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Trends in Diabetes-Attributable Ischaemic Heart Disease Burden in Kazakhstan: A Global Burden of Disease Analysis

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Abstract

Non-communicable diseases, particularly cardiovascular diseases and diabetes mellitus, represent leading causes of mortality worldwide. Elevated fasting plasma glucose (FPG) is a major metabolic risk factor for ischaemic heart disease (IHD). However, comprehensive analyses of diabetes-attributable IHD burden in Kazakhstan remain limited.

This study aimed to assess the burden of IHD attributable to elevated FPG in Kazakhstan and to analyse temporal trends and sex-specific differences from 1990 to 2023.

Methods. Data were obtained from the Global Burden of Disease (GBD) 2023 database. High FPG was defined according to the GBD framework as fasting plasma glucose exceeding the theoretical minimum risk exposure level of 4.9–5.4 mmol/L. Absolute numbers, crude rates, and age-standardized rates of deaths, DALYs, YLLs, and YLDs were examined. Temporal trends were assessed across three periods (1990–2000, 2000–2010, 2010–2023), and percentage changes were calculated to evaluate long-term patterns and sex differences.

Results. In 2023, diabetes-attributable IHD accounted for 3,307 deaths (95% UI: 2,649–4,160) and 65,426 DALYs (52,668–83,043) in Kazakhstan. Premature mortality dominated the burden, with YLLs contributing 91.3% of total DALYs. Although absolute deaths were higher among females (1,979 vs 1,328), age-standardized DALY rates were consistently higher in males across all years, with the male-to-female rate ratio exceeding 1.4 throughout the study period. Age-standardized DALY rates demonstrated a non-linear trend: rates increased by 38.0% between 1990 and 2000, followed by a decline of 29.3% during 2000–2010, and a further reduction of 40.2% during 2010–2023. Over the full study period, age-standardized DALY rates fell by 41.7% overall (males −48.8%; females −37.9%).

Conclusions. Despite a substantial decline in age-standardized rates, IHD attributable to elevated FPG remains a significant public health burden in Kazakhstan, driven predominantly by premature mortality and disproportionately affecting males. The findings highlight the importance of sex-specific approaches and underscore the need for strengthened national strategies focusing on diabetes prevention, early detection, and effective management to reduce cardiovascular complications.

Keywords: ischemic heart disease, diabetes mellitus, blood glucose, global burden of disease, cardiovascular diseases, risk factors, premature mortality, Kazakhstan.

1. Introduction

Non-communicable diseases (NCDs) are the primary contributors to mortality and morbidity globally, with cardiovascular diseases (CVDs) and diabetes mellitus being the most significant factors [1]. The correlation between diabetes and ischemic heart disease (IHD) is extensively documented. Chronic hyperglycemia induces endothelial dysfunction, accelerates atherosclerosis, and hinders myocardial regeneration. These effects result in a two- to fourfold increased risk of ischemic heart disease (IHD) in diabetic patients compared to non-diabetic persons with carbohydrate metabolism disorders [2,3].

Kazakhstan is a Central Asian country with a population of about 20 million people and an upper-middle-income level [4]. Since becoming independent, the country has gone through an epidemiological shift marked by a surge in metabolic risk factors such as being overweight, not exercising enough, and diabetes mellitus, especially type 2 diabetes. National statistical data indicate that the incidence of diabetes in adults is around 7–10%, with a considerable number of undiagnosed cases [5-7]. Cardiovascular disorders are responsible for about 40% of all fatalities in the country, with IHD as the primary cause of death [8].

Despite the significant burden of diabetes and IHD, comprehensive studies in Kazakhstan assessing the influence of diabetes, particularly elevated fasting plasma glucose, on the IHD burden over time remain limited. This study was conducted to address the identified gap. The aim of the study is to evaluate the burden of ischemic heart disease due to increased fasting plasma glucose levels in the Kazakhstani population. High fasting plasma glucose (FPG) was defined as levels above the theoretical minimal risk exposure threshold of 5.4 mmol/L, which is below the diagnostic criterion for diabetes (≥7.0 mmol/L), according to Global Burden of Disease (GBD) data [9]. The results may enhance national policies for the prevention and management of cardiovascular and metabolic disorders.

2. Materials and methods

Basic descriptive statistical methods were used to analyze the data. Absolute numbers, crude rates, and age-standardized rates were examined for Kazakhstan from 1990 to 2023, with results presented separately for men and women. The database and toolkit are publicly accessible and available at no cost.

Measures. We analyzed temporal trends in life expectancy, primary causes of mortality, principal contributors to disability-adjusted life years (DALYs), years of life lost (YLLs), years lived with disability (YLDs) as essential indicators of population health trends. Conceptual definitions and data of these concepts are accessible [10,11].

Statistical Analyses. Basic descriptive statistical methods were used to analyse the data. Absolute numbers, crude rates, and age-standardized rates were examined for Kazakhstan from 1990 to 2023, with results presented separately for men and women. Trends over time were assessed using selected years, and percentage changes in key indicators were calculated to evaluate overall patterns and sex differences.

3. Results

In 2023, diabetes-attributable IHD resulted in 3,307 deaths (95% UI: 2,649–4,160), 65,426 DALYs (52,668–83,043), 59,730 YLLs (47,036–74,081), and 5,696 YLDs (3,757–8,361) in Kazakhstan (Table 1). YLLs substantially dominated the DALY composition (59,730 out of 65,426), indicating that premature mortality rather than non-fatal disability is the primary driver of burden. Deaths were more frequent among females (1,979; 1,560–2,574) than males (1,328; 1,032–1,671). In absolute terms, DALYs were marginally higher in females (33,375) than males (32,051), though the difference was negligible and DALYs were nearly equally split between the sexes.

Table 1 - Absolute Burden of IHD Attributable to Diabetes, Kazakhstan, 2023. Number (95% UI)

Measure	Both sexes	Male	Female
Deaths	3,307 (2,649–4,160)	1,328 (1,032–1,671)	1,979 (1,560–2,574)
DALYs	65,426 (52,668–83,043)	32,051 (24,887–40,384)	33,375 (26,553–43,054)
YLLs	59,730 (47,036–74,081)	29,367 (22,521–36,569)	30,363 (24,088–39,519)
YLDs	5,696 (3,757–8,361)	2,684 (1,715–4,030)	3,012 (1,991–4,428)

DALYs = disability-adjusted life years; YLLs = years of life lost; YLDs = years lived with disability; UI = uncertainty interval. Risk factor = high fasting plasma glucose

The all-ages crude death rate was 16.2 per 100,000 (95% UI: 13.0–20.4), notably higher in females (18.9; 14.9–24.6) than males (13.3; 10.4–16.8), reflecting the older age structure of the female population. For DALYs, the all-ages rate was 320.7 per 100,000 (258.1–407.0) and was essentially equal between the sexes (males 322.1; females 319.3), as were YLLs and YLDs (Table 2).

Table 2 - All-Ages Rates of IHD Attributable to Diabetes, Kazakhstan, 2023. Rate per 100,000 (95% UI)

Measure	Both sexes	Male	Female
Deaths	16.2 (13.0–20.4)	13.3 (10.4–16.8)	18.9 (14.9–24.6)
DALYs	320.7 (258.1–407.0)	322.1 (250.1–405.9)	319.3 (254.0–411.9)
YLLs	292.8 (230.5–363.1)	295.2 (226.4–367.6)	290.5 (230.4–378.1)
YLDs	27.9 (18.4–41.0)	27.0 (17.2–40.5)	28.8 (19.1–42.4)

IHD = ischaemic heart disease; UI = uncertainty interval

The period-specific analysis of age-standardized DALY rates for diabetes-attributable IHD in Kazakhstan is presented in Table 3 (3a-3c). During 1990–2000, DALY rates increased markedly across all sex groups, by 38.0% in both sexes combined, 38.9% in males, and 33.6% in females. A substantial reversal occurred in the subsequent decade (2000–2010), with rates declining by 29.3% overall (males −29.1%; females −30.2%). The most pronounced and accelerated decline was observed in the 2010–2023 period, particularly among males (−48.0%), compared to females (−33.4%) and both sexes combined (−40.2%). Over the entire study period (1990–2023), age-standardized DALY rates fell by 41.7% overall, with males experiencing the greatest absolute reduction (−394.1 per 100,000) compared to females (−179.7 per 100,000).

Table 3 - The period-specific analysis of age-standardized DALY rates for diabetes-attributable IHD in Kazakhstan, 1990 – 2023

Table 3a - Age-Standardized DALY Rates — Both sexes

Period	Rate (start)	Rate (end)	Absolute Δ	% Change
1990-2000	602.3	831.3	229.0	38%
2000-2010	831.3	587.4	-243.9	-29.3%
2010-2023	587.4	351.0	-236.4	-40.2%
1990-2023 (total)	602.3	351.0	-251.3	-41.7%

Rates per 100,000, age-standardized

Table 3b - Age-Standardized DALY Rates — Male

Period	Rate (start)	Rate (end)	Absolute Δ	% Change
1990-2000	807.8	1,121.8	313.9	38.9%
2000-2010	1,121.8	795.4	-326.4	-29.1%
2010-2023	795.4	413.8	-381.6	-48%
1990-2023 (total)	807.8	413.8	-394.1	-48.8%

Rates per 100,000, age-standardized

Table 3c - Age-Standardized DALY Rates — Female

Period	Rate (start)	Rate (end)	Absolute Δ	% Change
1990-2000	474.5	633.9	159.4	33.6%
2000-2010	633.9	442.7	-191.2	-30.2%
2010-2023	442.7	294.8	-147.9	-33.4%
1990-2023 (total)	474.5	294.8	-179.7	-37.9%

Rates per 100,000, age-standardized

4. Discussion

This study provides a comprehensive assessment of the burden of IHD attributable to elevated (FPG) in Kazakhstan over the period 1990–2023. The findings demonstrate that diabetes-related IHD remains a significant public health issue [12]. The findings reveal that in 2023, diabetes-attributable IHD resulted in 3,307 deaths and 65,426 DALYs in Kazakhstan. Importantly, the burden is largely driven by premature mortality as the dominant component YLLs accounted for 59,730 of total DALYs. In absolute terms, female deaths (1,979) exceeded male deaths (1,328), which is primarily explained by the older age structure and higher life expectancy of the female population in Kazakhstan rather than a genuinely higher risk in women [13,14]. All-ages DALY rates were marginally higher in males (322.1 vs 319.3 per 100,000), consistent with the direction of the age-standardized estimates, though the absolute difference was negligible. These findings underscore the importance of using age-standardized indicators rather than crude counts when assessing sex-specific disease burden, particularly in ageing populations [15]. The higher burden in males is likely attributable to a greater prevalence of behavioural and metabolic risk factors, including smoking, unhealthy dietary patterns, physical inactivity, and lower engagement with preventive healthcare [16-18]. Additionally, men are more prone to developing cardiovascular complications at a younger age, which translates into a greater proportion of YLLs within total DALYs [19,20].

The marked increase in age-standardized DALY rates observed between 1990 and 2000, by 38.9% in males, 33.6% in females, and 38.0% overall is consistent with the documented deterioration of healthcare systems and worsening metabolic risk profiles during the period of socioeconomic transition in the early 1990s [21,22]. Compared to global attribution within that timeframe, Central Asia had a higher proportion of IHD DALYs attributable to high systolic blood pressure, high fasting plasma glucose, and high BMI [23]. The substantial decline in DALY rates during 2000–2010 years coincides directly with major national healthcare investments. State programs including the Reform and Development of Healthcare (2005–2010) and Development of Cardiac and Cardiac Surgery Assistance (2007–2009) helped reduce mortality from cardiovascular diseases from 535.5 per 100,000 people in 2005 to 200.26 in 2015 [24]. Mortality from cardiovascular disease declined substantially over the study period, particularly after 2010, which may be due to earlier diagnosis and timely treatment [25]. Notably, the decline was broadly similar across sexes during this phase, suggesting that systemic healthcare improvements benefited both groups relatively equally. The most pronounced decline occurred between 2010 and 2023, with males demonstrating a steeper reduction than females. This trend coincided with the implementation of a nationwide cardiovascular and diabetes screening program in Kazakhstan (2011–2015), which evaluated over 7.5 million adults and identified more than 600,000 instances of heart disease, potentially facilitating earlier detection and enhanced disease management [26]. Despite the overall decline, males consistently maintained higher age-standardized DALY rates than females throughout the period. The persistent sex disparity in DALY burden warrants continued attention.

Limitations. Several limitations should be acknowledged. GBD estimates are modelled outputs that depend on the quality of underlying data sources; vital registration coverage and cause-of-death attribution in Kazakhstan may be incomplete, particularly for earlier years. The GBD definition of high fasting plasma glucose encompasses individuals with impaired fasting glucose who do not meet diagnostic criteria for diabetes. Consequently, the burden estimates presented here should not be directly equated with diabetes-attributable burden in the clinical sense. Finally, as a descriptive study, causal inference between specific policy interventions and observed trends cannot be established; the temporal associations discussed require confirmation through analytical epidemiological studies.

5. Conclusions

IHD attributable to elevated FPG remains a significant contributor to premature mortality and disease burden in Kazakhstan. The observed non-linear trend marked by a peak in 2000, followed by a sustained

decline through 2023, reflects the pivotal role of healthcare system reforms. Future strategies should prioritize early diabetes screening, sex-specific cardiovascular risk management, and sustained investment in primary care to reduce the cardiovascular complications of hyperglycemia in Kazakhstan.

Conflict of Interest. The authors declare that they have no conflicts of interest related to this study.

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All authors have read and agreed to the final version of the manuscript and have signed the copyright transfer form.

AI Declaration. The authors confirm that no generative AI or AI-assisted technologies were utilized at any stage of the preparation, writing, or data analysis of this manuscript. The entire work is the result of original research conducted solely by the authors.

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Түйіндеме

Жұқпалы емес аурулар, әсіресе жүрек-қан тамырлары аурулары және қант диабеті, бүкіл әлемде өлім-жітімнің негізгі себептерінің бірі болып табылады. Аш қарынға плазмадағы глюкозаның (АШГ) жоғарылауы ишемиялық жүрек ауруының (ЖИА) негізгі метаболикалық қауіп факторы болып табылады. Дегенмен, Қазақстанда қант диабетімен байланысты ЖИА ауыртпалығының кешенді талдауы шектеулі болып қала береді.

Зерттеудің мақсаты: Қазақстанда ЖИА жоғары болуына байланысты ЖИА ауыртпалығын бағалау және 1990 жылдан 2023 жылға дейінгі уақыттық үрдістер мен жыныстық ерекшеліктерді талдау.

Әдістері. Деректер «Аурулардың жаһандық жүктемесі» (ЖБА) 2023 жылғы дерекқорынан алынды. ЖБА шеңберінде теориялық ең төменгі тәуекел экспозиция деңгейінен (4,9–5,4 ммоль/л) жоғары АШГ деңгейі ретінде анықталды. Өлімдердің, DALY, YLL және YLD көрсеткіштерінің абсолютті сандары, жалпы және жасқа стандартталған коэффициенттері зерттелді. Уақытша үрдістер үш кезең бойынша (1990–2000 жж., 2000–2010 жж., 2010–2023 жж.) бағаланды және ұзақ мерзімді заңдылықтар мен жыныстар арасындағы айырмашылықтарды анықтау үшін пайыздық өзгерістер есептелді.

Нәтижесі. 2023 жылы Қазақстанда қант диабетімен байланысты ЖИА 3 307 өлімге (95% сенімді аралық: 2 649–4 160) және 65 426 DALY-ге (52 668–83 043) себеп болды. Жүктеменің негізін мерзімінен бұрын өлім-жітім қалыптастырды: жоғалған өмір сүру жылдары (YLL) жалпы DALY санының 91,3%-ын құрады. Абсолютті өлім-жітім саны әйелдер арасында жоғары болғанымен (1 979-ға қарсы 1 328), жасқа стандартталған DALY көрсеткіштері зерттеу кезеңі бойы ерлер арасында жоғары болды. Ерлер мен әйелдер арасындағы коэффициент қатынасы 1,4-тен асты. Жасқа стандартталған DALY көрсеткіштері сызықтық емес үрдісті байқатты: 1990–2000 жылдары 38,0%-ға өсті, одан кейін 2000–2010 жылдары 29,3%-ға, 2010–2023 жылдары тағы 40,2%-ға төмендеді. Бүкіл зерттеу кезеңінде жасқа стандартталған DALY көрсеткіштері жалпы алғанда 41,7%-ға (ерлерде −48,8%; әйелдерде −37,9%) азайды.

Қорытынды. Жасқа стандартталған көрсеткіштердің айтарлықтай төмендегеніне қарамастан, жоғары АШГ деңгейіне байланысты ЖИА Қазақстанда маңызды халық денсаулығы мәселесі болып қалуда. Бұл жүктеме негізінен мерзімінен бұрын болған өлім-жітіммен байланысты және ерлерге диспропорционалды түрде әсер етеді. Алынған нәтижелер жыныстық айырмашылықтарды ескерудің маңыздылығын көрсетіп, қант диабетінің алдын алуға, оны ерте анықтауға және тиімді емдеуге бағытталған ұлттық стратегияларды нығайту қажеттілігін баса көрсетеді.

Түйін сөздер: жүректің ишемиялық ауруы, қант диабеті, қан глюкозасы, аурулардың жаһандық жүктемесі, жүрек-қан тамыр аурулары, қауіп-қатер факторлары, мерзімінен бұрын болған өлім-жітім, Қазақстан.

Казахстанские тренды бремени ишемической болезни сердца, обусловленной сахарным диабетом: Анализ на основе базы «Глобальное бремя болезней»

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Резюме

Сердечно-сосудистые заболевания и сахарный диабет, являются ведущими причинами смертности во всем мире. Повышенный уровень глюкозы плазмы натощак (ГПН) представляет собой значимый метаболический фактор риска развития ишемической болезни сердца (ИБС). В Казахстане по-прежнему недостаточно исследований, комплексно оценивающих распространенность ИБС, ассоциированной с сахарным диабетом.

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Цель исследования: оценить бремя ИБС, обусловленную повышенным уровнем ГПН, а также анализ временных тенденций и половых различий в Казахстане за период 1990–2023 годов.

Методы. Данные получены из базы данных «Глобальное бремя болезней» (ГББ) 2023 года. Повышенный уровень ГПН определялся в соответствии с методологией ГББ как уровень глюкозы плазмы натощак, превышающий теоретический минимальный уровень экспозиции риска 4,9–5,4 ммоль/л. Анализировались абсолютные числа, грубые и стандартизованные по возрасту коэффициенты смертности, DALY, YLL и YLD. Временные тенденции оценивались в трех периодах (1990–2000 гг., 2000–2010 гг., 2010–2023 гг.); для характеристики долгосрочных закономерностей и половых различий рассчитывались процентные изменения показателей.

Результаты. В 2023 году ИБС, ассоциированная с сахарным диабетом, стала причиной 3 307 смертей (95% ДИ: 2 649–4 160) и 65 426 DALY (52 668–83 043) в Казахстане. Основной вклад в структуре показателей DALY вносила преждевременная смертность. Несмотря на то что в абсолютных показателях смертность была выше среди женщин (1 979 против 1 328), стандартизованные по возрасту показатели DALY на протяжении всего периода наблюдения оставались стабильно выше у мужчин, при этом соотношение коэффициентов мужчин и женщин превышало 1,4. Стандартизованные по возрасту показатели DALY демонстрировали нелинейную динамику: в период 1990–2000 годов они возросли на 38,0%, затем снизились на 29,3% в 2000–2010 годах и еще на 40,2% — в 2010–2023 годах. За весь период наблюдения стандартизованные по возрасту показатели DALY снизились в целом на 41,7% (у мужчин — на 48,8%; у женщин — на 37,9%).

Выводы. Несмотря на существенное снижение возраст-стандартизованных показателей, ИБС, ассоциированная с повышенным уровнем ГПН, остается значимой проблемой общественного здравоохранения в Казахстане, характеризуясь преимущественно высокой долей преждевременной смертности и более выраженными показателями среди мужчин. Полученные результаты подчеркивают необходимость учета половых различий и усиления национальных стратегий, направленных на профилактику сахарного диабета, его раннее выявление и эффективное лечение с целью снижения сердечно-сосудистых осложнений.

Ключевые слова: ишемическая болезнь сердца, сахарный диабет, глюкоза крови, глобальное бремя болезней, сердечно-сосудистые заболевания, факторы риска, преждевременная смертность, Казахстан.

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