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Prospective Approaches to Forecasting the Health and Social Consequences of the Burden of Chronic Non-Communicable Diseases under Conditions of a Prolonged Wartime Emergency

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Перспективні напрями прогнозування медико-соціальних наслідків тягаря хронічних неінфекційних захворювань в умовах тривалого впливу надзвичайного стану воєнного характеру

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Introduction

Contemporary models for protecting and promoting public health, amid transformations in social capital and intensified collective efforts to address the consequences of armed conflicts, use a salutogenic approach to the design of preventive programmes, with a central emphasis on cross-sectoral public policy. This approach is both important and highly relevant to Ukraine [1; 2; 3; 4; 5]. A range of wartime challenges has caused psychological, somatic, and social trauma among the population and has substantially reduced people's motivation to maintain and strengthen their adaptive resources and psychosocial well-being, as well as their capacity to cope with stress, crisis, or psychological trauma and to recover in the future. Research on non-communicable diseases (NCDs) has given rise to prominent international and Ukrainian schools of thought. Their leading representatives include international scholars [3; 6; 7; 8; 9; 10; 11] and well-known Ukrainian researchers [12; 13; 14; 15; 16], who have studied the causes and consequences of NCDs and substantiated the need to implement modern population-level prevention strategies.

Salutogenesis provides a foundation for health by focusing on the factors that support human health and well-being. It shifts attention from disease and risk to resources that foster resilience and strengthening, and from treating consequences to preventing stress and building resilience. Particular emphasis is placed on individuals' conscious care for their physical, emotional, and mental health, the maintenance of balance, and harmony between personal needs and external demands [5; 17; 18]. The application of forward-looking tools to support and improve population psychosocial well-being requires a high level of professional competence within the public health system [19].

Ukraine has confronted with a prolonged and unpredictable war that has adversely affected its citizens' living conditions and quality of life. Age-standardised NCD mortality rates in Ukraine exceed those in European Union countries by almost twofold among women and by more than twofold among men. In particular, mortality from the cardiovascular diseases in Ukraine is nearly twice the average for the WHO European Region [17; 20].

The Global Burden of Disease (GBD) projects, together with analytical materials from international organisations (WHO, the World Bank, the United Nations, FAO, and others), provide foundation for contemporary research. These sources enable comprehensive and comparable assessments of the "epidemiological transition", whereby chronic NCDs have displaced communicable diseases as the predominant cause of morbidity [1; 2; 12; 13; 20].

The purpose of the research is to provide a scientific rationale for, and develop innovative approaches to, preventing the development and spread of chronic non-communicable diseases under conditions of a wartime emergency.

Object, materials and research methods

Object: the prevalence of non-communicable diseases as the principal component of the health burden in Ukraine.

Materials and research methods the dynamics, spatial distribution of risk determinants, and regional disparities in the prevalence of non-communicable diseases under wartime emergency conditions, with Odesa Region as a case study.

To achieve the stated aim and objectives, the study employed a set of general scientific and specialised research methods: theoretical analysis, synthesis, generalisation, and systematisation to examine scientific approaches to

assessing the burden of NCDs; comparative and content analysis of NCD prevalence and associated risk factors; strategic macro-environmental analysis (PESTEL) to assess the influence of relevant factors on the development and spread of NCDs under wartime; empirical and statistical analysis to assess morbidity patterns and the spatial differentiation of indicators; socioeconomic and medical-geographical analysis to identify relationships among morbidity, socioeconomic conditions, urbanisation, and environmental conditions; the disability-adjusted life year (DALY) method to provide an integrated measure of population health loss; and structural-logical modelling and expert analytical forecasting to substantiate directions for reducing the burden of NCDs.

The informational and empirical basis of the study comprised Ukrainian legislation and regulatory instruments; publications from 2015 to 2026 (regarding the effects of martial law since 2022); official materials from the State Statistics Service of Ukraine, the Ministry of Health of Ukraine, and the Public Health Centre of the Ministry of Health of Ukraine; and statistical reports and analytical data from healthcare institutions in Odesa Region, including the Main Department of Statistics in Odesa Region and the State Institution "Odesa Regional Centre for Disease Control and Prevention of the Ministry of Health of Ukraine".

Research results

According to the WHO definition, chronic non-communicable diseases are a heterogeneous group of human diseases characterised by a prolonged course (usually more than three months), slow progression, a non-communicable aetiology, multifactorial causation, irreversible structural changes, and a need for long-term or lifelong medical care and lifestyle modification [8; 9; 10]. Chronic conditions account for 84–86% of all deaths in Ukraine, which underscores the need to shift the focus from emergency treatment to primary management of modifiable risk factors.

Contemporary disease prevention extends beyond the healthcare sector and requires an intersectoral approach involving local authorities, educational institutions, civil society organisations, and territorial communities themselves in creating conditions that support healthy lifestyles and reduce environmental and social risks [12; 21; 22; 23; 24].

Ukraine exhibits substantial regional disparities, ranging from large cities with well-developed healthcare infrastructure to small territorial communities with limited access to qualified medical care [18]. Odesa Region is characterised by the predominance of cardiovascular diseases within the NCD profile, an increasing prevalence of chronic conditions, insufficiently effective prevention and screening measures, and a growing burden on the healthcare system under martial law (Table 1).

Odesa region has a unique socioeconomic profile characterised by a combination of port and industrial development, a coastal location, a high level of urbanisation in the city of Odesa and adjacent districts, intensive migration, and, since 2022, substantial wartime consequences due to increased environmental pressure [25; 26; 28]. Key challenges include air pollution caused by energy-sector enterprises and the growing number of motor vehicles, as well as frequent wartime technological emergencies. Concentrations of harmful substances in the air and soil exceed permissible levels by five to seven times, which increases the risk of respiratory and cardiovascular diseases [8; 29]. War actions have had major adverse consequences for both the physical and mental health of the entire population of Odesa Region (Table 2).

Table 1

Analytical Indicators of the NCD Situation in Odesa Region (Compared with Ukraine)

Indicator	Odesa Region	Ukraine average / other regions	Analytical interpretation
Share of NCDs in the morbidity profile	Dominant	Dominant throughout Ukraine	Reflects the systemic nature of the problem
Diseases of the circulatory system (per 100.000)	3.569.96	A similar trend is observed in Ukraine, with particularly high values in southern regions	Leading cause of death (more than 60% of deaths in southern regions)
Mental and behavioural disorders (per 100.000)	420.20	Increasing during the war	Reflects the impact of wartime stress
Type 2 diabetes mellitus (per 100.000)	349.95	Persistently high rates in Ukraine	Increasing and exceeding the rate of malignant neoplasms
Malignant neoplasms (per 100.000)	263.25	Approximately 193.1 (premature mortality)	Substantially above the national average
Obesity (per 100.000)	184.20	Increasing throughout Ukraine	Major risk factor for NCDs
Premature cancer mortality (per 100.000)	218.3	193.1	Above the national average
Early cancer detection rate	3.3%	20.8%	Critically low level of preventive detection
HIV (per 100.000)	150.9	41.1	Substantially higher rate
Tuberculosis (per 100.000)	91.8	42.2	High epidemic risk
Proportion engaging in self-treatment	32.9%	Approximately 31.7%	Insufficient engagement with healthcare services

Source: [25; 26; 27].

Table 2

Comparative Trends in the Prevalence of Major NCDs in Odesa Region, 2015–2024 (Cases per 100,000 Population)

NCD group	2015–2019 (mean)	2022	Term 1 2024
Circulatory diseases	3200–3400	≈3550	3569,96
Type 2 diabetes mellitus	280–310	≈330	349,95
Malignant neoplasms	230–250	≈255	263,25

Source: data from the State Institution "Odesa Regional Centre for Disease Control and Prevention of the Ministry of Health of Ukraine" [25].

As a strategic frontline hub, Odesa Region is exposed to persistent hostile attacks, missile strikes, and the destruction of civilian and critical infrastructure. These circumstances have become powerful stressors associated with a rapid increase in NCD morbidity, including cardiovascular disease, cancer, diabetes, and chronic respiratory disease; accelerated disease progression; and reduced access to routine healthcare. The city of Odesa has hosted the largest number of internally displaced persons (IDPs) in the region. This has placed considerable additional pressure on municipal healthcare facilities and prolonged waiting times for routine diagnosis and NCD screening. At the same time, patients in the city have better physical access to healthcare infrastructure and are more likely than residents of suburban areas to reach hospital within the therapeutic "golden window" during acute events [26; 28]. In remote parts of Odesa Region, particularly the southern districts of Izmail and Bolhrad and the northern Podilsk district, the NCD crisis is compounded by logistical, workforce, and economic barriers. An acute shortage of healthcare personnel has interrupted routine preventive care, which has lead to cancer and diabetes detection at late, incurable stages. Recurrent shelling and power outages cause chronic distress, which contributes to cardiovascular events at younger ages and prompts some residents to adopt unhealthy coping strategies, including alcohol consumption, tobacco use, and unhealthy eating.

Discussion of research results

Ukraine's healthcare system is progressing towards preventive management and strategic planning as part of the development of the national public health system. This transition requires the use of up-to-date integral tools for assessing population health loss. Conventional descriptive indicators, such as prevalence and mortality rates, are statistically important but cannot fully capture the hidden socioeconomic losses that society incurs as a result of chronic disease. Chronic non-communicable diseases are associated with prolonged periods of incapacity for work and substantial deterioration in quality of life. There is therefore a clear methodological need to measure the health and social burden of chronic NCDs using modern composite indices and to develop forecasting models based on these indices to inform managerial decision-making (Table 3).

In contemporary epidemiology and health economics, the methodology used to measure disease burden remains a subject of debate. Representatives of the classical school of demographic analysis, including D. Shushpanov [30], state that priority should be given to indicators of premature mortality and years of potential life lost (YPLL). They report that mortality data are the most verifiable and accurate because they are supported by official national statistics, whereas subjective assessments of quality of life have a high error risk.

Advocates of the Global Burden of Disease (GBD) framework, developed under the auspices of the Institute for Health Metrics and Evaluation (IHME) and associated with the leadership of C. Murray [23], argue for the clear advantages of the DALY index [2]:

$$DALY = YLL + YLD, \quad (1.1)$$

where YLL (Years of Life Lost) denotes years lost because of premature mortality and is calculated as the product of the number of deaths (N) and the standard life expectancy at the age of death (L), representing the years an individual would otherwise have been expected to live;

YLD (Years Lived with Disability) denotes years lived with disability or a substantial health limitation and is calculated as the product of the number of cases (I) and the disability weight (DW, where 0 represents full health and 1 represents death) assigned by the WHO to each condition.

The DALY framework estimates the total loss of human potential attributable to premature mortality and chronic disability. It combines two core components mathematically: YLLs, which reflect the number of years not lived because of early death, and YLDs, which capture the time lived with disability or ill health [2].

The use of DALYs, combined with modelling its reduction through the complete or partial elimination of modifiable risk factors, permits a fundamental reassessment of the scale of the adverse health and social effects of chronic somatic disease at the population level. This analytical approach provides an evidence base for the strategic planning, validation, and revision of regional public health and preventive cardiology programmes, thereby underscoring the high scientific and practical value of the present study. As Ukrainian researchers O. Orlova and V. Ruden [13] have noted, reliance on mortality indicators alone artificially underestimates the true burden of conditions such as diabetes mellitus, mental disorders, and chronic rheumatic diseases. Although these conditions are seldom recorded as the direct cause of death in official health statistics, interfere with the workforce potential quality of the region.

In Odesa region, assessment of the health and social burden of chronic NCDs is complicated by

Table 3

Characteristics of Methods Used to Study NCDs

№	Method category	Essence and instruments	Examples of application and regional specificity
1	Descriptive and standardised statistical methods	Calculation of crude and standardised rates (per 100.000 population). Direct or indirect age and sex standardisation using the world or European standard population to control for differences in population age structure	Analysis of cardiovascular disease (CVD) mortality demonstrates geographical variation: rates are lower in western regions than in eastern and southern regions. Identification of regions with the maximum deviations
2	Methods for measuring inequality and dispersion	Quantitative assessment of disparities using measures of dispersion: coefficient of variation (CV), the health Gini index, the Theil index, and the concentration index	Assessment of inequality in the distribution of the NCD burden across regions within the Global Burden of Disease Study. Analysis of data from the State Statistics Service of Ukraine and the Public Health Centre of the Ministry of Health showed that interregional differences in CVD mortality reach 20-40%
3	Epidemiological and analytical methods	WHO STEPS (questionnaires and physical and biochemical measurements). Cohort and longitudinal observations and case-control studies. Cluster analysis and spatial statistics (Moran's I and Getis-Ord Gi*) to identify hotspots	The 2019 STEPS survey in Ukraine recorded a high prevalence of risk factors (smoking approximately 34%, excessive salt intake, and physical inactivity) and enabled regional disaggregation of the data
4	Geospatial methods and GIS technologies	Integration of health statistics with socioeconomic and environmental indicators in geographic information systems. Visualisation of disparities on digital maps	Identification of spatial correlations among environmental pollution, urbanisation rates, and NCD prevalence at the regional level
5	Composite indices of disease burden	Composite DALY (disability-adjusted life year) and QALY (quality-adjusted life year) indices. These combine mortality and health loss due to disease in a single measure	Regular provision of regional disease-burden estimates for Ukraine within international projects, despite certain limitations in national statistical data

Source: [1; 2; 10; 13; 23; 24; 25].

pronounced intra-regional disparities. The studies [25; 26; 28] demonstrate persistent inequalities between the highly urbanised Black Sea coastal agglomeration (Odesa, Chornomorsk, and Pivdenne) and economically disadvantaged agricultural districts in the south of the region (Podilsk, Bolhrad, and Izmail districts). In urban centres, higher registered morbidity is often associated with better access to diagnostic equipment and a high concentration of private healthcare providers, whereas peripheral districts show a hidden accumulation of advanced chronic NCDs [26]. This distorts crude statistics and requires longitudinal analytical approaches. The region is experiencing a "deferred healthcare catastrophe": as residents deliberately postpone routine medical visits and screening examinations, hospital admissions for advanced cancer and major cardiovascular events, including myocardial infarction and stroke, are projected to increase sharply in the coming years.

To assess the structure of the health and social burden of chronic NCDs in Odesa Region during wartime [25; 26; 27], we developed an analytical matrix to show the distribution of losses by major disease class and burden component (Table 4).

Assessment of population health losses attributable to chronic NCDs in Odesa region using the composite DALY index reveals hidden socioeconomic losses that are overlooked due to conventional mortality statistics and demonstrates that cardiovascular diseases account for more than 60% of the burden.

The scientific debate confirms the need to combine strong demographic markers with longitudinal epidemiological studies of inequality to map risk areas accurately.

The mathematical models developed in this study indicate that without the immediate implementation of differentiated management interventions the cumulative effects of wartime stress and infrastructure collapse will increase the burden of chronic disease in Odesa Region by 18–35% by 2030. This finding highlights the urgent need to develop and implement innovative models of prevention and digital monitoring of modifiable risk factors directly within the region's territorial communities.

Prospects for further research

Prospects for further research should include a comprehensive regional STEPS 2027 study and a more detailed investigation of the cumulative effects of environmental and wartime factors on different age and social groups within territorial communities.

Conclusions

Non-communicable diseases remain among the most pressing medical, social, demographic, and economic challenges in Ukraine nowadays.

1. The most effective means of assessing regional disparities in NCDs arising from environmental, socioeconomic, demographic, behavioural, and wartime determinants is a combined methodological approach incorporating statistical methods (standardised rates and health indices), epidemiological tools (the WHO

Table 4

Structure and Components of the Health and Social Burden of the Leading Chronic NCD Groups in Odesa Region

ICD-10 disease class	Share of regional DALYs (%)	Principal contributors to the YLL component (premature mortality)	Principal contributors to the YLD component (disability / quality of life)	Projected medium-term trajectory
Cardiovascular diseases (ischaemic heart disease, stroke, and hypertension)	62.4%	High rate of sudden coronary death; delays in emergency thrombolytic treatment because of air-raid alerts and disrupted logistics	Chronic wartime stress; hyperactivation of the cortisol system; poor adherence to daily antihypertensive therapy	Rapid increase and a shift towards younger patients (35–50 years)
Malignant neoplasms (lung, gastrointestinal, and breast cancers)	16.8%	Late diagnosis (stages III-IV); limited access to advanced radiotherapy and chemotherapy during power outages	Environmental carcinogenic exposure due to wartime fires at oil depots; prolonged pain; psychosocial isolation of patients	Moderate increase, with a pronounced rise in the proportion of advanced untreated clinical cases
Diabetes mellitus (type 2) and endocrine disorders	7.2%	Acute diabetic coma; decompensation associated with severe comorbid infections or stress-induced myocardial infarction	Forced dietary changes (excess preservatives, salt, and simple carbohydrates); limited access to regular glycated haemoglobin monitoring	Steady increase driven by stress and changing behavioural patterns

Sources: [25; 26].

STEPS instrument), geospatial methods (GIS analysis), and composite measures of disease burden (DALYs).

2. The empirical analysis confirmed that non-communicable diseases constitute the principal health burden in the population of Odesa Region. Cardiovascular diseases, malignant neoplasms, and diabetes mellitus predominate within the NCD profile, with a sustained increase in both prevalence and mortality across the major NCD groups since 2022. Standardised indicators show that the region is among those with a high NCD burden. Application of the Global Burden of Disease methodology established that cardiovascular diseases account for more than 62% of the health and social burden. A pronounced spatial and geographical asymmetry was identified: in the city of Odesa and coastal districts, wartime stress, power outages, and behavioural risk factors predominate, whereas rural districts, including Izmail, Bolhrad, and Podilsk, are primarily affected by workforce shortages, logistical barriers, and delayed diagnosis, which results in a 'hidden accumulation' of advanced non-treated chronic diseases.

3. Comprehensive reform of primary care based on person-centredness, digitalised screening, and motivation to preserve health is an effective means of moving towards an optimistic scenario of reducing the NCD burden. Such reform should include standardised prevention and control measures that are differentially adapted to the specific characteristics of individual territories.

The article presents prospective approaches to predicting the health and social consequences of the burden of chronic non-communicable diseases under a continuous wartime emergency.

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Purpose is to provide a scientific rationale for, and develop innovative approaches to, preventing the development and spread of chronic non-communicable diseases under a wartime emergency.

Materials and methods. The informational and empirical basis of the study comprised Ukrainian legislation and regulatory instruments; national and international scientific publications from 2015 to 2024, regarding the effects of martial law since 2022; official materials from the State Statistics Service of Ukraine, the Ministry of Health of Ukraine, and the Public Health Centre of the Ministry of Health of Ukraine; analytical data from healthcare institutions in Odesa Region.

Results. Standardised indicators show that the region bears a high burden of non-communicable diseases. Following to the Global Burden of Disease methodology, it was established that cardiovascular disease accounts for more than 62% of the health and social burden, with a trend towards onset at younger ages.

Conclusions. The most effective means of assessing regional disparities in NCDs arising from environmental, socioeconomic, demographic, behavioural, and wartime determinants is a combined methodological approach incorporating statistical methods (standardised rates and health indices), epidemiological tools (the WHO STEPS instrument), geospatial methods (GIS analysis), and composite measures of disease burden (DALYs).

Prospects for further research should include a comprehensive regional STEPS 2027 study and a more detailed investigation of the cumulative effects of environmental and wartime factors on different age and social groups within territorial communities.

Key words: non-communicable diseases, risk factors, regional disparities, martial law/wartime, public health, prevention.

У статті подані перспективні напрями прогнозування медико-соціальних наслідків тягаря хронічних неінфекційних захворювань в умовах тривалого впливу надзвичайного стану воєнного характеру.

Мета – наукове обґрунтування та розробка інноваційних підходів до попередження розвитку та поширення хронічних неінфекційних захворювань в умовах надзвичайного стану воєнного характеру.

Матеріали та методи. Для досягнення поставленої мети та реалізації визначених завдань у роботі використано комплекс загальнонаукових і спеціальних методів дослідження: теоретичного аналізу; порівняльного та контент-аналізу; стратегічного макроаналізу (PESTEL); емпіричного та статистичного аналізу; соціально-економічного та медико-географічного аналізу; метод оцінки тягаря хвороб (DALY); структурно-логічного моделювання та експертно-аналітичного прогнозування.

Інформаційну та емпіричну базу дослідження становили законодавчі та нормативно-правові акти України, наукові публікації вітчизняного та міжнародного рівнів за 2015–2024 рр. (з урахуванням впливу воєнного стану з 2022 р.), офіційні матеріали Державної служби статистики України, Міністерства охорони здоров'я України, Центру громадського здоров'я МОЗ України, а також статистичні звіти та аналітичні дані медичних закладів Одеської області.

Результати. Проведений емпіричний аналіз (на прикладі Одеської області) підтвердив, що неінфекційні захворювання (НІЗ) становлять основний тягар здоров'я населення. У структурі НІЗ домінують хвороби системи кровообігу, злоякісні новоутворення та цукровий діабет зі стійким зростанням поширеності та смертності від основних груп захворювань після 2022 року. Стандартизовані показники свідчать, що регіон належить до областей з високим тягарем НІЗ. На основі методології Global Burden of Disease встановлено, що понад 62% медико-соціального тягаря припадає на серцево-судинні захворювання з тенденцією до «омолодження» патології. Одеська область є стратегічним прифронтовим хабом, зазнає постійних ворожих атак з руйнуванням цивільної і критичної інфраструктури, прийняла найбільшу кількість внутрішньо переміщених осіб (ВПО). Це створило значне додаткове навантаження на медичні заклади, подовжило черги на планову діагностику та скринінг НІЗ, а гострий дефіцит медичних кадрів призупинив планову профілактику серед населення. У віддалених районах Одещини (особливо на півдні та на півночі регіону) криза НІЗ поглиблюється через логістичні, економічні бар'єри та дефіцит кадрового забезпечення у системі охорони здоров'я, що веде до виявлення у пацієнтів онкології та діабету на пізніх, невиліковних стадіях. Водночас у місті пацієнти мають кращий фізичний доступ до медичної інфраструктури та спроможність потрапити у «золоте вікно» госпіталізації у разі невідкладних гострих станів, ніж у приміських зонах. Постійні обстріли та блекаути спричиняють хронічний дистрес, що «омолоджує» серцево-судинні катастрофи у здоров'ї та змушує населення переходити на деякі нездорові копінг-стратегії (вживання алкоголю, тютюну, нездорової їжі).

У контексті Одеського регіону оцінювання медико-соціального тягаря хронічних неінфекційних захворювань ускладнюється вираженою внутрішньообласною диференціацією, наявністю стійких диспропорцій між високо урбанізованою причорноморською агломерацією та депресивними аграрними районами півдня області. Це призводить до штучного спотворення «сирої» статистики та вимагає застосування лонгітюдних аналітичних методів спостереження. В регіоні сформувався ефект «відтермінованої медичної катастрофи»: через свідоме відкладання населенням планових візитів до лікарів та скринінгових обстежень. У найближчі роки прогнозується стрімке зростання госпіталізацій із запущеними стадіями онкологічних захворювань та критичних серцево-судинних катастроф (інфаркти міокарда, інсульти).

Висновки. Для оцінювання регіональних розбіжностей НІЗ, які формуються під впливом екологічних, соціально-економічних, демографічних, поведінкових та воєнних детермінант, найбільш ефективними є комбіновані методологічні підходи,

що включають статистичні методи (стандартизовані коефіцієнти, індекси здоров'я), епідеміологічні інструменти (STEPS ВООЗ), геопросторові методи (ГІС-аналіз) та комплексні індекси тягаря хвороб (DALYs).

Перспективи подальших досліджень пов'язані з проведенням повноцінного регіонального STEPS-2027 дослідження, а також більш ґрунтовним вивченням кумулятивного впливу екологічних і воєнних факторів на різні вікові та соціальні групи територіальних громад.

Ключові слова: неінфекційні захворювання, фактори ризику, регіональні розбіжності, воєнний стан, громадське здоров'я, профілактика.

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