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Research article

INTER-COHORT ANALYSIS OF PARENTAL RISK FACTORS FOR DEVELOPMENT OF INFANTS

Yu.E. Shmatova, I.N. Razvarina, A.N. Gordievskaya

Vologda Research Center of the Russian Academy of Sciences, 56a Gor'kogo Str., Vologda, 160014, Russian Federation

Children develop rapidly in the first year of life and this period should create a solid ground for their health in future. Diseases of the nervous system, mental and behavioral disorders occupy leading places among causes of childhood disability. Given that, the aim of this study was to search for parental risk factors endangering physical and neuropsychic development of infants.

Infants living in Vologda region were selected as a research object. Our informational basis was represented by sample data of the prospective monitoring over children's health (894 children from five different cohorts born in 1998, 2001, 2004, 2014 and 2020); statistical and sociological data on prevalence of risk factors in Russia and in the region. The information was provided by healthcare workers (obstetrician-gynecologist, neonatologist, and pediatrician) and children's mothers. The applied methodology included inter- and intra-cohort sociological analysis; calculation of relative risk (RR) to assess a correlation between developmental delay and parental factors. Child development was assessed by a pediatrician using abnormal psychology and adaptation approaches. We analyzed Russian and foreign studies that focused on the same research subject.

We calculated relative risks of various social-demographic, socioeconomic, biomedical and environmental factors for the development of children who participated in the cohort monitoring. This allowed us to identify those with prognostic value including young age of parents (RR = 1.40); a single-parent family (RR = 1.46), bad relationships between spouses (RR = 1.36); low purchasing ability of a family (RR = 1.59), poor living conditions (RR = 1.66); a future mother being exposed to chemicals and toxic substances (RR = 1.31), gas pollution (RR = 2.02), hand high temperatures (RR = 1.56) at her workplace one year prior to childbirth; a smoking mother (RR = 1.56); a father having a sexually transmitted disease (RR = 3.23); abnormal pregnancy. The identified risk factors for child development occur prior to childbirth and are manageable. Awareness about them makes it possible to neutralize their negative influence when a pregnancy is being planned.

Our analysis of statistical and sociological data has revealed a descending trend for prevalence of practically all the analyzed risk factors. Still, some factors cause certain concern including high prevalence of smoking among women, future mothers included; prevalence of anemia in pregnant women; unresolved financial issues and poor living conditions of a considerable share of families who are expecting a child; effects produced on women by harmful working conditions. The results of this study can be used for developing programs aimed at protecting child's health at any level, from an individual to the national one.

***Keywords**: physical and neuropsychic development of a child, risk factors, age of a mother and father, harmful working conditions of a mother, parents' health, anemia, edemas, pregnancy, smoking, socioeconomic conditions, a single-parent family.*

Yulia E. Shmatova – Candidate of Economic Sciences, Researcher at the Department for the Studies of Lifestyles and Standards of Living (e-mail: ueshmatova@mail.ru; tel.: +7 (8172) 59-78-10 (ext. 335); ORCID: https://orcid.org/0000-0002-1881-0963).

Irina N. Razvarina – Researcher at the Department for the Studies of Lifestyles and Standards of Living (e-mail: irina.razvarina@mail.ru; tel.: +7 (8172) 59-78-10 (ext. 371); ORCID: https://orcid.org/0000-0002-9377-1829).

Aleksandra N. Gordievskaya – Junior Researcher at the Department for the Studies of Lifestyles and Standards of Living (e-mail: alessu85@mail.ru; tel.: +7 (8172) 59-78-10 (ext. 311); ORCID: https://orcid.org/0000-0001-7777-3456).

Early childhood is a critical period in the formation of all organs and systems. It is in the first years of life when the body develops resistance to adverse conditions of the surrounding world, the level of physical and neuropsychological development of children (P&NPD) is formed [1]. Therefore, health in this period is a kind of foundation and determines a person's development in the future throughout life.

Physical development of children includes anthropometric data (weight, body length, head and chest circumference, etc.), growth and body formation, including rates, stages, and critical periods of their change during growth. Any deviations from a norm in physical development indicate a relative disadvantage in the state of health, and a harmonious combination of indicators characterizes its normal formation. Assessment of physical development is based on comparing individual indicators with the average value of the accepted standards for this group in each region (which are recommended to be corrected every 5–10 years [2]). Any abnormalities in children physical development and biological maturation are an absolute indication for placing them on medical checkup.

Considering children's development, it is worth noting that deviations in the psychoemotional sphere are no less important than disorders of the somatic status.

Nervous system diseases occupy one of the leading places among pathologies in children and adolescents. According to the data of the Ministry of Health of the Russian Federation[1], the incidence of diseases of this nosological group among children from 0 to 14 years old in the country increased from 2000s (2,731 per 100 thousand children) to 2011 by 57 % (4,293 per 100 thousand children), with a subsequent decrease (by one third) to 2,876 cases per 100 thousand children by 2020.

We should also note that "nervous system diseases" as well as "mental and behavioral disorders" are the leading causes of disability among children (in 2020 – 27 % and 24 % of all children with disabilities). Moreover, this indicator has increased since 2010 by more than a third (by 40 and 35 %, respectively), as has the share in total disability (by 2 p.p.).

In the DSM-5 and ICD-11 classifications, neurodevelopmental disorders (NDD) are introduced as an overarching category of disorders characterized by impairments in cognitive functioning, communication skills, behavioral and/or motor skills. They include: general intellectual disability (intellectual developmental disorders), communication disorders (development language disorders), autism spectrum disorders, attention deficit hyperactivity disorder (ADHD), specific learning disorders, and motor development disorders [3].

In the future, such children may have difficulties in mastering the curriculum, forming and observing moral and ethical norms and rules, and interacting with others[2]. Children with delayed neuropsychological development (NDP) at the age of 1 are at risk of mental development disorders at an early age [4]. Nevertheless, there is a problem: the untested system of dynamic observation of children with perinatal pathology and other risk groups in different childhood periods, untimely diagnosis and, accordingly, late start of therapeutic and corrective measures, which can lead to impaired formation of higher mental functions and delayed cognitive development. The complexity of prevention, diagnosis, and treatment of neurological pathologies, as well as the problem of adaptation and socialization of such children represent a very important challenge not only in pediatrics (in the future – therapy), but also in social medicine [5].

In this regard, timely diagnosis of developmental abnormalities in children in the first

[1] Sem'ya, materinstvo i detstvo. Zdravookhranenie, druzhestvennoe k detyam, i zdorovyi obraz zhizni. 3.17. Deti-invalidy po zabolevaniyam, obuslovivshim vozniknovenie invalidnosti [Family, Motherhood and Childhood. 3.17. Children with disabilities due to the diseases that caused the disability]. *Rosstat*. Available at: https://rosstat.gov.ru/folder/13807 (April 11, 2023) (in Russian).

[2] Razvarina I.N. Adaptatsionnyi podkhod k otsenke nervno-psikhicheskogo razvitiya detei mladshego shkol'nogo vozrasta: metodicheskie rekomendatsii dlya pedagogov-psikhologov, sotsial'nykh pedagogov i klassnykh rukovoditelei obshcheobrazovatel'nykh organizatsii [The adaptation approach to evaluating the neuropsychological development of children of elementary school age: Methodological recommendations for educational psychologists, social educators, and class teachers of general educational organizations]. Vologda, ISERT RAN, 2017, 23 p. (in Russian).

year of life is an extremely urgent task. Especially given the growth of the number of children with NDP lags, which was 150 % in the period from 2000 to 2018 (from 62.4 to 91.1 per 1,000 children aged 0–14). At the same time, the most significant NDP lags are noted in the lines of speech development and mental health [6]. The analysis has shown that children with mental retardation are the most numerous nosological group in Russia, accounting for about 40 % of the total population of children with disabilities [7]. In addition to the true increase in morbidity, this trend may be due to the application of new approaches to the education of children and the informatization of society, as well as certain flaws in the current system of professional examinations [6].

Assessment of the NDP is carried out at certain age periods (epicrisis time): in the first year – monthly, in the second year – once a quarter, in the third year – once a half-year, from the age of three years – once a year.

For instance, normally, by the end of the first year of life, a child should recognize themselves and their acquaintances in photographs; can transfer learned actions from one object to another, to toys; phonetically understands names of objects, actions, adults' names; does single word errands such as "bring", "find", "give" etc.; starts walking without support; recognizes relatives' voices; can speak 10–12 words consciously. When performing any tasks, a child's face should be focused. If they succeed, there is a joyful expression. Failure is accompanied by mimicry of displeasure. A child should be able to use a potty. A comprehensive medical assessment of child's health is given with mandatory consideration of all the above criteria (in accordance with the Order of the Ministry of Health of the Russian Federation 514, dated August 10, 2017 "On the procedure for conducting preventive medical examinations of minors"[3]).

Often, developmental delay is the first important symptom of both a functional condition and an existing disease. Timely diagnostics of the lagging P&NPD increases the level of children's health and will help to solve many problems, not only medical but also social ones[4]. Given the above, it is necessary to pay close attention to the dynamics of child development, including the intrauterine period, taking into account risk factors from both parents, using all stages of prevention of disorders.

The aim of the research is to identify mother and father risk factors for physical and neuropsychological development of a child at the age of 1.

The tasks of the research are:

1. To analyze the scientific literature on the topic of parental risk factors for child's development.

2. To calculate the relative risk of exposure to sociodemographic, socioeconomic, biomedical, and environmental factors by both parents for the development of a child in the first year of life.

3. To assess the prevalence and dynamics of the identified risk factors for the child's development over a 24-year cohort study.

4. To suggest directions for minimizing controllable parental risk factors promoting the development of children in the first year of life.

The object of the research is the Vologda region children of the first year of life. **The subject of the research** is the health of children in the first year of life.

Research methodology. Vologda Research Center of the Russian Academy of Sciences (VolRC RAS) has been conducting prospective monitoring ("Studying conditions of formation of health generation") of cohort observations of families with children since 1995. The informants who filled out the questionnaires are:

[3] O Poryadke provedeniya profilakticheskikh meditsinskikh osmotrov nesovershennoletnikh: Prikaz Ministerstva zdravookhraneniya RF ot 10 avgusta 2017 g. № 514n [On the procedure for conducting preventive medical examinations of minors: the Order of the Ministry of Health of the Russian Federation 514, dated August 10, 2017]. *GARANT*. Available at: https://base.garant.ru/71748018/ (April 10, 2023) (in Russian).

[4] Tkachuk E.A., Martynovich N.N. Otsenka nervno-psikhicheskogo razvitiya detei i osnovnye klinicheskie proyavleniya narushenii so storony nervnoi sistemy: uchebnoe posobie dlya studentov [Assessment of the neuro-psychological development of children and the main clinical manifestations of disorders of the nervous system: a training manual for students]. Irkutsk, Setevoi institut dopolnitel'nogo professional'nogo obrazovaniya Publ., 2020, 75 p. (in Russian).

1. Healthcare workers. At the time of inclusion in the cohort, they were: obstetrician-gynecologist (on the specifics of pregnancy and childbirth) and neonatologist (on the health status of an infant newborn). Thereafter, once a year it was pediatrician at child's place of residence (about features of child's P&NPD).

2. Child's parent (predominantly mother): at birth (retrospective answers about different aspects of mother's life and a child's father), in the first year of the child's life – at the age of 1, 6 and 12 months (about features of family's life, health and child development). Thereafter, it is annually.

3. Children participating in monitoring when they reach the age of 10.

The present study focuses on data collected during the first year of child's life from parents and healthcare workers. The sample consisted of 894 participants in five cohorts (166 children in 1998, 211 in 2001, 190 in 2004, 243 in 2014, and 227 in 2020) who were further monitored at the first year of age. We used an inter-cohort method to analyze the research data.

The control group included those children in whom, according to the answers of a local pediatrician (based on a child's medical records), to the question *"Do the child's physical and neuropsychological development indicators correspond to the norm?"*, the following answers are noted: *"There are minor deviations"* or *"Deviations from the norm are significant"*. On average, every third (n = 294) of the 894 participants was placed in this category. The comparison group was those children whose P&NPD at 1 year was normal (n = 600). A positive trend can be noted in the 2.8-fold decrease in the proportion of children with developmental disabilities from 47 % in 2001 to 17 % in 2020.

The most frequent diagnoses of children with developmental disorders in the first year of life were the following: perinatal encephalopathy (PEP), perinatal lesion of central nervous system (PLCNS), vertically transmitted infections (VTI) and congenital malformations, hyposomia and weight deficiency, rickets, anemia, vegeto-visceral disorder syndrome, exudative diathesis and dermatitis, hydrocephalus, epilepsy, joint dysplasia, cardiac anomalies (patent foramen oval (PFO), congenital heart defect (CHD)), hydrocephalic-hypertension syndrome, paratrophia, myotonical syndrome, developmental speech delay (DSD), neutropenia and other clarified CNS diseases, otitis media, ARVI. As we can see, the vast majority of them arose in the intrauterine period of child development.

Table 1

Characteristics of the research sample

Indicator	Cohort (year of birth)					Total
	1998	2001	2004	2014	2020	
Number of newborns recruited into the cohort, people	166	211	190	243	227	1037
Dropped out of the monitoring at the age of 1 year, people	19	34	44	39	7	143
P&NPD of a child at 1 year* corresponds to the norm, person	86	94	87	151	182	600
Lagging P&NPD at the age of 1 year**, people	61	83	59	53	38	294
in % of those remaining in the monitoring	41.5	46.9	40.4	26.0	17.3	-

Notes: *According to the answer of the pediatrician at the residence (on the basis of a child's medical records) to the question *"Do the child's physical and neuropsychological development indicators correspond to the norm?"*. The answer option is *"They correspond to the norm"*.

**We took into account only the following answers: "There are minor deviations" and "Deviations from the norm are significant".

Based on studying Russian and foreign literature, available medical-biological and sociological monitoring data, as well as our own earlier studies on health risk factors in infants, we have identified the following groups of factors, which came into existence even before the child is born:

1. Socio-demographic group: parental age and education level, marital status;

2. Socio-economic group: satisfaction with income level and housing conditions, family's purchasing power;

3. Biomedical group: (a) parents' anamnesis of chronic diseases, dangerous infections, (b) obstetric anamnesis of previous pregnancies and (c) features of the current pregnancy; (d) complications of childbirth; (e) bad habits of both parents (smoking);

4. Environmental effects: environmental conditions in family's residence and occupational hazards of both parents in the year before the child's birth (mental stress, increased noise, work in 2–3 shifts, high physical load, work on the assembly line, work at night, chemical and toxic effects, radiation and ultra-high frequency, dustiness, gas pollution, humidity, vibration, high and low temperature, and biological hazards).

In this paper, we analyze parent-related risks that had an impact on the development of a child before birth, without considering those factors that affect health and development in the first year of life. We will try to characterize the category of newborns who are at high risk of further P&NPD retardation in order to increase the attention of medical professionals to them starting from birth.

To assess the influence of the risk factors under consideration, we chose the relative risk index (RR)[5]. The RR is calculated on the basis of a four-field contingency table: risk factor (yes/no) × adverse outcome (yes/no):

$$RR = \frac{A \cdot (C + D)}{C \cdot (A + B)}$$

Table 2

Four-field contingency table

	Outcome (1)	No outcome (0)	Total
There is a risk factor (1)	A	B	A+B
There is no risk factor (0)	C	D	C+D
Total	A+C	B+D	A+B+C+D

If the RR is more than 1, the effect of the factor under consideration increases the risk of disease development (in our case, developmental delays), and the greater the RR value, the higher the probability. If the RR is less than 1, the factor is protective and reduces the probability of developmental delay. In each case, the statistical significance of the relative risk is necessarily assessed based on the values of the 95 % confidence interval (CI). We should note that the RR does not provide information about the magnitude of absolute risk but demonstrates the strength of the relationship between the influencing factor and developmental delay.

We performed statistical analysis of biomedical and sociological data using the SPSS statistical software package.

The scientific novelty of the study lies in the assessment of the influence of risk drivers for the development of children in the first year of life by both parents and family living conditions using an intergenerational analysis of several generations of children. The presented work allows deepening the knowledge about the degree of exposure to the most significant and controllable risk factors for child health even before birth.

Risk factors of a child's P&NPD: research analysis. Modern studies confirm that most of the neurological and psychiatric abnormalities and developmental disorders can be predicted long before their clinical manifestation at preschool age.

[5] Relative risk is defined as the ratio of event probabilities in one group to similar probabilities in another group. The RR was calculated as the ratio of the risk of a child's P&NPD lagging in the first year of life in the "exposed" group (exposed to the risk driver) to a similar risk in the "unexposed" group (not exposed).

We have identified a significant number of various risk factors that contribute to the formation of different variants of developmental deviations: medical and biological (associated with complications of pregnancy and childbirth, genetic disorders), medical and social (low income, one-parent families, socially disadvantaged), medical and organizational (inefficient system of prevention, flaws in the structure of care for certain groups of children, etc.), and also risk factors created by living conditions (exposure to adverse environmental factors, improper diets, hypodynamia, stress, impaired interpersonal contacts in a family, destructive education style etc.). It is worth considering that the multifactorial and combined nature of adverse influences heightens their effect and increases the likelihood of the development of deviations [4].

First, genetic diseases are an important predictor of developmental and/or intellectual disability in children. Among them, 25–30 % are chromosomal abnormalities, and 10 % are monogenic diseases (metabolic diseases, neuroectodermal syndromes, diseases with predominant lesions of the gray or white matter of the brain) [8].

The majority of previous studies consider the features of pregnancy and childbirth to be an important risk factor for the health and development of children in the first year of life, namely, diseases suffered by the mother, intrauterine growth restriction (IUGR), prematurity, use of cesarean section (CS) in childbirth, etc.

Classical infectious pathogens such as herpes simplex virus, rubella virus, toxoplasmosis and cytomegalovirus are known to have a direct teratogenic effect on a fetus, which can affect the development of the brain, leading to future neuropsychiatric effects. The link between schizophrenia in a child and a pregnant mother's flu was first described more than 30 years ago. Several current studies suggest that infections during pregnancy may increase the risk of developing autism spectrum disorders and depression in a child [9].

The IUGR is an integral indicator of intrauterine disadvantage, a predictor of increased morbidity, development of chronic disabling pathology, perinatal and infant mortality, as well as delayed physical and intellectual development and maladaptation in the postnatal period. In economically developed countries, the rate of babies born with the IUGR is 30–40 %, while in developing countries it is 70 % (against a background of a higher rate of low birth weight babies). It is known that perinatal morbidity in children with the IUGR ranges from 17–36 %, and perinatal mortality from 8–24 %[6].

The development and improvement of new reproductive technologies, advances in intensive care and nursing newborns of high-risk group with combined perinatal pathology, reducing mortality among premature and low birth weight babies, have the other side of the coin. All this becomes (along with abnormalities of pregnancy and childbirth) the cause of P&NPD disorders spreading among the child population. Morbidity among survivors, including abnormalities in the nervous system development, has increased, especially in extremely premature infants. Nearly half of their survivors have severe neurodevelopmental abnormalities. Long-term adverse outcomes of extremely premature infants include mental retardation (5–36 % of cases), cerebral palsy (9–18 %), blindness (1–9 %), and deafness (2–4 %) [10]. Late preterm infants (those born at 34 to 36 weeks gestation) are also considered to be at risk for adverse outcomes of the P&NPD, and, therefore, of learning ability [11].

Surgical delivery may be necessary to save a mother and a baby. But there is evidence that children born by cesarean section (CS) are exposed to various hormonal, physical, bacterial and medical influences that can adversely affect the health of a newborn. Separate works are devoted to the impact on cognitive and educational abilities of a child [12].

A number of modern studies reflect the contribution of the psychological component to child development in early childhood. For

[6] Zaderzhka vnutriutrobnogo razvitiya: uchebno-metodicheskoe posobie [Intrauterine growth restriction: Study guide]. In: prof. L.V. Kozlova ed. Smolensk, SMA Publ., 2011, 82 p. (in Russian).

example, it has been proven that mother's emotional well-being during pregnancy and after delivery is associated with normal motor and cognitive development of a newborn [13]. And exposure to deep maternal neglect in early childhood can interfere with child development. Mother's attachment, tenderness, and attention to an infant are the most important factors in infant's motor development [14]. For example, the development of children adopted before the age of six months is similar to that of their non-adopted siblings. If children were adopted later, they had a high risk of cognitive impairment, behavioral problems, autism, and hyperactivity [15], which is also confirmed by Russian studies [16]. Therefore, early medico-psychological intervention for children with adverse psychotraumatic experiences is the basis for their healthy development.

A number of scientific studies are aimed at finding risk factors for individual components of development (physical, speech, psychomotor, emotional, intellectual, etc.) in children of different ages.

For instance, the scientists of the Federal State Budget Institute Ivanovo Scientific-Research Institute named after V.N. Gorodkov, identified the following unfavorable prognostically significant biological risk factors for low body length in children: occupational hazards of a future mother (within five years prior to conception), pathology of the urinary tract system in a mother, threat of non-pregnancy, feto-placental insufficiency, oligohydramnios, cerebral ischemia of the III degree, bilateral intraventricular hemorrhage in a baby in the neonatal period, a baby on artificial ventilation for more than seven days, bronchopulmonary dysplasia, intrauterine infection, and intestinal dysbacteriosis in a baby. Social risk factors included unregistered marriage at the time of conception, vocational education, and father's occupation (as well as his lack of days off and irregular working hours). Maternal age over 35 years, unemployed status, third and subsequent pregnancies, presence of acute respiratory diseases in a mother during pregnancy, fetal malnutrition, and irregular working hours of a father may contribute to child underweight [17].

The Consortium of Health-Oriented Research in Transitional Societies (COHORTS) showed that low birth weight was associated with short stature, lower parental education, and lower family affluence [18].

A cohort study in Finland [19], aimed at identifying the determinants of speech development showed that the social status of both parents had an important predictive value for the language development of a child. And increased maternal anxiety correlated with poor language comprehension and a limited vocabulary of children by the age of 2.

Another study (on 1,314 children from the Children in Focus (CiF) sample of the Avon Longitudinal Study of Parents and Children (ALSPAC)) using multivariate regression models also confirmed a particular contribution to early language development of indicators of social disadvantage. For example, family income, housing, and material well-being are associated with the development of expressive and receptive language, and verbal comprehension in children at one year and three months [20].

Many studies have been devoted to finding the causes of attention deficit/hyperactivity disorder (ADHD) in children. Thus, the young age of a mother was identified as a risk factor. Children born to mothers aged 18–24 had an increased chance of ADHD (OR = 1.34) and learning disabilities (OR = 1.36). The mother's age of 35–39 years, on the contrary, acts as a protective factor for the development of ADHD in offspring (OR = 0.60) [21]. Another risk factor is intrauterine hypoxia, which was found in the anamnesis of children with ADHD much more often than in the general population [22, 23]. Maternal smoking during pregnancy also increases the risk of hyperactivity in offspring by 60 % (and in heavy smokers – by 75 %) [24]. In another study, it was proved that intrauterine exposure to high levels of non-ionizing radiation increases the likelihood of an unborn child developing hyperactivity with concomitant immune diseases [25].

A number of studies aimed at finding the causes of autism spectrum disorders (ASD) in children have revealed a history of specific complications in childbirth in such patients [26–28].

The mature age of a father can also lead to a decrease in the functioning of a child's brain [29].

A group of Russian scientists led by G.O. Momot conducted a study aimed at finding statistically significant risk factors for NPD disorders in children 4–6 years old. According to the data obtained, from the group of socio-biological factors, the lowest Apgar score at birth (RA = 2.700), burdened labor (RA = 2.489), pathologically occurring pregnancy (RA = 2.354) had the greatest negative impact. Among the socio-economic factors, the factor of incomplete family was significant (RA = 1.687) [6]. We have not found a similar comprehensive analysis of risk factors for the development of a child at an earlier age in the scientific literature.

Results and discussion. The table below shows all the prognostically significant risk factors identified by us at the time of a child's birth for its development in the first year of life.

The young age of parents, according to our calculations, is a risk factor for a mismatch of P&NPD indicators with the norm in the first year of life. If a mother is younger than 20, then RR = 1.42 (95 % CI: 1.09–1.85), if younger than 30, then the indicator is slightly lower – RR = 1.25 (95 % CI: 1.02–1.53). If a father is younger than 30 years old, the probability of developmental disorders of his child in the first year of life increased by 40 % (RR = 1.40; 95 % CI: 1.13–1.74).

Table 3

Significant risk factors of P&NPD of a child in the first year of life (*n* = 294)

Risk factors	Occurrence in the sample	RR	95 % CI
Family			
Financial situation of the family			
Low purchasing power of income[7]	*n* = 299	**1.59**	(1.30–1.94)
Low assessment of housing conditions[8]	*n* = 494	**1.66**	(1.37–2.03)
Marital status			
Incomplete family (single, widow, divorced)	*n* = 122	**1.46**	(1.15–1.84)
Lack of a good relationship with the spouse / child's father[9]	*n* = 183	**1.36**	(1.09–1.71)
On mother's side			
Age			
Age up to 20 years	*n* = 95	**1.42**	(1.09–1.85)
Age up to 30 years	*n* = 663	**1.25**	(1.02–1.53)
Harmful working conditions in the year before the child's birth			
Chemical and toxic substances	*n* = 94	**1.31**	(1.00–1.72)
Gas contamination	*n* = 24	**2.02**	(1.45–2.83)
High temperature	*n* = 49	**1.56**	(1.13–2.16)
Smoking			
Smoking before pregnancy	*n* = 272	**1.26**	(1.03–1.54)
Smoking during pregnancy	*n* = 117	**1.56**	(1.23–1.97)
Complications of the current pregnancy			
Anemia	*n* = 540	**1.23**	(1.02–1.49)
Edemas	*n* = 126	**1.53**	(1.22–1.91)
Protein detection in urine tests	*n* = 171	**1.53**	(1.24–1.88)
On father's side			
Age up to 30 years	*n* = 468	**1.40**	(1.13–1.74)
Vocational education and below	*n* = 587	**1.52**	(1.19–1.95)
Sexually transmitted diseases in the anamnesis	*n* = 2	**3.23**	(2.91–3.59)

N o t e : source of the data is own calculations based on cohort monitoring in the Vologda region (1,037 respondents born in 1998, 2001, 2004, 2014 and 2020).

[7] On the question "Please assess the possibility of meeting the needs of your family based on its total income", the answer variants were "There is enough money only to buy food"; "There is not enough money even to buy food, I have to go into debt".

[8] On the question "Your assessment of living conditions", the answer variants were "satisfactory"; "poor"; "very poor".

[9] On the question "What do you think is your relationship with your spouse?" (in 2020 – with a father of a child), the answer variants were "normal"; "could be better"; "I am not satisfied with it; bad"; "other".

We should note that the prevalence of this risk factor has been decreasing in recent years. The age pattern of fertility worldwide is shifting to older ages (for women, by 25–29 years; for men, by 30–34 years) [30]. According to demographers, the postponement of motherhood is due, among other things, to reproductive literacy and a woman's desire to finish higher education and achieve success in her career before the birth of children. The average age of a Russian mother at the birth of a child in the 2000s increased by three years (from 25.8 to 28.8 years), and in the Vologda region – by almost 4 (from 24.3 to 28.1 years) [10]. The average age of female participants in our cohort monitoring increased even more – by 6 years (from 24.8 in 1995 and 2001 to 31 years in 2020).

The education level of a mother did not demonstrate a connection with the P&NPD of her offspring, unlike a father. So, it was revealed that if he did not have a higher education at the time of the birth of his son or daughter, the risk of lagging the development of his child by the year increased by 50 % (RR = 1.52; 95 % CI: 1.19–1.95).

According to our calculations, the problem of family relations is an important predictor of impaired child development in the first year of life, which is consistent with other scientific studies. So, if a newborn's mother was single (unmarried, divorced or widowed), then the risk of lagging behind the norm of her one-year-old child's P&NPD indicators increased by 46 % (RR = 1.46; 95 % CI: 1.15–1.84). Moreover, we found that a one-parent family at the time of the child's birth remains a risk factor not only in the year, but also in the future, increasing the likelihood of violations of the NPD by 3–4 years by two-thirds (RR = 1.64; 95 % CI: 1.07–2.52), and by pre-school age (6–7 years) – almost by 4 times (RR = 3.89; 95 % CI: 2.09–7.23).

In turn, dissatisfaction with marital relations in an officially registered marriage also increases the likelihood of impaired development of a child at the age of 1 year by more than a third (RR = 1.36; 95 % CI: 1.09–1.71).

According to scientific research, single women who are expecting a child are exposed to the greatest stress, which is an important risk factor for the health of both mother and child [31, 32]. According to our earlier calculations, these women were more likely to develop anemia during pregnancy (RR = 1.20), IUGR of a fetus (RR = 2.22) and congenital malformations of a newborn (RR = 1.66); a child was significantly more likely to be ill in the first year of life (RR = 1.13), which may have a negative impact on child's P&NPD [33].

The institution of marriage in Russia has undergone significant negative changes in recent decades. There is a legitimization of cohabitation, procreation becoming a major motive to get married or postpone it, the emergence of new types of marriage (trial, guest or marriage at a distance) [34].

According to statistics[11], the number of marriages in Russia was increasing from the year 2000 (6.2 per 1,000 people) only until 2011 (9.2). Then this indicator was decreasing (to 5.3 by 2020). The number of divorces fluctuates at the same level in the range of 4.7–4.0 per 1,000 people (exception: the pandemic year of 2020, with a minimum of 3.9 over the past 30 years).

According to surveys of Vologda region[12] population conducted regularly by VolRC RAS, over the past 22 years the proportion of married female residents of the region decreased by 10 %, and the proportion of single, on the contrary, increased by 65 % [35]. In contrast, the proportion of unmarried mothers participating in the cohort monitoring of children's health between 1998 and 2020 de-

[10] Shabunova A.A., Kalachikova O.N., Korolenko A.V. Demograficheskaya situatsiya i sotsial'no-demograficheskaya politika Vologodskoi oblasti v usloviyakh pandemii COVID-19: II regional'nyi demograficheskii doklad. [Demographic situation and socio-demographic policy of the Vologda region in conditions of the COVID-19 pandemic: II regional demographic report]. In: A.A. Shabunova ed. Vologda, VolRC RAS, 2021, 89 p. (in Russian).

[11] Demografiya. Braki i razvody [Demographics. Marriages and divorces]: official statistics. *Rosstat*. Available at: https://rosstat.gov.ru/folder/12781 (April 11, 2023) (in Russian).

[12] Source of data in the general female population of the region: Monitoring of socio-economic situation and social well-being, VolRC RAS.

creased 3.7-fold. This can indirectly confirm the fact that reproductive motives for marriage prevail among the population.

Self-evaluation of the relationships with a spouse over the 25 years of cohort monitoring is also improving. In 1995, only two-thirds of respondents characterized them as "good" and in 2020 – already 84 %. The same number is convinced that their marriage is based on love (in the early 2000s there were 3/4 of them), or on respect and similarity of views, system of values (a third of respondents).

Other significant risk factors for the development of a child in the first year of life, according to our calculations, are such socio-economic indicators as low purchasing power and poor living conditions of the family during the year preceding the birth of the child. Thus, if during pregnancy and childbirth, according to respondents' answers, "I only had enough money to buy food" or "I even ... had to go into debt", the risk of their child's P&NPD disorders increased by 60 % (RR = 1.59 %; 95 % CI: 1.30–1.94). If living conditions of a family were rated as "satisfactory", "poor" or "very poor", there was a two-third increase in the likelihood of child developmental delays at age 1 (RR = 1.66 %; 95 % CI: 1.37–2.03).

Parents' financial reserves provide living conditions and access to paid medical and educational services in order to maintain the health and development of a child, a possibility of full recreation. For example, pediatricians monitoring the health of young participants in our cohort study often noted antisocial family type and parental alcoholism in those children, who were diagnosed with P&NPD delay not only at one year old, but throughout their preschool years.

According to the monitoring data, there is a positive trend showing growth of well-being and purchasing power of families recruited into the cohorts (and at a higher rate than among the population of the region as a whole). The low level of purchasing power decreased almost 4-fold and amounted to 17 % in 2020[13]. The share of families whose income is "enough to buy everything necessary except for major purchases" increased 2.5-fold (76 %).

The self-assessment of housing conditions by the participants of the cohort monitoring also improved. In 2020 more than 70 % assessed them as "good" (in the late 1990s – 27 %). The level of communal facilities of the respondents is 80 %.

The growth of future parents' welfare has led to a 2.5-fold decrease (between 1998 and 2020) of those who expect deterioration of their living conditions after the birth of a child. The number of families able to provide a newborn child with a separate room grew by a quarter (24 %).

This indicates that not only the standard of living of the region's residents is growing but also the desire to strengthen their financial situation before the birth of a child.

Nevertheless, only half of the 2020 cohort has their own debt-free housing (one in nine is renting, and one in three is paying a mortgage).

Harmful working conditions of a woman a year before the birth of a child, according to our study, have a negative impact on their development in the first year of life. For example, if a mother was exposed to chemicals and toxic substances at a workplace three months before and during pregnancy, her child's risk of P&NPD delay increased by a third (RR = 1.31; 95 % CI: 1.00–1.72), with high temperature by 56 % (RR = 1.56; 95 % CI: 1.13–2.16), and with excessive gas contamination by twice as much (RR = 2.02; 95 % CI: 1.45–2.83).

We also found that the risk of CS increased by three-quarters among women who had to work with toxic and chemical substances in the year before birth (RR = 1.74) [36]. Nevertheless, we can note a favorable downward trend in the frequency of pregnant women's contacts (from 1998 to 2020) with chemical and toxic substances at a workplace (by a quarter from 7 to 5 % of respondents).

Scientists have already identified some aspects of the impacts exerted by parents' unhealthy lifestyles on the development of their offspring. For example, the British BCS70 co-

[13] Source: data from the monitoring "Study of the conditions for the healthy generation formation" and the monitoring of the socio-economic situation and social well-being, VolRC RAS.

hort study, found a strong correlation between maternal smoking during pregnancy and the appearance of behavioral disorders in a child in early childhood [37].

According to our calculations, maternal smoking before pregnancy increased the risk of developmental delays in her baby in the first year of life by one quarter (RR = 1.26; 95 % CI: 1.03–1.54) and by one half during pregnancy (RR = 1.56; 95 % CI: 1.23–1.97). We did not find a similar association with father's nicotine addiction. However, prior sexually transmitted diseases in a father tripled the likelihood of P&NPD disorders in his offspring by the age of 1 year (RR = 3.23; 95 % CI: 2.91–3.59).

As for the bad habits of pregnant women in our cohort study, they have undergone some changes over the past two decades. There was a slight decrease in the number of women who smoked before pregnancy (from 28 % of the 1998 cohort to 26 % of the 2020 cohort) and who did not quit their addiction even while expecting a baby (from 13 to 11 %, respectively). Thus, we note that in the last cohort recruited, one in four mothers smoked before pregnancy and one in ten smoked during pregnancy. And the volume of cigarettes consumed daily among them is increasing compared with the participants of the monitoring in the late 1990s. Perhaps this is caused by a change in the composition of cigarettes, the appearance of "lighter" versions of them.

Complications during pregnancy and the threat of pregnancy termination are well-known risk factors for adverse outcomes for the health and development of the child [32].

We confirmed that maternal anemia during gestation period increases by 23 % the chance of developmental abnormalities in her baby in the first year of life (RR = 1.23; 95 % CI: 1.02–1.49), and edema and presence of protein in urine tests by 50 % (RR = 1.53; 95 % CI: 1.22–1.91 and 1.24–1.88, respectively).

According to Rosstat calculations[14] from the Russian Ministry of Health data, the diagnosis of anemia in pregnant women both in 1995 and in 2020 remains almost at the same level (35 % of pregnant women whose births ended in childbirth; see Table 3). There was an increase in the rate in the first half of the 2000s. However, the number of anemias that complicated childbirth increased by a quarter during this period (from 209 per 1,000 births in 1995 to 261 in 2020). It is possible that the increase is associated with improved diagnostics.

The detection of edema in pregnant women has halved over the past quarter century (from 15 % of pregnant women in 1995 to 8 % in 2020), as well as their contribution to birth complications (from 157 to 84 cases per 1,000 births).

The prevalence of risk factors for pregnancy complications in the cohorts we recruited is as follows. In the cohorts recruited in 1998, 2001, and 2004, the prevalence of anemia in pregnant participants was 36–41 %, edema was 20–22 % and protein in urine tests was 29–31 % (Table 5)[15]. Anemia was diagnosed in 2014 in 24 % of pregnant women, and in 2020 – already 38 %. So, we can say that this risk factor of P&NPD of the child in the first year of life remains quite common (in the range of 35–40 %).

Findings and conclusion. As for today, Russia does not have a full-fledged system for monitoring the condition of newborns and early detection of developmental problems. Under the circumstances, early intervention practices, which involve an interdisciplinary approach with the participation of the spheres of medicine, education, psychology and the social sciences, are relevant. It is important to

[14] Zdravookhranenie. Pokazateli zdorov'ya materi i rebenka, deyatel'nosti sluzhby okhrany detstva i rodovspomozheniya. Sostoyanie zdorov'ya beremennykh, rozhenits, rodil'nits i novorozhdennykh [Healthcare. Indicators of maternal and child health, the activities of the child protection and obstetric services. Health status of pregnant women, women in labor, new mothers and newborns]. *Rosstat*. Available at: https://rosstat.gov.ru/folder/13721 (April 11, 2023) (in Russian).

[15] In 2014, the wording in the questionnaire designed for obstetricians and gynecologists changed, as a result of which there were open-ended questions about pregnancy complications, where no answer options were offered as before. Therefore, only 1–2 % of medical professionals noted the presence of edema and protein in the urine analysis.

Table 4

Prevalence of anemia and edema in pregnant women in Russia in 1995–2021

Disease	1995	2000	2001	2004	2005	2010	2014	2015	2020	2021
Of those, who completed their pregnancies suffered from, percent:										
Anemia	34.4	43.9	42.7	41.7	41.5	34.7	32.0	32.6	35.5	35.4
Edema*	14.9	21.4	21.2	21.5	21.6	18.1	14.6	9.2**	7.6	2.2
Number of diseases, which complicated childbirth (per 1,000 births):										
Anemia	209.5	267.9	274.7	257.9	259.5	230.8	235.0	235.3	261.7	258.1
Edema*	156.8	217.0	224.6	225.1	223.5	189.5	154.3	88.3**	84.2	85

Notes: * Edema, proteinuria and hypertensive disorders; ** The evaluation system has changed since 2015.

Table 5

Prevalence of anemia, edema and protein in urine among pregnant women participating in the cohort monitoring in Vologda region in 1998–2020 (in %)

Pregnancy complications	Cohort born in 1998	Cohort born in 2001	Cohort born in 2004	Cohort born in 2014	Cohort born in 2020
Anemia	36.1	41.2	36.8	23.5	37.9
Edema	21.7	22.3	19.5	0.8*	1.8*
Protein in urine	28.9	29.9	30.5	0.0*	0.9*

N o t e: *changes in 2014 in methodology and questions in the questionnaire for obstetricians and gynecologists.

improve forms of medico-social and educational impact, aimed not only at children and their health and developmental disorders, but also at a family. It is necessary to identify and minimize manageable risk factors, which is of great importance for building an adequate diagnosis, therapy and prevention of developmental disorders. Knowledge about the risk factors for the health and development of the child, which are already laid at the time of their birth, will help neutralize their negative impact even at the stage of pregnancy planning.

In this study, we calculated the relative risk for child development in the first year of life created by various socio-demographic, socio-economic, biomedical and environmental factors on the example of participants in a multi-year regional cohort monitoring of five waves. This allowed us to identify those with prognostic significance. Among these are young age of parents (under 20); one-parent families or broken relationships with partners; low purchasing power and poor family housing conditions; an expectant mother being exposed to chemicals, toxic substances, gas contamination and high temperatures at a workplace; smoking habits of a mother before and during pregnancy; pregnancy complications and a history of sexually transmitted diseases in a father's anamnesis.

A positive trend is the decrease in the prevalence of almost all risk factors. Nevertheless, given the negative consequences for the development of a child in the first year of life (and thus the aggravation of the situation in the future as a child grows older), we can conclude that a rather high level of smoking among women, including expectant mothers, the frequency of anemia in pregnant women, the unresolved housing and material problems of a significant proportion of families expecting a child, the impact of harmful working conditions on women are still the causes for concern.

In this connection, we believe that the experience of implementing early intervention programs aimed at the development of young children with developmental disorders or the risk of such disorders can be taken as the basis for interventions focused on comprehensive support of both mother and father, and a child before birth.

These include a system of measures to provide material support to a family, providing comfortable housing to a family before the

birth of a child, organizing accessible psychological and psychotherapeutic care, overseeing the health of expectant parents, especially those working in hazardous conditions, providing women with the necessary free medications during pregnancy.

In the process of assessing a child's perinatal risk of P&NPD, it is important for the diagnosis to be comprehensive and involve aspects of both child's condition and their immediate environment. Early intervention requires a team of specialists with different professional backgrounds: a pediatrician, neonatologist, pathologist, infectious disease doctor, venereologist, psychologist, psychotherapist, social worker, and a lawyer. In the evaluation process, each specialist uses his or her own professional tools and methods, but the results are analyzed collegially.

Thus, the following measures are necessary:

1. Development of normative acts to regulate the activities of early intervention programs and interdepartmental interaction.

2. Training of specialists, licensing of services.

3. Improving the professional skills of specialists and the development of appropriate training courses and trainings based on such principles as family-centeredness and interdisciplinarity.

4. Conducting multidisciplinary research studies to determine the effectiveness of existing or emerging programs.

Limitations of the study. (1) The study sample consisted of only those women who wished to participate in the monitoring, not all those who gave birth during the cohort recruitment period. We assume that women with serious complications of pregnancy and childbirth, and mothers of children with dangerous pathologies of intrauterine development were not included in our recruited cohorts. (2) One year later, 86 % of the five-wave cohort monitoring sample remains in the study. And the sample is shrinking every year. (3) We realize that there is an immeasurable mixture and combination of all internal and external factors which requires further study. (4) Changing the wording of the questions, excluding former questions and adding new ones to the questionnaires in some cases does not allow us to trace trends and specifics of the impact of risk factors.

Perspectives of the study. It is important to assess risk factors for child development in the first year of life, affecting a child after birth (such as breastfeeding, medical literacy and activity of parents, preventive measures, material situation and family relationships, and others). In this paper, we also intentionally did not consider the set of risk factors for child health and development related to the organization of medical aid in the healthcare and education system (level, quality and accessibility of medical and social care, etc.). In the future, we plan to conduct an in-depth study of institutional factors, including in terms of interagency cooperation.

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