RESEARCH ARTICLE

Frequency of congenital malformations and chromosomal disorders in Bacau and Vaslui counties (Romania)

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Abstract

This paper presents the state of genetic health of the human populations in two Romanian counties, Bacau and Vaslui, as they are different in area, number of inhabitants, level of economic and social development, etc. The data presented in this paper is from the Public Health Directions of the two counties, reflecting the situation recorded during 2006–2013. In the 8 years study, 1894 cases of congenital and chromosomal disorders were recorded in the newborns from the populations in the two counties. The identified cases were distributed based on years, categories of disorders and sexes. The average frequency of congenital disorders in the two populations over the investigated period was about 1.65 in Bacau county and 1.83% in Vaslui counties. In the population of Bacau county, these disorders affect in the same number in both the sexes (49.62% female cases and 50.38% male cases), while in Vaslui, the male cases are more than the females (53.92 and 46.08%, respectively). The main congenital disorders observed were: cardiovascular system anomalies, musculoskeletal system, urogenital system, etc. During the investigation period, in the human population of Bacau county, 97 cases of newborns with chromosomal disorders were diagnosed (0.16% of the living newborns), while in Vaslui county there were 106 cases (0.26% of the living newborns). Among these disorders, the Down's syndrome was the most frequent one, representing 83.5 and 85.8% of cases in the population of Bacau county, and Vaslui counties.

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Introduction

Congenital malformations and genetic disorders are numerous and diverse, affecting various human systems and organs, many of them being dramatic because of their manifestations and the consequences they have on the families of the afflicted children. Although in the past decades important progress was made in the prenatal diagnosis of these disorders, which lead to a relative decrease in their frequency and the preventive medicine can become even more effective. According to the data provided by the World Health Organization, annually, worldwide, 7.5 million infants are born with genetic diseases, chromosomal anomalies and serious congenital malformations. The frequency of these disorders differs from one area to another, one country to another, one evaluation period to another. According to the information provided by Rizk *et al.* (2014), the birth prevalence of congenital anomalies is 1.07% in Japan, 1.49% in South Africa, 2% in UK, 2–3% in USA and 4.3% in Taiwan. The presented differences supposedly have social, racial, ecological and economic causes. A study conducted by Singh *et al.* (2014) on the major congenital malformations recorded during 1993–2012 in Barbados Islands, showed that their total prevalence was 59/10,000 in the living newborns and 399/10,000 in the stillborns (the most frequent malformations are of the circulatory system and of the chromosomal disorders, the Down's syndrome). A study conducted in Egypt on a group of 5000 infants born in the Assiut University Hospital highlighted a prevalence of congenital disorders of 2.06%, with a male/female ratio of 1.7 : 1 (Mohammed *et al.* 2011).

In an ample retrospective research on the congenital disorders recorded in Glasgow (Scotland) during 1980–1997, calculated on 233,777 births, it is shown that the total prevalence of these disorders over the investigated period was 324/10,000 births, but being reduced since 1980 (382/10,000) by one third until 1997 (238/10,000). The most frequent anomalies recorded were the congenital heart, limbs and digestive system disorders (Dastgiri *et al.* 2002). An ulterior study

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conducted by Rankin (2007) in relatively the same part of the world, England and Wales showed also a tendency of reduction for these anomalies over the years from 168.1/10,000 in 1964 to 114/10,000 in 2001 for living newborns.

Regarding the origin of congenital anomalies, it has been calculated that ∼40–60% of them have unknown origin, 30–40% are the consequence of genetic disorders and 5–10% are caused by the environment. Out of those with a genetic cause, 6% are presumably due to chromosomal anomalies, 25% due to monogenic anomalies and 20–30% due to multifactorial causes (Rajangan *et al.* 2007). Other authors believe that the genetic factors are involved only in 15% of these disorders, the environmental factors, are ∼10%, while the interaction between the genetic and environmental factors would cause 20–25% of the congenital anomalies (Mohammed *et al.* 2011).

In Europe, chromosomal anomalies represent ∼15% of the congenital disorders diagnosed within the age of 1 year in infants and are associated with ∼25% of the perinatal deaths. Approximately a quarter of the early neonatal deaths recorded in the EU in 2004 were caused by congenital anomalies, out of which 18% (according to European Surveillance of Congenital Anomalies (EUROCAT)) were chromosomal (most of them being trisomies of the chromosomes 21, 18, 13 and anomalies of the heterosomes) (Welesley *et al.* 2012).

In Romania, ∼7200 children are born every year with congenital anomalies, monogenic or chromosomal diseases, while other 12,500 children are suffering from a multifactorial disorder during 1–25 years (Covic *et al.* 2004), means that over 20,000 children and their families need annual diagnosis, various investigations and genetic advice. A study on congenital malformations conducted during 1970–1972 at the Iasi Clinic of Obstetrics–Gynecology revealed a total frequency of 7.6% major and minor malformations in living and dead newborns (Ivan *et al.* 1981). Another research of this type extended over a period of 22 years (1984–2005) in Oradea, has identified 3377 children with congenital anomalies, representing 2% of the total number of living newborns in the reported period of time (Suciu 2009).

Despite the differences in the criteria that were used in the recording and reporting of the cases; one can say that the total frequency of the major congenital malformations visible at birth and distinguishable in newborns through a clinical examination is in the average of 1.5–2% (Ivan *et al.* 1981). The early diagnosis of this type of diseases is crucial, especially when some of the sequelae can be corrected surgically, thus avoiding an abnormal neuro-motor development of a child.

Materials and methods

To evaluate the incidence of human congenital malformations and chromosomal disorders, the populations of two counties, Bacau and Vaslui, were chosen as they are different not only in area and number of inhabitants, but also in their social and economic development. It was believed that this last factor could have an impact on the frequency of the investigated disorders. The study was conducted over a period of 8 years from 2006 to 2013. The data presented in this paper were provided by the Public Health Directions of the two counties, according to codes Q0–Q99, which include all the diseases reported by the hospitals and the family physicians in the county. The clinical diagnosis of the disorders presented in this paper was established by the specialist physicians according to the symptoms (general or facial dysmorphisms, psycho-motor retardation and sexual ambiguity) present at birth or in the first year of life. Over the course of the research, various specialist physicians were consulted, who gave information on the diagnosis methods that were used, invasive and noninvasive, and who described in detail the structure and functions of the systems.

Thus, in the investigation of cyanogenic heart malformations, such as tetralogy of Fallot, transposition of the great arteries, tricuspid atresia, hypoplastic left heart syndrome, etc., the diagnosis was suggested by the presence of heart murmurs, heart failure or cyanosis, usually seen during the first months after birth. Various assessment methods were used: pulse oximetry, electrocardiography (ECG) and thoracic radiography, but the echocardiography has confirmed the presence of the disorders. The diagnosis of the noncyanogenic malformations, such as atrial and ventricular defects and persistent arterial duct was established through an ECG, echocardiographic 2D colour and Doppler examination.

Ultrasound and somatoscopic examinations were used to assess the musculoskeletal system in the newborn children up to 1 year old, and in case of older children radiographic investigations were used. In this way various anomalies were diagnosed, such as: congenital hip and leg deformities, osteoarticular system malformations, member anomalies, etc. To spot neuropathic and musculopathic disorders, investigations such as electromyography and muscular biopsy were conducted.

The diagnosis of the congenital urogenital anomalies was done based on the anamnesis, family medical history, physical and imagistic examination. Ultrasonography, CT scan and biopsy were the main methods to spot the cysts in the kidneys, while the micturition and filling cystography as well as the radioisotope cystogram were used mainly to diagnose cases of urinary bladder obstruction.

To diagnose the gastrointestinal disorders (malformations of the gallbladder, liver, small intestine, upper digestive tract, etc.), the following investigations were used: radiological examinations using contrast media, anoscopy or sigmoidoscopy, MRI or CT scan.

The diagnosis of cerebral congenital anomalies was done through ultrasonography in the case of newborns and through CT scan, MRI, or radiography in the case of older infants. For the respiratory system anomalies, the following identification methods were used: bronchoscopy, thoracic radiography, CT scans, ultrasound scans to assess the quality of the pleural fluid. The confirmation of the diagnosis in the case of chromosomal anomalies was made through karyotyping.

Table 1. Incidence of congenital anomalies in the counties of Bacau and Vaslui (Romania), during 2006–2013.

Year	Bacau county		Vaslui county	
	Living newborns	Incidence of congenital malformations (%)	Living newborns	Incidence of congenital malformations (%)
2006	8141	0.67	5533	1.73
2007	8067	0.95	5481	1.82
2008	7880	0.98	5152	1.37
2009	7542	0.98	5241	1.92
2010	7305	2.17	4464	2.06
2011	6858	2.75	4346	2.14
2012	6981	1.20	4564	1.84
2013	6672	3.53	5022	1.75

Table 2. Incidence of the most frequent congenital anomalies and chromosomal disorders among the living newborns in the counties of Bacau and Vaslui (Romania), during 2006–2013.

Bacau county				Vaslui county			
Congenital malformations		No.	(%)	Congenital malformations		No.	(%)
Cardio-vascular system	Circulatory system	79	7.51	Cardio-vascular system	Circulatory system	121	14.37
	Heart cavities, orifices and septa	196	18.63		Heart cavities, orifices and septa	205	24.34
Musculo-skeletal system	Disorders of the hip	79	7.51	Musculo-skeletal system	Disorders of the hip	14	1.66
	Disorders of the foot	80	7.60		Disorders of the foot	57	6.76
	Osteoarticular system disorders	19	1.81		Polydactyly and syndactyly	12	1.42
Urogenital system	Polycystic kidney	46	4.37	Urogenital system	Polycystic kidney	8	0.95
	Male genital system anomalies	29	2.76		Male genital organs anomalies	6	0.71
	Renal agenesis	–	–		Renal agenesis	12	1.42
Digestive system	Hirschsprung's disease	20	1.90	Digestive system	Hirschsprung's disease	–	–
	The upper digestive tract anomalies	16	1.52		The upper digestive tract anomalies	7	0.83
	The small intestine anomalies	10	0.95		The small intestine anomalies	5	0.59
Nervous system	Hydrocephalus	10	0.95	Nervous system	Hydrocephalus	10	1.18
	Spina bifida	29	2.76		Spina bifida	9	1.06
Respiratory system	Cleft lip and palate	25	2.38	Respiratory system	Cleft lip and palate	26	3.08
Chromosomal disorders				Chromosomal disorders			
Down's syndrome		81	0.14	Down's syndrome		91	0.23
Turner syndrome		13	0.02	Turner syndrome		5	0.01
Other chromosomal disorders		3	0.005	Other chromosomal disorders		10	0.025

In the above mentioned period, Bacau county recorded 59,446 living newborns, while Vaslui county, recorded 39,803 living newborns. Out of these, 1052 cases of congenital and chromosomal anomalies were reported in Bacau county, and 842 cases in Vaslui county. The study took into consideration both the incidence of these anomalies in the investigated human populations, and their distribution on categories of diseases and sex. In addition to the investigation of the way in which these anomalies evolved in time in the north eastern part of Romania. The study also accounts for the possible influence of the socio-economic level of the development of one area on the frequency of these disorders. The results from the observations are presented in tables 1–4.

Results and discussion

Comparative incidence of congenital disorders in the populations of Bacau and Vaslui counties

There are many classification systems for the congenital malformations that take into account a series of criteria such as: severity, incidence, pathogeny and clinical manifestation. In the last 30 years, the incidence of congenital malformations in different human populations was: 1.2% in Switzerland, 1.23% in Japan, 1.3% in Sweden, 1.8% in Germany (Ivan *et al.* 1981), 2.1% in USA (Chavez *et al.* 1988), 2% in Uganda (Ndibazza *et al.* 2011) and 0.6% in Barbados (Singh *et al.* 2014).

Table 3. Incidence of chromosomal disorders among the living newborns in the populations of Bacau and Vaslui counties (Romania), during 2006–2013.

	Bacau county		Vaslui county	
Year	Living newborns (no.)	Incidence of chromosomal disorders (%)	Living newborns (no.)	Incidence of chromosomal disorders (%)
2006	8141	0.07	5533	0.25
2007	8067	0.07	5481	0.13
2008	7880	0.25	5152	0.07
2009	7542	0.04	5241	0.15
2010	7305	0.10	4464	0.24
2011	6858	0.14	4346	0.07
2012	6981	0.10	4564	0.20
2013	6672	0.55	5022	0.99

Table 4. Distribution on sexes of the congenital malformations and chromosomal disorders in Bacau and Vaslui counties (Romania), during 2006–2013.

	Bacau county		Vaslui county	
Year	Women	Men	Women	Men
2006	35	26	62	59
2007	52	31	52	55
2008	46	52	17	58
2009	36	41	54	55
2010	84	83	43	60
2011	114	85	47	49
2012	46	48	43	50
2013	109	164	70	68
Total	522 (49.62%)	530 (50.38%)	388 (46.08%)	454 (53.92%)

Analysing comparatively the incidence of congenital malformations during 2006–2013 in the human populations of Bacau and Vaslui counties, we observed that it varied from one county to another, and from one year to another, being comprised between 0.67% (in 2006) and 3.53% (in 2013) of the newborns in Bacau county, and 1.37% (in 2008) and 2.14% (in 2011) in Vaslui county (table 1). The average frequency of congenital disorders in the two human populations over the course of the investigated period was about 1.65% in Bacau county and 1.83% in Vaslui county.

In the population of Vaslui county, the incidence of congenital anomalies was higher (∼11%) than in Bacau county, which leads to the conclusion that the frequency of these disorders is not caused by the diet or the pollution in the area, but rather by the level of development, the degree of civilization of the human populations, by the quality of medical assistance, the level of education of the people. From these points of view, the population of Bacau seeming to be more advantageous than the Vaslui county.

The data presented in table 2 show that the most common malformations in the human population of Bacau county were: cardiovascular system anomalies (26.14%), musculoskeletal system (16.92%), urogenital system (7.13%), digestive system (4.37%), nervous system (3.71%) and respiratory system (2.38%) anomalies. In the population of Vaslui county, the hierarchy of these diseases is largely similar, the most numerous being the cardiovascular system anomalies (38.71%), followed by those of the musculoskeletal system (9.84%), urogenital system (3.08%), respiratory system (3.08%), nervous system (2.24%), and digestive system (1.42%) anomalies. It seems that the frequency of the types of congenital anomalies differs from one geographical area of the world to another. Thus, in a retrospective study conducted in Nigeria, on 200 cases with congenital anomalies, it has been observed that the highest frequency belonged to the gastrointestinal system anomalies (30.5%), followed by the central nervous system (24.5%), skeletal (8%), cardiovascular system (7.5%), urogenital system anomalies (5%), etc., and 13.5% of the cases present multiple anomalies (Ekwere *et al.* 2011). A similar study, conducted in the district of Tabriz, Iran (Abdolahi *et al.* 2014) during 2004–2012, on 22,500 newborns has highlighted the prevalence of congenital anomalies of ∼1.12%, the most frequent ones being the nervous system (24%) anomalies.

The malformations of the cardiovascular system are generally frequent (4–8% of the new-born babies), with various types of the clinical manifestation. The heritability is of 35%, with a recurrence risk of 1–4% for first degree relatives. The cardiac anomalies occupy an important place in child pathology, statistics indicate that ∼6% of the children have a heart anomaly and 25% of the cases with other malformations (Maiorescu 1986). In the populations studied in this research, the cardiovascular system malformations affected, during 2006–2013, ∼0.75 and ∼1.06% of the living newborns in Bacau and Vaslui counties. In the total number of malformations, the incidence of these diseases was higher in Vaslui county (38.71%) when compared to Bacau county (26.14% of the newborns with anomalies) (table 2). The most frequent anomaly of this system encountered in both counties was the ventricular septal defect, representing 20–38% of the total malformations. The complete atrioventricular septal defect must be surgically corrected when infant is 1 year old, to prevent the development of the Eisenmenger syndrome, especially in children who have Down's syndrome (Park 2009). Other malformations, with lower incidence, present in both counties were: tetralogy of Fallot, coarctation of the aorta, hypoplastic left heart syndrome, malformations of the large arteries and veins, etc. The oetiology of congenital heart malformations is multifactorial, and up to now it is not completely elucidated. From known data, 8% of the anomalies are determined by genetic factors, 2% by environmental factors, and 90% by the interaction of the genetic and environmental factors (Park 2009).

In our study, the second place regarding their incidence were the musculoskeletal system anomalies, and out of these, the anomalies of the leg and hip had a higher frequency. Congenital deformity of legs/feet is a relatively frequent anomaly

(1–3% births), with a heritability of 68% and a recurrence risk of 3%. The frequency of this disorder is 1:800 newborns, with a predilection for the females is 1:8. The dislocation is favoured by the pelvic presentation and a predisposition of low muscle tone (a mixed component, mechanical and hereditary) (Maiorescu 1986). Out of the total infants born with congenital anomalies, the number of cases with congenital deformations of the leg/foot in the population of Bacau county was 7.60% with hip dislocation is 7.51% and with other anomalies of the musculoskeletal system is 1.81%. In Vaslui county, the congenital anomalies of the leg/foot had an incidence of 6.76% of the total cases, the hip anomalies is 1.66%, while the polydactyly and syndactyly is 1.42% (malformations that were not encountered in the population of Bacau county) (table 2). In both counties there were recorded cases such as: spine malformations, achondroplasia, osteogenesis imperfecta, etc.

The multifactorial inheritance is responsible for the apparition of isolated forms of congenital 'nonsyndromic' anomalies in the human urogenital system (Georm̆neanu and Georm̆neanu 1986). This research found the most frequent anomalies of the urogenital system observed in the newborns of the two counties to be: polycystic kidney disease, congenital malformations of the male reproductive system and renal agenesis. The latter was identified only among the Vaslui county patients, representing 1.42% of the total cases. The cause for renal agenesis is multifactorial, having a higher frequency among the individuals with a family history of this disease. Children diagnosed with unilateral agenesis can live a normal life. It is interesting to observe the high percentage of newborns with cystic kidney (4.37% of the total cases with anomalies) in the population of Bacau county (table 2). Besides the previously enumerated disorders, which were the most frequent ones, there were less frequent anomalies, such as: malformations of the uterus and cervix, supernumerary kidney, ectopic kidney, renal aplasia etc.

The most frequent anomalies of the digestive system observed in the newborns of the two investigated counties of Romania were congenital malformations of the digestive upper tract and small intestine (table 2). The latter ones were characterized by anomalies of fixation and rotation of the small intestine, caliber anomalies (small intestinal atresia, megacolon, colon diverticula etc.). In Bacau county there was a high frequency of Hirschsprung's disease (congenital aganglionic megacolon), which was not observed in the population of Vaslui county. The manifestations of these diseases usually have an early start: in 15% of the patients, in the first month of life; in 60%, up to 1 year old; and in 85% up to 4 years old. The infant has constipation, abdominal distension and vomiting. The diagnosis must be as early as possible because there is a risk for the child to develop Hirschsprung's disease that can be brutal, leading even to death (Cochran 2009). Other malformations observed in this study over the researched period, with a more reduced frequency however, were: malformations of the gallbladder and liver, diaphragmatic hernia, gastroschisis, pyloric stenosis etc.

The frequency of nervous system malformations was in average 4.94% among the newborns with anomalies in Bacau county, and of 3.20% among the Vaslui county. In both counties, the most frequent anomalies of this type were spina bifida (1.06–2.76%) and hydrocephalus (0.95–1.18%) (table 2). Less frequent anomalies that were identified included: microcephaly, spine malformations, holoprosencephaly, agenesis of the corpus callosum etc.

According to several authors, after a child with neural tube malformation is born in a family, the risk for a second child to be born with a similar anomaly is increased to 2.4–5% and the risk being doubled at a third birth (Cowchock *et al.* 1980). Generally, the neural tube defects can be associated with mental retardation and in open forms with hydrocephalus, with lower limbs paralysis, sphincter incontinence etc., their prognosis being severe. After a surgical treatment, 1/3 of the cases with open spina bifida survive for at least 5 years, 85% present a severe neurological handicap, 10% manifest a light form and only 5% do not present a handicap (Bembea *et al.* 2004).

During 2006–2013, in Bacau county there were 29 cases of spina bifida (2.76%), while in Vaslui there were nine cases (1.06%). With regard to this anomaly, the open forms can be associated frequently with hydrocephalus, congenital deformed leg/foot, paralysis of the lower limbs and sphincter incontinence. The prognosis is quite severe: after the surgical treatment, ∼1/3 of the open spina bifida cases survive for at least 5 years, but 85% of them will have a severe neurological handicap and only 5% will not have one (Covic *et al.* 2004).

Hydrocephalus is caused by an extension of the cerebrospinal fluid with increased pressure in the ventricular or subarachnoid spaces. The causes for hydrocephalus are: cranial hemorrhage, infections, cranial–cerebral traumas, vascular disorders, structural brain defects etc. (Roessler and Muenke 1998). The diagnosis is easy when the clinical signs are present: headaches, vomiting (suggestive for a diagnosis), visual impairment (e.g. diplopia), ideation, activity or speech impairment, shaking, uncoordinated movements (Iordăchescu 1998). In the two human populations investigated in this study, the frequency of hydrocephalus was relatively similar i.e. 0.95% in Bacau county and 1.18% in Vaslui, most patients die before reaching age of 5 years.

The most frequent malformations of the respiratory system were the cleft lip and palate. In the total number of cases, Vaslui county represented 3.08%, while Bacau county represented 2.38% (table 2). In both counties several other malformations were diagnosed: of the lung, larynx, trachea, etc. To avoid complications, it is important to spot neonatally any form of this type of anomaly (10% of the cleft palates escape the neonatal diagnosis). The risk of recurrence depends on the degree of complexity of the anomaly and the number of cases in the family, 50% of them being autosomal dominant (Gorduza 2007).

The incidence of chromosomal disorders in the human populations of Bacau and Vaslui counties

The most frequent nonlethal chromosomal diseases are autosomal and sexual chromosomes aneuploidies. During miscarriages, there were reported cases of foetuses with triploidy and polyploidy, the polyploid state being rarer among the living newborns, seemingly being lethal for humans (Luthardt and Keitges 2001). Their frequency is much higher among embryos, in the intrauterine life, than among living newborns: 80% of the miscarriages happened during the first two weeks of pregnancy are caused by a chromosomal aberration; 60% of the cases if it happened between the 2nd and the 20th week; 6% for the stillborns and 0.6% for the living newborns (Georm̆neanu and Georm̆neanu 1986).

Our investigations revealed that during 2006–2013, in the human population of Bacau county, 97 cases of newborns with chromosomal disorders were diagnosed (0.16% of the living newborns), while in the human population of Vaslui county there were 106 cases (0.26% of the living newborns). The incidence of these disorders was comprised within narrower borders over the course of the investigated period (0.04–0.55%) in the population of Bacau county and within larger borders (0.07–0.99%) in the population of Vaslui county (table 3). The frequency of these disorders was higher (by ∼62.5%) in the population of Vaslui county than in Bacau county. Out of all the chromosomal disorders, the most frequent and most studied syndrome in the human population is the Down's syndrome (trisomy 21), a fact confirmed also by our study. Thus, out of the total 97 cases with chromosomal disorders in the population of Bacau county, 81 are newborns with Down's syndrome (representing 83.5% of cases), and out of the total 106 cases in Vaslui county, 91 are Down's syndrome (representing 85.8% of cases) (table 2).

A worrying situation with regard to this situation, emerged in 2013 when in the two counties an obviously larger number of Down's syndrome cases was spotted, compared to any of the other investigated years, i.e. 34 cases in Bacau county (representing 0.06% of the total cases) and 49 cases in Vaslui county (representing 0.12%), (table 3). This situation should alarm the medical authorities in these counties and task responsible with the task of investigating the causes of this phenomenon and finding solutions to prevent and limit this disorder in future. Down's syndrome is a genetic disease that causes numerous other disorders in the affected body. It is estimated that 40% of the Down's syndrome children have congenital malformations of the heart, the most frequent ones being the ventricular septal defect and the atrioventricular septal defect (Haydon 2007), the Down's syndrome have an increased susceptibility to infections (Iordăchescu 1998), many of the Down's syndrome patients develop at an early age, clinical manifestations of Alzheimer's disease (Hall 2009), they have a reduced weight of the brain, especially of the cerebellum and brainstem (Crome 1965), they manifest eye disorders (Pulg *et al.* 2002) etc.

Another chromosomal disorder found in the newborns from the counties investigated in this study is the Turner syndrome. This anomaly affects approximately 1/2500 – 1/3000 of the female newborns (Sybert 2001). Our researches recorded 13 Turner syndrome cases in Bacau county and five in Vaslui county, representing 13.40% and, respectively, 4.71% of the total observed chromosomal disorder cases (table 2). This syndrome represents a monosomy viable for humans that can be identified at birth or before puberty, at the age an appropriate hormonal treatment can have very good results.

Comparative observations regarding the incidence on sexes of congenital disorders

With regard to the sex distribution of the congenital anomalies and chromosomal diseases, we observed that in Bacau county newborn population, the two sexes were affected in relatively the same way, while in the Vaslui population, the males were more affected than the females. Thus, out of the total cases identified in Bacau county, 49.62% were females and 50.38% were males, while out of the total cases in Vaslui county, 53.92% were males and 46.08% were females (table 4). This observations are in agreement with other investigations of this type. Thus, a study conducted in UK during 1990–2009 (Sokal *et al.* 2014) observed that the incidence of genetic and congenital anomalies was higher among men (51.4%) than women (48.6%).

The differences regarding the incidence among the two sexes of these anomalies were even more obvious in a study conducted in Iran during 2000–2004 by Movafagh *et al.* (2008), 59.7% cases men being affected (539 cases out of a total of 902).

If one follows the data presented in table 4, they can see that these are years in which the distribution of these disorders on sexes is clerly favours one of them. This is the situation for 2011 and 2013 years in the population of Bacau and for 2008 and 2010 years in the population of Vaslui. Thus, in 2011, out of the 199 observed cases, 57.29% were female and 42.71% male, while in 2013 the situation is reversed, in the sense that out of the 273 affected individuals, 39.93% were female and 60.07% were male. As previously presented, in the Vaslui county the more affected individuals were males, this situation being obvious in 2008, out of 75 observed cases, 22.67% were females and 77.33% were males.

We consider that the higher incidence of congenital malformations in the human population of Vaslui county does not depend much on the eating habits (which are healthier in this county, its rural population being higher), nor on the pollution level of the area (more reduced than in Bacau county, which is more industrialized), but rather on the level of development of the county, the financial state of the population, the civilization degree, medical assistance (probably more precarious), the education level of the future mothers etc. Among the factors that could contribute to a higher incidence of congenital anomalies in the human populations in

certain areas, one could count: pollution of the environment and water with nitrites, lack of proper food for pregnant women, lack of information, obsolete medical equipment used in spotting certain intrauterine diseases, the couple's precarious living conditions etc. In these authors' opinion, reduced economic development, the underdevelopment of certain areas can certainly influence the long-term health of the human population, including its genetic health.

Conclusions

Observations made during 2006–2013 on two human populations in Romania, on 59,446 living newborns in Bacau county, and on 39,803 living newborns in Vaslui county have identified 1052 cases of chromosomal and congenital anomalies in Bacau county and 842 cases in Vaslui county. The frequency of these anomalies over the course of the investigated period has oscillated between 0.67% and 3.53% in Bacau county and between 1.37 and 2.14% in Vaslui county, being in average of ∼1.65% in the first case and ∼1.83% in the second case.

With regard to the distribution of the congenital malformations on systems, the highest incidence in both populations belonged to the cardiovascular system anomalies (26.14% in Bacau county and 38.71% in Vaslui county), followed by anomalies of the musculoskeletal system (16.92 and 9.84%, respectively), the urogenital system (7.13 and 3.08%, respectively), the digestive system (4.37 and 1.42%, respectively), the nervous system (3.71 and 2.24%, respectively) etc.

The incidence of chromosomal disorders recorded in the human populations of Bacau and Vaslui counties over the analysed period of time had average values of 2.17% for Bacau county and 1.92% for Vaslui county, presenting important variations from one year to another, as follows: between 0.04 (2009) and 0.55% (2013) in Bacău county and between 0.07 (2008) and 0.99% (2013) in Vaslui county. In both counties there was a higher incidence of chromosomal disorders in 2013, among which the Down's syndrome was the most frequent anomaly (83.5 of the total cases recorded in Bacau county, and respectively, 85.8% in Vaslui county).

With regard to the sex distribution of the investigated anomalies, in the human population of Bacau county, these disorders affect about the same way in both the sexes (49.62% female cases and 50.38% male cases), while in Vaslui county, the male cases were numerous than the female cases (46.08 and 53.92%, respectively).

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