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Cognitive profile and academic achievement of children with absence epilepsy

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ABSTRACT

The main aim of this study was to examine the cognitive profile and academic achievement of children with absence epilepsy. It is investigated whether all scale intelligence score, intelligence subscale scores, and academic achievement of the children with absence epilepsy differed from healthy peers and Turkish norm values. Nineteen children with absence epilepsy and 19 healthy children participate in the study. The Wechsler Intelligence Scale for Children-IV (WISC-IV) is used to measure their intelligence scores. A teacher assessment form (Teacher's Report Form (TRF)) is obtained from the participants' teachers for the measurement of academic achievement, and the students' report cards are collected as an additional measure of it. Participants with absence epilepsy have significantly lower scores of total intelligence score (Mean (M) = 76.68, Standard Deviation (SD) = 25.18), verbal comprehension score (M = 81.68, SD = 25.29), perceptual reasoning score (M = 85.47, SD = 20.61), processing speed score (M = 77.95, SD = 18.61), and working memory (M = 83.74, SD = 19.04), which are measured by WISC-IV, than healthy peers (respectively M = 105.84, SD = 16.20; M = 105.47, SD = 18.12; M = 103.63, SD = 12.88; M = 104.05, SD = 12.98; M = 104.74, SD = 18.97) and norm values (M = 100, SD = 10). No difference is observed between the subscale scores of WISC-IV for within group with absence epilepsy. Moreover, they have lower Turkish language (M = 73.65, SD = 19.19) and mathematics (M = 76.26, SD = 22.29) grade report scores than healthy peers (respectively M = 90.76, SD = 12.01; M = 88.64, SD = 15.93). There is no difference between the two groups in terms of the academic achievement obtained from the TRF. It is necessary to support children with absence epilepsy academically. We analyzed whether the current pattern has changed by comparing the intelligent scores and academic achievement of children with absence epilepsy who have recovered after treatment with their healthy peers. In fact, there is no difference between the children with absence epilepsy who have recovered after treatment and their healthy peers in terms of total intelligence score and its subscale scores. Similarly, there is no difference between them in terms of mathematics score on their report. Only the difference in the score of Turkish language continues in the same direction.

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1. Introduction

Epilepsy is defined as a brain disorder characterized by predominantly recurrent disruptions to normal functions of the brain, often referred to as epileptic seizures [1]. About 50 million people of all ages in the world have symptoms that will be diagnosed with epilepsy according to the World Health Organization (WHO) [2]. Accordingly, epilepsy is defined as the most common neurological disorder worldwide. Changes in cognitive functions and social adaptation behavior of individuals with epilepsy may be observed. In addition, psychosocial differentiation with the disease may occur [3]. Epilepsy is a disorder that affects the central nervous system and causes various neurology and psychiatric outcomes. Different types of psychiatric, neurological, and radiological findings can be observed in each type of epilepsy. For example; in addition to neurological symptoms, various sensory hallucinatory symptoms are seen in individuals with temporal lobe epilepsy [4] and occipital lobe epilepsy [5]. In absence epilepsy, symptoms such as loss of consciousness and interruption of motor activation can be observed. In addition, generalized 3-Hertz spike waves can be seen on electroencephalography (EEG) output [6]. The epileptiform activities, which mean deviations from normal brain waves in EEG recording, in children with epilepsy may affect their learning mechanisms. They

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lead to distortions in the coding, storage, and recall processes of information and cause difficulties in learning new information [7]. This difficulty may lead to a decrease in academic performance of children with epilepsy.

Seizures are characteristic features of epilepsy; thus, antiepileptic medications are highly preferred for reducing and eliminating seizures [8]. However, they have various effects on cognitive functions also [9]. For instance, they may create focus and memory problems [10]. Moreover, they may cause increasing cognitive response time and deterioration on short- or long-term memory and semantic verbal fluency [11] and behavioral problems [8]. Ethosuximide, valproic acid, and lamotrigine are generally used in the treatment of children with absence epilepsy. Ethosuximide is more effective in the short term while three antiepileptic medications have similar efficacy in seizure control in the long term. On the other side, lamotrigine users reported less adverse side effects [12].

Approximately 20% of the epilepsy types seen in childhood are absence epilepsy [13]. The cognitive functions of children with absence epilepsy are impaired in their executive functions and in their sustained and divided attention. The intelligence scores of these children do not differ from the intelligence scores of healthy children [14]. In contrast, there are studies showing that these children differ from healthy children in terms of various variables. For instance, children diagnosed with absence epilepsy have lower scores on the Wechsler Intelligence Scale for Children — Revision (WISC-R) performance subscale and memory tests than healthy children [15]. In addition, the intelligence scores of these children differ from those of the healthy group [16–19]. Children with epilepsy also experience academic difficulty at a higher rate compared with healthy participants [20–24]. For instance, about 25% of children with epilepsy have more academic difficulties and cognitive–behavioral problems than their healthy peers [17,25,26]. In addition to the deterioration of cognitive domains, the sociodemographic variables may also be considered as reasons for the difficulties in the academic field. For instance, in a study about children with epilepsy having academic difficulties, the mediating effect of parent support between neuropsychological findings and academic achievement was evaluated, and it was found that parent support strongly mediated academic achievement [27].

The aim of this study was to examine the cognitive profiles and academic achievement of children with absence epilepsy. Research has been done to find out whether the Wechsler Intelligence Scale for Children-IV (WISC-IV) full-scale intelligence score and subscales intelligence scores of children with absence epilepsy differ from healthy children's scores. In the context of research, findings obtained by intelligence tests, especially in children with epilepsy, serve as guides for the professionals in the provision of diagnostic and treatment services, and preparers of educational programs [28]. Findings from this study will provide information about which areas children with absence epilepsy have cognitive differences and academic difficulties.

2. Method

2.1. Participants

Forty-two children participated in the study, and they were aged between 6 years and 1 month and 16 years. One participant from the healthy group (due to medications used that could impair cognitive performance) and 3 participants from the group with absence epilepsy (due to attention deficit hyperactivity disorder comorbidity and the use of more than two antiepileptic medications) were removed from the data set. Of the remaining 38 participants, 26 were female (68.42%) and 12 were male (31.58%). Half of the participants (M_{age} = 10 years and 6 months) were healthy (M_{age} = 9 years and 10 months) while the other half were diagnosed with absence epilepsy (M_{age} = 11 years and 3 months).

The participants had a history of absence epilepsy ranging from 4 months to 12 years. In addition, participants' treatment history is differentiated in relation to the diagnosis history of epilepsy (from 3 months to 12 years). Only one of the participants stated that the epileptic seizure occurred several times a month while others (n = 18, 94.74%) stated that they had seizures several times a day. None of them had pathologic magnetic resonance symptom. They had epileptiform activities characterized by absence epilepsy. Other demographic information is given in Table 1.

2.2. Measures

2.2.1. Demographic information form

Information on participants' age, gender, hand preferences, literacy problems, parental education level and status, and epilepsy history was collected with a demographic information form, which was prepared by the researcher.

2.2.2. Wechsler Intelligence Scale for Children-IV

The WISC-IV was developed to measure the cognitive skills of children aged 6 to 16 years [29,30]. This scale consists of 10 subscales and 5 supplemental tests. A total of 4 transformed cluster points are obtained from 10 subscales applied in WISC-IV. These are the following: verbal comprehension index (VCI), perceptual reasoning index (PRI), the working memory index (WMI), and the processing speed index (PSI). Together, the VCI, PRI, WMI, and PSI provide the full-scale of intelligence (FSIQ).

2.2.3. Achenbach Teacher's Report Form

For each participant, (a) the participant's academic achievement status according to his/her classmates, (b) his/her level of recognition by their teachers, and (c) the teachers' perceptions of participant's academic competence were collected through the Achenbach Teacher's Report Form (TRF) [31]. This form was filled in by the participant's teacher (class, guidance, or other). High scores indicated (a) Turkish and Mathematics scores above the class average, (b) high recognition by the teacher, and (c) teacher's positive academic competence perception toward the student.

2.2.4. Report cards

Information on the academic achievements of the participants was collected via the report cards received by the participants at the end of the last semester, which includes grades of a variety of lessons. Since participants had different educational levels, grades ranging from 0 to

Table 1
Exploratory information about children with absence epilepsy.

		N	%
Epilepsy type	Typical	12	63
	Atypical	7	37
Treatment status	Completed	7	37
	Ongoing	12	63
Duration of epileptic history (years)	<2	4	21.1
	2–4	6	31.65
	4–6	3	15.6
	>6	6	31.65
Duration of treatment history (years)	<2	5	26
	2–4	9	46.9
	4–6	2	10.5
	>6	3	15.6
Number of medication used	1	13	68
	2	6	32
Therapeutic strategies	Only valproic acid	13	68
	Valproic acid + ethosuximide	3	15.6
	Valproic acid + carbamazepine	1	5.3
	Valproic acid + levetiracetam	1	5.3
	Valproic acid + lamotrigine	1	5.3
Regular medication use	Yes	17	89
	No	2	11

100 of their classes in common (Turkish and mathematics) were used as the measure of academic achievement.

2.3. Procedure

The database of the Pediatric Neurology Clinic of Mersin University was reviewed to reach children diagnosed with absence epilepsy between the ages of 6 and 16 years. Children with a neurological or psychiatric diagnosis [32] (for all participants) and who use more than two antiepileptic medications [33] (for children with absence epilepsy) were excluded from the sample. The purpose of the research was explained by communicating with the families of the eligible participants, and the parents who agreed to participate in the survey were given appointments to participate in the research with their children. Healthy children (those without neurological or psychiatric diagnoses) were reached through relatives of the patients admitted to the Children's Health and Diseases Clinic of Mersin University or other similar clinics. The participants with absence epilepsy were matched with healthy peers in terms of their age, gender, and socioeconomic variables. After receiving a written approval form showing the consent of a child and his/her parents, the participant's parents were asked to fill out the demographic information form. Following this process, WISC-IV was used, and the process took an average of 120 min for each participant. Upon completion of the applications, the parents were invited to the application room and given the TRF prepared for their children's teachers. Parents asked the participant's teacher to fill in the form and send it to the researcher by e-mail. Lastly, a copy of the report card that the parents have recently received from the teachers was required to be forwarded to the researcher's e-mail address. When the gathering process came to an end, the process was terminated by informing the parents of the participants about their children's scores from WISC-IV in accordance with ethical principles and rules.

2.4. Statistical approach

The educational levels of parents and the scores of problems in reading and writing of healthy participants and those with absence epilepsy were compared using the Z-ratio test. The question of whether there was a significant difference between WISC-IV total and subscale scores of these groups was tested by Hotelling's T^2 test. A Student's t test was performed to determine whether there was a difference between the values for children with absence epilepsy and the norm values of the Turkish population. Bonferroni correction was used where more than one t-test was performed in this process. Repeated analysis of variance (ANOVA) was performed to see if there were significant differences among WISC-IV subscales scores in this group. When different covariance variables were kept constant, the relationship between subscale scores of the WISC-IV test was examined with repeated analysis of covariance (ANCOVA). Hotelling's T^2 analysis was conducted to determine whether the participants differed in terms of their level in Turkish and mathematics classes according to their health status. When the various covariates were kept constant, ANCOVA was used again, and Hotelling's T^2 analysis was conducted to test whether there was any difference in terms of academic achievement in Turkish and mathematics from the grades in the report card according to the health status. The threshold of statistical significance was set at $P = .05$. In order to investigate the differentiation in the state of the children who recovered after treatment, the children who improved and their healthy peers were compared in terms of their intelligence scores and academic achievements. Because of the small number of children recovered ($N = 7$), the assumptions of parametric tests were found to be violated. Therefore, the Mann–Whitney U tests were used to test these research questions. At this stage, P value for each set (intelligence scores, scores from the report card, scores from TRF) was corrected using Bonferroni correction when evaluating H_0 hypothesis. Statistical analyses were performed by the Statistical Package for the Social Sciences (SPSS) Version 22 of IBM.

3. Result

3.1. Descriptive results of participants

The academic achievement of children with epilepsy can be influenced by the level of education of their parents as noted in the Introduction [27,34]. In order to discuss the potential causes of future findings, the educational levels of the parents of participants that are healthy were compared with the parents of those with absence epilepsy. Therefore, parents who are illiterate or have primary or secondary school education were classified into a group of low education while others who are high school graduates or have a bachelor's degree were classified into a group with high levels of education. Accordingly, children with absence epilepsy (13 mothers and 11 fathers) have a higher ratio of parents with lower educational levels (63% and 26%, respectively) than their healthy peers (5 mothers and 5 fathers), $Z = 3.23$, $P < .01$. To determine whether there is a meaningful difference in academic achievement among healthy participants and the ones with absence epilepsy, and to describe the characteristics of the sample, the ratios of reading and writing problems that the participants expressed in the demographic information form were compared. While there were no participants who stated that they had a problem with reading in the healthy group, a total of 8 children (42%) in the group with absence epilepsy stated that they had reading difficulties. According to the results of the Z-ratio test, reading difficulty is significantly higher in participants with absence epilepsy, $Z = 3.18$, $P < .01$. Likewise, while there were no children in the healthy group who stated that they had a problem with writing, 5 children (26%) in the group with absence epilepsy stated that they experienced this problem; thus, participants with absence epilepsy appear to be at a significantly higher ratio of writing problems, $Z = 1.99$, $P < .05$.

3.2. WISC-IV results

The WISC-IV total and subscale scores were compared according to the health status of the participants. According to the results of the analysis, verbal comprehension (T^2 (1,38) = 11.11, $P < .01$), perceptual reasoning (T^2 (1,38) = 10.61, $P < .01$), working memory (T^2 (1,38) = 11.60, $P < .01$), processing speed (T^2 (1,38) = 25.15, $P < .001$), and full-scale intelligence scores (T^2 (1,38) = 18.02, $P < .001$) of children with absence epilepsy were significantly lower than healthy participants. Information for average and standard errors are presented in Table 2.

Aforementioned scores of participants with absence epilepsy were compared with the norm values of the Turkish sample [35] ($Mean_{norm}$ (M_{norm}) = 100 ± 10 standard deviation (*SD*) for each variable) to test the validity of these findings. Results of the comparison with the norm

Table 2
Statistical information from WISC-IV of children with absence epilepsy and their healthy peers.

	Groups	Means	SD	Mean differences	Significance values
Verbal comprehension	Healthy	105.47	18.12	23.79	0.002
	Absence epilepsy	81.68	25.29		
Perceptional reasoning	Healthy	103.63	12.88	18.16	0.002
	Absence epilepsy	85.47	20.61		
Working memory	Healthy	104.74	18.97	21.00	0.002
	Absence epilepsy	83.74	19.04		
Processing speed	Healthy	104.05	12.98	26.11	0.0001
	Absence epilepsy	77.95	18.61		
Full-scale of intelligence	Healthy	105.84	16.20	29.16	0.0001
	Absence epilepsy	76.68	25.18		

values also supported the findings above. Accordingly, verbal comprehension (T (18) = 3.16, P < .01), perceptual reasoning (T (18) = 3.07, P < .01), working memory (T (18) = 3.72, P < .01), processing speed (T (18) = 5.17, P < .001), and full-scale intelligence scores (T (18) = 4.04, P < .01) of children with absence epilepsy were significantly lower than Turkish norm values. Furthermore, none of the WISC-IV subscales scores of children with absence epilepsy differed from each other, F (3,111) = 0.67, P = .56.

There are various studies in the literature that indicate that different variables such as the medications used, the number of medications used, and the duration of the epilepsy are the differentiating power on intelligence scores [32,36]. Since we think that some variables such as age at onset, duration of medications use, status of treatment (continuing or terminated), and the number of antiepileptic medications used may affect this pattern in the subscale of intelligence of participants with absence epilepsy, these variables were coded as covariance, and analysis was conducted again; however, the results showed no differences.

Are the intelligence scores of children recovering after treatment (RC) different from their healthy peers? In order to examine this, we compared them (N = 7) with their healthy peers and found that there was no difference between two groups in terms of verbal comprehension (M_{RC} = 89.43, SD_{RC} = 26.37), perceptual reasoning (M_{RC} = 89.57, SD_{RC} = 14.10), working memory (M_{RC} = 92.29, SD_{RC} = 15.38), processing speed (M_{RC} = 90.14, SD_{RC} = 90.28), and full-scale intelligence scores (M_{RC} = 86.86, SD_{RC} = 17.82).

3.3. Academic achievement results

Two different indicators have been used for academic achievement in this study. The first one is academic achievements in Turkish and mathematics, obtained from the TRF and the evaluation of the participant's academic achievement according to their class. There is no significant difference between healthy children and children with absence epilepsy in terms of their classroom positions in Turkish and mathematics classes. The teacher's recognition duration/status of the participants and scores of academic proficiencies perception toward them were coded as covariance, and the analysis was repeated; however, even if these variables were controlled, there was no significant difference between the healthy group and the group with absence epilepsy. The second indicator, which expresses the academic achievements of the participants, was the grades of Turkish and mathematics classes obtained from the participants' report cards that they have taken in the last academic semester. The mean of Turkish (M = 90.76, SD = 12.01) class grades of healthy children is significantly higher (T^2 (1,37) = 10.85, P < .01) than the average of children with absence epilepsy (M = 73.65, SD = 19.19); however, difference between them in terms of mathematics class grades is approximately significant (for healthy children, M = 88.64, SD = 15.93; for children with absence epilepsy, M = 73.65, SD = 19.19; T^2 (1,37) = 3.88, P = .057).

Is academic achievement of children recovering after treatment different from their healthy peers? As mentioned before, in order to examine this, we compared them with their healthy peers and found that there was no difference between the two groups in terms of Turkish language (M_{RC} = 2.29, SD_{RC} = 0.76) and mathematics (M_{RC} = 2.56, SD_{RC} = 0.55) from TRF and mathematics scores on the report card (M_{RC} = 83.24, SD_{RC} = 11.45); however, still, there was a difference between them in terms of Turkish language score (M_{RC} = 78.89, SD_{RC} = 10.32, P = .024).

4. Discussion

The aim of this study was to determine whether cognitive functions and academic achievement of children with absence epilepsy differed from healthy controls. It was found that children with absence epilepsy had significantly lower scores on all subscales of intelligence and on full-scale intelligence scores than healthy same-aged peers and Turkish norms. Findings in this study are consistent with findings in the literature [16,18,19] that show that the cognitive skills of children with absence epilepsy are worse than their healthy peers; however, these studies contradict some other studies claiming that these children do not differ in their overall intelligence scores from their healthy age group [14]. No significant difference was found between the children recovering and their healthy peers in terms of intelligence scores and mathematics grade. In other words, after treatment, they have caught their healthy peers on the intelligence test and academic performance. Future studies may replicate the current study with more observation to increase the ecological validity of findings.

Furthermore, according to another study [15], children with absence epilepsy only had lower scores on the performance subscale. This may be related to the structure of the scales that was used. Generally, Neuropsychological Test Battery (NTB), Wechsler Intelligence Scale for Children — III (WISC-III), and WISC-R are used to examine the cognitive functions of children with epilepsy [14,17,20]. Renewed Wechsler Intelligence Scale for Children (i.e., WISC-IV) provide broader information about cognitive abilities; thus, the current study presents wider knowledge on different aspects of children with absence epilepsy. In addition, the nonappearance of another concomitant disease of children with absence epilepsy provided us with a clearer finding of the effect of absence epilepsy on cognitive functions. In addition, although there are studies evaluating the academic success of children with epilepsy, there are limited studies evaluating the academic success of children with absence epilepsy [24]; therefore, it is crucial for children diagnosed with absence epilepsy to be supported by medical treatment as well as supportive intervention programs.

In this study, it was observed that Turkish and mathematics lecture grades of children with absence epilepsy were lower than those of healthy children. Findings of the participants' reading and writing problems, however, support the finding that the academic achievement of children with absence epilepsy is lower than the academic achievement of healthy children. However, according to the findings obtained from the TRF, the academic achievement of children with absence epilepsy does not differ from the academic achievement of healthy children. Although full-scale intelligence scores of children with absence epilepsy are much lower than those of the healthy comparison group, it is interesting to note that when the participants' academic achievements are compared, participants with absence epilepsy have similar results with their healthy age group. However, in TRF, participants are assessed according to their classmates. In this study, information about the academic achievements of participants' classmates is missing. For this reason, it is recommended to use large batteries containing assessments from different teachers, which predicts the overall academic success of both participants and classmates. Moreover, lower intelligence scores and lower academic success of children with absence epilepsy may be associated with ongoing or past epileptiform activities, as we mentioned in the Introduction.

Something that is of great importance in the academic achievement of children with epilepsy is parental support [27]. Parental support and education are crucial for children with epilepsy, as the parents can get their children to regularly use medication, recognize their need for academic support, and provide their children with the necessary support. For this reason, the level of education of the participants' parents was evaluated in this study, and as a result of the evaluation, education levels of the parents of the children with absence epilepsy were found to be lower. However, in studies evaluating the academic achievement of children with epilepsy in the literature, the level of education of the parents of children with epilepsy was not evaluated. Accordingly, the evaluation of parents' education during future work will guide the training programs to be prepared in the future.

5. Conclusion

The current study showed that academic achievement and intelligence scores of children with absence epilepsy were lower than their

healthy peers. Therefore, children with absence epilepsy should be supported academically; teachers and families should be informed and guided about this issue. Increasing the number of participants and replicating in different socioeconomic levels in future studies will increase the generalizability of the findings.

Antiepileptic use may reduce or eliminate seizures; however, they may cause various side effects. Thus, when choosing antiepileptic medications in children, the primary goal should be not only to reduce seizures but also to prevent the deterioration of existing cognitive impairment, as Moavero et al. stated [37]. In addition, if possible, improvement of existing cognitive impairment should be considered as a secondary target.

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Disclosure statement

We confirm that we have no conflicts of interest to disclose. We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this study is consistent with those guidelines.

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