EPIDEMIOLOGICAL ASPECTS OF DEVELOPMENTAL DISORDERS IN SCHOOL AGED CHILDREN

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Abstract: *Multiple factors influence the discrepancy between the prevalence rates of developmental disorders worldwide. In addition to different prevalence rates of developmental disorders, there are differences in terminology and their classification. The purpose of the research was to estimate the prevalence and gender distribution of developmental disorders and to calculate the number of children with developmental disorders and special educational needs in a convenience sample of school-age children. We also calculated the number of children with congenital malformations and diseases that affect vision and hearing. We processed the data from medical records of 1750 children (835 males and 915 females) who were examined in the Pediatric Dispensary, Military Hospital, Skopje, Republic of Macedonia during the period of June 30 1992 to June 30 2011. A descriptive method was used. For statistical data analysis we used Chi-square test and Fisher exact test with level of significance $p<0.05$.*

A total of 153 out of 1750 (8.7%) children had developmental disorders and special educational needs. Gender distribution shows that 97 children (11.6%) were males and 56 children (6.1%) were females. Specific developmental disorders of speech and language were most frequent (82.3%) from all developmental disorders.

Prevalence rates of some diseases and developmental disorders were lower in comparison to other studies, e.g., specific developmental disorders of scholastic skills, hyperkinetic disorders, refractive errors and conductive hearing loss. Low prevalence rate of certain disorders could indicate their underdetection.

Keywords: *epidemiology, development, children with disabilities*

INTRODUCTION

Multiple factors influence the discrepancy between the prevalence of behavioral and developmental disorders among infants and young children and the typical frequency of their recognition and management by pediatricians and other practicing professionals. The Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV) focuses on child and adolescent mental disorders that are less prevalent than behavioral and developmental disorders commonly seen in infants and young children (Drotar, 2004). Most physicians depend on clinical judgment rather than screening tools when detect developmental disorders. Unfortunately, research shows that clinical judgment detects fewer than 30% of children who have intellectual disability, learning disabilities, language impairments, and other developmental disabilities. Approximately 15% to 18% of children in the United States have developmental or behavioral disabilities and one in four children has serious psychosocial problems (Glascoe, 2000). Screening systems should identify existing social-emotional concerns in very young children as well as significant child, parent and family risks for development of early social-emotional problems (Baggett et al., 2007). Results

from recent systematic review of epidemiological surveys of pervasive developmental disorders worldwide show that most studies conducted since the year 2000 converge on estimates of 17/10.000 for autistic disorder and 62/10.000 for all pervasive developmental disorders combined (Elsabbagh et al., 2012). Many authors reported an estimated prevalence of congenital hearing loss between 1-2 cases per 1000 newborn infants (Chang et al., 2009). Shargorodsky et al. (2010) found increased prevalence of hearing loss among US adolescents in comparison to studies in 1990-ies. An estimate of the global prevalence of blindness in 2002 was 0.57% and prevalence of low vision was 2% (Resnikoff et al., 2004). In addition to different prevalence rates of developmental disorders, there are differences in terminology and their classification. It is important to collect epidemiological data for developmental disorders for planning of early intervention services and other social programs.

OBJECTIVES

The objectives of the research were to estimate the prevalence and gender distribution of developmental disorders, to calculate the number of children with developmental disorders and special educational needs in a convenience sample of school-age children and to calculate the number of children with congenital malformations and diseases that affect vision and hearing.

HYPOTHESES

According to the results from previous researches and the objectives of the research, we formulated the following hypotheses:

H1: The most prevalence rates of developmental disorders are similar to prevalence rates of developmental disorders from other studies.

H2: The number of males with developmental disorders is bigger than number of females with developmental disorders.

H3: The most frequent developmental disorders are specific developmental disorders of speech and language.

WORK METHOD

We processed the data from medical records of 1750 children (835 males and 915 females) who were examined in the Pediatric Dispensary, Military Hospital, Skopje, Republic of Macedonia during the period of June 30 1992 to June 30 2011. From medical records we collect only the data related to developmental disorders, gender and age of the patients. The inclusion criteria for this retrospective study were age between 7 and 19 years and complete medical record of the child at the moment of research. Children were born from 1992 to 2004. We conducted unstructured interview with pediatricians to obtain additional information for early detection of symptoms of developmental disorders and definitive diagnoses. We used descriptive method and Chi-square test and Fisher exact test with level of significance $p<0.05$ for statistical data analysis. The classification of diseases was according to the International Classification of Diseases (ICD-10).

RESULTS AND DISCUSSION

The total number of children surveyed in our study was 1750 (835 males and 915 females). The number of children with developmental disorders and special educational needs was 153, 8.7% (11.6% males and 6.1% females) from the total number of children (Table 1). Gender distribution shows that 97 children (63%) were males and 56 children (37%) were females. Blackburn et al. (2010) reported similar findings: 7.3% of UK children (8.8% males and 5.8% females) were disabled. Boyle et al. (2011) reported 13.87% (18.04% in boys and 9.50% in girls) prevalence of developmental disabilities in US children. Most common disorders in our study were specific developmental disorders of speech and language (82.3%). Two children in the sample had special educational needs because of their health status: one child had leukemia and one child had congenital heart disease. Statistical analysis shows that there is statistical difference between the number of males and females in the groups of children with developmental disorders and children without developmental disorders ($p=0.00004$).

Given the presence of more than one developmental disorder in any given child we separately estimated lifetime prevalence of all disorders. A total of 170 children had mental and behavioral disorders. Seven children (6 males and 1 female) had mild intellectual disability (0.4%), and one girl

Table 1. *Number of children with and without developmental disorders and special educational needs*

Types of developmental disorders/diseases	Males	Females	Total
	N (%)	N (%)	N (%)
Specific developmental disorders of speech and language	81 (52.9)	45 (29.4)	126 (82.3)
Cerebral palsy	1 (0.7)	3 (2)	4 (2.6)
Autism and mild mental retardation	4 (2.6)	0 (0)	4 (2.6)
Mild mental retardation	2 (1.3)	1 (0.7)	3 (2)
Specific developmental disorders of scholastic skills	2 (1.3)	1 (0.7)	3 (2)
Hyperkinetic disorders	2 (1.3)	1 (0.7)	3 (2)
Autism	2 (1.3)	0 (0)	2 (1.3)
Hearing loss	1 (0.7)	1 (0.7)	2 (1.3)
Visual impairment	1 (0.7)	1 (0.7)	2 (1.3)
Deafness	0 (0)	1 (0.7)	1 (0.7)
Rett syndrome and moderate mental retardation	0 (0)	1 (0.7)	1 (0.7)
Leukemia	0 (0)	1 (0.7)	1 (0.7)
Congenital heart disease	1 (0.7)	0 (0)	1 (0.7)
Total	97 (63.4)	56 (36.6)	153 (100)
Total (with developmental disorders)	97 (5.5)	56 (3.2)	153 (8.7)
Total (without develop. disorders)	738 (42.2)	859 (49.1) p=0.00004*	1597 (91.3)
Total (children in the sample)	835 (47.7)	915 (52.3)	1750 (100)

* Chi-square test

Table 2. *Types of articulation and fonological disorders*

Types of articulation and fonological disorders	Males	Females	Total
	N (%)	N (%)	N (%)
Sigmatism	27 (22)	19 (15.4)	46 (37.4)
Rhotacism	22 (17.9)	14 (11.4)	36 (29.3)
Lambdacism	15 (12.2)	6 (4.9)	21 (17.1)
Rhotacism and Lambdacism	5 (4.1)	3 (2.4)	8 (6.5)
Sigmatism and Lambdacism	4 (3.3)	1 (0.8)	5 (4.1)
Sigmatism and Rhotacism	3 (2.4)	1 (0.8)	4 (3.3)
Sigmatism, Rhotacism and Lambdacism	2 (1.6)	1 (0.8)	3 (2.4)
Total	78 (63.4)	45 (36.6)	123 (100)

had moderate intellectual disability (0.06%). The prevalence of intellectual disability in our sample was 0.5%. The prevalence of intellectual disability in US children was 0.71%, 0.78% in boys and 0.63% in girls (Boyle et al., 2011). From the pervasive developmental disorders 6 children (males) had autism (0.3%), and one girl had Rett syndrome (0.06%). The prevalence of pervasive developmental disorders was 0.4%. The prevalence of autism in US children was 0.47%, 0.74% in boys and 0.19% in girls (Boyle et al., 2011). Yeargin-Allsopp et al. (2003) reported prevalence of autism 3.4 per 1000 with a male-female ratio of 4:1. Bienvenu et al. (2006) conducted a large epidemiologic study of Rett syndrome in France and estimated its prevalence as 0.578 case per 10.000 females aged 4-15 years. A total of 126 children in our study had specific developmental disorders of speech and language (7.2%). Prevalence rates for speech and language delay have been reported across wide ranges. Studies that evaluated combined speech and language delay for preschool-aged children, 2 to 4.5 years old, had prevalence rates ranging from 2-3% to 19% (Nelson et al., 2006). Blanchard et al. (2006) reported prevalence of speech problems 5.8% in preschool children. In our study most of the children with specific developmental disorders of speech and language had dyslalia (78 males and 45 females). We displayed the types of articulation and fonological disorders (Table 2).

Sigmatism was present in a total of 58 children (3.3%), rhotacism in 51 children (2.9%), and lambdacism in 37 children (2.1%). From all children with dyslalia in our sample, 103 (83.7%) had problem with articulation of one phoneme and 20 (16.3%) had problem with articulation of more than one phoneme. In a sample of children with dyslalia Honová et al. (2003) found that at least 16% of children had defective more than one phoneme. Three children had developmental dysphasia. Two males had expressive type, and one male had receptive type. In our sample three children (2 males and 1 female) had specific developmental disorders of scholastic skills. The prevalence was 0.2%. In US children the prevalence of learning disabilities was 7.66%, 8.97% in boys and 5.01% in girls (Boyle et al., 2011). Altarac and Saroha (2007) reported 9.7% lifetime prevalence of learning disability. Nine children (7 males and 2 females) in this study had stuttering (0.5%). Children with stuttering were not separately displayed in the sample in Table 1 because they also have other developmental problems. Boyle et al. (2011) reported stuttering and stammering prevalence of 1.60%, 2.25% in boys and 0.91% in girls. Tic disorders were seen in 0.4% of children (6 males and 1 female). Khalifa and von Knorring (2003) reported prevalence 6.6% of tic disorders in children aged 7-15 years. Five children (4 males and 1 female) had hyperkinetic disorders. The prevalence was 0.3%. ADHD prevalence in US children was 6.69%, 9.51% males and 3.73% females (Boyle et al., 2011). With changes in diagnostic criteria within the same samples, the prevalence rates of the ADHD increased from 7.2% to 11.4% from DSM-III-R to DSM-IV (Wolraich, 2006). Guardiola et al. (2000) reported prevalence of ADHD as 18% using DSM-IV criteria, and as 3.5% when neuropsychological criteria were used. A total of 5 children (0.3%) in our study had emotional disorders with onset specific to childhood. Three children (1 male and 2 females) had phobic anxiety disorder and 2 children (1 male and 1 female) had separation anxiety disorder. Beesdo et al. (2009) reported that the most frequent disorders among children and adolescents were separation anxiety disorder with estimates of 2.8% and 8% and specific and social phobias, with rates up to around 10% and 7%. Results from our study related to the prevalence rates of disorders from the group of mental and behavioral disorders show that only prevalence of specific developmental disorders of scholastic skills, tic disorders, stuttering, hyperkinetic disorders and emotional disorders with onset specific to childhood were lower than prevalence rates in mentioned studies. Prevalence rates of other disorders were similar to results from other studies. The low prevalence rate of certain disorders could indicate their underdetection.

With analysis of the presence of motor disorders we found a number of congenital and acquired conditions. Four children (1 male and 3 females) had cerebral palsy (0.2%). Cerebral palsy occurs in 2 to 3 per 1000 live births (Surveillance of cerebral palsy in Europe, 2000). In US children the prevalence of cerebral palsy was 0.39%, 0.36% in boys and 0.37% in girls (Boyle et al., 2011). One boy in the sample had achondroplasia (0.06%). Achondroplasia occurs between 1 in 15.000 and 40.000 live births (Vajo et al., 2000). One male and one female had congenital dislocation of hip (0.1%). De Alwis et al. (2007) reported a prevalence of congenital dislocation of hip as 26.3 per 10.000. From the congenital deformities of feet 2 girls (0.1%) had pes planovalgus. Pfeiffer et al. (2006) found prevalence of flexible flat foot 44% (52% in boys and 36% in girls) in the group of 3- to 6-year-old children and prevalence of pathological flat foot < 1%. One boy had talipes equinovarus (0.06%) and one girl had talipes calcaneovalgus (0.06%). Congenital clubfoot occurs in 0.39 of 1000 newborns worldwide (Nogueira et al., 2011). De Alwis et al. (2007) estimated a prevalence of talipes equinovarus as 31.8 per 10.000 live births. The estimated incidence of calcaneovalgus was 0.4-1 in 1000 live births (Nunes and Dutra, 1986, according to Hart et al., 2005). Polydactyly and syndactyly also had a prevalence of 0.1%. Two boys had accessory thumb, 1 boy had webbed fingers, and 1 boy had webbed toes. Duplication of the thumb occurs in 1:3000 births (Jain, 2003). Syndactyly is thought to occur about once in every 2000 to 2500 births (Flatt, 2005). Two children (1 male and 1 female) had congenital torticollis (0.1%). Freed and Coulter-O'Berry (2004) reported estimated incidence of congenital muscular torticollis one infant in every 300 live births. Some

children had transient acquired conditions. Ten children (7 males and 3 females) had bone fracture (0.6%). Six children (5 males and 1 female) had fractures of forearm, 3 newborns (1 male and 2 females) had fracture of clavicle, and one child (male) had a humerus fracture. Seven children (5 males and 2 females) had dislocation of the tibiotalar joint (0.4%). One girl had spondylolisthesis (0.06%). We did not compare frequency of bone fractures, joint dislocation and spondylolisthesis because they were accidental traumatic conditions. Eight children had kyphoscoliosis (0.5%). The prevalence of adolescent idiopathic scoliosis is about 2.5% of most populations (Asher and Burton, 2006). We did not find clear prevalence estimates for the cases when it was combined with kyphosis. From the types of juvenile osteochondrosis 2 males (0.1%) had Osgood-Schlatter disease. Jakovljevic et al. (2010) found 8.9% prevalence in boys practicing sport, aged 10-16 and 4% in boys at the same age who did not practice sports. One boy had Legg-Calvé-Perthes disease (0.06%). Margetts et al. (2001) reported a decreased incidence per 100.000 from 16.9 in the period 1976-1981 to 8.7 in 1990-1995. Sever disease was also present in one boy (0.06%). Sever's disease was reported to have an incidence of 2% to 16% of musculoskeletal injuries in children (Scharfbillig et al., 2008). One girl had juvenile arthritis (0.06%). The combined incidence of juvenile rheumatoid arthritis and juvenile spondylathritis reported in recent US and Canadian studies ranges from 4.1 to 6.1 per 100.000 (Helmick et al., 2008). Transient synovitis of the hip was also present in one girl (0.06%). Krul et al. (2010) reported the incidence rate 76.2 per 100.000. In addition to the diseases in the group of deforming dorsopathies 41 children (21 males and 20 females) had scoliosis, but there were not severe cases of scoliosis that can lead to restricting physical activities. In this group of motor disorders in most cases comparison of prevalence rates was uncertain because the prevalence rates from other studies were estimated in very large samples.

The total number of children with hearing loss was 31. Twenty-eight children (17 males and 11 females) had conductive hearing loss (1.6%). Most of them had secretory otitis media, but we did not find clear data for all children. Three children had sensorineural hearing loss (0.2%). One girl was deaf and two children (1 male and 1 female) had severe hearing loss. Congenital hearing loss has an estimated prevalence between 1-2 cases per 1000 newborn infants (Chang et al., 2009). Boyle et al. (2011) reported prevalence 0.45% (0.54% in boys and 0.35% in girls) of moderate to profound hearing loss. The prevalence of sensorineural hearing loss was similar to other studies' results. We did not compare the prevalence of conductive hearing loss. We found data for audiologic assessment only in 41 children. The prevalence of conductive hearing loss may be underestimated.

The sampled population included 154 children with disorders of refraction. From them, 94 children (49 males and 45 females) had myopia (5.4%). Prevalence of myopia in school children in Hong Kong was 36.71% (Fan et al., 2004). A total of 51 children (33 males and 18 females) had astigmatism (2.9%) and 9 children (5 males and 4 females) had hypermetropia (0.5%). Kleinstein et al. (2003) reported prevalence of myopia as 9.2%, 12.8% for hyperopia and 28.4% for astigmatism in children aged 5-17 years. Twenty-eight children (16 males and 12 females) had strabismus (1.6%). Prevalence of strabismus is 2% to 5% in European-based and African-American populations. The prevalence of strabismus in Native-American children was 1.5% and 1% in different groups of children (Garvey et al., 2010). A total of 3 children in our sample (1 male and 2 females) had congenital cataract (0.2%). Rahi and Dezateux (2001) reported incidence of congenital and infantile cataract as 2.49 per 10.000 in the first year of life. Adjusted cumulative incidence at 5 years was 3.18 per 10.000, increasing to 3.46 per 10.000 by 15 years. From all children with diseases that affect vision in our sample only two children had special educational needs according to the degree of the visual impairment (one girl was blind and one boy had moderate visual impairment). From this group only the prevalence rates of disorders of refraction were lower than results from other authors' findings.

We estimated the prevalence of congenital malformations, deformations and chromosomal abnormalities. In Table 3 we displayed the gender distribution of congenital malformations in the sample.

A total of 51 children out of 1750 (2.9%) had congenital malformations. Eleven children (0.6%) had atrial septal defect (ASD), 0.3% had ventricular septal defect (VSD), and 0.1% had patent ductus arteriosus (PDA). The prevalence of atrioventricular septal defect (AVSD) and coarctation of aorta was 0.06%. Congenital heart disease was present in 20 children or 39.2% of all children with congenital malformations and 1.1% of all children in the sample. The reported prevalence of CHD in many studies varies between 4 and 10 per 1000 live births (Marelli et al., 2007).

In the group of congenital malformations of the musculoskeletal system 0.2% of children had pectus excavatum and 0.1% had pectus carinatum. Dislocation of hip, pes planovalgus, polydactyly and syndactyly were also present in 0.1% of children. Achondroplasia, craniosynostosis, facial asymmetry, talipes equinovarus, and talipes calcaneovalgus were present in 0.06% of children. In the group of congenital malformations of the digestive system 0.1% of children had Meckel's diverticulum, and 0.1% of children had anorectal malformations. Atresia of oesophagus was present in 0.06% of children. From the other malformations, 0.2% had congenital cataract, 0.1% had congenital torticollis, and one child had microtia (0.06%). From chromosomal abnormalities only one child had Turner syndrome (0.06%). According to the European Surveillance of Congenital Anomalies (EUROCAT) network of population-based congenital anomaly registries for 2004-2008, total congenital anomaly prevalence was 239.3 per 10.000 births (Loane et al., 2011). Our results for congenital anomalies are similar to results from other studies.

We also displayed the gender distribution of congenital malformations among different groups (Table 4). In our sample we found congenital malformations of circulatory system, musculoskeletal system, malformations of eye, ear and neck, malformations of digestive system and chromosomal

Table 3. *Gender distribution of congenital malformations*

Types of congenital malformations	Males	Females	Total
	N (%)	N (%)	N (%)
Atrial septal defect	5 (9.8)	6 (11.8)	11 (21.6)
Ventricular septal defect	2 (3.9)	3 (5.9)	5 (9.8)
Pectus excavatum	2 (3.9)	2 (3.9)	4 (7.8)
Congenital cataract	1 (2)	2 (3.9)	3 (5.9)
Patent ductus arteriosus	0 (0)	2 (3.9)	2 (3.9)
Pectus carinatum	2 (3.9)	0 (0)	2 (3.9)
Dislocation of hip	1 (2)	1 (2)	2 (3.9)
Pes planovalgus	0 (0)	2 (3.9)	2 (3.9)
Polydactyly	2 (3.9)	0 (0)	2 (3.9)
Syndactyly	2 (3.9)	0 (0)	2 (3.9)
Meckel's diverticulum	2 (3.9)	0 (0)	2 (3.9)
Anorectal malformation	1 (2)	1 (2)	2 (3.9)
Congenital torticollis	1 (2)	1 (2)	2 (3.9)
Coarctation of aorta	1 (2)	0 (0)	1 (2)
Atrioventricular septal defect	0 (0)	1 (2)	1 (2)
Achondroplasia	1 (2)	0 (0)	1 (2)
Craniosynostosis	1 (2)	0 (0)	1 (2)
Atresia of oesophagus	0 (0)	1 (2)	1 (2)
Facial asymmetry	0 (0)	1 (2)	1 (2)
Talipes equinovarus	1 (2)	0 (0)	1 (2)
Talipes calcaneovalgus	0 (0)	1 (2)	1 (2)
Microtia	1 (2)	0 (0)	1 (2)
Turner syndrome	0 (0)	1 (2)	1 (2)
Total	26 (51)	25 (49)	51 (100)

Table 4. *Gender distribution of congenital malformations among different groups*

Groups of congenital malformations	Males	Females	p	Total
	N (%)	N (%)		N (%)
Malformations of circulatory system	8 (15.7)	12 (23.5)		20 (39.2)
Malformations of musculoskeletal system	12 (23.5)	7 (13.7)		19 (37.2)
Malformations of eye, ear and neck	3 (5.9)	3 (5.9)		6 (11.8)
Malformations of digestive system	3 (5.9)	2 (3.9)		5 (9.8)
Chromosomal abnormalities	0 (0)	1 (2)	p=0.547*	1 (2)
Total	26 (51)	25 (49)		51 (100)

* Fisher exact test

abnormalities. There were not malformations from other groups of diseases. There is no statistical difference (p=0.547) in gender distribution of congenital malformations among different groups. However, this is a small sample of children to make a conclusion about gender distribution.

CONCLUSION

Most prevalence rates of disorders in our study were similar to results from other studies, e.g., intellectual disability, pervasive developmental disorders, specific developmental disorders of speech and language, stuttering, cerebral palsy, sensorineural hearing loss, but prevalence rates of some developmental disorders and diseases were lower in comparison to other authors' findings, e.g., specific developmental disorders of scholastic skills, tic disorders, hyperkinetic disorders, emotional disorders with onset specific to childhood, refractive errors, and conductive hearing loss. The low prevalence rate of certain disorders could indicate their underdetection. Unfortunately, there was not system of screening that all children went through. In that way some developmental disorders and sensory impairments can not be early recognized and treated. There is a need for national strategy for early detection of developmental disorders and national register of developmental disabilities for better follow-up of disabled children. The hypotheses of the research were confirmed. The number of males with developmental disorders was bigger than number of females with developmental disorders. Most common disorders were specific developmental disorders of speech and language. Further studies could focus on the diagnostic criteria for developmental disability.

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