

## ARTICLE

EFFECTS OF NOISE POLLUTION ON ATTENTION DEFICIT AND  
HYPERACTIVITY DISORDER IN COLLEGE STUDENTSAida Sahmurova<sup>1</sup>, Mustafa Can Gursesli<sup>2\*</sup><sup>1</sup>Faculty of Health Sciences, Istanbul Okan University, Istanbul, TURKEY<sup>2</sup>Department of Human and Social Sciences, University of Bergamo, Bergamo, ITALY

## ABSTRACT

Attention Deficit Hyperactivity Disorder (ADHD) springs in childhood and is described with behaviors like impulsivity, inattention, struggling with paying attention and hyperactivity. Causes can be various such as inheritance, neurological/neuropsychological or environmental. People get affected not only psychologically, but also physiologically. Noisy environments usually affect people with ADHD as well. The inattention symptoms of ADHD become clearer as the noise gets louder. The relation between ADHD and noise is aimed to be studied in this research. 622 individuals participated in the research in Istanbul Okan University. CESVA DC 311 model device was used in 8 different places in order to measure noise levels in the first part of the survey. Next, in order to study the relation between ADHD and noise, Adult Self-Report scale was used on students. The analysis indicated that average of impulsivity and hyperactivity of participants in Humanities and Social Sciences Faculty is much lower than those in Wellness Center. A significant difference in ADHD total point average was found. By Tukey test, the origin of difference was analyzed, and it was observed that total average points of participants in Humanities and Social Sciences Faculty was significantly lower than those in Wellness Center. According to unpaired T-test data in demographic parameter studies, no significant difference between these parameters and ADHD points was found.

## INTRODUCTION

## KEY WORDS

ADHD, noise pollution,  
location, decibel, health

Known as a common disorder among children, adolescents and adults, Attention Deficit and Hyperactivity Disorder (ADHD) shows some persistent indications such as impulsivity, excessive hyperactivity, inattentiveness and difficulty in maintaining concentration. The disorder can begin in early childhood and the symptoms may last a lifetime [1]. While symptoms of ADHD are most obvious in childhood, the symptoms begin to decrease with age and are replaced by internal restlessness in adolescence. Similar symptoms appear in adulthood such as internal unrest, distractibility, impatience and planning difficulties [2].

ADHD increases over years and ADHD prevalence rates vary among children, adolescents and adults. ADHD prevalence is between 7.8 % and 9.5 % among children; between 5.9% and 7.1% among adolescents; and between 1.2% and 7.3% among adults. As for university students this rate is proven to be 2% worldwide while it is reported to be 6.1% among university students studying in Turkey [3][4][5]. The parents need to be aware of the situations regarding the behavioral characteristics of children diagnosed with ADHD and the kind of arrangements they need to do in their house. The teachers also need to obtain the necessary information in order to make arrangements in the classroom considering the characteristics of children with ADHD, in case they have problems in obeying the classroom rules, make mistakes because of their attention deficit or experience problems in participating in the games or other classroom activities [6]. In the treatment of ADHD, along with the individual treatments offered to the child, the child should be evaluated together with the family members as a whole, and his/her parents, especially the mother, should be subjected to psychological examination and, if necessary, they should be provided appropriate treatment [7]. ADHD is a complicated and multifaceted syndrome and there is a very large literature regarding its causes, biological sub-structures and its impact on the individual and the community [8]. Literature review shows that ADHD may develop out of various factors. Those can be classified into inheritance-related factors, neurological / neuropsychological factors and environmental factors. Most of the studies conducted on the field of genetics refer to genetic factors as the key determinants of ADHD symptoms [9, 10]. These studies suggest that ADHD might be influenced by some hereditary variables which may also change phenotype of ADHD. ADHD or a similar phenotype is more commonly seen in children born with extreme low weight and premature [11]. However, genetics is not the only factor responsible for ADHD. Environmental factors also have important effects on the emergence of ADHD and interaction of environmental and genetic factors significantly contribute to ADHD. Exposure to toxic metals such as lead, mercury and manganese contribute to ADHD development. Exposure to nicotine or alcohol especially in fetal period may also increase the risk. ADHD is also linked to social and economic disadvantage. That is to say, ADHD develops more within families with low socioeconomic status. Many studies show that environmental factors are consistent in terms of time and countries [12-14].

Researchers conducted over the last ten years suggest that cognitive factors may also lead to ADHD. ADHD is attributed to low level of cognitive control. Attention is one of the cognitive factors and it has three aspects which are directing attention, drawing attention and vigilance. Among those only vigilance is associated with ADHD. In order to fully understand whether a person has ADHD or not, it is important to make accurate definitions of the typical parameters such as inattention, impulsivity and hyperactivity, and to identify how inappropriate the person performs those behaviors in relation with his/her developmental

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age [15]. Symptoms given under the title of “inattention” are inappropriate for one’s developmental level and impair social activities. Inattention symptoms given under that title are being indifferent details, committing incautious errors during activities, inability to concentrate while working on something, failing to follow given instructions and fulfill ordinary daily responsibilities, difficulty in planning work and activities, being distracted easily with external stimulus and memory impairment about daily activities. These symptoms are more persistent with respect to other ADHD symptoms and they are experienced more frequently. As like inattention symptoms, the symptoms given under the title of “excessive hyperactivity” are also inappropriate for one’s developmental age and they lead to negative results in social activities. However, those do not stem from a hostile attitude, resistance or being unable to understand the instructions. Symptoms like making continuous hand or foot movements, not sitting on a seat when he/she is supposed to do so, running or climbing improperly, inability to get involved in leisure activities, often being “on the go”, talking excessively or interrupting others are also important for the understanding of hyperactivity and impulsiveness [2, 16]. Literature review show that among the adults who have developed ADHD in childhood and still hold symptoms, inattention symptoms appear more obvious with respect to hyperactivity/impulsivity symptoms [17]. These symptoms cause the individuals to have numerous social and academic problems. The difficulties a child who has ADHD may encounter within her/his own house are not obeying rules, not being able to adapt to mealtime or sleep time, having frequent conflict with siblings, and not being able to complete homework without parents. On the other hand, these problems turn into concentration problems, inappropriate behaviors and inappropriate words in the classroom [18].

Noise is defined as unwanted sound. Environmental noise consists of all the unwanted sounds in our communities except that which originates in the workplace. Environmental noise pollution, a form of air pollution, is a threat to health and well-being. It is more severe and widespread than ever before, and it will continue to increase in magnitude and severity because of population growth, urbanization, and the associated growth in the use of increasingly powerful, varied, and highly mobile sources of noise [19]. Based on the literature review, positive correlation was found between noise and noise sensitivity. Individuals with ADHD are usually sensitive to high sounds. Noise pollution causes impairment in short term memory and distraction. Because, when an individual with ADHD is exposed to noise, he/she feels in a constant state of danger, thus focusing on the noise and keeping it at the center of his/her focus. Research shows that individuals with ADHD have short-term memory capacity and they tend to be distracted more than others who do not have ADHD symptoms. Research findings also suggest that as the noise pollution increases, inattention-related symptoms of ADHD also increase. Recent studies revealed that high level noise might have long-term effects on preterm infants’ auditory system. Preterm infants exposed to such noise have a high risk of ADHD.

## MATERIALS AND METHODS

This study aims to examine how ADHD is related to noise, which is an environmental factor having a crucial function in ADHD phenomenon. In line with this purpose, the study was conducted on 622 students studying at Okan University. Data collection was conducted in two steps. First, noise level was measured at 8 different locations in Okan University with the use of Cesva DC311 model device with T240385 serial number. Sound measurements have been made at a variety of locations in Okan University by a field specialist via a sound level meter. The testing and data collection phases were conducted under Istanbul Okan University’s permission and participants were given informed consent form to confirm their volunteering.

### Participants

The original sample consisted of 622 students studying at Okan University. But 4 participants were not included in the study because their forms were uncompleted, and 5 participants were excluded because they were not within the age group specified for the sample of the study. Finally, the sample included 613 participants: 379 female and 234 males. They are aged between 18 and 25, and their mean age is  $20.90 \pm 1.78$ .

### Measures

Demographic data such as age, gender, university, faculty, department, grade and cumulative grade point average were obtained via Personal Information Forms.

Developed by World Health Organization (WHO), Adult attention deficit and hyperactivity disorder self-report scale (ASRS); [20] consists of 18 questions. Each question requires the participants to answer the frequency of having a specific ADHD symptom in the last six months. The questions are divided into two sub-scales. 9 questions are related to inattention and the other 9 questions are related to hyperactivity/impulsivity. 1st, 2nd, 3rd, 4th, 7th, 8th, 9th, 10th, and 11th questions are categorized under the inattention subscale (F1) while 5th, 6th, 11th, 12th, 13th, 14th, 15th, 16th, 17th and 18th questions are categorized under the hyperactivity/impulsivity subscale (F2). ASRS is a four-point Likert type scale including options like never (0), rarely (1), sometimes (2), often (3), and very often (4). If the sum score in either F1 subscale or F2 subscale is calculated between 17 and 23 the person is classified having “likely” ADHD, while individuals with scores of 24 and over are classified having “highly likely” ADHD. Six of the 18 questions constitute the A part of the form. “Stepwise logistic regression” proved that part A is a better predictor of ADHD [21] [22].

## Procedures

Data were collected at different indoor and outdoor locations such as faculties, coffee houses all having different noise levels. It was stated that the participation in the survey was entirely voluntary, and students who did not want to participate were not included. Participants were informed about the research in advance, and then their consent for participant was taken through informed consent form. Subsequently, participants were asked to fill in personal information forms and scales that were in the content of the work. The application lasted about 10 minutes. Sound measurements have been made at a variety of locations in Istanbul Okan University by a field specialist via a sound level meter. Below, you can see decibel intervals with respect to participants' locations.

**Table 1:** Decibel intervals with respect to participants' locations

Locations		Decibels
Location 1	Social Sciences Faculty Building	44
Location 2	Engineering Faculty Building	56.8
Location 3	Faculty of Medicine 2 <sup>nd</sup> floor	60.9
Location 4	Faculty of Medicine 4 <sup>th</sup> floor	64
Location 5	Starbucks outdoor Building	68.5
Location 6	Faculty of Medicine 3 <sup>rd</sup> floor	69
Location 7	Starbucks indoor Building	72.9
Location 8	Wellness Center Building	82

## Data analysis

Data was analyzed on the SPSS (Statistical Package for Social Sciences). The analysis involved the use of One-Way Analysis of Variance (ANOVA) which is implemented for the aim of comparing variation among more than two groups and Tukey test which is a multiple comparison test as well as descriptive statistics (mean, standard deviation, frequency). Significance was found  $p < 0.05$  and  $p < 0.01$  as shown in tables regarding analysis.

## RESULTS AND DISCUSSION

The present research has been conducted with 613 university students as study subjects, with 61.83% (n=379) females and 38.17% (n=234) males studying at different faculties in Istanbul Okan University. The participants are aged between 18 and 25, and their mean age is  $20.90 \pm 1.78$ . [Table 2] presents participants' demographic information.

**Table 2:** Demographic Information

Age	Min-Max (Median) Mean $\pm$ Sd	18-25 (21.5) 20.90 $\pm$ 1.78
Gender; n (%)	Female Male	379 (61.83) 234 (38.17)
Level of Income	Low Low-Middle Middle Middle-High High	12 (2.0) 13 (2.2) 282 (46.8) 226 (37.5) 70 (11.6)
Faculty	Faculty of Health Sciences Faculty of Humanities and Social Science Faculty of Business and Administrative Sciences Faculty of Law Faculty of Education Faculty of Architecture School of Applied Sciences Faculty of Fine Arts Faculty of Engineering	267 (43.6) 47 (7.7) 32 (5.2) 71 (11.6) 24 (3.9) 26 (4.2) 38 (6.2) 21 (3.4) 87 (14.2)

Analysis of students' income levels shows that 2% (n=12) of the students have low-income level, 2.2% (n=13) have low-middle income level, 46.8% (n=282) have middle income level, 37.5% (n=226) have middle-high income level and 11.6% (n=70) have high income level.

When the distribution of the students with regard to the faculties they are studying at is examined, we can see that 43.6% (n=267) of the students study at Faculty of Health Sciences; 7.7% (n=47) at Faculty of Humanities and Social Sciences; 5.2% (n=32) at Faculty of Business and Administrative Sciences; 11.6% (n=71) at Faculty of Law; 3.9% (n=24) at Faculty of Education; 6.2% (n=38) at School of Applied Science; 3.4% (n=21) at Faculty of Fine Arts; and 14.2% (n=87) at Faculty of Engineering.

**Table 3:** Distribution of Attention Deficit and Hyperactivity Disorder Scores

			Female	Male	Total
ADHD Level	No ADHD	Count % within gender	172 45.4%	123 52.6%	295 48.1%
	Likely ADHD	Count % within gender	158 41.7%	79 33.8%	237 38.7%
	Highly Likely ADHD	Count % within gender	49 12.9%	32 13.7%	81 13.2%
Total		Count % within gender	379 100.0%	234 100.0%	613 100.0%

According to the ADHD scores, 45.4% of the female participants (n=172) have no ADHD; 41.7% (n=158) have likely ADHD; and 12.9% (n=49) have highly likely ADHD. When it comes to male participants' scores, 52.6% (n=123) of the males have no ADHD; 33.8% (n=79) have likely ADHD; and 13.7% (n=32) have highly likely ADHD. Total ADHD scores, on the other hand, show that 48.1% (n=295) of the participants have no ADHD, 38.7% (n=237) have likely ADHD; and 13.2% (n=81) have highly likely ADHD.

**Table 4:** Analysis of ADHD levels based on gender

	Gender	N	Mean	SD	T	p
Inattention	Female	379	14.34	4.851	.207	.836
	Male	234	14.26	5.318		
Hyperactivity and Impulsivity	Female	379	17.15	5.168	.138	.890
	Male	234	17.09	5.235		
ADHD Total	Female	379	31.49	8.774	.211	.833
	Male	234	31.33	9.478		

Independent T-Test data do not indicate a significant difference between inattention scores based on participants' gender. [t=.207; p>.05]. Likely, results did not reveal a significant difference between hyperactivity and impulsivity scores of females and males. [t=.138; p>.05]. Also, difference between total ADHD scores of males and females was not significant, either.

**Table 5:** Analysis of ADHD levels based on noise level

Df: 7-605		N	Mean	SD	F	P	Tukey
Hyperactivity and Impulsivity	1	25	14.16	5.022	2.419	.019	8 > 1 p=.010
	2	82	17.48	4.595			
	3	101	16.50	5.157			
	4	27	17.33	4.350			
	5	82	17.54	5.659			
	6	146	16.66	4.693			
	7	40	17.58	5.905			
	8	110	18.19	5.601			
ADHD Total	1	25	25.88	7.870	2.452	.017	8 > 1 p=.008
	2	82	31.99	8.137			
	3	101	29.96	8.872			
	4	27	32.19	7.322			
	5	82	31.83	10.350			
	6	146	31.21	8.150			
	7	40	32.48	10.375			
	8	110	33.05	9.594			
Total	613	31.43	9.042				

One-way ANOVA calculations indicated a significant difference between the participants' hyperactivity and impulsivity subscale scores with respect to their locations. [F(7-605)=2.419; p<.05]. Tukey test was used in order to identify the reason behind the difference and it was found that hyperactivity and impulsivity average of participants in the 8th Location (Wellness Center) (=18.19) was significantly higher than the average score of participants in the 1st Location (Faculty of Humanities and Social Sciences) (=14.16).

A significant difference was found between participants' total ADHD score averages regarding their locations [F (7-605) =2.452; p<.05]. Tukey test was used in order to identify the reason behind the difference and it was found that Participants in Wellness Center scored meaningfully higher (=33.05) than those in Faculty of Humanities and Social Sciences (=25.88) with regard to total ADHD averages (p=.008).

According to Bremmer et al. [23], Miedema and Vos [24] and Pelletier et al. [25], noise affects ADHD patients by causing distraction and impairment in short term memory. It is also proposed that individuals are mostly at risk of experiencing higher level of hyperactivity and higher number of emotional problems in noisy environments. Another study concludes that students with ADHD performed better when they were assigned a work in a silent class environment [26]. A gender-based research has been made in this field and it is found that males experience ADHD more often than females. It is also reported that people having high status jobs are less likely to develop ADHD. In parallel with this claim, another study reports that ADHD is more popular among males on international basis. In addition, ADHD is reported to be more common among those who do not hold a university degree [22]. According to results of other studies, ADHD is influenced by socioeconomic factors, and ADHD patients are also affected by psychosocial and socioeconomic factors such as professional in qualification which emerge as a result of the disorder [28]. In a study, the link between the genes and the effect of socioeconomic factors on ADHD were investigated. The results suggest that low economic level has the ability to affect specific genes that may decrease or increase the possibility of ADHD, although it is not the most important factor leading to ADHD [27]. Another study conducted on children shows that socioeconomic parameters such as education level, welfare level and parenting alone are among the strong determinants of ADHD, and the results show no significant relationship between the gender differences and ADHD [29].

## CONCLUSION

In the present study, we detected noise level at a variety of locations in Okan University and then we analyzed the impact of noise on ADHD. According to results, hyperactivity and impulsivity average of participants in Wellness Center was significantly higher than the average score of participants in Faculty of Humanities and Social Sciences. Another significant difference was found between participants' total ADHD score averages in terms of their locations. Participants in Wellness Center scored meaningfully higher than those in Faculty of Humanities and Social Sciences. It is known that social factors and socio-demographic parameters (gender, income status, educational status, etc.) are the ones that significantly affect the level of ADHD among university students. In this regard, this study shows us that the effect of noise pollution on ADHD levels has reached an ignorable level. For prevention and precaution purposes in the future on this topic, diversification of literature has utmost importance. Despite that, because of lack in literature (especially Turkey sample), causes individuals to overlook the significance of this topic.

### CONFLICT OF INTEREST

There is no conflict of interest.

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None.

### FINANCIAL DISCLOSURE

None.

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