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ADHD – the scourge of the 21st century?

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Summary

Currently, attention deficit hyperactivity disorder (ADHD) is intensively studied by world medical community, its understanding expands, for example, it has now been diagnosed not only in children but also in adults. On the other hand, ADHD raises a number of discussions on the need of its treatment and, if there is a need, how it shall be treated, it is doubtful whether this disorder overall exists, because its "morphological component" has not been identified so far, and all the symptoms of ADHD, including anxiety, concentration difficulties, motor hyperactivity, cognitive disorders or social disadaptation, can be found in a number of mental disorders and somatic diseases. Modern attention, emotional and behavioral changes can be considered as a result of changing human social portrait. Those who question ADHD existence argue that this disorder is likely temperament and parenting matter, rather than the illness, and that the diagnosis and treatment of this illness can be a matter invented by doctors and pharmacists, the aim of which is to tame individuals disregarding public standards of conduct and get the maximum profit from medicines in the treatment of this illness. Due to the fact that ADHD is diagnosed more often, it is even called the twenty-first-century scourge. In this article we will review the historical aspect of formation of ADHD diagnosis, illness etiology, comorbidity with other mental and somatic diseases as well as treatment necessity and opportunities, paying attention to adult ADHD as well.

Key words: attention deficit hyperactivity disorder, ADHD

Introduction

ADHD – the four-letter acronym is now well known to many people regardless of how the full name of this disorder sounds in different world languages. Currently, attention-deficit/hyperactivity disorder (ADHD) is intensively studied by world medical community [1], its understanding expands, for example, it has now been diagnosed not only in children but also in adults [2, 3]. On the other hand, ADHD raises a number of discussions on the need of its treatment and, if there is a need, how it should be treated; it is doubtful whether this disorder actually exists, because its morphological basis has not been identified so far, and all the symptoms of ADHD, including anxiety, concentration difficulties, motor hyperactivity, cognitive disorders or social disadaptation can be found in a number of mental disorders and somatic diseases [4, 5]. Skeptics argue that diagnostic criteria of the illness include a variation of behavior norm in childhood, which can be observed even in healthy individuals. In addition, due to rapidly developing technology, computers, the Internet, mobile phones, etc. in the last 20–30 years, interpersonal communication and the way of spending time changed dramaticly, new social requirements occurred, human activity and attention allocation had to change, while brain activity could not change so quickly, which might cause relevant functional disorders which usually might suggest mental illness [6].

Modern attention, emotional and behavioral changes can be considered as a result of changing human social portrait. Especially sharp debates arise from ADHD diagnosis in adults. The arguments which cast doubt on ADHD diagnosis (about 90 percent) in adults are: high comorbidity with other mental disorders and illnesses, certain diagnostic criteria imperfection, adult ADHD diagnosis in individuals who have not been diagnosed with this illness in childhood [6]. Those who question ADHD existence argue that this disorder is likely temperament and parenting matter, rather than the illness, and that the diagnosis and treatment of this illness can be a matter invented by doctors and pharmacists, the aim of which is to tame individuals disregarding public standards of conduct and get the maximum profit from medicines in the treatment of this illness [7]. There are also publications on the fact that ADHD is overdiagnosed in recent years, and in addition consumption of psychostimulants is growing dramatically [7]. Meanwhile, the proponents of diagnosis of ADHD argue that early diagnosis of ADHD and its treatment in childhood may protect against more severe and chronic course of the illness in adulthood [8, 9]. Due to the fact that ADHD is diagnosed more often, it is even called the twenty-first-century scourge..

In this article we will review the historical aspect of formation of ADHD diagnosis, illness etiology, comorbidity with other mental illnesses and somatic diseases as well as treatment necessity and opportunities, paying attention to adult ADHD as well.

The history is very short

In the literature, restless and undisciplined children have been described since the ancient times, but in the scientific and medical context these children started

to be mentioned only since the end of the 18th century. Therefore, ADHD history is relatively short when comparing it with other mental disorders. Doctors in their clinical practice beheld restless children, who would simply "terrorize" surrounding people with their behavior. It was then speculated that such behavior could be caused by brain dysfunction which displayed after certain events or under the influence of external circumstances. In 1775, German physician Melchior Adam Weikard [10] described attention and activity changes in his book, and in 1798, Scottish doctor Sir Alexander Crichton described the state that was called "mental restlessness" in the chapter *Attention* of his textbook. Both Weikard and Crichton similarly described the main features of this disorder – attention disorder, restlessness and early onset, and pointed out that this disorder determines the quality of learning [11]. In 1902, British pediatrician George Frederick Still issued several medical articles where he described the children's behavioral disorders. He was the first who raised the hypothesis that this disorder was likely to be determined by genetic factors [12].

After encephalitis (encephalitis lethargica), also known as Economo's disease and the flu epidemic in 1917 and 1918, it was noticed that behavioral disorders called "post-encephalitic behavioral disorder" were evidenced in many children who survived the disease, while in the adults who suffered from the same disease, parkinsonism – rigidity and tremors, restlessness and akathisia, which are typical signs of damage to the base ganglia – was displayed more often. Therefore, a hypothesis that post-encephalitic behavioral disorders in children were determined by brain pathology was raised, and this disorder was called "minimal brain damage". This disorder was manifested by impulsive behavior, emotional lability and tendency to get distracted, and was called by the society "a disease that creates criminals". Subsequent studies showed that there were children who had no history of encephalitis, but had similar behavioral disorders. In 1962, on the initiative of Oxford children neurology specialists, "minimal brain damage" was renamed to "minimal brain dysfunction" (MBD), emphasizing that there were no structural damages to the brain [12]. Since the middle of the 20th century, this disorder took on a name more similar to the modern one: the terms "Hyperkinetic behavior Syndrome in Children" and "Hyperkinetic Impulse Disorder" were used.

For the first time the adult patients with ADHD symptoms were mentioned in the same book by German doctor Melchior Adam Weikard in 1775. However, for a long time only children were mentioned by scientists discussing hyperkinetic disorders. It was thought that they would "grow out" of that. The interest in adult ADHD was shown only since 1960, after the occurrence of the first research and articles about it. More extensive monitoring and examination of children with ADHD revealed that their parents often also have this disorder, so the idea of existence of ADHD in adults naturally began to rise as well.

ADHD prevalence

According to various sources, ADHD prevalence ranges from 3 to 10% among school-age children and 4–5% among adults [13–15]. Meyers et al. [14] indicate that in as much as 50–80% of children who were diagnosed with ADHD, the consequences of this disorder were also present later. The geographical position has almost no influence on ADHD prevalence. The fluctuations of such prevalence are more associated with the subtleties of methodological research characteristics [16]. ADHD prevalence reaches 4–5% in children and about 2% in adults in the countries where the ICD-10 is used. When the DSM-5 diagnostic criteria are applied, the prevalence is twofold higher [16]. In boys, this disorder is diagnosed 4–5 times more often than in girls, and this is associated with genetic and hormonal differences between genders [17]. Biederman et al., in their article, indicate that boys are more sensitive to impact of certain environmental risk factors than girls [18].

Fulton et al., skeptics of ADHD diagnosis, performed a research in the USA the aim of which was to examine the frequency of the diagnosis of this disorder and prescription of medicine in individual states. The research results showed that in some regions of the country the morbidity of ADHD is much higher (the odds ratio was calculated in the research, which ranged from the lowest in Vermont (OR = 0.62), Colorado (OR = 0.65) and North Dakota (OR = 0.70) up to the highest in Maryland (OR = 1.41) and Alabama (OR = 1.37)), however, the authors suggested that it is associated with overdiagnosis of the disorder, which is associated with the marketing of pharmaceutical companies addressed to physicians and general society in those states where the frequency of ADHD diagnosis was the highest [7].

ADHD etiological factors

This disorder is a result of coexistence of various causes – genetic, biological, psychological, socio-cultural, etc. [19].

Genetic factors

Research on families, twins and adopted children shows that ADHD is a hereditary disorder, and genetic component increases the risk of this its occurrence [20]. Using specific methods of genome scanning, the changes in 5p13, 6q, 7p, 9q, 11q, 12q, and 17p chromosomes were determined [4]. Todd and Neuman (2007) [21] claim that in 30% of men who had been diagnosed with ADHD in childhood, ADHD symptoms were still observed in adulthood, which suggests that it is a genetically inherited disorder. Although the studies show that ADHD may be conditioned by specific gene mutation, there is still a lack of detailed research related to which genetic changes determine the emergence of the disorder [22, 23]. Currently, there is an opinion that large-scale international research on detection of specific genes, their combinations and alleles possibly responsible for the predisposition to ADHD, as well as cooperation of scientists from various countries are necessary [24].

Pregnancy and early development of a child

Barkley and Murphy (2006) claim that brain dysfunctions occurring in early childhood due to pregnancy or childbirth pathology (preterm delivery, inadequate or incorrect mother's nutrition, use of medication, alcohol, drugs, smoking, difficult delivery) have implications for the occurrence of ADHD [25]. Frodl et al. (2010) agree that the following factors increase the risk of ADHD occurrence: smoking during pregnancy is characteristic of hyperactive children's mothers; there is a higher chance for heavy smoking pregnant women for having a hyperactive child [26]. However, Langely et al. (2012) argues that smoking and alcohol consumption may influence hyperactivity, but does not determine it [27].

Increase in alcohol consumption, anti-social behavior and frequent hysteria are noticed among the parents of children with ADHD [28]. In families of patients with ADHD, drug addiction cases are also more common [29]. Here one of the most important questions arises: to what extent is ADHD development determined by genetic factors, and to what extent is it determined by the factors of the environment in which a hyperactive child is born, which, in turn also affect the child's genetic profile? When the disorder occurs, it is often difficult or even impossible to distinguish whether the changes found in genome are accidental or are determined by harmful environmental factors (pollution, inadequate food, preservatives, pesticides, etc.). Hyperactive children are more often born to mothers with ADHD, compared to healthy mothers, however, these more often have inappropriate lifestyle (smoking, excessive drinking, using drugs, etc.). Therefore, such yet unborn baby can not only get a set of disorder predisposing genes from the mother, but also can be influenced by unsuitable environment, which in turn also influences the genes.

Neurobiological changes

There is a causal relationship between the neurobiological factors and ADHD [30]. A series of research works with the nuclear magnetic resonance imaging (MRI) in children with ADHD were carried out [31, 32]. MRI showed smaller caudate nucleus (Lat. *nucleus caudatus*) volume and abnormalities in frontal lobe area. The studies where the changes in the hippocampus and amygdala were investigated, showed an increased volume of the hippocampus, which negatively correlated with the clinical symptoms. No distinct changes in amygdala volume were observed, however, the surface analysis showed a reduced size on both sides over the lateral nuclei and basolateral complex. The interesting fact is that a reduced volume of the amygdala in the left hemisphere is observed in children with Tourette syndrome [33]. It was subsequently determined that there is a clear negative correlation between the amygdala volume and ADHD symptoms (amygdala volume is smaller when the accompanying symptoms of ADHD are more severe).

Only a few studies investigated structural abnormalities in the brain of the adults with ADHD. The study that investigated a group of eight adult patients with ADHD

found smaller orbitofrontal cortical volume. Another study, where 27 patients with ADHD and 27 healthy controls were examined, showed no clinically significant changes in the hippocampus and amygdala [34]. Nevertheless, the majority of authors indicate that there are changes in the hippocampus and amygdala in children with ADHD. It is plausible, because the amygdala determines the emotional processes such as learning, experience of negative emotions and perception of emotional stimulus. Decreased emotionality is associated with dysfunction of the amygdala and ventromedial prefrontal cortex. The amygdala-related research is becoming one of the main areas of interest, as reduced emotionality and impulsivity are very common symptoms of ADHD. The hippocampus plays a key role in regulating motivation and emotions as well as in learning and memory. In the case of ADHD, metabolic disorder of certain neurotransmitters – dopamine and noradrenaline are evidenced. These neurotransmitters regulate the functions associated with motor activity, emotions, attention, and working memory. This is confirmed by the use of medications containing dopamine and noradrenaline, which reduce the symptoms of this disorder [35]. Dopamine plays an important role in working memory, and noradrenaline is associated with vigilance and attention.

Food effect

In 1965, Ben Feingold hypothesized that the hyperactivity of children and their inability to concentrate are influenced by frequent use of the food containing flavor enhancers, preservatives and other additives. He believed that the primary method of ADHD treatment should be diet [12, 36]. Lindgren (1986, as cited in [37]) also stated that there is a link between nutrition of children and their restless state. It was noticed that the children's food rich in sugar or other sweeteners increases hyperactivity. However, detailed studies did not confirm that sugar or preservatives in the food cause hyperactivity [38, 39]. There is also the hypothesis stating that the intake of nutrients, especially omega-3, omega-4 and omega-6 fatty acids, by children, adolescents and adults with ADHD can be improper or insufficient compared with healthy persons. However, there are no reliable data justifying that additional administration of these fatty acids reduces ADHD symptoms [40, 29].

There is evidence of potentially negative impact of gluten on the occurrence of ADHD [41]. Suspicions regarding the positive effect of gluten-free diet in the treatment of ADHD emerged after the research where it was applied in order to understand the pathogenesis of the disorder and to reduce the symptoms of the disorder. The lack of magnesium in the diet is indicated as one of possible causes of the disorder [42]. It was also observed that in children with ADHD there is a lack of ferritin, as compared to the control group, which is necessary for the proper metabolism of dopamine. The research performed by Konofal et al. found that after the administration of iron preparations to children with ADHD, ADHD symptoms decreased [43]. Nevertheless, to confirm this hypothesis more detailed and larger scale clinical research are required.

Lately, there are more thoughts of the scientists that any factors that cause organic changes in the CNS can cause a mild form of ADHD. In 2014, Perera et al. [44] published an opinion that polycyclic aromatic hydrocarbons in the urban air can have a negative effect on the occurrence of behavior problems in children with ADHD. Quirós-Alcalá et al. [45] examined the relationship between the level of used pesticides and ADHD morbidity in post-natal period. Since no strong links between these two phenomena have been discovered yet, the authors in their findings do not exclude the possibility of the presence of this link and propose to continue research in this area analyzing the effect of pesticides during the critical period in the development of the brain.

Assumptions concerning the relationship between vaccines and ADHD development are being verified. Doubts arise due to possible harmful effect of mercury-containing thiomerosal –preservative used in vaccines – on the development of children's nervous system. The publication issued by the US Immunization Safety Review Committee considers this hypothesis; however, the Committee believes that it is difficult – if not impossible – to prove this hypothesis; therefore, in epidemiological terms, the refusal of using vaccines against potentially fatal infectious diseases on this basis would be dangerous and irresponsible [46].

New technologies

There are drastically different opinions on the links between new technologies (smartphones, television, computer games, DVD players, etc.) and ADHD. At that point, when some scientists are trying to prove the negative effect of technology on the brain, especially in its developmental period, others offer the use of computer games to improve the quality of learning of such children and to concentrate their attention [47, 48].

Change of ADHD diagnostic criteria

For the first time, ADHD appeared in the DSM-III in 1980. The scientists then agreed to regard inattention as the main criterion, while the impulsivity and hyperactivity were considered equally important, but secondary criteria. Therefore, in the DSM-III, the disorder is classified as attention deficit disorder, which might have been diagnosed as attention-deficit/hyperactivity disorder (ADHD) or attention deficit disorder without hyperactivity (ADD). The experts also agreed that this disorder often continues in adulthood, however, it is no longer so clear and defined. In subsequent revised version of the DSM-III, it was recognized that the disorder can occur in adulthood, but the first symptoms should begin in childhood. In addition, inattention, hyperactivity and impulsivity were treated in the DSM-III-R as equally important criteria, and the disorder had one name – ADHD.

In the DSM-IV, published in 1994, one general name of ADHD was left, but the subtypes of disorder were indicated: with the predominance of attention deficit or with

the predominance of impulsivity with hyperactivity. Thus, the disjuncture between the inattention and the group of other symptoms (impulsivity and hyperactivity) occurred again. These guidelines remained in the DSM-5 (2013): ADHD is defined as inattention with or without hyperactivity and impulsivity. Therefore, there are three types of ADHD: combined type, predominantly inattentive type and predominantly hyperactive/impulsive type. Also the DSM-5 has been updated to more accurately characterize symptoms occurring in adolescents and adults with ADHD. It should be noted that a belief that a substantial proportion of children remain relatively impaired untill adulthood is getting stronger.

Therefore, the main symptoms of ADHD are: inattention, hyperactivity and impulsivity, and depending on how those symptoms "group themselves", some individuals may be hyperactive and impulsive, while others – only inattentive [21].

In the ICD-10, the diagnostic criteria for ADHD are more stringent than in the DSM-V. Chang and Chuang (2000) found that using more stringent diagnostic criteria included in the ICD-10, ADHD in the UK is diagnosed only in 1–2% of children, and using a wider DSM-IV criteria – in 3–9% [49]. The problem also arises because the main symptoms of ADHD in both ICD-10 and DSM-V are inattention, hyperactivity and impulsivity, but the division into disorder subtypes differ. According to the ICD-10, a mixed type of ADHD and hyperkinetic behavioral disorder are distinguished, and according to the DSM-V, ADHD is divided into subtypes of inattention and hyperactivity/impulsivity [50].

ADHD diagnosis in children and adults

It should be noted that the diagnosis of ADHD in children does not disappear in adulthood, it remains, but the symptoms change. When diagnosing ADHD, all the available medical documentation of the patient and psychopathological assessment are used. ADHD diagnosis in children is easier for medical specialists, because they can see and evaluate child here and now, while it is much more complicated to diagnose ADHD in adults when this diagnosis has not been established in childhood. Diagnostic classification requires that the symptoms of ADHD would show up to twelve years of age, and it is often difficult to assess in older adult patients. There are two ways to obtain this information: either to contact the patient's parents or guardians, or to question the patient himself/herseslf using specialized questionnaires (e.g., Attention-Deficit Hyperactivity Disorder in Adults, Oxford University Press, New York, 1995) on the basis of which the severity of ADHD symptoms in childhood is assessed [3]. Practically, most often adult ADHD is diagnosed in one of three cases: 1) when sick adult comes to consultation because his/her child was diagnosed with this disorder; 2) when sick adults comes to specialists because of other comorbid diseases; 3) when such adult is noticed by health system specialist after cases of car accident or getting to a prison.

European ADHD clinical guidelines were published by the European Society for Child and Adolescent Psychiatry (ESCAP) in 2004. In 2006, the European guidelines

on the procedures for the use of long-acting medication in children and adults with ADHD, with subsequent amendments were published [51–54]. Another source of information for the physicians working with patients with ADHD are the new guidelines (published in 2009) of the UK National Institute for Health and Clinical Excellence [52]. One of the last amendments in this regard is the European consensus statement on diagnosis and treatment of adult ADHD published in 2010, which recommends following both the DSM and ICD-10 diagnostic criteria. Individual European countries have also created individual national guidelines for this disorder.

Currently, the aim is to discover much more convenient and more objective ADHD diagnostic methods such as genetic, neurophysiological, and neuroimaging examination to determine clear and objective differences between the patients with ADHD and a group of healthy people. By now, none of these methods is sufficiently sensitive or specific for ADHD diagnosis. Thus, further and deeper research, especially genetic research in people with ADHD, are necessary. It is believed that the investigation of genotype will help to formulate objective ADHD diagnostic criteria in the future [3].

Living with ADHD

Firstly, as there is no approved visual test that gives solid proof of ADHD existence, some patient and especially parents of sick children may have a hard time to believing that ADHD is a real disorder. Secondly, relatives and loved ones of ADHD patients often stigmatize children and adults with ADHD [55]. Parent's stigma about their children's inattentive and hyperactive/impulsive symptoms may have negative consequences for parent-child interactions and social functioning of children [56]. Juvenile patients with learning difficulties may experience stigmatization in school environment, among unaffected peers. ADHD stigma ultimately increases patient's noncompliance to stimulant drug treatment because of beliefs about risk of becoming addicted, being no longer under the control of one's senses and feelings of being different from peers. A study of Martin et al. [57] showed that about 25% of the adult respondents did not want "their child to make friends with a child with ADHD" and about 20% clearly expressed that they do not want to engage with a child presenting behavior typically seen in ADHD. ADHD diagnosis also influence teachers' professional attitude toward such a child. For example, child with ADHD cause more stress to their teachers during learning process. Similar opinion are expressed in high schools, although stigmatization level is much lower. ADHD in adulthood is even more likely than ADHD in childhood to be associated with misperceptions and confusion; there is also an increased number of laypeople and professionals lacking disorder-related knowledge [58].

ADHD comorbidity with other mental disorders

ADHD comorbidity with mental illnesses is a huge problem because ADHD does not have any symptom exclusively specific for this disorder. Michielsen et al. (2013) argues that a large part of children and adults with ADHD has clinically significant comorbidity: about 30% of patients suffer from depression and over 25% – from anxiety disorders [59]. ADHD is often accompanied by psychiatric disorders, such as mood and anxiety disorders, as well as abuse of psychoactive substances, anti-social behavior, motor and vocal tics. The people surrounding such patients can describe them as angry, aggressive and lazy, which can be regarded as behavioral or special needs problems [4, 60]. These and other co-morbid psychiatric disorders may mask the symptoms of ADHD or conversely, some symptoms of other psychiatric disorders may mistakenly be regarded as ADHD. Patients with ADHD have a higher risk of developing mood disorders and, most likely, not only due to psychosocial problems emerging when suffering from ADHD but also because of neurobiological changes. More than 50% of patients suffering from ADHD have mood or anxiety disorders [25].

There is a higher risk of developing sociopathy, alcoholism and addiction diseases in adulthood for people who were diagnosed with ADHD in childhood [61]. ADHD also affects their further social life, academic achievement and self-esteem as well as interpersonal relationships. Although Barkley and Murphy (2006) and Wender (2001) argued that ADHD symptoms decrease and disappear when children grow [25, 61], Polier et al. (2010), having compared a control group of adolescents and adults with a group of people with a history of ADHD, found that oppositional defiant disorder develops in patients significantly more often [62]. Psychosocial adaptation, behavioral and emotional control as well as learning abilities of such persons were also significantly disordered. Patients with ADHD may have a relatively high IQ and their learning problems then are associated not with the lack of mental capacity but with a permanent inability to use their mental skills for the communication with other people or during study or work [49].

Comorbidity of ADHD and depression depends on gender and age. Based on the results of sample groups, it was found that comorbidity of depression and ADHD among adults is higher than among children and adolescents. Biederman (2004) in his studies found that only 11% of girls with ADHD also suffered from depression, while up to 72% of adult women with ADHD also suffered from depression. The differences in the results of men were not so huge – 21% of boys with ADHD met the criteria of depression, and 35% of adult men with ADHD were also diagnosed with depression [63]. The incidence of bipolar disorder in individuals with ADHD varies. Tamam et al. (2006) indicate that 11–20% of children with ADHD also suffer from bipolar disorder. Ryden et al. (2009) conducted a research which involved 51 adults and found that 3 of them suffered from bipolar disorder type 1, and 21 – bipolar disorder type II [64].

One of the four children with ADHD also suffered from one or more anxiety disorders. It is known that anxiety disorders in patients with ADHD are common, but

there is lack of more precise data on the incidence of anxiety among both children and adults with ADHD. This is explained by the fact that the anxiety component may occur in patients suffering only from ADHD, however, it can also be a separate illness accompanied by ADHD as well as a component of a third psychiatric disorder – depression, bipolar disorder, obsessive-compulsive disorder, dysthymia, etc.[65].

There are no precise, uniform data on the comorbidity of ADHD and obsessive-compulsive disorder in children. It is associated with the differences in methodological criteria and calculation methods in individual studies. There is also a lack of published data on the prevalence of ADHD and obsessive-compulsive disorder among the adults.

A personality disorder is also diagnosed in more than 30% of patients with ADHD: usually borderline, histrionic and narcissistic personality disorder. This comorbidity increases the suicide risk: it was found that patients suffering from ADHD and personality disorder thought about suicide more often (74%) [66].

It was observed that 71% of patients with ADHD abuse psychoactive substances. Individuals suffering from ADHD start to use psychoactive substances earlier and are more likely to experiment with different types of substances than healthy individuals [67]. In addition, ADHD is often accompanied by other psychiatric disorders (depression, anxiety, personality disorder, etc.), and the risk of developing addiction [68]. According to various studies, comorbidity of alcohol addiction and ADHD is observed in 6–71% of patients, while comorbidity of ADHD and psychoactive substance addiction – in 13–40% [69]. Men are especially at high risk. Ohlmeier et al. (2007) found that individuals suffering from ADHD are more often dependent on nicotine [70]. Lambert and Hartsough (1998) clarified that this addiction is twice as common as in healthy people [69]. Addiction to the following substances is quite common in this group: alcohol, cannabis (marihuana), psychostimulants (cocaine and amphetamine), and tranquilizers.

Patients with ADHD are prone to obesity and overeating. Davis et al. found that ADHD symptoms are more common among the obese than among the normal-weight controls. The authors suggest checking whether the obese persons applying for treatment suffer from ADHD. The relationship between the obesity and the disorder is explained by compulsive eating behavior, and there is an attempt to link it with altered functioning of individual receptors (dopamine, insulin). According to the authors, in this case ADHD treatment could also be the treatment of a severe obesity [71].

A research of Golimstok et al. (2011) mentions that patients with ADHD are at higher risk of developing dementia with Lewy bodies [72]. Their study showed that 48% of patients with dementia with Lewy body had symptoms typical of ADHD, compared with 15% of subjects without dementia in the control group. It is believed that this is due to the lack of neurotransmitters, dopamine and noradrenaline, which leads to the development of ADHD in younger age and later development of dementia with Lewy bodies.

Social problems

While symptoms of ADHD in children are reflected in the spheres of learning and playing, in the adults they are more evidenced in social areas. ADHD diagnosis in forensic psychiatry is becoming more frequent: these patients are characterized by criminal behavior; they tend to be arrested, accused and imprisoned more often [73]. ADHD increases the risk of dangerous driving in adults. A study of Barkely et al. [74] examined 105 17–28 year-old people with ADHD and 64 healthy persons. It was found that persons suffering from ADHD exceeded the speed, caused the accident and lost the right to drive significantly more often than the subjects from control group. Moreover, the patients with ADHD were less attentive and more often made mistakes doing visual tasks. In addition, their knowledge of the traffic rules was poorer [74].

Comorbidity of ADHD and somatic diseases

Unlike the children, morbidity of adult patients with ADHD with somatic diseases and the mortality rate is higher than among the healthy individuals. This is determined not only by the fact that people with ADHD are more frequently involved in car accidents, unfortunate accidents and more often suffer from injuries but also by the fact that they the more often suffer from diseases caused by their lifestyle (primary arterial hypertension, coronary heart disease, metabolic syndrome, poor nutrition, etc.) and, in general, careless attitude towards own health (risky sexual behavior, abuse of psychoactive substances) [5, 75]. The digestive tract, skin, immune, neurological, respiratory, metabolic, and blood diseases as well as hearing impairment are more often diagnosed in patients with ADHD. However, at the same time, the authors warn to be careful assessing this data because one cannot deny that these health disorders are diagnosed in patients with ADHD more often because they simply more often visit health care facilities. People with ADHD quite often complain of headaches and abdominal pains, fatigue, atopic eczema and sleep disorders [5].

A study conducted in Finland found that hyperactivity in children increases the risk of occurrence of atherosclerosis risk factor, smoking (in both sexes), higher body mass index, higher systolic blood pressure and lower level of education (among women) in adulthood. Atherosclerosis is a major risk factor for cardiovascular diseases. The authors guess that there may also be a direct negative impact on the vascular endothelium [76].

ADHD treatment

The first described treatment methods of this disorder covered a special individual diet, improvement of social environment and treatment with potassium bromide, whose effectiveness was limited, thus the search for new medicine and treatment methods was

necessary (T.S. Clouston). In the middle of the 20th century, the article published by the psychiatrist Charls Bradley in 1937 on the positive effect of benzedrine sulphate (amphetamine) on children with behavioral and activity problems, became a notable achievement in the treatment of ADHD [77]. At present, according to the European clinical guidelines (ESCAP, 2004), the treatment should consist of psychological (non-pharmacological) measures at home (which enables including family members into the therapy) and at school, treatment with psychostimulants and non-stimulants as well as supervision of nutrition [51].

Pharmacological treatment

Both skeptics of the diagnosis of ADHD as well as opponents of its pharmacological treatment raise a number of questions. There are doubts related to safety and effectiveness of treatment, especially the long-term one [6]. There are reasonable suspicions regarding the actual impartiality of publications evidencing positive treatment effects; the issue of distorting research results and the participation of pharmaceutical companies in this process is also raised [7]. Scientists are considering possible impairment of dopaminergic system due to long-term use of psychostimulants, the potential neurotoxicity of these medications on developing brains, dysfunction of neurons, growth retardation in children, occurrence of tics, however, the evidence has not been found yet [78].

A number of research to determine the relationship between the use of psychostimulants and the of risk of cardiovascular diseases (such as transient ischemic attack, stroke, angina pectoris, myocardial infarction, arrhythmias) in patients without cardiovascular disease risk factors, are being carried out; however, statistically significant results have not been found yet [78]. There is a hypothesis on the possible link between the use of psychostimulants, particularly in patients who are already at increased risk of sudden death, and such disorders as: short QT syndrome, arrhythmogenic right ventricular cardiomyopathy, Brugada syndrome or WPW syndrome [79]. Psychostimulants from the group of sympathomimetic drugs may increase blood pressure and heart rate.

In 2013, the American scientist L.Greenhill presented the analysis of 6-evidence-based scientific articles that analyzed sudden death associated with the use of psychostimulants. The author concludes that physicians should be more cautious administering the treatment with psychostimulants when there were cases of sudden deaths due to heart diseases in patient's family, patients have heart abnormalities, suffer from heart disease such as heart failure, faints, intolerance to exercise due to heart problems [80]. Therefore, before administering such treatment, it is recommended to evaluate the anamnesis, perform ECG, neurological examination, blood tests, and only then, if the patient is physically healthy, administer the treatment with psychostimulants.

Prasad et al. (2009) believe that the first-line medication for children and adults with ADHD are psychostimulants, which is in line with the official treatment guidelines [73].

The most commonly used stimulants are short-acting methylphenidate or its modified form. In the absence of sufficient effect, a non-stimulating medication – atomoxetine – is administered. Zoëga et al. (2011) hypothesized that the use of stimulating medications for the ADHD treatment could encourage these patients to abuse psychotropic and narcotic substances in the future, however, the research did not prove this fact. On the contrary, the treatment of children with ADHD with stimulants was significantly associated with a lower risk of the use of narcotic substances at older age [81]. If the first-line medications do not provide the desired effect or cannot be prescribed, the treatment with second-line medications – tricyclic antidepressants, selective serotonin reuptake inhibitors, second generation heterocyclic antidepressants, selective serotonin and noradrenaline reuptake inhibitors, centrally acting alpha 2 adrenergic receptor agonists, is recommended [82].

Studies in a group of adults confirmed that in about two-thirds of adults with ADHD who were administered the treatment with stimulants, there was a significant reduction in symptoms [73]. Long-acting stimulating medications are more commonly prescribed to the adult patients s it is easier for them to take such medication regarding their forgetfulness, distraction and non-concentration. Prescription of stimulating medications to the adult patients with ADHD is quite complicated because many of them had or have addiction to one or more psychoactive substances [83]. In the absence of sufficient effect, the adults should be administered non-stimulating medication – atomoxetine of selective noradrenaline reuptake inhibitors group (NARI) [73, 84]. This medication, in some cases, may be a first-line medicine in case of tics, Tourette syndrome, anxiety disorders, abuse or improper use of stimulants [85].

In addition, the parents themselves often express attitude against the long use of the medication for ADHD by their children. Poor adherence to the medication intake regime is associated with possible side effects of the medicine [86].

There is also an issue of the risk of abuse of stimulants and their use outside the therapeutic purposes. The abuse is associated with euphoric effect caused by higher doses of drugs [87, 88]. Psychostimulants, influencing the dopaminergic system, can lead to addiction, however, according to the studies, patients with ADHD taking stimulants are not more prone to addiction compared with the general population. During the studies, the pupils and students name the psychostimulants as a convenient option to improve their learning or sport outcomes and cause euphoria [87, 88]. Young patients even share their stimulants with other peers (e.g., according to McCabe et al. this concerns 23.3% of middle and senior pupils), and such trend also continues during the studies [87]. It is observed that males tend to abuse the stimulants more often than females [87].

Non-pharmacological treatment

According to the European consensus statement on diagnosis and treatment of adult ADHD, ADHD treatment in adults can improve disordered psychosocial func-

tions of patients and fight the comorbid diseases [60]. Initial non-pharmacological treatment of the disorder is very important: an individual and/or cognitive behavioral therapy, relaxation and the ability to manage stress, training to organize own activities, day employment planning, family training and therapy [89]. This treatment should include psychological functioning of patients, relationships with family and the people around them, working environment, cognitive disorders, driving style and risk factors of addiction. It is advisable to involve family members in the treatment. Often the perception of own illness allows the patient to look at the events of the past in a different way [60]. The patients are recommended to increase physical activity. It is important to choose an appropriate profession – individuals with ADHD can successfully have a professional career in sales and media areas, as actors, businesspersons, teachers, and paramedics.

Conclusions

1. Working with adult patients and confronting with vague and hardly corrected mental and behavioral disorders, the doctor should remember about the possibility of adult ADHD syndrome. ADHD symptoms in childhood do not cease to exist. Personality, social relations and affective disorders more commonly observed in adults with ADHD than motor hyperactivity.
2. ADHD is a multi-factorial disorder, in which genetic changes and negative environmental impact probably play the most important role.
3. Early treatment during childhood can help to reduce the negative consequences of ADHD in adults.
4. The main criteria for the diagnosis of adult ADHD is the diagnosis of this disorder in the childhood, however, in adults it is often undiagnosed or diagnosed retrospectively.
5. ADHD is often accompanied by mental and somatic disorders such as mood or anxiety disorders, abuse of psychoactive substances, anti-social behavior, motor and vocal tics, eating disorders, earlier occurrence of cardiovascular diseases, etc.
6. Compared with children, adults with ADHD are more likely to have ADHD accompanied by comorbid disorders; adult ADHD is more often diagnosed when an adult visits a doctor because of other comorbid disorders and not because of ADHD symptoms.
7. Stimulants with central effect or antidepressants with dopaminergic and/or noradrenergic effects are offered as a first-line treatment of ADHD in both children and adults; social interventions and appropriate choice of professional activity are especially important.

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