



Relationship between suicidal behavior/self-mutilation and vitamin B12 and folic acid levels in adult attention deficit hyperactivity disorder

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Abstract

Aim: Attention deficit hyperactivity disorder (ADHD) and suicidal behavior are common situations that cause social and emotional problems. deficiencies of folate and vitamin B12 have been related to suicidal behavior and the etiology of ADHD. We aimed to evaluate the association between suicide/self-mutilation behaviors and Vitamin B12 and folic acid levels in adult ADHD.

Materials and Methods: Adult ADHD patients were evaluated in terms of sociodemographic characteristics and suicidal behavior/self-mutilation, suicide ideation, impulsivity, and functionality with clinical interviews and scales. Comorbid psychiatric diagnoses were excluded. Levels of vitamin B12 and folate were detected. All results were compared to healthy controls statistically. Then ADHD patients were divided into two groups with and without suicidal behavior/self-mutilation and compared clinically.

Results: There were 40 ADHD patients and 40 healthy controls in the study. Suicidal behavior/self-mutilation, suicide ideation and impulsivity scores and psychiatric diagnosis history of first-degree relatives were higher in the patient group. Levels of Vitamin B12 and folic acid were similar in both groups and not correlated with suicidal behavior/self-mutilation and suicidal ideation.

Conclusion: There was a significant association between adult ADHD and suicidal behavior/self-mutilation. Suicide-related consequences were particularly related to impulsivity. It may be recommended to screen individuals with ADHD for suicidal ideation and impulsivity to reduce risky behaviors. However, it does not support the hypothesis of a relationship between low B12 and folate and suicidality in adult ADHD.



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Introduction

Attention deficit hyperactivity disorder (ADHD) is a neurodevelopmental disorder and it is characterized by attention deficit, hyperactivity, and impulsivity, and is also often associated with cognitive dysfunction [1]. The ADHD prevalence has been reported to be 5-10% in children and adolescents, and approximately 4% in adults [2]. Symptoms of ADHD are known to begin in childhood and may continue into adulthood and have effects of antisocial behavior, substance use, depression, inhibition loss, and cognitive impairments [3].

Individuals with ADHD have the risk of suicidal behaviors/self-mutilation [4,5]. ADHD symptoms continuing in adulthood may cause emotional and behavioral problems, including suicidality. A longitudinal study of

adolescents and young adults with ADHD found that the likelihood of suicidal ideation in young adulthood was approximately twice as high as in those without ADHD [6]. Some studies have reported higher rates of suicidal behavior such as attempted suicide and death by suicide, among people with ADHD compared to others. The mechanisms that may be responsible for this high rate are not clear, but it has been suggested that accompanying psychiatric comorbidities in ADHD may be factors mediating suicide outcomes [4].

Although the cause of ADHD is not yet known exactly, some factors such as psychosocial stress, diet, exposure to toxins and heavy metals, structural/functional abnormalities of the brain, neurotransmitter dysregulation in the frontostriatal area play a role in the etiology [7,8,9]. Cognitive functions in particular are affected by factors such as nutrition, and deficiencies of folate and vitamin B12 have been associated with neurodevelopmental disorders, including ADHD [10]. Folate is an essential nutrient that

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regulates numerous biochemical pathways, apoptosis, synthesis of neurotransmitters, DNA and myelin synthesis, gene expression regulation, and amino acid metabolism [11,12]. Supplementation of the amino acid that leads to the formation of S-adenosylmethionine (SAM) has been found to improve psychiatric disorders [10]. Neurotransmitter synthesis with the involvement of folate (especially 5-methylenetetrahydrofolate) is one of the most important factors in cognition and mood. Folate also seems to be important for the regeneration of tetrahydrobiopterin via the enzyme dihydrofolate reductase, which metabolizes folate [13] and this enzyme serves as a cofactor in the formation of monoamine neurotransmitters [14].

Vitamin B12 deficiency is also common and is related to cognitive impairment. One study showed that homocysteine- folate metabolic pathway may affect ADHD due to hyperhomocysteinemia and vitamin B12 deficiency [15]. Vitamin B12 and folate deficiencies may cause psychiatric symptoms such as irritability, agitation, disorientation, confusion, amnesia, attention problems, and insomnia [16]. Their function in carbon transfer metabolism seems to play a role in these symptoms. They have roles in dopamine, serotonin, other monoamine neurotransmitters, and catecholamine production [17].

Suicidal behavior has been associated with low levels of folate and vitamin B12 related to serotonergic dysfunction [18]. Although the relationship between suicide and folate and vitamin B12 has been shown in various psychiatric diagnoses [19], these studies are few and, in line with our research, no study investigating the relationship between suicide or self-harm and folate and vitamin B12 in adult ADHD has been found.

We aimed to examine the relationship between suicide/self-mutilation behaviors and Vitamin B12 and folic acid levels in a group of adult participants with and without a diagnosis of ADHD.

Firstly, we hypothesized that ADHD symptoms may be related to the suicide/self-mutilation behaviors, and secondly, low vitamin B12 and folic acid levels may increase ADHD symptoms and the risk of suicide.

Materials and Methods

Adult patients applying to the psychiatry polyclinic of our hospital and diagnosed with ADHD according to diagnostic criteria of DSM-5 for six months, and healthy volunteers similar in terms of gender, age, and education were included. Diagnosis of the patients was confirmed with the DIVA 2.0 scale (Diagnostic Interview for Adult ADHD according to DSM-IV). Additional psychiatric diagnoses of participants were excluded from the Structured Clinical Interview for DSM-5 (SCID-5). All participants signed a written consent form.

Power analysis was done to determine the sample size. Our sample size was 40 ADHD patients and 40 controls, with 80% effect size, 5% alpha error, and 20% beta error with the power analysis determined by the G*power (version 3.1.9.7) program, according to a reference study evaluating the relationship between suicide and Vit B12 and Folate levels in BAD [19].

The study was approved by the Atatürk University Faculty

of Medicine Clinical Research Ethics Committee (2022/10-30).

The exclusion criteria were; mental retardation, comorbid psychiatric disorder, neuropsychiatric conditions such as delirium, dementia, epilepsy, and known systemic chronic medical illness requiring regular drug use, using vitamins or supplements.

All participants completed the sociodemographic data form, Suicide Ideation Scale (SIS), Barratt Impulsivity Scale-11 (BIS-11) and participants in the ADHD group also completed the Wender-Utah Rating Scale (WURS) (25-item short form) and Sheehan Disability Scale (SDS). Vitamin B12 and folic acid levels of all participants were examined in the system within a maximum of three months.

Sociodemographic data form

The researcher created it according to the literature and consists of questions evaluating the age, gender, educational status, marital status, income rates, suicide, and self-mutilation situations, smoking and alcohol-substance use, psychiatric diagnosis or suicide history in self or the family of the participants.

Structured Clinical Interview for DSM-5 Disorders (SCID-5)

SCID-5 is a semi-structured interview guide developed by First et al. to make DSM-5 diagnoses [20]. It consists of 10 modules and includes detailed diagnostic criteria in 32 diagnostic categories and probing questions in 17 diagnostic categories. Modules include psychotic symptoms, psychotic disorders, mood disorders, substance use disorders, anxiety disorders, obsessive-compulsive disorder and related disorders, post-traumatic stress disorder, attention deficit and hyperactivity disorder, investigative questions for other disorders, and adjustment disorder. The addition of the attention deficit and hyperactivity disorder module as a new module is among the prominent innovations in SCID-5. Its adaptation to Turkish and reliability studies have been carried out [21].

DIVA 2.0 (Diagnostic Interview for ADHD in Adults)

DIVA 2.0 Diagnostic Interview Scale for ADHD in Adults is a structured interview form in Dutch developed according to DSM IV diagnostic criteria to question the diagnosis of ADHD in adults [22]. During the interview, information can be obtained from the patient and his/her relatives and evaluated together. It consists of 3 parts, each of which is questioned separately for childhood and adulthood, including attention deficit, hyperactivity/impulsivity symptoms and the onset of the symptoms, and the loss of functionality that develops due to the symptoms. Concrete examples are given for each of the symptoms based on DSM IV and 18 symptoms are questioned individually. It was translated from Dutch to Turkish and from Turkish to Dutch and reviewed by DIVA Foundation [22].

Suicide Ideation Scale (SIS)

The scale developed by Levine et al. [23] includes 17 questions that include parameters of the risk of suicide, depression and hopelessness, uncontrollable anger, thoughts and

wishes of death, desire to harm, decrease in self-esteem, feelings of guilt, thinking and speaking slowly. This questionnaire, which aims to determine the severity of suicidal thoughts, is answered by the patient. The total score is between 0 to 17, and a high score means suicidal ideation. The Turkish validity and reliability were determined by Dilbaz et al. [24].

Barratt Impulsivity Scale-11 (BIS-11)

It was developed by Patton and Barratt [25]. It is a self-rating scale used to evaluate impulsivity. The individual is asked to mark the most appropriate response among the options 'rarely/never', 'sometimes', 'often', and 'almost always/always'. It has thirty items and three subscales attention, motor impulsivity, and failure to plan. When evaluating the Barratt Impulsivity Scale-11, there are 4 different sub-scores; total score, lack of planning, attention, and motor impulsivity. The higher the total BIS-11 score, the higher the patient's impulsivity level. The Turkish validity and reliability were determined by Gulec et al. [26].

Wender Utah Rating Scale (WURS)

WURS was developed to question childhood ADHD symptoms retrospectively and to help diagnose ADHD in adults [27]. It was stated that the sensitivity was 82.5% and the specificity 90.8% when the cut-off score was 36 in the validity and reliability study [28].

Sheehan Disability Scale (SDS)

"Work", "social life and leisure pursuits", and "family life and responsibilities at home" subscales are used to determine disability in these areas [29].

Statistical analysis

Statistical evaluation was analyzed with the SPSS 25.0 program. The variables of normal distribution were examined by histogram graphics, skewness, kurtosis and the Kolmogorov-Smirnov test. Mean, standard deviation, median, and min-max values were used for evaluating descriptive analyses. Categorical variables were compared with the Chi-Square Test. In the comparisons between two independent groups, the independent samples t-test was used when the normal distribution condition was met, and the Mann Whitney u test was used if it was not. For the analysis of the comparing data with each other, the Spearman Correlation Test was used. The factors affecting the Suicide Ideation Scale Total Score were examined by Linear Regression Analysis. $p < 0.05$ were considered statistically significant.

Results

A total of 80 participants 40 ADHD patients and 40 healthy controls have participated in the study. There were 19 (47.5%) females and 21(52.5%) males in the patient group, and 19 (47.5%) females and 21(52.5%) males in the healthy control group. The mean age of the patients was 25.75 ± 7.12 , and the mean age of the controls was 26.15 ± 7.17 . There was no difference between the groups in

terms of gender, age, and education level. The groups did not differ in terms of marital status, income rate, smoking, alcohol, and substance use ($p > 0.05$).

Self-mutilation or suicide attempt was higher in the patient group ($p = .003$). Previous psychiatric diagnosis history except ADHD and psychiatric diagnosis history of first-degree relatives were also higher in patients than healthy controls ($p = .000$, $p = .000$ respectively).

The comparison of the sociodemographic characteristics of the participants is illustrated in Table 1.

Barrat Impulsivity Scale total score and lack of planning, motor impulsivity and attention impulsivity subscale scores were significantly higher in the patient group ($p = .000$, $p = .000$, $p = .000$, $p = .000$ respectively). Suicide ideation scale scores were also significantly higher in the patient group ($p = .000$). But there was no difference between the vitamin B12 and folic acid levels of the groups ($p = .106$, $p = .113$ respectively).

The clinical characteristics of the groups are shown in Table 2.

Then ADHD patients were divided into two groups with and without suicidal behavior/self-mutilation and compared clinically in terms of the Sheehan Disability Scale, Barrat Impulsivity Scale, Suicide Ideation Scale, Wender-Utah Rating Scale, Vitamin B12 and folic acid levels. Comparing the clinical characteristics of the ADHD patients with and without suicide attempts or self-mutilation behaviors, Sheehan Disability scores, Barrat Impulsivity scores, Wender-Utah Rating scores, Vitamin B12, and folic acid levels did not show any difference between the groups. But patients with suicide/self-mutilation were younger ($p = .023$) and had a higher suicide ideation score ($p = .000$) compared to the patients without suicide/self-mutilation.

The clinical characteristics of ADHD patients with and without suicide attempts or self-mutilation behaviors are in Table 3.

When we evaluated the correlations between the clinical variables; Suicide Ideation Scale (SIS) scores and self-mutilation behavior were positively correlated with all clinical variables ($p < .05$ in all). But number of suicide attempts was not correlated with any of the clinical variables ($p > .05$ in all).

Sheehan Disability Scale (SDS) scores were positively correlated with Barrat Impulsivity Scale (BIS) scores ($p < .05$ in all) and Suicide Ideation Scale (SIS) scores ($p < .05$ in all) but not correlated with WURS scores ($p > .05$ in all). WURS scores were correlated with BIS motor impulsivity ($p = .005$, $r = 402^{**}$), attention impulsivity ($p = .041$, $r = 299^*$) and total scores ($p = .020$, $r = 299^*$) but not correlated with lack of planning ($p = 152$, $r = 212$).

Vitamin B12 and folic acid levels were not correlated with Suicide Ideation, self-mutilation behavior, number of suicide attempts, and any of the other clinical variables ($p > .05$ in all).

The correlations between the clinical variables are shown in Table 4.

We examined the factors affecting the Suicide Ideation Scale Total Scores by Linear Regression Analysis.

Table 1. Sociodemographic characteristics of the participants.

Sociodemographic characteristics	Patients (n=40)	Controls (n=40)	p
Age	25.75±7.12	26.15±7.17	.895
Gender			
Female	19 (47.5%)	19 (47.5%)	1.000
Male	21 (52.5%)	21 (52.5%)	
Marital status			
Married	7 (17.5%)	9 (22.5%)	.608
Single	33 (82.5%)	31 (77.5%)	
Income rate			
Low	23 (57.5%)	16 (40%)	.255
Moderate	8 (20%)	11 (27.5%)	
High	9 (22.5%)	13 (32.5%)	
Education			
Primary	1 (2.5%)		.505
High school	6 (15%)		
University	33 (82.5%)		
Self-mutilation or suicide attempt			
Yes	14 (35%)	1 (2.5%)	.003
No	26 (65%)	39 (97.5%)	
Psychiatric diagnose history (except ADHD)			
Yes	21 (52.5%)	2 (5%)	.000
No	19 (47.5%)	38 (95%)	
Smoking			
Yes	13 (32.5%)	12 (30%)	.658
No	27 (67.5%)	28 (70%)	
Alcohol			
Yes	19 (47.5%)	14 (35%)	.143
No	21 (52.5%)	26 (65%)	
Substance use			
Yes	1 (2.5%)	0 (0%)	.315
No	39 (97.5%)	40 (100%)	
Psychiatric diagnose history of first degree relatives			
Yes	17 (42.5%)	4 (10%)	.000
No	23 (57.5%)	36 (90%)	

p<0.05 values were considered statistically significant and indicated in bold.

Vitamin B12 and folic acid levels did not affect the suicide ideation. WURS scores had only moderate effect on suicide ideation.

Linear regression model for suicide ideation scale according to clinical variables is shown in Table 5.

Discussion

In our study, we examined the suicide/self-mutilation behaviors of adult ADHD patients and its relation with Vitamin B12 and folic acid levels. Consistent with our hypothesis, the suicide/self-mutilation behavior rate was significantly higher in the ADHD group, and was correlated with impulsivity scores and ADHD severity, however, vitamin B12 and folate levels were not different from

the healthy controls and were not related to suicide/self-mutilation behavior or suicidal ideation.

These results are similar to some previous studies reporting high suicide rates in adolescents and adults with ADHD [4,5,30]. These studies indicated a relationship between comorbid psychiatric disorders and suicide. The exclusion of psychiatric comorbidity in our study suggests that ADHD alone increases the risk of suicide. Previous psychiatric diagnosis rate was also high in our ADHD group, but in the current evaluation, we excluded those with comorbid psychiatric diagnoses. We are excluding other psychiatric comorbidities provided to evaluate the results independently from another diagnosis. Therefore,

Table 2. Clinical characteristics of the participants.

Clinical characteristics	Patients Mean± SD	Controls Mean± SD	p	95% Confidence Interval of the Difference	
				Lower	Upper
BIS lack of planning	13.45±2.93	8.70±3.11	.000	3.51	5.98
BIS Motor Impulsivity	13.15±3.32	7.89±3.06	.000	3.95	6.56
BIS Attention Impulsivity	13.21±3.47	7.66±2.51	.000	4.31	6.79
BIS Total	39.81±8.04	24.26±7.70	.000	12.33	18.78
SIS Total	5.98±4.24	1.89±1.84	.000	2.75	5.42
Vitamin B12 levels	392.64±129.22	349.96±124.58	.106	-9.37	94.68
Folic acid levels	9.28±6.58	7.56±3.32	.113 ^a	5.34	11.70

BIS: Barrat Impulsivity Scale SIS: Suicide Ideation Scale. p: Independent samples t-test, p<0.05 values were considered statistically significant and indicated in bold. ^a: p score for Mann-Whitney U test, Lower and Upper values for folic acid levels refer to the 1st and 3rd quarters.

Table 3. Clinical characteristics of the patients with and without suicide attempts or self-mutilation behavior.

Clinical characteristics	Patients with	Patients without	p	95% Confidence Interval of the Difference	
	suicide/self mutilation	suicide/self mutilation		Lower	Upper
	(n=14)	(n=26)			
	Mean±SD	Mean±SD			
Age	23.36±2.62	27.06±8.12	.023	-8.92	1.15
SDS total	18.14±4.52	18.36±6.05	.903	-2.89	5.19
SDS working field	7.50±1.70	6.55±2.11	.141	.09	2.89
SDS social life and leisure pursuits	5.58±2.41	5.85±2.31	.712	-1.89	1.47
SDS family life and responsibilities at home	5.07±2.23	5.97±2.70	.280	-2.00	1.74
WURS total score	52.14±9.63	46.69± 11.89	.137	1.85	17.41
BIS lack of planning	13.14±2.74	13.57±3.04	.649	-1.80	2.45
BIS Motor Impulsivity	12.71±2.16	13.33±3.72	.565	-2.35	2.48
BIS Attention Impulsivity	12.29±4.08	13.61±3.16	.237	-2.66	2.37
BIS total	38.14±7.50	40.52±8.27	.361	-5.59	6.08
SIS Total	10.43±3.03	4.09±3.12	.000	2.59	7.88
Vitamin B12 levels	411.00±146.53	384.85±122.76	.532	-68.12	118.83
Folic acid levels	7.50±3.97	10.03±7.34	.230	5.40	10.50

SDS: Sheehan Disability Scale BIS: Barrat Impulsivity Scale SIS: Suicide Ideation Scale WURS: Wender-Utah Rating Scale. p: Independent samples t-test, p<0.05 values were considered statistically significant and indicated in bold. a : p score for Mann-Whitney U test, Lower and Upper values for folic acid levels refer to the 1st and 3rd quarters.

we think that we could evaluate our results only in terms of ADHD.

The high prevalence of psychiatric diagnosis in first-degree relatives is similar to the results of another previous study showing psychiatric diagnosis in first-degree relatives as a high risk for suicide [31]. In this study, the risk of suicide was reported to be high in ADHD, even after adjustment for comorbid psychiatric diagnoses. In another study evaluating suicide in children and adolescents, a significant decrease in family functionality was found in those who attempted suicide [32]. The presence of familial risks suggests that genetic factors contribute to the relationship between ADHD and suicidal behavior. This genetic predisposition specifically reflects genetic variants associated with impulsivity [33].

Impulsivity scores of the ADHD patients were significantly higher and correlated with suicidal ideation scores and self-mutilation, suggesting that impulsivity, one of the most important components of ADHD, is effective on suicide and self-mutilation. The fact that the impulsivity subscale scores of inability to plan, motor impulsivity, atten-

tion impulsivity, and suicidal ideation scores in our patient group were higher than those of the controls and that there was a positive correlation between suicidal ideation and self-mutilation gives an idea about the relationship between impulsivity and suicide.

The other issue we addressed in our study was to evaluate vitamin B12 and folic acid levels, which can be biomarkers for better determining ADHD patients who are at high risk for suicidal behavior. Both play significant roles in the development, functioning, and differentiation of the brain, particularly in the synthesis of DNA and protein. In case of deficiency, homocysteine re-methylation decreases and hyperhomocysteinemia occurs [15,16].

Studies made before have found that vitamin B12 and folate deficiencies, may be associated with, mood disorders, depression, obsessive-compulsive disorder, psychotic disorders, and cognitive functions [34]. Deficiencies in folate and vitamin B12 have also been associated with ADHD [10] and psychiatric symptoms, such as irritability, agitation, concentration and attention problems, and insomnia, overlap with the core symptoms of ADHD [16].

Table 4. Correlations of clinical characteristics.

Clinical characteristics		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Age	p	.	.872	.371	.663	.914	.451	.651	.111	.515	.503	.048	.156	.217	.490	.029
	r	1000	-.017	-.093	.046	-.011	-.113	.047	-.165	-.068	-.070	-.204*	-.148	.129	.072	.226*
2. SDS total	p	.872	.	.000	.000	.000	.453	.000	.000	.000	.000	.000	.073	.001	.195	.582
	r	-.017	1000	.960**	.960**	.972**	.112	.600**	.695**	.691**	.719**	.499**	.186	-.350*	.135	.057
3. SDS working field	p	.371	.000	.	.000	.000	.261	.000	.000	.000	.000	.000	.246	.000	.135	.631
	r	-.093	.960**	1.000	.904**	.905**	.167	.602**	.685**	.711**	.727**	.536**	.121	-.432**	.155	.050
4. SDS social life and leisure pursuits	p	.663	.000	.000	.	.000	.737	.000	.000	.000	.000	.000	.031	.004	.213	.719
	r	.046	.960**	.904**	1.000	.909**	-.050	.595**	.640**	.659**	.682	.470**	.222	-.295*	.130	.038
5. SDS family life and responsibilities at home	p	.914	.000	.000	.000	.	.268	.000	.000	.000	.000	.000	.076	.733	.277	.505
	r	-.011	.972**	.905**	.909**	1.000	.165	.587**	.682**	.659**	.699**	.456**	.184	.124	.113	.070
6. WURS total	p	.451	.453	.261	.737	.268	.	.152	.005	.041	.020	.005	.321	.012	.909	.225
	r	-.113	.112	.167	-.050	.165	1.000	.212	.402**	.299*	.339*	.404**	.148	-.363*	-.017	.181
7. BIS lack of planning	p	.651	.000	.000	.000	.000	.152	.	.000	.000	.000	.000	.855	.014	.241	.654
	r	.047	.600**	.602**	.595**	.587**	.212	1.000	.657**	.780**	.877**	.464**	-.019	-.252*	.122	.047
8. BIS Motor Impulsivity	p	.111	.000	.000	.000	.000	.005	.000	.	.000	.000	.000	.125	.012	.199	.151
	r	-.165	.695**	.685**	.640**	.682**	.402**	.657**	1.000	.824**	.906**	.449**	.159	-.258*	.134	.149
9. BIS Attentional Impulsivity	p	.515	.000	.000	.000	.000	.041	.000	.000	.	.000	.000	.865	.034	.113	.463
	r	-.068	.691**	.711**	.659**	.659**	.299*	.780**	.824**	1.000	.950**	.421**	.018	-.218*	.164	.077
10. BIS Total	p	.503	.000	.000	.000	.000	.020	.000	.000	.000	.	.000	.584	.010	.101	.406
	r	-.070	.719**	.727**	.682**	.699**	.339**	.877**	.906**	.950**	1.000	.474**	.057	-.264*	.170	.087
11. SIS total	p	.048	.000	.000	.000	.000	.005	.000	.000	.000	.000	.	.079	.000	.749	.834
	r	-.204*	.499**	.536**	.470**	.456**	.404**	.464**	.449**	.421**	.474**	1.000	.182	-.455**	.033	-.022
12. Number of suicide attempts	p	.156	.073	.246	.031	.076	.321	.855	.125	.865	.584	.079	.	.000	.897	.075
	r	-.148	.186	.121	.222	.184	.148	-.019	.159	.018	.057	.182	1.000	-.427**	.014	-.185
13. Self-mutilation	p	.217	.001	.000	.004	.003	.012	.014	.012	.034	.010	.000	.000	.	.446	.397
	r	.129	-.350**	-.432**	-.295**	-.305**	-.363**	-.252*	-.258*	-.218*	-.264*	-.455**	-.427**	1.000	-.079	.088
14. Vitamin B12 levels	p	.490	.195	.135	.213	.277	.909	.241	.199	.113	.101	.749	.897	.446	.	.026
	r	.072	.135	.155	.130	.113	-.017	.122	.134	.164	.170	.033	.014	-.079	1.000	.229
15. Folic acid levels	p	.029	.582	.631	.719	.505	.225	.654	.151	.463	.406	.834	.075	.397	.026	.
	r	.226	.057	.050	.038	.070	.181	.047	.149	.077	.087	-.022	-.185	.088	.229	1.000

SDS: Sheehan Disability Scale BIS:Barrat Impulsivity Scale SIS: Suicide Ideation Scale WURS: Wender-Utah Rating Scale *p < .05; **p < .01; ***p < 0.001.

Table 5. Linear regression model for suicide ideation scale according to clinical variables.

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1(Constant)	-.037	6.754		-.006	.996
Folic acid levels	-.151	.097	-.235	-1.560	.127
Vitamin B12 levels	.001	.004	.045	.331	.742
Wender-Utah rating scale total scores	.135	.058	.366	2.335	.025
Sheehan disability scale working field scores	.470	.295	.225	1.590	.120
Education	-.183	.326	-.080	-.563	.576

Dependent Variable: Suicide Ideation Scale Total Score.

In our study, we did not detect a deficiency of vitamin B12 and folate in ADHD patients. Suicide/self-mutilation behavior or suicidal ideation were not related to Vitamin B12 and folate levels in ADHD patients. Some previous studies have reported high vitamin B12 and folate deficiency prevalences in suicide attempters of several psy-

chiatric samples. We have been unable to replicate the previous findings. There have been also some previous studies that did not find a relationship between vitamin B12 and folate and between suicidal behavior, similar to ours [18,35].

There may be some possible explanations for not finding

a relationship between vitamin B12 and folate and suicidal behavior in this study. The connections between methylation and monoamine metabolism can be disrupted in various ways. The relationship between monoamine metabolism and folate and B12 in CNS has not been fully understood. Monoamine metabolism may exhibit a non-linear relationship with folate and may be affected by CSF 5-HIAA, vitamin B12, and folate, only when their concentrations are very low. Measuring folate in blood and/or in erythrocytes is thought to be more stable than folate in serum and therefore less sensitive to changes in intake [18].

However, it was found that B12 and folate levels did not differ significantly between groups, and our findings do not support the hypothesis of a relationship between low B12 and folate and ADHD or suicidality.

Limitations

This is the first study to examine the relationship between suicide/self-mutilation and folate and vitamin B12 levels in adult ADHD. The strengths of the study are that the diagnosis of ADHD and the exclusion of comorbid psychiatric diagnoses were made through a comprehensive clinical evaluation. However, there are some limitations. The relatively small sample size is one of the limitations. The fact that the adult ADHD population is relatively small and comorbid psychiatric diagnoses are excluded can be considered as a reason for the smaller size of our sample. Retrospective evaluation of folate and vitamin B12 levels may be another limitation.

However, our time criterion was that they were evaluated within a maximum of three months, and we think their values do not change very fast making our results meaningful.

Conclusion

Our findings have shown a significant relationship between ADHD and suicide/self-mutilation. Screening individuals with ADHD, especially for suicidal ideation and impulsivity, will be beneficial in reducing risky behaviors. Psychiatric diagnosis or history of suicide in first-degree relatives should be taken into consideration. However, it does not support the hypothesis of a relationship between low folate and vitamin B12 and suicidality in adult ADHD. More studies are needed to recommend examining vitamin B12 and folate levels to predict suicide.

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Ethical approval

The study was approved by the Atatürk University Faculty of Medicine Clinical Research Ethics Committee (2022/10-30).

Informed consent

The written consent form was signed by all participants.

Conflict of interest

There is no conflict of interest to declare.

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