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RESEARCH ARTICLE

Work disability due to cardiovascular diseases in newly diagnosed patients in Ukraine during the first year of the war (2022) compared to prior nine years (2013-2021): a 10-year retrospective study

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Aim: Cardiovascular diseases (CVDs) are a significant problem in Ukraine, accounting for over 60% of all deaths in the country. It is expected that the ongoing Russian aggression will augment this problem. The study aimed to analyze the trends of work disability due to CVDs in newly-diagnosed patients between 2013 and 2022.

Methods: This retrospective study included data obtained from the official document "Report on the Causes of Disability and Indications for Medical, Professional, and Social Rehabilitation" commissioned by the Ministry of Health of Ukraine. The data on disability due to CVD were obtained from 24 regions and the city of Kyiv for 2013-2022.

Results: Between 2013 and 2022, the average incidence of work disability due to CVD per 10000 working-age individuals was 9.86. Among these disabilities, cerebrovascular diseases accounted for the highest proportion, followed by ischemic heart disease (IHD). The incidence of CVD-related primary disabilities displayed a variable upward trend over the observed period, with cerebrovascular diseases and hypertensive diseases showing clear upward trends. Compared to 2021, in the year 2022 (corresponding to the beginning of the Russian aggression) an 20% increase has been observed for CVDs, while for cerebrovascular diseases, IHD, hypertensive disease, acute rheumatic fever, and chronic rheumatic heart disease the increase was 20%, 18%, 22%, and 14%, respectively. The CVD-related work disability varied substantially in different regions of Ukraine.

Conclusions: During the first year of the war in Ukraine (the year 2022) there was an increase in primary disability due to CVD compared to the period between 2013 and 2021. This may be associated with war-related psychosocial factors and global impact on CVD. The regions in southwestern parts of Ukraine proved to be especially prone to this increase requiring special attention.

Keywords: Ukraine; war; stress; work disability; cardiovascular diseases.

Introduction

Cardiovascular diseases (CVD) account for 37% of all deaths in the European Union [1] while in Ukraine, this indicator exceeds 60% [2]. That makes CVDs a huge medical, social, and economic problem for Ukraine. Every day in Ukraine more than 1000 people die from CVD, and 100 of them belong to the working-age population [2]. The ongoing Russian aggression in Ukraine poses a serious threat, that can exacerbate the problem and increase the already high number of CVD deaths.

Stressful situations as a risk factor for CVD are still an under-investigated area [3]. Although the association between acute stress and CVDs has been well established [4, 5], the long-term effects of chronic stress on physical health, particularly on CVDs, have only lately been recognized [6, 7]. The explanation of those findings is likely to be complex and multifactorial. Excessive stimulation of the sympathetic nervous system, excessive secretion of glucocorticoid hormones, and a decrease in the level of the estrogen hormone increase the risk for CVD [8]. Psychosocial factors such as unhealthy lifestyle (alcohol abuse, smoking, low physical activity, and unbalanced diet) can additionally induce pathophysiological changes in the cardiovascular system and increase the risk of ischemic heart disease (IHD), causing ventricular arrhythmia and sudden coronary death [9].

Persons affected by war are constantly under emotional tension and stress [10], which puts them at a greater risk for the development of CVDs. It has been shown that the frequency of CVDs, including severe and disabling ones, increases during armed conflicts [11]. In the context of the contemporary nature of armed conflicts, it can be expected that CVD mortality will overshadow the one due to infectious disease, malnutrition, and one directly related to military violence [12]. The consequences of Russian aggression on Ukraine, with the constant threat of missile attacks, martial law conditions, and a wide range of hostilities, will likely have enormous health consequences, especially for those in a vulnerable position in the labor market.

This study aimed to analyze data on work disability due to CVDs in newly-diagnosed patients in Ukraine during the first year of the war (2022) and to compare these data with indicators of disability during the prior nine years (2013-2021).

Participants and methods

Study design

This was a retrospective study.

Collected data

The analyzed data were obtained from the "Report on the Causes of Disability and Indications for Medical, Professional, and Social Rehabilitation" (Form No. 14, Supplementary material) commissioned by the Ministry of Health of Ukraine. The form for that report was developed in 2007 by the Ministry for collecting data on patients with newly diagnosed work

disabilities, i.e., people who were categorized as disabled for the first time in their lives. The form is filled out by responsible persons from the regional centers (bureaus) of the Medical and Social Expert Commission (MSEC) and submitted to the Ministry of Health. The sources of information for filling out form No. 14 are MSEC records, logbooks, and acts. The analysis comprises all the data collected in Ukraine during the observed period except for occupied territories.

The diagnostic procedures for the cardiovascular diseases included in the analysis were performed according to the standard diagnostic protocols. They included laboratory examinations (general blood tests, lipogram, blood glucose, etc.) and instrumental examinations (e.g., ECG, Holter ECG monitoring, Doppler echocardiography, coronary angiography, treadmill test, BP monitoring, etc.). The goal of the examination was the initial diagnostics and diagnostics of functional limitation that leads to disability.

The Ministry of Health of Ukraine is categorizing work disability in three stages depending on functional limitations: a) patients with mild persistent functional impairment that do not require assistance or supervision, b) patients with moderate persistent functional impairment that may require assistance or supervision from time to time, and c) patients with severe persistent functional impairment that requires constant assistance or supervision. The working-age population comprises all persons between 15 and 65 years of age [13].

The data were analyzed for the period from 2013 to 2022. Russia's full-scale invasion of Ukraine began on 24 February 2022, so the data collected in 2022 are considered the data obtained during wartime.

Data were collected and presented according to the administrative division of Ukraine, which is based on 27 administrative divisions organized into three levels: 24 regions (ukr. oblasts), 2 cities with special status (Kyiv and Sevastopol), and one Autonomous Republic of Crimea [14]. However, due to the annexation of Crimea and Russian aggression, data for 2014-2022 from Crimea and Sevastopol as well as parts of Donetsk, Luhansk could not be obtained. Also, for the year 2022 data are missing for the partially occupied regions of Kherson and Zaporizhzhia.

The diseases included in the study were classified according to the latest version of the International Classification of Diseases (ICD-11), which came into effect on 1 January 2022 [15].

The study was conducted according to bioethics principles outlined in the Declaration of Helsinki, "Ethical Principles of Medical Research Involving Human Subjects", the "Universal Declaration of Bioethics and Human Rights (UNESCO)" and approved by the Bioethics Commission of Ukrainian State Research Institute of Medical and Social Problems of Disability, Ministry of Health of Ukraine.

Data analysis

The data collected were analyzed as a part of the regular annual report of the Ukrainian State Research Institute of Medical and Social Problems of Disability [16]. We used descriptive statistics while data processing, trendline generation, and R^2 calculations were carried out using MS Excel for Windows (Microsoft Inc., Redmond, WA, USA).

Results

Work disability due to cardiovascular diseases in Ukraine during the war in 2022 and 9 years before the war

During the ten years, from 2013-2022 the average number of disabled patients due to CVD per 10000 working-age persons was 9.86. The main causes of disability among those related to CVDs were cerebrovascular diseases (average values per 10000 in the working-age population were 4.14) followed by IHD (3.6 per 10000). Hypertensive disease, acute rheumatic and chronic rheumatic heart disease accounted for 0.43 and 0.16 per 10000 persons in the working-age population (**Table 1**).

The incidence of CVDs as a cause of primary disability between 2013 – 2022 shows a relatively variable upward trend (R^2=0.0755) (**Figure 1**, panel A). Among the subgroups of CVDs, an upward trend was observed for cerebrovascular diseases (R^2=0.7496) and hypertensive diseases (R^2=0.2523). A slight downward trend was observed for IHD (R^2=0.163) and acute rheumatic disease and chronic rheumatic heart disease (R^2=0.7273) (**Figure 2**, panel B).

The variability of the trend pattern for CVDs was a result of two peaks (2018 – 2019 and 2022) and troughs (2015 and 2020). Similar variability was observed for all analyzed subgroups, except for acute rheumatic disease and chronic rheumatic heart disease, regardless of trend direction.

In 2015 a slight decrease in primary disability due to CVDs in the employable population was observed. However, after 1015 the trend changed to an upward direction with just one downward drop in 2020 (**Table 1**; **Figure 1**, panel A). Compared with 2021, in the year 2022, there was a 20% increase in the number of persons diagnosed for the first time as persons with disabilities due to the CVDs (from 29,103 in 2021 to 34,790 in 2022).

In the structure of disability in the working-age population by subgroups of CVDs, the relative contribution of cerebrovascular diseases was constantly the highest one. Between 2013 and 2017 the trend was almost horizontal, followed by a steep upward trend with only one drop in 2020. The increase between 2021 and 2022 was 18%.

The relative contribution of IHD to the structure of primary disability of the working age followed the same pattern as one observed for cerebrovascular diseases. A slight downward trend was registered between 2019 and 2020, followed by an increase of 22% between 2021 and 2022. During the period from 2013 and 2021, the trendline for hypertensive disease showed a slight upward trend. An increase of 19% in disability rates related

to hypertensive disease was observed between 2021 and 2022. Acute rheumatic fever and chronic rheumatic heart diseases showed a weak downward trend with constant values between 0.1-0.2 new cases per 10000 working-age population with a 14% increase from 2021 to 2022 (**Table 1**; **Figure 1**, panel B).

Table 1. Work disability in Ukraine due to cardiovascular diseases in newly-diagnosed patients from 2013 to 2022

Year	All cardiovascular diseases (working age population/ 10000)	Cerebrovascular diseases (working age population/10000)	Ischemic heart disease (working age population/10000)	Hypertensive diseases (working age population/10000)	Acute rheumatic fever & chronic rheumatic heart disease (working age population/10000)
2013	9.9	3.9	3.8	0.5	0.2
2014	9.9	4	3.7	0.4	0.2
2015	9.4	3.8	3.6	0.3	0.2
2016	9.6	4	3.6	0.3	0.2
2017	9.8	4	3.6	0.3	0.2
2018	10.3	4.3	3.7	0.5	0.2
2019	10.2	4.3	3.7	0.5	0.1
2020	9.2	4.1	3.2	0.4	0.1
2021	9.8	4.5	3.3	0.5	0,1
2022	10.49	4.6	3.8	0.6	0.1

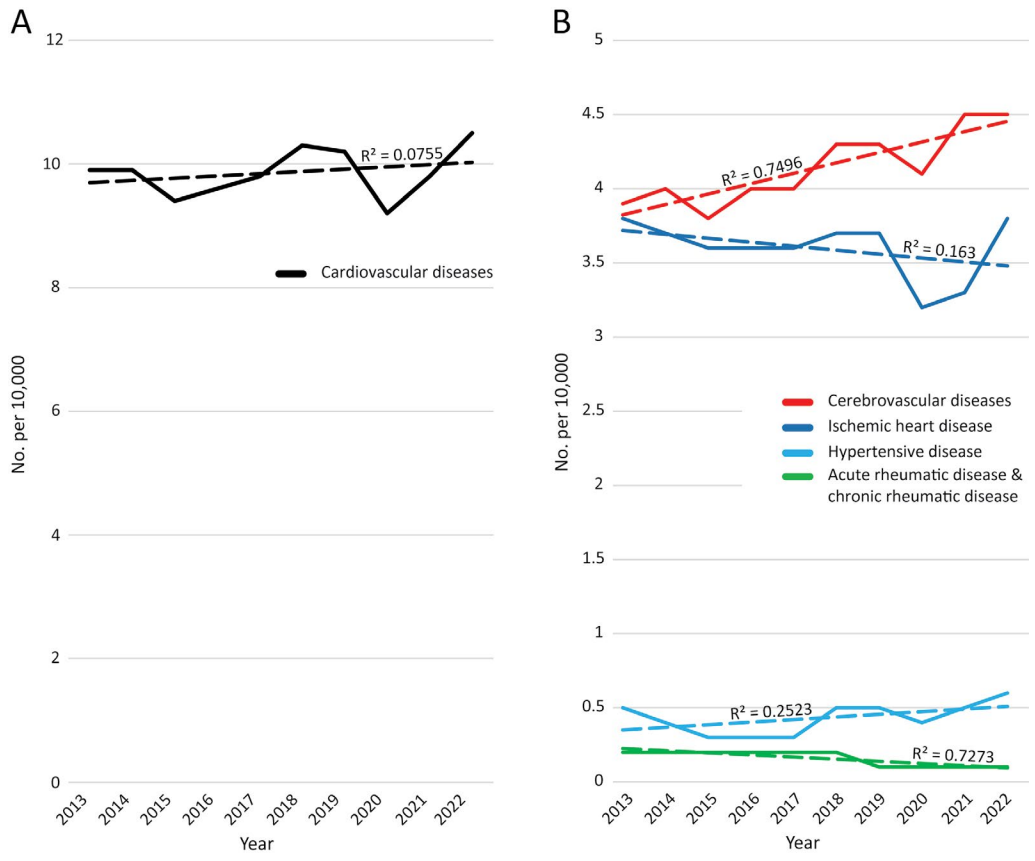

Figure 1. The trends of work disability due to A) cardiovascular disease and B) cerebrovascular diseases, ischemic heart disease, hypertensive disease, acute rheumatic and chronic rheumatic disease in the newly-diagnosed working-age population from 2013 to 2022. Legend: dashed line=trendline with R^2.

Work disability due to the CVDs in administrative regions of Ukraine

The distribution of newly diagnosed patients with work disability among different administrative regions of Ukraine shows a large variance. The regions with the highest rates of newly-diagnosed CVDs in the working-age population per 10000 were Odesa, Chernivtsi, Lviv, Poltave, and Zakarpattia (86%, 55%, 46%, 43%, and 41% increase, respectively, compared to the country average for 2022). The regions with an increase between 30% – 40% compared to the country average were Vinnytsia and Zaporizhyhia, while the observed increase in Zhytomyr, Mykolayivska, and Ivano-Frankivsk regions was below 20% compared to the country average (**Table 2**, **Figure 2**). Similar regional patterns were also observed for the year 2021 (data not shown).

Table 2. Work disability due to the CVDs in newly-diagnosed patients in administrative regions of Ukraine in 2022

Regions in Ukraine	Cardiovascular diseases (No./10000)	Cerebrovascular disease (No./10000)	Ischemic heart disease (No./10000)	Hypertensive disease (No./10000)	Acute rheumatic disease & chronic rheumatic disease (No./10000)
Vinnytsia	1897/15.4*	1020/8.3*	473/3.9*	96/0.8*	11/0.1
Volyn'	732/9.3	278/3.5	283/3.6	25/0.3	9/0.1
Dnipro	2269/9	1074/4.2	697/2.8	47/0.2	16/0.1
Donetsk†	625/4	345/2.2	159 /1	3/0.02	1/0.01
Zhytomyr	1262/13.3*	712/7.5*	264/2.8	82/0.9*	18/0.2*
Zakarpattia	1532/16.1*	515/5.4	662/6.9*	40/0.4	11/0.1
Zaporizhzhia	1959/14.4*	945/7*	575 /4.2*	133/1*	10/0.1
Ivano-Frankivsk	1317/12.2*	502/4.7	455/4.2*	15/0.1	14/0.1
Kyiv	1472/10.4	797/5.6*	406/2.9	8/0.1	8/0.1
Kirovohrad	615/8.3	293/4	174/2.4	4/0.1	3/0.04
Luhansk†	14/0.3	8/0.1	2/0.04	/	/
Lviv	3287/16.6*	1452/7.3*	1277/6.4*	42/0.2	26/0.1
Mykolayivska	1,134/12.7*	422/4.7	466/5.2*	11/0.1	7/0.1
Odesa	3,790/20.2*	1670/8.9*	1094/5.8*	534/2.8*	38/0.2*
Poltava	1822/16.3*	1178/10.5*	276/2.5	67/0.6*	10/0.1
Rivne	769/8.9	335/3.9	290/3.3	11/0.1	7/0.1
Sumy	828/9.5	419/4.8	236/2.7	19/0.2	7/0.1
Ternopil	932/11.2	393/4.7	334/4*	26/0.3	5/0.1
Kharkiv	2,068/9.6	1,169/5.4	686/3.2	1/0.005	4/0.02
Kherson	247/3	121/1.5	79/1	3/0	5/0.1
Khmelnytska	874/8.8	338/3.4	270/2.7	28/0.3	2/0.02
Cherkassy	870/9	254/3.6	179/1.8	72/0.7*	6/0.1
Chernivtsi	1253/17.7*	528/7.5*	465/6.6*	9/0.1	15/0.2*
Chernihivska	874/10.9	448/5.6*	272 /3.4	5/0.1	16/0.2*
Kyiv (city)	2348/10	1066/4.6	1006/4.3*	119/0.5	15/0.1
Sevastopol†	/	/	/	/	/
Crimea†	/	/	/	/	/
Ukraine, 2022	34790/11.4	16282 /5.4	11080/3.6	1400/0.5	264/0.1
Ukraine, 2021	29103/9.5	13797/4.5	9069/3	1175/0.4	232/0.1

* Regions with higher than average rates of primary disability due to cardiovascular diseases.
† Occupied or partially occupied regions at the time of data collection.

The most common subgroup of CVD contributing to the disability included cerebrovascular diseases. The regional distribution of cardiovascular disease followed the patterns observed for all the CVDs. The disability rates due to IHD in 2022 have been the highest in the Zakarpattia Oblast (6.9 per 10000), Chernivtsi (6.6 per 10000), and Lviv (6.4 per 10000) regions, compared to the average for Ukraine (3.6 per 10000). The highest rates of primary disability per 10000 population due to hypertension in 2022 are registered in the Odesa region (2.8 per 10000). Stable low rates of primary disability due to acute rheumatic fever and chronic rheumatic heart disease are noted among the employable population in all regions.

Figure 2. Administrative regions in Ukraine with a relative increase (darker beige color) and decrease (light beige color) of working-age patients with newly-diagnosed work disability due to cardiovascular diseases in 2022 (compared to the average value for the whole of Ukraine). Asterisks indicate occupied or partially occupied regions of Ukraine where accurate data could not be obtained.

Discussion

Noncommunicable diseases (NCDs), such as CVDs, cancer, diabetes, and chronic respiratory illness, place a heavy social and economic burden on society at large, especially in low- and middle-income nations [17]. CVDs, especially the combination of IHD, diabetes, and hypertension, are among the most critical medical and social problems in Ukraine and the world [2, 18]. Here we showed that, as in recent decades, in 2022, the CVDs continued to play a leading role in disability in Ukraine. Furthermore, in the presence of a military conflict, the specific weight of CVDs among people of working age is increasing. Massive psychological informational influence, destruction of the population's life support systems,

paralysis of the economy, anxiety, and/or depression contribute to the progression of CVDs and the development of complications.

This is especially important for cerebrovascular diseases, which showed a steep upward trend during the whole observed period, with an 18% increase in 2022 during the Russian aggression compared to 2021. According to the systematic review by Murray et al., stroke is the diagnosis most commonly associated with disability among the global CVD cohort, with a prevalence of functional disability among stroke patients almost as high as functional impairment for late-stage cancer patients [18].

The observed increase between 2021 and the first year of the war (2022) are in line with previously published articles. In a systematic review conducted by researchers from Imperial College London and the London School of Hygiene and Tropical Medicine, it was found that military conflicts are directly linked to an increased risk of IHD, stroke, diabetes, hypertension, and elevated cholesterol, as well as increased cigarette and alcohol consumption [11]. However, the studies included in the systematic review did not provide sufficient detail to understand the causal relationship between armed conflict and CVD [11].

The simple explanation could be that war increases the likelihood of adopting behaviors such as smoking, alcohol, an inactive lifestyle, and failure to take medication [11]. Besides being a leading risk factor in the global disease burden [19, 20], those risk factors have been confirmed as an important contributor to increased CVD morbidity in armed conflicts [21-23]. However, the explanation for the observed link between war and CVDs is likely to be complex and multifactorial, possibly driven by a stress response besides changes in health behaviors at the individual level and disruptions to healthcare provision at the population level.

The main mechanisms through which acute psychosocial stress could increase the risk of CVD morbidity and mortality are caused by increased blood pressure and heart rate due to the activation of the sympathetic and decreased activity of the parasympathetic nervous system, which leads to an increase in the demand of the myocardium for oxygen; transient endothelial dysfunction; increased blood clotting; hyperglycemia and hyperlipidemia [24]. All this leads to further potentiation of atherosclerotic vascular damage. The risk of developing diabetes mellitus (DM) type 2, and IHD [24]. In addition, the influence of chronic (daily) stressors is accompanied by increased production of adrenocorticotropic hormone and cortisol that can further influence the homeostasis of the cardiovascular system [25, 26]. Recently, the term “stress-induced arterial hypertension” has become increasingly common, meaning a transient increase in blood pressure due to the influence of psychosocial factors [27, 28].

Besides psychosocial distress, anxiety, and depression are also recognized as independent risk factors for CVD [3, 29]. According to meta-analyses of studies, anxiety during long-term observation is associated with a 52% increase in the risk of CVD and a 26-41% increase for IHD [29, 30]. Furthermore, anxiety can increase the risk of myocardial infarction and other acute cardiovascular complications in patients with stable CAD by 74-109% [31].

The relationship between depression and the risk of myocardial infarction, angina pectoris, and cardiovascular death is well known. Meta-analyses of prospective cohort studies

show that in patients without IHD, depression increases the frequency of IHD by 1.3-1.5 times, regardless of somatic risk factors for CVDs. It is believed that the risk of CAD is higher, the more severe the symptoms of depression [32].

Based on the results of this study, the regions of Ukraine are characterized by a significant regional variation and a stable territorial profile of morbidity from CVDs, with the concentration of its higher levels in the demographically older regions. Besides demographic characteristics, the observed increase in CVDs-related disability in certain regions could be the result of war. Notably, most areas that show growth above the national average are in the western part of Ukraine. It is known that the flow of internally displaced persons affected these regions the most. Consequently, a relatively significant number of refugees underwent initial examination for work-related disability.

This study had several limitations. First, our results were observational, so it is impossible to establish a causal link between the first year of war and observed changes in the incidence of CVDs. This problem is the common one for all the studies on this topic, as clearly elaborated in the systematic review dealing with the topic of armed conflict and CVD [11]. However, numerous conceptual and empirical arguments support the observed link. Second, the proper trend analysis requires longer observational periods, and third, our database is missing data from occupied or partially occupied regions of Ukraine. In conclusion, our data on primary disability due to CVDs in 2022 and the prior 9 years indicates an increase in CVDs-related work disability in the employable population during the war. The observed increase threatens permanently losing the working capacity of the country's population, which determines the priority of further improvement of primary, specialized cardiac and medical, and social care in wartime conditions. The current situation following Russian aggression on Ukraine requires a comprehensive and regionally differentiated approach by the Ukrainian government and agencies in reducing morbidity and disability due to CVDs. Postconflict reconstruction efforts should aim to deliver low-resource preventative interventions through primary care to prevent threatening excess CVD-related morbidity and mortality.

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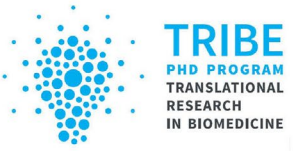

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Ethical approval: The study has been approved by the Ethical Committee of the Dnipro State Medical University.

Availability of data and materials: Raw data from the study can be requested from the corresponding author.

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Authorship declaration: Alla Kyrychenko conceptualized the study and edited the text of the article. Inna Khanyukova participated in data collection, writing of the article, data analysis, and interpretation. Olena Moroz participated in data interpretation. Nataliia Sanina participated in the conceptualization of the study and in reviewing and editing the article text. All authors read and approved the final manuscript.

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