reappraise the role of sugar consumption? Postgrad Med 2011; 123:39-49.
15. Lunsford-Avery JR, Krystal AD, Kollins SH. Sleep disturbances in adolescents with ADHD: A systematic review and framework for future research. Clin Psychol Rev 2016; 50:159-174.
16. Coogan AN, Baird AL, Popa-Wagner A, Thome J. Circadian rhythms and attention deficit hyperactivity disorder: The what, the when and the why. Prog Neuropsychopharmacol Biol Psychiatry 2016; 67:74-81.
17. Stevens T, Mulsow M. There is no meaningful relationship between television exposure and symptoms of attention-deficit/hyperactivity disorder. Pediatrics 2006; 117:665-672.
18. International Obesity Task Force data, based on population weighted estimates from published and unpublished surveys,1990-2010 using IOTF-recommended cut-offs for overweight and obesity, London: IOTF, 2011. Available at: http://iotf.org.
19. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a Standard definition for child overweight and obesity worldwide: internationals survey. BMJ 2000; 320:1240-1243.
20. National Centre for Health Statistrics. Data table of BMI-for-age charts.Centers for Disease Control and Prevention. https://www.cdc.gov/growthcharts/html_charts/bmiagerev.htm
21. Chen W, Jiang H, Yang JX, Yang H, Liu JM, Zhen XY, et al. Body Composition Analysis by Using Bioelectrical Impedance in a Young Healthy Chinese Population: Methodological Considerations. Food Nutr Bull 2017; 38: 172-181.
22. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004; 114:555-576.
23. Wu Y, Zhang H, Liu G, Zhang J, Wang J, Yu Y, et al. Concentrations and health risk assessment of trace elements in animal-derived food in southern China. Chemosphere 2016;144:564-570.
24. Polanczyk GV, Salum GA, Sugaya LS, Caye A, Rohde LA. Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. J Child Psychol Psychiatry 2015; 56: 345-365.
25. Faienza MF, Wang DQ, Frühbeck G, Garruti G, Portincasa P. The dangerous link between childhood and adulthood predictors of obesity and metabolic syndrome. Intern Emerg Med 2016; 11:175-182.
26. Krebs NF, Jacobson MS; American Academy of Pediatrics Committee on Nutrition. Prevention of pediatric overweight and obesity. Pediatrics 2003; 112:424-430.
27. National Health, Lung and Blood institute, 8. High Blood Pressure Report, https://www.nhlbi.nih.gov/health-pro/guidelines/current/cardiovascular-health-pediatric-guidelines/full-report-chapter-8
28. Çöl N, Kilinc A, Demircioğlu-Kılıç B, Aydin N, Keskin M, Balat A. Predictive value of the Blood Pressure to Height Ratio in diagnosis of prehypertension and hypertension during childhood in southeastern Turkey. Clin Exp Hypertens 2018, doi: 10.1080/10641963.2018.1433198