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Precision public health – hopes and threats

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Abstract

Introduction and Objective. The article formulates the following theses and conclusion: (1) the development processes of precision medicine and precision public health (PPH) are correlated; (2) the development of public health genomics depends not only on an increasingly complete exploration of the principles of the human genome, but also on a fundamentally better investigation of how broad environmental factors can alter gene expression or structure; (3) a necessary condition for the development of both precision medicine and precision public health is the collection of increasingly broader and more complete information about pro- and anti-health factors; (4) the above necessary condition is only possible in a situation of strong authoritarianism with regard to taking health-promoting measures. It is likely that in the near future public health will be shaped by health-promoting authoritarianism.

Brief description of the State of Knowledge. There are two main problems in the development of precise public health (PPH). The first, is maintaining the right proportions between actions based on the genomic data, and actions determined by better understanding of the effect of environmental factors. The second, is the necessity to subject individuals and populations to increasingly closer pro-health surveillance, which must be increasingly more effective, forcing specific health-promoting behaviours on individual and social scales.

Summary. PPH in full can only exist in conditions of complete information concerning health determinants of an individual, and each distinguished group of individuals, as well as fully pro-health organization of individual and social life, i.e. in conditions of full individual and social medicalization. However, such a full medicalization cannot be achieved in any way other than authoritarian.

Key words

genetics, environment, genomics, public health

OBJECTIVE, MATERIALS AND METHOD

High hopes for increasing the effectiveness of treatment and prophylactic actions associated with the development of genetics originally concerned medicine as a field of knowledge serving the health of an individual. However, it was relatively quickly noticed that the development of the methods of genetic therapy may, and should also be used in relation to improving the health of the whole population, i.e. in the domain of public health. The achievements of genetics were used in medicine mainly in order to improve the methods of personalized therapeutic interventions based on a person's genome; the ultimate goal is to create and develop 'precision' medicine which would enable the most effective therapies possible for each individual patient. Obviously, the development of individualized medicine may, and should be accompanied by individualized prophylaxis – it may be said that individualized medicine and individualized prophylaxis will create a complementary whole. In this context, the problem should be seen about how to use the achievements of genetics and 'precise' individualized medicine on a social scale – the problem, which is a major determinant of public health genomics as a multidisciplinary domain dealing with the application of knowledge and technologies, based on the genome for the improvement of the health of the population [1].

The need for intensification of actions has been increasingly clearly noticed, aimed at improvement of the state of population health by means of methods and tools provided by the development of genetics and genetic technologies [2]. In this respect, the findings of the participants of international expert workshops conducted in April 2005 in the Italian resort of Bellagio are important. In these workshops participated specialists in various fields, from Canada, France, Germany, United Kingdom and the USA, who reached full agreement on the need for constant development of methods for the effective translating of the achievements of genetics and genome-based technologies into the practice of improving population health [3].

Public health genomics is not a separate scientific discipline, but the field of practical applications of genomics to improve population health, while genetics and genomics are separate scientific disciplines. The former is the study of heredity and variability of organisms, examining genes, i.e. the basic units of heredity. Thanks to genetics we know increasingly more about how an individual gene functions, what is its composition, how genes interact with each other and with external factors, and how this affects the state of our body. On the one hand, this is very important for the development of medicine and methods of medical therapy, but on the other hand, it is limited by focusing on studies of diseases associated with mutations in only one gene. Usually, however, the causes of diseases are multifactorial, caused by mutations in many genes, by changes in their interactions, and by reactions to environmental impacts. This is the meaning of genomics – the science that studies the genome, i.e. the set of all genes in the cells of an organism, and their effect on the growth and development of an organism in the processes of mutual interactions and responses to environmental factors.

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In simple terms, genomics investigates the causes of diseases with multifactorial conditioning.

Studies in the field of genomics have increased our understanding of the causes of diseases susceptibility to individual complaints, adverse reactions to medications, etc. This has exerted an effect not only on clinical practice, but also on actions in the area of public health. Clinical practice, to an increasingly higher degree, begins to be adjusted to the individual genetic conditioning of an individual, and the vision of precise medicine implementing therapy based on knowledge of a patient's genetic composition is becoming increasingly more real. Thereby, the vision of 'precise' public health is also becoming more real, using the achievements of genomics to improve the state of health on the population level. Genomics is the basis for 'precise medicine', while the methods and technologies applied become a basis for 'precise public health' (PPH), due to which it will be possible for us to 'improve our ability to provide the right health intervention to the right population at the right time' to an increasingly higher degree [4].

Undoubtedly, the main problem in the development of precise public health is maintaining the right proportions between actions based on the genomic data, and actions determined by better understanding of the effect of environmental factors. In health models, health behaviours are of primary importance because they greatly modify the effect of genetic and environmental factors. The scope of precise public health goes beyond genomics and includes also the assessment of many complex interactions between biological, environmental and social determinants of health. According to one of the most broad definitions, precise public health is 'the application and combination of new and existing technologies, which more precisely describe and analyse individuals and their environment over the life course, to tailor preventive interventions for at-risk groups and improve the overall health of the population' [5]. Thus, this is about the skills of combining skills and technologies based primarily on the sets of data, and 'the ability to aggregate, analyze, visualize, and make available high quality data, larger or linked, in closer to real time, that is at the heart of PPH, much like epidemiology is at the heart of traditional public health' [5].

The term *Precision Public Health* (PPH) was first used officially in June 2016 during the conference 'Precision Public Health Summit' in San Francisco. The scope of problems at the meeting was dominated by health issues from a global perspective, problems concerning the collection and interpretation of data, possibilities of greater engagement of communities in pro-health activities. In the same year, an article was published in the journal *Nature* which summed-up the findings and recommendations of the above-mentioned conference [6]. The researchers focused on the problems of development of public health in the developing countries, based rightly on the assumption that in these countries it is necessary to introduce already existing solutions which work well in developed countries. However, for this reason, analysis of the situation in the countries on a lower level of development allows us to see more clearly the direction in which actions should be heading and aimed at the creation of precise public health.

Researchers indicate four types of actions which exert an essential effect on the effectiveness of prophylaxis and treatment of diseases on a social scale. Firstly, they indicate the necessity for accurate registration of births and deaths, because this constitutes an indispensable basis for making rational decisions concerning public health. According to their opinion, the state of full registration of population and life statistics should be achieved by 2030. The second type of action is monitoring, as fully as possible, outbreaks of diseases that may spread beyond the borders of a given country. Obviously, this requires appropriate infrastructure and proper systems of data collection and analysis, as well as appropriately trained personnel. The third type of action is increasing the possibilities of collecting samples of tissues and diagnostic possibilities. This applies in particular to poorer countries, where the cause of death of an individual is often determined only based on reports of close persons. Without an increase in the potential of laboratory diagnostics we will not recognize the exact distribution of causes of mortality. Finally, the necessary action is proper training of the staff dealing with public health. Persons engaged in this sphere should be permanently trained in the area of the essentials of epidemiology, have the authority to use local information in order to determine the strategy of actions, and should also be provided with possibilities for practical implementation of the given pro-health decisions. There is undoubtedly the conviction in the subtext of all these proposals that the precondition for the effectiveness of pro-health actions on a social scale is an increasingly closer monitoring of both individuals and societies.

Placing emphasis on actions in the sphere of environmental conditioning of health, to a great extent, is enhanced by fears of domination of health-promoting activities by a one-sided attitude towards the achievements of genomics. Voices are very frequently being raised expressing concerns about ascribing too much importance to the genetic determinants of the body, and thus neglecting strategies based on environmental and social conditioning of the level of health [7]. This is also considered by those who are convinced that it is genomics that will most strongly stimulate, in the context of precise medicine, the development of precise public health [8]. The basic problems originate from the fact that the main goal of actions in the area of public health is improvement of the level of population health by the prevention of diseases, i.e. widely understood prophylaxis. Meanwhile, guidelines concerning prophylaxis are usually designed to refer to statistically average persons in the examined population. However, the majority of diseases, especially chronic diseases, are caused by a multiplicity of factors, and we do not yet know very well the heritability sequences explained by common genetic variants. For this reason, epidemiological studies still do not indicate that prediction of the genetic risk provides more information, and is more accurate than the prediction of risk based on simple measurements, such as body mass index (BMI), or lipid level. Moreover, even if we know that genomic data specify the risk factor, they may not be clinically applicable. In addition, we are only at the beginning of developing and deepening analyses of very numerous and very complex genetic-environmental interactions.

According to those who in actions aimed at constructing precise public health based on genomics see the beginning of the new era in health care, overcoming difficulties and solving problems, depends on an effective collection of the largest number of health data possible.

A priority for public health is the use of information technology and data science in enhancing public health surveillance and tracking. Surveillance is the systematic, ongoing collection, management, analysis, and interpretation of data to stimulate and guide action. The best-recognized use of surveillance is the detection of epidemics and community health problems. Big data has the potential to accelerate early detection of outbreaks and other community health issues. New technologies will accelerate timeliness and completeness of electronic laboratory reporting for notifiable conditions. Tracking population movements and contact of potentially infected individuals can also be modernized using available technologies. For example, during the West African Ebola outbreak, mobile phone data provided objective, real-time information on location and movement of people to pre-empt future outbreaks [8].

Thus, the development of public health depends on a constant, increasingly wider and deeper monitoring of everything that has an effect on the state of health of an individual and the population. It is emphasized that this refers to both precise public health and precise medicine – in both cases, population perspective is needed. The development of medicine, as well as public health, seems to be clearly heading towards the development of systems for the total pro-health control of individuals and communities.

Arguments for the need to create increasingly more effective systems of pro-health control, on the one hand, is based on indicating therapeutic benefits obtained as a result, and on the other hand, on emphasizing a wider aspect – the era of genomics is to be the time of personalized health care and pharmacogenetics-assisted drugs, which should eliminate chronic diseases, and primarily raise the effectiveness of prevention to the highest level. According to the authors of a comprehensive 2003 report on the state and perspectives of development of applications of genomics in activities on behalf of improvement of population health, genomics will be increasingly more widely used in public health: 'In the future, genomics will be integrated into the fabric of public health activities as seamlessly and universally as epidemiology is today' [9].

The postulate in this regard is significant, that that the focus should be shifted from creating independent genetic programmes to the integration of genetics and genomics with the existing health, social, and environmental policy.

The case for integration is strong. All health conditions have a genetic basis. Most common diseases result from gene/environment interactions, so genetic advances are likely to extend and expand, not supplant, current practices in medicine, public health, and environmental protection. Because there is wide variation in the extent to which genetic factors affect health risks, a one-size-fits-all policy is inappropriate. Decisions about genetic policies involve complex issues about ethics, costs, benefits, and individual and societal interests. Medical care decisions should be linked with research, insurance, and broader public health policies. Finally, the intersection between genetics and public policy is both immediate and long-term, warranting close monitoring and timely actions in a broad context" [10].

It is assumed – and this assumption seems to be fully justified – that an exponential increase will be observed in the amount of genomic information concerning the problem of how specified genetic factors are connected with the risk of a disease, and what is their interaction with environmental factors. Therefore, it becomes necessary to obtain the largest number of environmental and behavioural data possible for eco-genetic analyses, and to discover how they may be connected with the data concerning genetic variability and environmental conditions. However, in terms of public health, this means that wider and deeper monitoring of the population will become necessary to obtain the largest amount of data possible and increasingly deeper pro-health activities.

Problems of implementation. However, with the development of genomics, it became increasingly clear that the initial high hopes for the possibilities of applications of the achievements of genetics on a social scale, i.e. in public health, will not be implemented so quickly or so conflict-free as enthusiasts of public health genomics seemed to assume [11]. We still remain unaware of the scale and depth of the effect of genomic factors on the development of diseases and, at the same time, we are increasingly more aware that genomic factors are only one of many etiologic factors of diseases. Moreover, the hopes will not be fulfilled that the provision of genomic information will be a strong factor motivating people to change unhealthy life styles. In addition, one should be aware of the very important problem are financial costs. Therefore, researchers began to indicate that this is not the right path to obtain the largest amount of genomic information possible about possibly the largest number of people, but the development of methods for obtaining selective information.

The time is right to aggressively investigate the promise of targeted sequencing of carefully selected genes to detect those members of the population who are at high risk of preventable disease. Critical, immediate tasks include determining which genes warrant sequencing in healthy individuals, how to do so in an affordable way, how to properly educate individuals about the implications of both a positive and negative result, and how to effectively implement preventive care when such mutations are found. In the end, if we determine that such a programme results in improved outcomes for individuals and their families, we will have begun to realize a promising vision of public health genomics [12].

Will the 21st century be the time to realize this vision? This will undoubtedly be a time of undertaking continued efforts in order to improve the methods of identification of the genes responsible for complex disorders, deepening of understanding of diseases, and also setting priorities of genomic studies for applications in public health [13]. The essence of the problem is not in that the development of genetics brought about a considerable progress in identification of the genetic background of diseases conditioned by one gene, i.e. the so-called Mendelian diseases, but in discovering the mechanisms of functioning of the genes responsible for complex disorders, takes place incomparably slower. Also, our understanding of interaction between genomic and environmental factors in the etiological processes of diseases still remains unsatisfactory. Therefore, there prevails a belief

that costly and time-consuming tools of molecular genetics should be applied mainly regarding diseases with the greatest genetic contribution, in which the genes responsible for family aggregation play a decisive role, and which currently cannot be treated or prevented through environmental changes; examples are type 1 diabetes, multiple sclerosis, Alzheimer's disease and schizophrenia. However, a lower priority is assigned to the selection of genes in the case of diseases considered as highly susceptible to environmental modification and life style, such as type 2 diabetes, AIDS, or alcoholism although, undoubtedly, genes are also involved in their etiology.

However, the hierarchy of values and actions established in this way cannot obscure the fact that a deeper recognition of the principles of functioning of the genome will allow not only a better understanding of the way and to what extent patterns of genetic information are affected by pathological changes resulting from the genetic structure one the one hand, and environmental factors, such as life conditions and life style, or dietary components, on the other hand [14]. Studies are being carried out concerning the interaction of genes and nutrients, intended to lead to more complete knowledge about how dietary components may change the expression or structure of genes, to what extent some diet-regulated genes may play the role in the incidence and course of chronic diseases, to what degree the effect of diet depends on individual genetic structure, etc.

Special hopes are associated with the development of genetic epidemiology, which combines the genetic method with the epidemiological method to analyze genetic variability in human populations, and its relationship with normal and pathological phenotypic changes. Genetic epidemiology evaluates the distribution and determinants of genetic traits in the human populations, and describes the role of genetic factors and their interactions with environmental factors in the development of diseases. This is significantly connected with studies of the effectiveness of a drug on a disease, depending on inter-individual variability in response to the drug. This is about creation in the future of individualized pharmacology, specifying the drug and the appropriate dose adjusted to particular symptoms of the disease in a given person, to achieve the therapeutic effect with minimum risk of the occurrence of adverse effects.

Visions of expected benefits which are the result of the development of public health genomics, with a simultaneous awareness of the importance of the problem and the size of accumulating difficulties in implementation, encourage the undertaking of various international initiatives aimed at increasing the research potential and coordination of studies [15]. In 2004, the Rockefeller Foundation initiated the Bellagio Group on Public Health. During 14–20 April 2005, this group organized expert workshops in the Rockefeller Foundation's Bellagio Center in Italy, with the participation of experts from Canada, France, Germany, the United Kingdom and USA; the results of the deliberations were included in so-called 'Bellagio Statement'. The participants – unanimous in vision and scope of the domain of public health genomics – established a forum under the name the Genome-based Research and Population Health International Network (GRAPH Int). The goal of the GRAPH Int is promotion of appropriate studies and research cooperation, and supporting the development of an integrated knowledge base; great emphasis was placed on the development of education and training, improving communication and engagement with society, and informing about public policy. The primary and ultimate goal is supporting the development and effective application of genome-based knowledge for the benefit of population health. Public health genomics itself has been undertaken as a responsible and effective use of knowledge and genome-based technologies in order to shape pro-health policy and health services on a social scale.

Also, the strategy of the European Union considers the important role of genetic determinants. The European Commission in its report 'Life Sciences and Biotechnology' (COM(2004) 250, 7 April 2004) committed to obtaining high quality genetic studies, and to increasing cooperation and information exchange in the area of applications of the achievements of genetics on a social scale. In 2005, the European Commission Directorate-General for Health and Consumers (DG SANCO), renamed in 2023 the *Directorate-General for Health* and Food Safety (*DG SANTE*), made a decision about financing the European Public Health Genomics Network (PHGEN), which is administered by the Landesinstitut für den Öffentlichen Gesundheitsdienst NRW (State Institute for Public Health Service, North Rhine-Westphalia) in Bielefeld, Germany, the German Centre for Public Health Genomics, also in Bielefeld, and the Public Health Genomics Foundation in Cambridge, UK. The network advises the European Commission concerning health policies and the integration of genome-based knowledge.

In February 2004, in the Centre for Interdisciplinary Research in Bielefeld, Germany, known internationally as the team of advisors in science, the first international symposium was held on public health genetics entitled 'Public Health Genetics – Experiences and Challenges' [16]. The symposium became a forum for presenting positions and points of view on issues for the development and importance of genomics for public health. It was pointed out that, on the one hand, the geneticists should reflect on the possibilities of considering the aspects of public health in their research programmes, and on the other hand, specialists in public health should be aware of and analyze in what way genomics changes the concept of public health. The second issue was considered as the primary task of public health genomics.

However, emerging difficulties significantly weakened the optimistic forecasts that genetic studies of the whole populations will significantly change health prophylaxis. Discussions on the possibilities of incorporating genomic technologies into public health practices which have been on-going since the beginning of the 21st century, are the continuation of lively discussions in the last two decades of the previous century, the level of optimism decreasing and the awareness of difficulties increasing; to-date there is also a lack of breakthrough moments.

It has become obvious that it is necessary to collect a considerably stronger evidence base and a larger amount of data concerning interactions between genotypes and common environmental exposure. Thus, we should be much more modest about our expectations of the beneficial impact of the development of genome medicine on population health [17]. Surveys show that specialists in public health declare having high hopes for the development of genomics while, at the same time, acknowledging that their knowledge on this subject is insufficient and should be deepened [18, 19]. It is taken for granted that in order to integrate the subsequent achievements of genetics with better health outcomes, specialists dealing with public health and employees of public health sphere

must possess at least basic knowledge concerning genomics in various disciplines of public health. Therefore, it is postulated that genomic education should be included in education programmes at various levels. In fact, it is about making the promise of precise public health a reality [20].

Nevertheless, it seems that there is a consensus that specialists in the area of public health should support the integration of genomics with public health practices and, to a greater degree, use genetic information in public health programmes. At the same time, more critical public health specialists indicate the necessity for establishing proper relationships between genomic studies leading to a better understanding of genetic mechanisms, and defining preventive strategies. Fuller integration of genetic and environmental perspectives in the etiology of diseases is intended to serve this purpose, to allow better understanding of the causes of diseases at both the population and individual levels, as well as to develop close cooperation between etiology and the branches of epidemiology oriented towards risk factors. In this context, concerns are expressed that over-estimation of genomics may lead to the preference of domains and projects which provide knowledge about the treatment of disorders, whereas studies oriented towards prophylaxis will experience problems with financing. In the long run, the knowledge base will suffer, as required by an integrated system of health care oriented on prophylaxis, as well as treatment [21].

With the passing of time, cautions against the risk of over-estimating the value of genomic data to determine health effects on the population level are increasingly more frequently being repeated. The existence of some potential risks is emphasized, associated with the preventive protection of public health based on genotype [22]. This additionally indicates that over-emphasis on heredity tends to disproportionately harm minorities and communities in an unfavourable health situation, caused mainly by the environment. Nevertheless, in this context it is emphasized that the existing inequalities in access to health care cannot be effectively eliminated without proper implementation of precise medicine which, in turn, requires analyzing specific projects from a public health perspective, including not only genetic factors, but also the socio-environmental conditioning of health [23].

It may be presumed that hopes associated with the development of public health genomics have not been weakened so much as having been made more realistic. Perhaps for this reason an increased awareness of the difficulties to be overcome will enable more effective actions in this area. In this respect, the history of the creation and development of so-called public health observatories is instructive [24]. In 1999, a so-called White Paper was published in the United Kingdom entitled *Saving Lives: Our Healthier Nation*. It was an ambitious document announcing a new, integrated approach to public health. Four main areas of actions were indicated – cancerous diseases, cardiovascular diseases, accidents and psychiatric diseases – in each area a decrease in mortality rate was specified as the goal. A number of new public health initiatives were announced, including the establishment of Public Health Observatories (PHO), first created in 2000 in England, and subsequently in other regions of the UK. Individual regional observatories were ultimately to be connected to create a national network of knowledge, information and surveillance in public health, which would become the main new source of information for local authorities dealing with public health. It was assumed that the emerging observatories would be closely linked to university centres to ensure that academic standards of research would be maintained. The Association of Public Health Observatories was established with the aim of coordinating work between the observatories.

In the document *Saving Lives: Our Healthier Nation*, the observatories were assigned six basic tasks: 1) monitoring of the state of health in a given area and revealing emerging trends in disease incidence; 2) detecting gaps in the collection of health information; 3) advising on methods for assessing the effect of external factors on health, and eliminating inequalities in access to health care; 4) collecting information from various sources, useful in health-promoting activities; 5) assessing the progress of local agencies in improving health and reducing inequalities in access to health care; 6) prediction of early warning about problems related with public health.

The observatories were also to focus on international cooperation which, over time, they achieved with great success. Quite quickly, observatories also began to be established in other European countries and in the USA, which intensified international cooperation. Among the multitude of international projects undertaken, the project Public Health Genomics European Network is of special importance, aimed at investigation of the effect of genetic revolution on public health in European countries. The coordinator of the project was Maastricht University in The Netherlands, in partnership with the UK. It mainly concerned discernment of the future of information collection supporting the development of public health genomics, with the aim of developing the basics of a programme of public health [25]. A possible plan of action was proposed supporting the development of public health genomics within Public Health Observatories. First of all, it was established that in addition to the standard collection of information concerning health and diseases, it will be necessary to intensify the collection of data on genetic composition (and therefore threats) to the population. It was admitted that the benefits derived from this type of action will only appear over time, although changes needed to be introduced now, to make the most of the achievements of genomics on a social scale. The observatories were to play a significant role in these undertakings, both as a source of data and as coordinating institutions.

However, it is interesting how the fate of the observatories in the UK turned out to be so different from those in other countries. On the European continent and in the USA, observatories developed and fulfilled their assigned roles, while in the UK they were completely liquidated. This was the result of conflicting interests between government and local government health care agencies, competence ambitions and, obviously, the constant fight for financial influence. The high independence of the observatories, reluctance of the government to signal wrong and harmful facts or decisions, aroused tendencies to subordinate them increasingly more closely to government agencies. Further reorganizations, changes in reporting lines, personnel changes, etc., caused the outflow of employees. Many public health specialists believe that the liquidation of the observatories was a serious mistake, and that the actual reasons for liquidation were of a non-substantive nature. 'There is now a strategic review being carried out into PHE. There is even some talk among senior colleagues that the loss of the observatories

should be reversed as it was a mistake. The way in which observatories have developed in other parts of the world has been something of a wake-up call to those in the public health system in England' [24]. However, it does not seem possible to restore British public health observatories in their previous form.

The effective and useful activities of public health observatories in many countries, and their liquidation in the United Kingdom, indicate that the development of the domain of public health, especially from the aspect of the use of achievements in biomedical sciences, including genomics, cannot and will not take place without conflict, and conflicts of interests, but also different research attitudes and the adopted hierarchy of importance which exert an inhibitory effect. However, it seems that in relation to public health genomics, two issues have been resolved with a high degree of certainty. Firstly, it was considered that from the point of view of public health objectives, an increasingly better understanding of interactions between genetic and environmental factors is crucial. Secondly, it was considered obvious that collecting data and expanding the scope of information is a precondition for the development of public health, both in the environmental and genomic contexts. This may mean that the pressure will become stronger to obtain increasingly more complete and detailed data concerning life style and the state of the environment, as well as the genotype of individuals and populations. Therefore, it may be assumed that this century will be a time of constantly increasing control over individuals and societies – control motivated by health-promoting reasons, the desire to improve the health well-being of each and every one of us. If so, this will undoubtedly be associated with the tendency to impose a specified life style on both individuals and populations, indicated behaviours, diet, types of activity, etc., and adapting to this, the organization of social life. Broadly speaking, medicalization will continue to increase, both in the individual and social dimensions.

Medicalization is the process of subordinating increasingly larger areas of both individual and social life to medical recommendations, expressing the desire to organize life in accordance with the requirements and indications of medicine in order to achieve an increasingly better quality of life. Full social medicalization would thus be a state of optimal standardization of living conditions and the full adherence of individuals (or at least the vast majority of them), to established health-promoting norms. Achieving such a state is conditioned by acquiring increasingly broader and deeper biomedical information, but also requires intensive promotional activities combined with appropriate legal regulations. In the modern world, especially in rich countries, developed and constantly intensified forms of health promotion strongly interfere with the life of society, creating various types of behaviours, such as a 'healthy' lifestyle, eating, dressing, etc., but also legally ordering or prohibiting certain activities and behaviours considered harmful from the point of view of health-promoting goals. In some simplification, it can be said that the greater the medicalisation of society, the greater the restriction of individual autonomy. This is the context in which efforts are being made to create precise public health.

Preconditions of precise health promoting activities. Since precision public health is to ensure appropriate interventions for the right population at the right time to improve health, these intervention must be based, on the one hand, on the achievements of genomics, and on the other hand, on large data sets obtained on the basis of the multiplicity, diversity and variability of information – biomedical, sociological, demographic, environmental, geographical, etc. In this context, large data sets are of key importance. To-date, most applications of large data sets for therapeutic purposes have served to explain pathobiology and the discovery of drugs adjusted to individual needs. Therefore, it becomes necessary to intensify research into how large data sets and predictive analytics can contribute to the creation of precise public health through the improvement of surveillance and assessment of the state of population health, and also to an increase in efforts on behalf of promoting the use of evidence based interventions, by including more information related to place, person and time [26, 27].

Therefore, in the future precise public health appears to be based on increasingly abundant and more complete information about any factors which exert an effect on population health. From the aspect of information concerning place, the point is that greater accuracy in the description of geographical, social and health care system organization conditioning, would serve such targeting interventions which would allow the most effective reduction in morbidity in hard-to-reach subpopulations, and to eliminate disproportions in access to health services. In turn, personal information should increasingly progress beyond traditional indicators, such as age, race, ethnic origin, etc., and concern patients' personal characteristics. Genome and other biomarkers are especially intended to enable the identification of subgroups reflecting the heterogeneity of the underlying disease, and potential reactions to various types of interventions. Large data sets may also improve the accuracy by analysis of repeated measurements of the same variables over time. Data collected from personal devices, such as sensors, smartphones, and other digital devices, provide information about the variability of various health indicators over time, such as nutrition, physical activity, and blood pressure. This will not only allow the undertaking of evidence-based interventions but, above all, increasingly more abundant and accurate data will provide an image of in which way the interventions were implemented, and what were the results obtained.

It therefore goes without saying that in every field of knowledge, also in the biomedical sciences, development requires inventiveness, i.e. acquiring new information. Public health aiming at greater accuracy is conditioned by the acquisition of new information enabling, on the one hand, elimination of unnecessary and harmful interventions, and on the other hand, application of interventions with respect to population groups identified according to the criterion of intervention effectiveness. 'If PM is defined as optimizing care for well-characterized individual patients, then precision public health is characterized by discovering, validating, and optimizing care strategies for well-characterized population strata' [28]. In the field of public health, such a targeted intervention would be used for programmes aimed at maintaining population health, as well as disease prevention programmes. The acquisition of information, i.e. increasingly more effective monitoring of individuals and populations, is intended to shape precise public health, identifying and translating information about factors determining morbidity, increasingly effectively into action.

Those who see in large data sets opportunities to create and improve precise public health, deal exclusively with 'technical' problems caused by the collection, selection, processing and analyzing huge amounts of information [27]. In thinking about precise public health, pragmatic attitudes dominate, determined by growing concerns about increasing epidemic threats and the spread of civilisation diseases. 'In these challenging times, further developments in the field will require global, national, and local leadership and commitment to enhance coordination of systems; sharing, harmonization, integration, and evaluation of data; robust stakeholder engagement; and support for the infrastructure and expertise needed to achieve the promise of PPH' [27]. This is in the focus of considerations, and is of concern for the analyses of problems occurring in the process of using genomic data for public health purposes.

> Improved data integration and methods will be necessary to leverage the complexity of human genomics data for addressing precision public health problems. Incorporating these data with other individual-, interpersonal-, community-, and environmental-level data in a meaningful and rigorous way, will require novel methods for data measurement, collection, management, and integration. In particular, advanced informatics is needed to fulfill the opportunities and meet the challenges of integrating human genomic research within precision public health through information technology infrastructure development. As the underpinnings of multi-level mechanisms take shape, multi-level systems-based interventions will be necessary. These include study designs and data storage infrastructure that allow researchers to understand both the synergistic and independent effects of these complex problems and multi-level solutions across diverse populations. Future opportunities in this area include improving complex study designs and big data management and storage [28].

These are obviously real problems, and their gradual solution is necessary to achieve the goals of public health. However, these problems are of an information technology, technical and organizational nature; therefore, focusing exclusively on them does not allow us to see their social dimension and social consequences.

If precision public health is to be shaped as a domain integrating elements of precise medicine and primarily studies on human genomics with public health methods, this fact determines the necessity for subjecting individuals and populations to increasingly strict health-promoting control, and increasingly effective enforcement of specific health-promoting behaviours on individual and social scale, i.e. determines the need to increase the level of medicalization.

Meanwhile, beyond the horizon of information technology and organizational considerations, there remains a simple – but also fundamental in this context – conclusion that full and precise public health can only exist in conditions of complete information about health determinants of an individual, and each distinguished group of individuals combined with a fully health-promoting organization of individual and social life, i.e., in conditions of full individual and social medicalization. However, such full medicalization can only be achieved in an authoritarian way. In the 21st century, it will be seen whether precise public health takes shape in the conditions of health-promoting authoritarianism.

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