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Global incidence of attention deficit/hyperactivity disorder among children †

Irena Ilic [1,*] and Milena Ilic [2]

[1] Faculty of Medicine, University of Belgrade, Belgrade, Serbia; ajrini10@gmail.com
[2] Department of Epidemiology, Faculty of Medical Sciences, University of Kragujevac, Kragujevac, Serbia; drmilenailic@yahoo.com
* Correspondence: ajrini10@gmail.com; Tel.: +381 11 3636300
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Abstract: In this descriptive epidemiological study, age-specific rates for attention-deficit and hyperactivity disorder (ADHD) incidence among children (0-14 years) were presented (per 100000). Joinpoint regression analysis was applied to calculate the average annual percent change (AAPC) with the corresponding 95% confidence interval (CI) to evaluate trends in 1990-2019. Global ADHD incidence was nearly threefold that of girls (307.9 and 114.4 per 100000, respectively) in 2019. Trends for global ADHD incidence were significantly decreasing both in boys (AAPC= -0.4%, 95%CI=-0.4 to -0.3) and girls (AAPC= -0.4%, 95%CI=-0.5 to -0.3).

Keywords: attention deficit/hyperactivity disorder; children; incidence

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1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a chronic condition which involves developmentally inadequate inattention level, hyperactivity, and/or impulsivity [1]. ADHD is among the most common childhood neurobehavioral disorders, that in a number of cases persists into adulthood [2-4]. A previous meta-regression analysis estimated that ADHD affects about 6% of children around the world, with a range from 1% to nearly 20% in school age children [2]. The significant differences in ADHD prevalence by geographic areas were described [2, 5, 6].

There have been only several studies reporting estimates of ADHD incidence trends, mostly indicating increasing incidence over the observed period [7, 8]. But, some studies did not find an increase in ADHD incidence trends over the past years [5]. This study aimed to estimate the global incidence of attention-deficit and hyperactivity disorder among children in the last three decades.

2. Materials and Methods

2.1. Study design

An observational descriptive epidemiological study was done to describe worldwide trends in incidence from ADHD in the period 1990-2019.

2.2. Data source

Data of ADHD incidence in children were obtained from the Global Burden of Disease Study 2019 [9]. In this study, age-specific rates of incidence for ADHD in children (0-

14 years) were presented (per 100000). Also, the socio-development level was quantified by the Socio-demographic index (SDI), a composite measure comprised of income per capita, educational level for persons aged 15 years and older, and total fertility rate for women <25 years of age [9]. An SDI of 0 describes a theoretical minimum level of development as it pertains to health, while an SDI of 1 marks maximum level. Countries were divided into 5 SDI quintiles: low-, low-middle-, middle-, high-middle- and high-SDI countries.

2.3. Statistical analysis

Joinpoint regression analysis was applied to determine the average annual percent change (AAPC) with 95% confidence interval (CI) to evaluate trends in 1990-2019 [10]. Additionally, disparities in trends of incidence by sex were assessed with a comparability test (specifically: test of parallelism), in order to assess if the two regression mean functions were parallel. A p value lower than 0.05 indicated statistical significance for all tests.

3. Results

Globally, there were 4,198,974 new ADHD cases in children (0-14 years) in 2019: it was diagnosed in 3,114,614 (74%) boys and 1,084,360 (26%) girls (Figure 1).

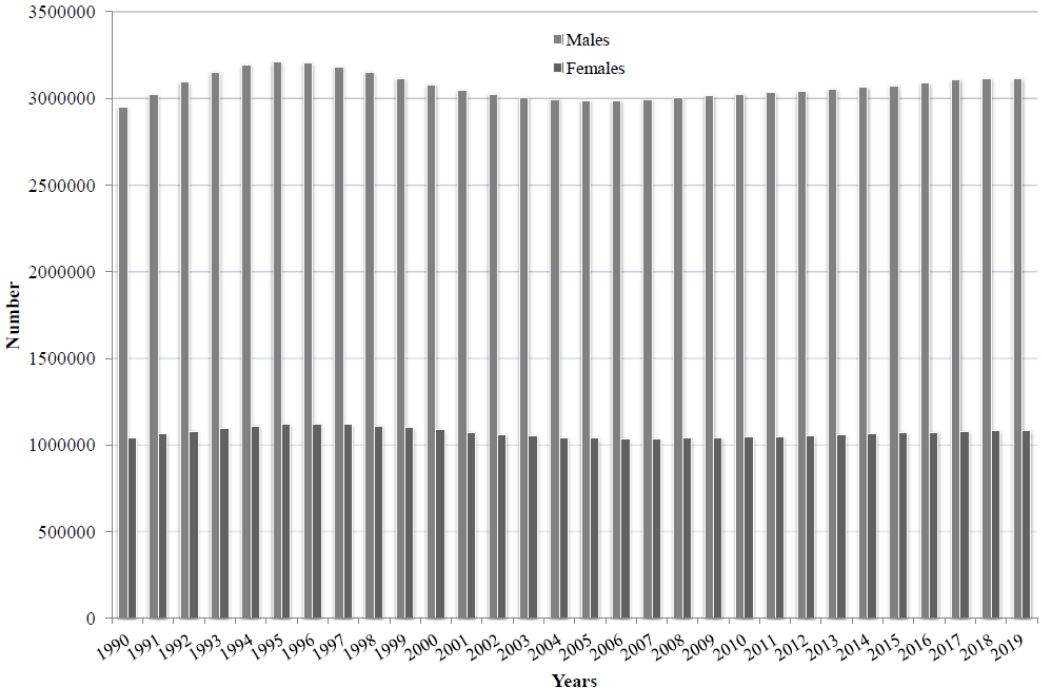

Figure 1. Number of new cases of attention-deficit and hyperactivity disorder in the world, by sex, 1990-2019.

Global rate of ADHD incidence in boys was nearly threefold that in girls (307.9 per 100000 and 114.4 per 100000, respectively) in 2019 (Figures 2 and 3). Globally, ADHD was a disorder that predominantly affected boys with a boy/girl sex ratio0 of approximately 3:1. Significantly decreasing trends for global ADHD incidence were observed both in boys (by -0.4% annually, 95%CI=-0.4 to -0.3) and girls (by -0.4% annually, 95%CI=-0.5 to -0.3) (Figures 2 and 4). The trends of ADHD incidence in children in both sexes followed an oscillating nonlinear pattern, with a significant increase at the beginning of the observed period, and a continuously significant decrease in trends after 1995 in boys and

after 1994 in girls and henceforth. Based on the comparability test, global trends in incidence of ADHD in boys and girls were not parallel (final selected model rejected parallelism, $p < 0.05$).

In both sexes together, the highest ADHD incidence was observed in high-SDI countries (Figure 3). The incidence rates of ADHD in children across all SDI quintiles showed that boys experienced higher burden compared with girls in 2019 (Figure 3). In boys, the highest incidence rate for ADHD in children was found in the high-SDI countries (521.28 per 100 000), followed by high-middle SDI countries (433.39 per 100 000), while the highest rates in girls were equally in high- and high-middle SDI countries (about 165.00 per 100 000).

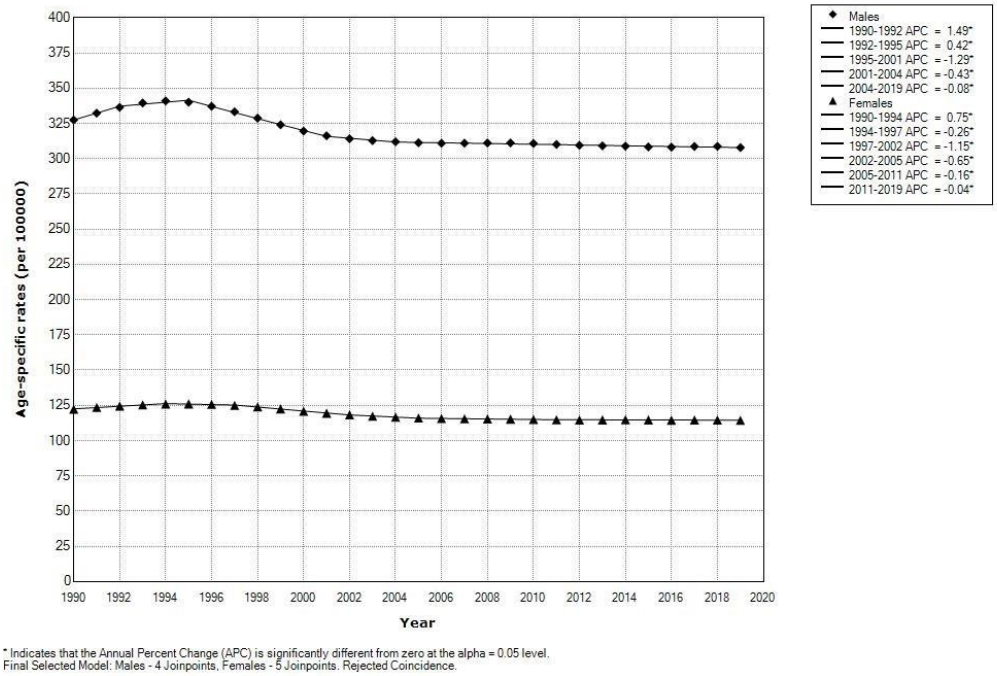

Figure 2. Trends in global incidence of attention deficit/hyperactivity disorder in children (0-14 years), 1990-2019; a joinpoint regression analysis: Males: 4 Joinpoints versus Females: 5 Joinpoints.

Over the 1990-2019 period, a significant decrease in ADHD incidence rates in boys was noted in only one area – in middle-SDI countries (by -0.3% per year) (Figure 4). Contrary to that, the incidence rates of ADHD in boys significantly increased in high-SDI countries (by +0.2% per year), and low-middle- and low-SDI countries (equally by +0.1% per year). A significant increase in incidence of ADHD was registered in girls in high- and low-middle SDI countries (by +0.3% and +0.2% per year, respectively). In middle- and high-middle SDI countries a significant decrease (by -0.2% and -0.1% per year, respectively) were recorded. Based on the comparability test, trends in incidence of ADHD by each SDI in boys and girls were not parallel (final selected model rejected parallelism, $p < 0.05$).

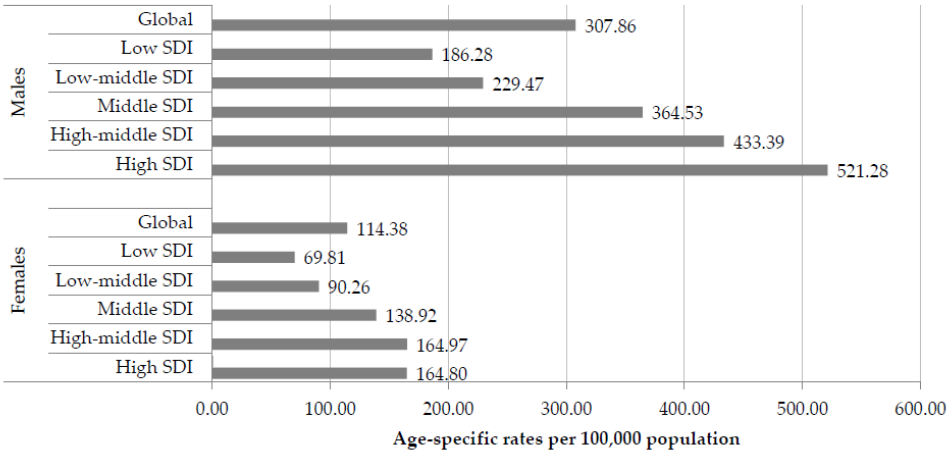

Figure 3. Incidence of attention deficit/hyperactivity disorder in children (global and by Socio-demographic index – SDI), by sex, 2019.

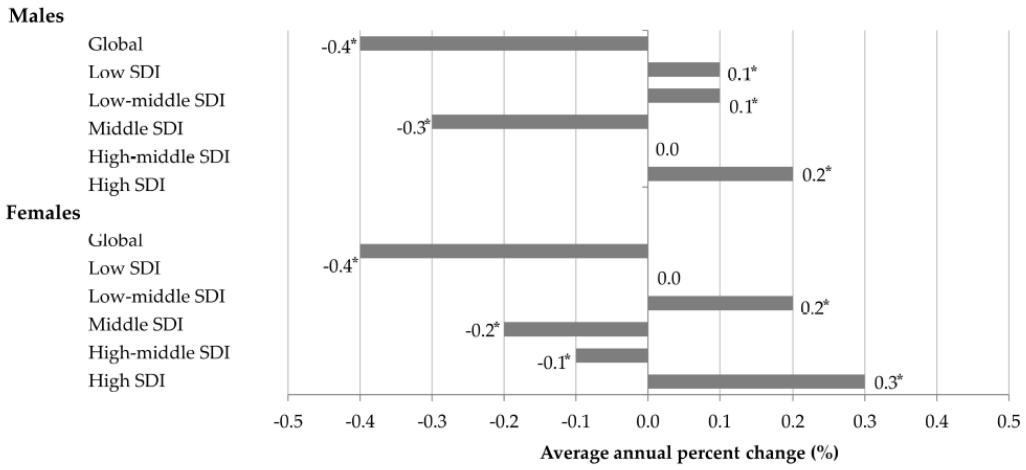

Figure 4. Trends in incidence of attention deficit/hyperactivity disorder in children (global and by Socio-demographic index – SDI), by sex, 1990-2019; a joinpoint regression analysis.

4. Discussion

The incidence of the ADHD in children is still not well researched. Although not numerous, epidemiological studies on the ADHD incidence have shown increasing temporal trends of this disorder in some countries [3, 8].

According to the available literature, until now there was no data on the global incidence of ADHD in children. Our study showed a decreasing trend in ADHD incidence among children in both sexes, with marked differences in trends by SDI. In contrast to the global trend, a pronounced increasing trend was observed in high SDI countries. The results of our study regarding the ADHD incidence among children are consistent with

some previous research done in Spain [5], Slovenia [3], Canada [11], the USA [12], Germany [13].

The observed differences in ADHD incidence temporal trends in children could mainly be due to the implementation of new diagnostic criteria (ICD-10, etc.) and the use of different case definitions, overdiagnosis / underdiagnosis in different health care systems, geographical and demographic factors, different observation periods, differences in study methodology.

In conclusion, the ADHD remains one of the most common neurodevelopmental disorders in children, although a decreasing global trend in incidence was observed. To explain the reasons for variations in ADHD incidence in children across the world, future analytical longitudinal studies are needed.

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Institutional Review Board Statement: The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of the Faculty of Medical Sciences, University of Kragujevac (Ref. No.: 01-14321, November 13, 2017), entitled "Epidemiology of the most common health disorders".

Informed Consent Statement: Not applicable. No patient approvals were sought nor required for this study. Namely, as our model-based analysis used aggregated data, patients were not involved in the research.

Data Availability Statement: Data is contained within the article.

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Conflicts of Interest: The authors declare no conflict of interest.

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