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PUBLIC HEALTH SERVICES: IMPLEMENTATION OF HEALTHCARE TECHNOLOGIES

Abstract. *This paper summarizes the arguments and counterarguments within the scientific discussion on the factors that influence public health service. The main purpose of this research is to determine the expected indicators of pathogenic and sanogenic effects on significant risk factors of pathology among children. For achieving the research goal, the authors substantiated the models of final results for the modification of risk factors. Investigation of antenatal and genealogical factors in healthy and ill children groups was performed using a specially compiled expert assessment card and parents' interviews. The systemic population modeling methods were applied to develop and substantiate population health management models (early diagnosis and primary prevention). Evaluation of the expected effectiveness of the N-factor program of primary prevention was carried out on a set of genealogical and antenatal factors. Conducted logical analysis of the methodology of quantitative and qualitative determination of health and the gathered experience in that respect were taken into account in developing population models of preventive effects. This study provides the identified priority directions for realizing the regional and population programs to implement them further. The authors presented the example of calculating the expected effectiveness of children's health management by eliminating the investigated factors. The authors determine the priority directions for realizing the regional and population programs pathology based on the influence on the various elements to improve the public health services system. An example of calculating the expected effectiveness of children's health management by eliminating these factors is given. The obtained results could be used to further research the issues associated with a prospective assessment of the program's effectiveness in reducing the impact of antenatal and genealogical factors on children's health.*

Keywords: children health, prevention, risk factors, efficiency assessment.

Introduction. An integrated accounting of potential risk factors for bronchopulmonary dysplasia (BPD) and dysplastic pathology (DP) of the bronchopulmonary system (BPS) in children that allows development strategies and tactics for their prevention (Gubler, 1965; Dogle and Radionova, 1986; Shipko, 2015; Demikhov et al., 2020) is an issue of modern medicine (preventive and social medicine) concern. Existing

many scientific treatizes on the pathogenetic aspects of investigated diseases raise the necessity to develop and improve medical and organizational support and adaptation (reorganization) of existing family, women, newborns and older children models for care (Shipko, 2015; Demikhov et al. 2020). The determination of the impact of different factors on the children's health status is difficult because of the relatively weak methodological elaboration. Thus, the development of the methodology of population health analysis, sanologic and pathometric approach to individual assessments of health level should play an essential role in solving this issue (Patent 56066; Patent 56864; Patent 56865; Patent 56866). In terms of quantity, the individual assessments should be billed as a single integrated index that reflects different facets of individual and public health. Therefore, the comprehensive of children's health indicators and conditions and factors driving within it determine the synthetic nature of individual and population health assessments (Patent 56066; Patent 56864; Patent 56865; Patent 56866).

Literature Review. The contemporary view of comprehensive health evaluation is based on synthetic (complex, integrated, multidimensional) indicators. The requirement for them is the need to consider various (by origin and methods for obtaining) indicators of health or «ill health» at the individual, population and regional levels (Patent 56066).

The systematization of scientific background indicated that many methodological methods had been developed recently to obtain a comprehensive qualitative and quantitative assessment of the actual state of a person's health. However, there is no one-size-fits-all approach to the problem solution. Thus, a developing generalized qualitative-quantitative assessment remains the essential methodological task of modern theoretical and practical medicine (Gubler 1965; Gubler 1990; Patent 56066; Patent 56864; Patent 56865; Patent 56866).

In addition, to model and verify the results of this study, the works of the economic and interdisciplinary direction were studied (Dzwigol, 2020; Kharazishvili et al. 2020; Khomenko et al. 2020; Kondratenko et al. 2020; Lakhno et al. 2018; Lyulyov et al. 2020).

This study aims to elaborate a methodology for evidence-informed prevention programs and an algorithm for assessing their performance on the example of dysplastic pathology of the bronchopulmonary system using antenatal and genealogical factors information.

Methodology and research methods. This article provides a comparative analysis of the frequency of antenatal and genealogical risk factors for BPD and DP bronchopulmonary system by groups of children (252 persons – with BPD and 252 persons – without BPD). Then, the further determination of each factor and their prognostic value in the population risk assessment system were conducted. A personalized analysis of existing antenatal and genealogical factors was performed for 116 children with bronchopulmonary dysplasia and 136 children with dysplastic pathology of the bronchopulmonary system in two administrative regions of Ukraine (SPG1 – the first stratified population group), 252 healthy children (SPG2 – the second stratified population group).

Investigation of antenatal and genealogical factors in groups of healthy and ill children was performed using a specially compiled expert assessment card with data on the presence of BPD or DP bronchopulmonary system for each child, as well as information (obtained from parents through a documented interview using a closed questionnaire) on the studied factors. The systemic population modeling methods were applied to develop and substantiate population health management models (early diagnosis and primary prevention). This methodology is based on the study of health (in this case of the child population) as a multifactorial system that could be in different states of orderliness (entropy) or disorganization (negentropy) under the influence of antenatal and genealogical factors, in particular.

Conducted logical analysis of the methodology of quantitative and qualitative determination of health and the gathered experience in that respect were taken into account in developing population models of preventive effects. Notably, the concept mentioned above models is based on a multifactorial

pathometric/sanologic approach to obtain children's health indicators based on information theory. (informational pathology law by E.V. Gubler) (Gubler, 1965; Gubler, 1990).

Results. The implementation of information entropy-based analysis for characterizing children's health is based on the concept of information pathometric-base assessments of individual and population health. In the investigation frame, the authors conducted a clinical and population analysis of possible factors in forming children's health and risk of DP and BPD to obtain the mentioned estimates (Shipko, 2015; Demikhov et al., 2020). The strength of influence and informativeness is determined for each of the significant factors. Therefore, it was identified the most pathometrically and sanologically valuable factors out of a significant number of population signs of BPD risk. Further, they would be the basis of multidimensional assessment and analysis of health factors of healthy and sick children. It allowed determining the forecast indicators of pathogenic and sanogenic influence of the most significant genealogical and antenatal factors of dysplastic pathology of the bronchopulmonary system among children (Fig. 1).
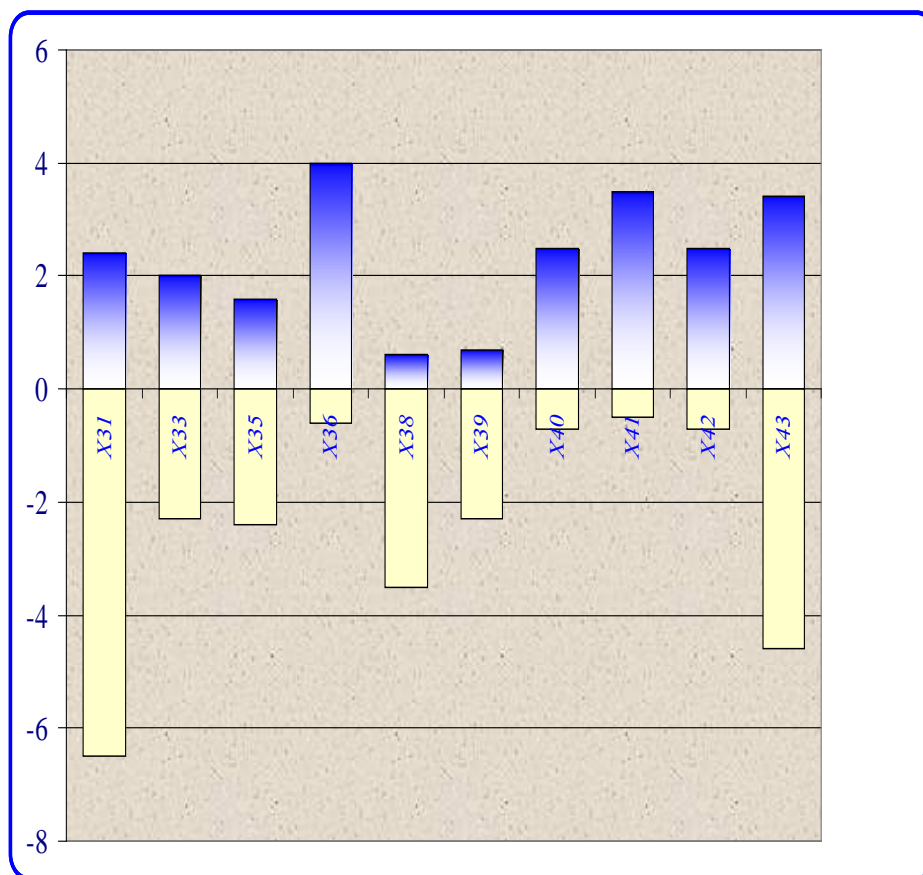

Figure 1. The forecast indicators (pat) of pathogenic and sanogenic influence of the most significant genealogical and antenatal factors of dysplastic pathology of the bronchopulmonary system among children

Source: developed by the authors.

Considering the population health as a multifactorial indicator (N – factor model), there is a need to use a large pool of factors from different backgrounds (e.g., factors of the antenatal gestation period, constitutional and biological factors, genealogical factors etc.) (Patent 56066; Patent 56864; Patent 56865; Patent 56866; Shipko, 2015).

Table 1. Absolute entropy (bits) of children's health in the population and differentiated prophylactic potential by eliminating the influence of the most informative genealogical and antenatal factors

Analyzed signs (factors)	Ill people		Healthy people		PP_{ill}	$PP_{healthy}$
	$^{+}H_{ill}$	$^{-}H_{ill}$	$^{+}H_{healthy}$	$^{-}H_{healthy}$		
Cigarette smoking by mother during the initial period (X_{36})	0,473	0,298	0,269	0,115	0,175	0,154
Junctional zone pathology of the mother (X_{37})	0,500	0,352	0,311	0,151	0,148	0,160
Cardiovascular diseases in the mother (X_{42})	0,490	0,384	0,295	0,176	0,106	0,119
Junctional zone pathology of the father (X_{40})	0,520	0,431	0,358	0,220	0,089	0,139
Digestive diseases of the mother (X_{45})	0,519	0,498	0,355	0,307	0,022	0,047
Cigarette smoking by the father (X_{47})	0,524	0,530	0,462	0,431	0,006	0,030
Previous abortions (X_{33})	0,393	0,525	0,529	0,456	0,132	0,072
Early or late toxemia of pregnancy (X_{35})	0,342	0,502	0,515	0,498	0,160	0,016
Complicated previous pregnancies (X_{31})	0,151	0,498	0,352	0,502	0,347	0,150
Feeding type (X_{43})	0,485	0,403	0,286	0,530	0,082	0,244
Average entropy (n_{x} =10)	0,440 +0,039	0,442 +0,27	0,373 +0,32	0,339 +0,54	0,127 ±0,032	0,113 ±0,024
Total entropy (n_{x} =10)	4,397	4,421	3,732	3,386	1,267	1,131

Note: PP_{ill} – the preventive potential of ill people with DP bronchopulmonary system; $PP_{healthy}$ – the preventive potential of patients of healthy children; for each factor, its dichotomic frequency is considered (existence or absence)
Source: developed by the authors

The predicted indicators of pathogenic and sanogenic effects were studied based on the concept of risk factors (Fig. 1). In turn, the most influential ($p<0.05$) antenatal and genealogical factors were identified. Reducing these factors' impact could significantly affect the risk of the bronchopulmonary system in childhood. It stands to mention (Shipko, 2015; Demikhov et al., 2020) that the genealogical predicament of several diseases, pathological conditions and pre-nosological disorders depends on several leading factors. Besides, on the one hand, these factors have pathogenic influence, while on the other hand – (in the absence or modification) – sanogenic.
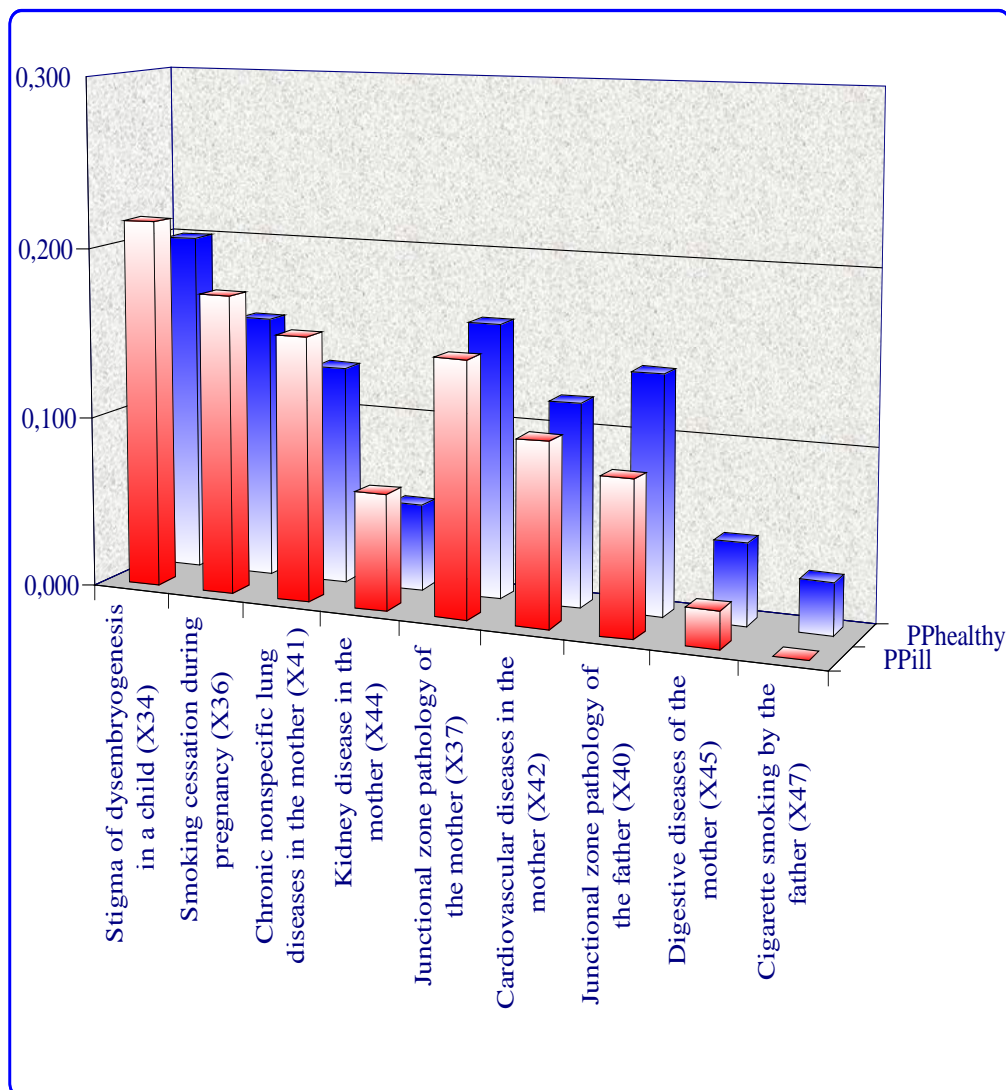

Figure 2. The comparison of prophylactic potential (bits) of population groups of healthy and sick children depending on the available antenatal and genealogical risk factors **(NX =10)**
Source: developed by the authors.

It is customary that researchers investigating antenatal and genealogical factors emphasize their negative (pathogenic) influence. However, there are no studies devoted to the sanogenic influence of factors that substantiate regional prevention programs (in this case, BPD). Therefore, to justify such programs, this study provides the evaluation method of order: information entropy of the multifactorial system of gaining in the health of the ill children with risk factors (+NILL), ill children without risk factors (-NILL), healthy children with risk factors (+ NHL) and healthy children without risk factors (-NHL) (Shipko, 2015; Demikhov et al., 2020). The view of information theory and modeling allowed determining the patterns of children's population health mentioned above groups. Moreover, it made it possible to predict the effectiveness of prevention programs for the DP bronchopulmonary system in childhood, aiming to eliminate these factors' impact and justify priority areas programs (including family physicians, obstetricians, gynecologists, pediatricians and prospective parent). Analysis of the information entropy-based model of antenatal and genealogical factors' influence on the children health in the population allows calculating the contribution of each analyzed element (Fig. 2) to the overall disorganization of the population health system. Besides, it enables determining the expected effect (forecast) of government, regional and municipal programs of population (primary) prevention of DP of the bronchopulmonary system among children. The N-factor model of primary prevention of DP (Fig. 3) does not consider the negative impact of factors, but their sanogenic impact (factor preventive potential) with the appropriate rank depending on the potential preventive indicators of relevant risk factors (-NHL) (Shipko 2015). Using an N-factor plan of primary prevention involves considering certain factors' control, drawing up plans for specific measures.

It stands to notice that using the developed model to reduce the risk level allows focusing on the expected efficiency (reducing the entropy of the child population, in percent).

Figure 3 demonstrates the application example of an N-factor plan of primary prevention of the bronchopulmonary system's dysplastic pathology by a complex of genealogical and antenatal risk factors. Thus, using one of the plan options to reduce the risk of DP, it is necessary to increase the frequency of breastfeeding (X43) not less than (65.1 ± 3.0)%, which reduces entropy by 10.5%; reduce the frequency of complicated pregnancy by (11.1 ± 2.0)% and less (X31) reduces entropy by 8.1%, while reducing the percentage of women with abortions by (33.7 ± 3.0)% and less (X33) reduces entropy by 6.8%. In general, the enrollment of these measures to individual and group programs allows achieving sanological efficiency by 25.4% (reducing the entropy of children's health on preventing DP BPD from 6,214 bits to 4,636 bits).

Conclusions. The obtained results present the expected indicators of pathogenic and sanogenic influence of the most significant antenatal and genealogical risk factors of dysplastic-dependent pathology of the bronchopulmonary system among children.

The authors substantiated models of final effects on elimination or modification of risk factors. The paper provides the justified expected impact of the N-factor program of primary prevention of dysplastic pathology of the children's bronchopulmonary system by a set of antenatal and genealogical factors.

In the study frame, the authors determine the priority directions for realizing the regional and population programs to prevent dysplastic pathology of the bronchopulmonary system based on the influence on the managed antenatal and genealogical factors. An example of calculating the expected effectiveness of children's health management by eliminating these factors is given.

N-factor plan of primary prevention of dysplastic pathology of the bronchopulmonary system										The preventive maintenance efficiency (medical component) on the level decrease/factors' elimination		
X_{43}	X_{31}	X_{35}	X_{33}	X_{47}	X_{45}	X_{40}	X_{42}	X_{37}	X_{36}	health quality improvement (%)	expected influence effect (%)	entropy system change
										+10,5	10,5	6,214
										+8,1	18,6	5,810
										+8,0	26,6	5,312
										+6,8	33,4	4,810
										+6,2	39,6	4,285
										+4,0	43,6	3,754
										+2,7	46,3	3,257
										+2,1	48,4	2,825
										+1,8	50,2	2,441
										+1,3	51,5	2,143

(X_{36}) smoking cessation during pregnancy

(X_{37}) ↓ DP level of women to (11,1±2,0)% and less

(X_{42}) ↓ Cardiovascular diseases in women to (23,4±2,7)% and less

(X_{40}) ↓ level of DP among men to (29,8±2,9)% and less

(X_{45}) ↓ frequency of digestive diseases of women to (29,4±2,9)% and less

(X_{47}) ↓ frequency of cigarette smoking by men to (57,1±3,1)% and less

(X_{33}) ↓ % of women with abortions to (33,7±3,0)% and less

(X_{35}) ↓ frequency of toxemia of pregnancy to (29,0±2,9)% and less

(X_{31}) ↓ frequency of complicated pregnancies to (11,1±2,0)% and less

(X_{43}) ↑ frequency of breastfeeding no less than to (65,1±3,0)%

Figure 3. Modeling of final effects on modification of antenatal and genealogical risk factors and their expected impact

N-factor program of primary prevention of dysplastic pathology of the bronchopulmonary system in children

Source: compiled by the authors.

The obtained results could be used for further research on the issues associated with a prospective assessment of the program's effectiveness in reducing the impact of antenatal and genealogical factors on children's health, particularly with dysplastic pathology of the bronchopulmonary system.

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O. D.; supervision, A. S., H. Dz.; project administration, A. S.; funding acquisition, O. D. All authors have read and approved the final manuscript.

References

Bogachov, S., Kwilinski, A., Miethlich, B., Bartosova, V., & Gurnak, A. (2020). Artificial intelligence components and fuzzy regulators in entrepreneurship development. *Entrepreneurship and Sustainability Issues,* 8(2), 487-499. http://doi.org/10.9770/jesi.2020.8.2(29).

Demikhov O.I., Shipko A.F., Heera Harpreet Singh, Najar Saleh, Shklyar S.P., Dehtyarova I.O. (2020). Intersectoral component of the healthcare management system: regional programs and assessment of the effectiveness of prevention of bronchopulmonary dysplasia. *Azerbaijan Medical Journal*, 2, 88-96.

Dogle, N. V., & Radionova, G. K. (1986). Use of the chief indices of information-entropy analysis in studies of the health status of workers. *Sovetskoe zdravookhranenie*, (6), 14-19. [Google Scholar]

Dzwigol, H. (2020). Methodological and empirical platform of triangulation in strategic management. *Academy of Strategic Management Journal*, 19(4), 1-8. [Google Scholar]

Gubler, E. V. (1965). A disease as a process of emergency regulation in a living organism. *Bionika*, 460-463.

Gubler, E. V. (1990). Informatics in pathology, clinical medicine and pediatrics. *Medicina, 175.* [Google Scholar]

Kondratenko, V., Okopnyk, O., Ziganto, L., & Kwilinski, A. (2020). Innovation development of public administration: management and legislation features. *Marketing and Management of Innovations,* 1, 87-94. https://doi.org/10.21272/mmi.2020.1-06.

Lakhno, V., Malyukov, V., Bochulia, T., Hipters, Z., Kwilinski, A., & Tomashevska, O. (2018). Model of managing of the procedure of mutual financial investing in information technologies and Smart city systems. *International Journal of Civil Engineering and Technology, 9*(8), 1802-1812. [Google Scholar]

Lyulyov, O., Us, Y., Pimonenko, T., Kwilinski, A., Vasylieva, T., Dalevska, N., Polcyn, J., & Boiko, V. (2020). The Link Between Economic Growth and Tourism: Covid-19 Impact. In Khalid S. Soliman (Ed.), *Proceedings of the 36th International Business Information Management Association (IBIMA) 4-5 November 2020.* (pp. 8070-8086). Granada, Spain: IBIMA Publishing.

Patent 56066 A, Ukraine, MKI 7 A61B10 / 00. The method of evaluating the strength and health of the patient with chronic non-specific legends S. Shklyar . – (UA); owner KhNMU (UA). – Application No.2002097717; Claim 09/27/02; Publ. 04/15/2003, Bull. No. 4.

Patent 56864 A, Ukraine, MKI 7 A61B10 / 00. A method for assessing the quality of health of healthy adolescents with risk factors for chronic nonspecific lung disease. S. Shklyar. – (UA); owner KhNMU (UA). – Application No. 2002107987; Claim 08.10.02; Publ. 15.05.2003, Bull. No. 5.

Patent 56865 A, Ukraine, MKI 7 A61B10 / 00. A method for assessing the quality of adolescent health with cardiovascular disease risk factors. S. Shklyar. – (UA); owner of KhNMU (UA). – Application No. 2002107988; Claim 08.10.02; Publ. 15.05.2003, Bull.No. 5.

Patent 56866 A, Ukraine, MKI 7 A61B10 / 00. A method of assessing the level of quality of health of adolescents with risk factors for chronic diseases of the gastrointestinal tract. S. Shklyar. – (UA); owner of KhNMU (UA). – Application No. 2002107989; Statement 08.10.02; Publ. 15.05.2003, Bul.№5.

Shipko,A. F. (2015). Problematic issues of resource support of the regional children's clinical hospital and ways to improve medical care for children. *Experimental and clinical medicine,* 1 (66), 196–200. [Google Scholar]

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Служби охорони здоров'я: упровадження технологій охорони здоров'я

Стаття узагальнює аргументи та контраргументи в межах наукової дискусії з питання впливу окремих факторів на стан здоров`я дитячого населення. Основною метою дослідження є визначення очікуваних показників впливу найбільш значимих факторів ризику захворювань серед дитячого населення. Для досягнення поставленої мети у ході дослідження обґрунтовано моделі кінцевих результатів щодо модифікації факторів ризику. Вивчення антенатальних та генеалогічних факторів у групах здорових та хворих дітей було здійснено за допомогою картки експертної оцінки та інтерв`ю з батьками. Для розроблення та обґрунтування популяційних моделей управління здоров`ям (ранньої діагностики та первинної профілактики) у дослідженні застосовано методи системного популяційного моделювання.

Оцінка очікуваної ефективності N-факторної програми первинної профілактики здійснена за комплексом генеалогічних та антенатальних факторів. У рамках статті автори визначили пріоритетні напрямки реалізації програм профілактики диспластикозалежної патології бронхолегеневої системи за рахунок впливу на керовані антенатальні на генеалогічні фактори. Це дослідження окреслює пріоритетні напрямки реалізації регіональних та демографічних програм для їх подальшого впровадження. Автори представили приклад розрахунку очікуваної ефективності управління здоров'ям дітей шляхом усунення досліджуваних факторів. Визначені пріоритетні напрямки реалізації регіональних та демографічних програм на основі впливу на різні елементи системи охорони здоров'я. Наведено приклад розрахунку очікуваної ефективності управління охороною здоров'я дітей шляхом усунення цих факторів. У статті представлено приклад розрахунку очікуваної ефективності управління здоров'ям дитячого населення за рахунок елімінації досліджуваних факторів. Отримані результати можуть бути використані для подальших досліджень проблематики щодо проспективної оцінки ефективності програми зменшення впливу антенатальних та генеалогічних факторів на стан здоров'я дітей, зокрема з диспластикозалежною патологією бронхолегеневої системи.

Ключові слова: здоров`я дитячого населення, профілактика, фактори ризику, оцінка ефективності.