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## THE BURDEN OF VISUAL IMPAIRMENT AMONG THE CHILDREN IN AZERBAIJAN

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The purpose of the study was to determine the dynamics of the burden of childhood blindness in the Republic of Azerbaijan. The official data of the State Committee on Statistics for 2011–2017 were obtained from the website. The burden of blindness was conducted by determination of the arithmetic mean of the age of the formation of blindness; individual duration of future life after the formation of blindness, arithmetic mean of the age of children at the time of the formation of blindness; calculating of life duration of children by age groups by multiplying the number of blind children in age groups; determining of burden of blindness in childhood as summary of years of future life of blind patients by calendar years. The prevalence rate of blindness was the lowest in 2012 ( $17.8 \pm 0.8^{0/0000}$ ), and the highest in 2017 ( $30.4 \pm 1.1^{0/0000}$ ). The tendency of burden of blindness is linear, accuracy of linear equation is 57.97 %. During period 2011–2017 the prevalence of blindness among children population changed within the range 17.8–30.4<sup>0/0000</sup>, the main tendency of which is dynamic increasing. The dynamics of the prevalence of blindness among children and its burden in Azerbaijan confirms the importance of developing a plan to reduce this pathology.

**Key words:** childhood blindness, dynamics, prevalence, epidemiology

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## ПОШИРЕНІСТЬ ПОРУШЕНЬ ЗОРУ У ДІТЕЙ В АЗЕРБАЙДЖАНІ

Метою дослідження було визначити динаміку тягаря дитячої сліпоти в Азербайджанській Республіці. Офіційні дані Держкомстату за 2011–2017 роки взято із сайту. Тягар сліпоти визначалося шляхом розрахунку середнього арифметичного віку формування сліпоти; індивідуальної тривалості життя після формування сліпоти, середнього арифметичного віку дітей на момент формування сліпоти; тривалості життя дітей за віковими групами шляхом множення числа сліпих дітей у вікових групах; визначення тягаря сліпоти у дитячому віці як підсумовування років майбутнього життя сліпих хворих за календарними роками. Показник поширеності сліпоти був найнижчим у 2012 році ( $17,8 \pm 0,8^{0/0000}$ ), а найвищим у 2017 році ( $30,4 \pm 1,1^{0/0000}$ ). Тенденція тягаря сліпоти лінійна, точність лінійного рівняння становить 57,97 %. За період 2011–2017 років, поширеність сліпоти серед дитячого населення змінювалася не більше 17,8–30,4<sup>0/0000</sup>, основний тенденцією якої є динамічне зростання. Динаміка поширеності сліпоти серед дітей та її тягаря в Азербайджані підтверджує важливість розробки плану зниження даної патології.

**Ключові слова:** дитяча сліпота, динаміка, поширеність, епідеміологія.

Blindness in childhood is a serious problem in human society [5, 10]. According to the information given by WHO the quantity of blind people in the world reached 39 million, the share of young people among them is 18 % [8]. Five percent of worldwide blindness involves children younger than 15 years of age; in developing countries 50 % of the population is in this age group. By World Health Organization criteria, an estimated 19 million of the world's children are visually impaired, while 1.4 million are blind: 1.0 million in Asia, 0.3 million in Africa, 0.1 million in Latin America, and 0.1 million in the rest of the world. Approximately 17.5 million children are at a risk of developing low vision. The estimated burden associated with blindness among children is 70 million blind person years [4].

Almost three quarters of blind children live in low-middle-income countries where the prevalence is reported to be as high as 1.5 per 1000 children in contrast to high-income countries where the prevalence is 0.3 per 1000 [6].

Using the UK as a model for high-income countries, from a population-based incidence study, the annual cumulative incidence of severe visual impairment/blindness (SVL/BL) is estimated to be 6/10 000 by age 15 years, with the incidence being highest in the first year of life [10].

There are marked differences in the causes of pediatric blindness in different regions, apparently based on socioeconomic factors.

Children and teenagers become blind more often in developing countries [3]. A blind child is more likely to live in socioeconomic deprivation. The main causes of childhood blindness in lower income settings are infective and nutritional corneal opacities and congenital anomalies. For children in higher income countries, cerebral visual impairment and optic nerve anomalies remain the most common causes of severe visual impairment and blindness, while retinopathy of prematurity (ROP) and cataract are now the most common avoidable causes [9, 11].

25.5 % of all blind patients in Eritrea are the persons under 26 years of age. The prevalence of blindness in children under 10 years of age in Nepal ranges from 0.05 % to 0.07 % [1]. The level of children's disability due to visual impairment is 5.2 person per 10 000 people [7]. One of the important reasons is the commitment of countries to the International Standard on care of very preterm infants (body mass 500–999 gr.), which increases the risk of blindness due to retinopathy and reflected in the statistics in the temporal aspect. Surviving of very preterm infants in Azerbaijan was started at 2015. The level of the burden of blindness depends on at least 2 factors: the prevalence of blindness and life expectancy after the onset of blindness, which are not well highlighted in the literature.

**The purpose** of the study was to determine the dynamics of the burden of childhood blindness in the Republic of Azerbaijan.

**Materials and methods.** The official data of the State Committee on Statistics for 2011–2017, which are published annually, have been used as materials of this research work. These reports have electronic versions on the website ([www.gov.stat.az](http://www.gov.stat.az)). The presented information covered the 0–1.5, 1.5–3.0, 4–7, 8–10, 11–17 years old age groups. Estimation of the burden of blindness – the total number of future years of life after the formation of blindness was conducted on the following order:

- Determination of the arithmetic mean of the age of the formation of blindness ( $B_i$ , years);
- Definition of individual duration of future life after the formation of blindness as a difference between duration of expected life at birth in Azerbaijan ( $LD_j$ ), by calendar years and the arithmetic mean of the age of children at the time of the formation of blindness ( $LD - B_i$ );
- Calculating of life duration of children by age groups by multiplying the number of blind children in age groups ( $K_i$ ) by the value of the individual life duration after the formation of blindness ( $LD_j - B_i$ );
- Determining of burden of blindness in childhood as summary of years of future life of blind patients [ $\sum K_i \times (LD_j - B_i)$ ] by calendar years;
- Assessment of size dynamics of burden of blindness in childhood by means of smoothing the trend line by means of the least squares method [2].

**Results of the study and their discussion.** The prevalence rate of blindness was the lowest in 2012 year ( $17.8 \pm 0.8^{0/0000}$ ), and the highest in 2017 year ( $30.4 \pm 1.1^{0/0000}$ ). The difference between these indicators is significant ( $P=0.001$ ). Actual evidence does not allow to detect any trend in prevalence rate of blindness, since they change chaotically. Data about the prevalence of blindness among 0–17 years old children in Azerbaijan are given in Table 1.

Table 1

**The prevalence of blindness among children aged 0–17 years in Azerbaijan during the period 2011–2017 (per 100 000 people aged 0–17 years)**

Years	Prevalence rate ( $^{0/0000}$ )	95% prevalence confidence interval ( $^{0/0000}$ )
2011	18.4±0.9	16.6–20.2
2012	17.8±0.8	16.2–19.4
2013	30.0±1.1	27.8–32.2
2014	22.3±0.9	20.5–24.1
2015	22.5±0.9	20.7–24.3
2016	27.3±1.0	25.3–29.3
2017	30.4±1.1	28.2–32.6

Mechanical smoothing of the dynamics line also hinders to establish a trend pattern. Analytic smoothing by the method of the least squares method allowed to reveal the following equations:

- Linear equation:  $y=1.694x+17.329$  ( $R^2=0.4929$ );
- Polynomial equation:  $y=9.1667x^6-4.668x^5+43.182x^4-218.29x^3+570.41x^2-709.68x+336.87$  ( $R^2=1.0$ ).

$Y$  – the blindness prevalence rate ( $^{0/0000}$ );

$R^2$  – coefficient of determination;

$X$  – serial numbers of years (2011–1; 2012–2; ..... 2017–7).

It is obvious, that the linear equation does not accurately describe the dynamics trend, the accuracy is approximately 49 %. The accuracy of the description of the polynomial equation is 100 %.

The total quantity of years of future life of blind children at age 0–1.5 years during the period 2011–2017 was: 438.3; 1389.9; 1762.8; 1042.3; 1637.9 & 1791.6. The accuracy of the linear equation ( $y=136.98x+855.72$ ) is 34.43 % ( $R^2=0.3443$ ), and the accuracy of the polynomial equation is 100 % ( $y=-12.661x^6+290.36x^5-2605.9x^4+11651x^3-27371x^2+32390x-13904$ ).

Dynamics of indicators of blindness burden in childhood during the period 2011–2017 in Azerbaijan are presented in Table 2.

Table 2

**Burden of blindness in childhood in dynamics during 2011-2017 years in Azerbaijan**

Years	Duration of expected	Quantity of blind children at age						Duration of expected future life of blind children at age (years)					
		0–1.5	1.5–3	4–7	7	8–10	11–17	0–1.5	1.5–3	4–7	7	8–10	11–17
2011	73.8	6	38	60	37	101	228	73,1	71.6	68.3	66.8	64.8	60.8
2012	73.9	19	41	69	43	80	199	73,2	71.7	68.4	66.9	64.9	60.9
2013	74.2	24	45	97	73	157	365	73,5	72.0	68.7	67.2	65.2	61.2
2014	74.2	24	59	85	41	109	256	73,5	72.0	68.7	67.2	65.2	61.2
2015	75.2	14	43	89	44	111	277	74,5	73.0	69.7	68.2	66.2	62.2
2016	75.2	22	50	105	57	149	326	74,5	73.0	69.7	68.2	66.2	62.2
2017	75.4	24	61	137	62	149	361	74,5	73.2	69.9	68.4	66.4	62.4
2018	75.8	18	67	128	60	145	365						
2019	76.4	23	61	127	51	144	353						
2020	73.2	18	67	111	58	145	380						
		Duration of expected future life of blind children at age (years)						Burden (person/years)					
		0–1.5	1.5–3	4–7	7	8–10	11–13						
2011		438.3	2718.9	4098	2471.6	6544.8	13862.4						30134
2012		1389.9	2937.7	4719.6	2876.7	5192	12119.1						29235
2013		1762.8	3237.8	6663.9	4905.6	10236.4	22338.0						49144
2014		1762.8	4245.1	5839.5	2755.2	7106.8	15667.2						37376
2015		1042.3	3136.9	6203.3	3000.8	7348.2	17229.4						37960
2016		1637.9	3647.5	7318.5	3887.4	9863.8	20277.2						46632
2017		1791.6	4462.2	9576.3	4240.8	9893.6	22526.4						52491

Total sums of years of future life of blind children aged 1.5–3.0 years during the period 2011–2017 are 2718.9; 2937.7; 3237.8; 4245.1; 3136.9; 3647.5; 4462.2, respectively. During 2011–2014 and 2015–2017 periods the dynamics trend was linear. The accuracy of the linear equation ( $y=233.8x+2548.2$ ) is 58.28 %, and the accuracy of the polynomial equation ( $y=-30.016x^6+713.73x^5-6647.3x^4+30691x^3-73122x^2+84224x-33110$ ) reaches 100 %.

Total sums of expected years of future life of blind children aged 4–7 years during the period 2011–2017 are 4098; 4719.6; 6663.9; 5839.5; 6203.3; 7318.5; 9576.3, respectively. The accuracy of the linear equation of tendency ( $y=756.15x+3321$ ) is high (82.28 %).

For the blind children aged 7 years, total sums of expected years of future life during the period 2011–2017 are 2471.6; 2876.7; 4905.6; 2755.2; 3000.8; 3887.4; 4240.8, respectively. The accuracy of the linear equation is low ( $y=193.72x+2673.4$ ;  $R^2=0.2142$ ), nominal equation ( $y=41.139x^6-1036.5x^5+10304x^4-51030x^3+130305x^2-158311x+72200$ ;  $R^2=1.0$ ) is highly accurate (100 %).

Total sums of expected years of future life of blind children aged 8–10 years during the period 2011–2017 are 6544.8; 5192; 10236.4; 7106.8; 7348.2; 9863.8; 9893.6, respectively. The accuracy of the linear equation ( $y=589.35x+5669.1$ ) 41.77 %, of the polynomial equation ( $y=66.301x^6-1715.3x^5+17536x^4-89495x^3+236200x^2-297523x+141477$ ) is high.

For the blind children aged 11–17 years, total sums of expected years of future life in the period 2011–2017 are 13862.4; 12119.1; 22338; 15667.2; 17229.4; 20277.2; 22526.4, respectively. The accuracy of the linear equation of the tendency ( $y=1328.6x+12403$ ) is 48–61 %, the polynomial equation describes the trend with 100 % accuracy. The burden of blindness in childhood during 2011–2017 had the following quantitative characteristics (years of life): 30134; 29234.9; 49144.45; 37376.55; 37960.85; 46632.3; 52490.85. The tendency of burden is linear and the accuracy of the linear equation is 57.97 %. The polynomial equation ( $y=258.99x^6-6645.5x^5+67445x^4-341892x^3+895756x^2-1E+0.6x+532124$ ;  $R^2=1.0$ ) describes the tendency more accurate. It is obvious, that during the period 2011–2017 the burden of blindness dynamically increased.

The burden of blindness per 1000 children for the period 2011–2017 are 12.87; 12.33; 20.65; 15.49; 15.74; 18.95 and 21.36 person/years, respectively. The linear tendency of this indicator is described by equation ( $y=1.207x+11.943$ ), accuracy of which is 51.94 %. The polynomial equation of 6<sup>th</sup> degree ( $y=0.1146x^6-2.9278x^5+29.591x^4-149.44x^3+390.31x^2-485.7x+230.92$ ;  $R^2=1.0$ ) accurately describe the tendency. So, the prevalence rate of blindness among children in Azerbaijan (17.8–30.4<sup>0</sup>/<sub>0000</sub> during the period 2011–2017) is comparatively less than in Russia, where the primary childhood disability is 52<sup>0</sup>/<sub>0000</sub> [8]. In comparison with Nepal (blindness among children less than 10 years is 50–70<sup>0</sup>/<sub>0000</sub>) the

prevalence rate of blindness among children in Azerbaijan is also lower [1]. According to Hussain AHME, et al, the same data for Bangladesh is 6.3 per 10,000 children, whereas the rate of unocular blindness was 4.8 per 10,000 children. The authors of the study, mentioned above, also revealed that the congenital problems were the major causes of both unocular and binocular blindness (unocular blindness: 84% and binocular blindness: 92%) [4]. But in this work the dynamics of blindness were not studied (in contrast to ours).

The investigators from India (Wadhvani M., et al, 2020) revealed, the current prevalence of blindness in children in India is known to be around 0.8/1000. A systematic review was performed as the database gathering method for the study in order to determine the prevalence and causes of childhood blindness. The authors emphasised that the prevalence is likely to be affected by the methodology used to estimate blindness such as community-based surveys and locations like rural or urban settings [12]. In our study, we used official statistic data which makes the results significant.

Liu L, et al, studied the dynamics of blindness and visual loss among children and adolescents for the period 1990–2019. The authors conducted a population-based study using 1990–2019 data on the burden of vision loss and blindness from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019. The burden of vision loss and blindness was evaluated in terms of case numbers, rates per 100 000 population and average annual percentage changes in prevalence rates and years lived with disability. They noted that globally, efforts in the past 3 decades have substantially decreased the burdens of blindness and vision loss among children and adolescents. However, the results of Liu L, et al, work showed, that there is extensive variation according to the kind of impairment, age group, and country sociodemographic index [5]. We did not study the impact of risk factors, but it might be the goal for future work.

So, increasing tendency of prevalence rate of blindness among children in Azerbaijan, detected in our study, likely is associated with increasing level of expected burden and requires serious attention. WHO considers action plan for preventing avoidable blindness and visual impairment for 2009-2013 years insufficiently effective, and the executive committee offered member-states start working on a new plan immediately [5]. This task, certainly, is actual for the Republic of Azerbaijan, too.

### Conclusions

1. During the period 2011–2017 the prevalence rate of blindness among children population, the main trend of which is dynamical increase, had changed in the range of 17.8–30.4<sup>0</sup>/0000.
2. Dependence of burden of blindness among blind children on age can be more adequately estimated by the total value of future life years of blind children, which was 12.87 person/year per 1000 blind children in 2011 and 21.36 person/ year in 2013.
3. The prevalence dynamics of blindness among children and its burden in Azerbaijan highlights the need to develop an action plan to prevent avoidable blindness and visual impairment in correspondence with WHO requirements.

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