

Changing Patterns of Morbidity and Comorbidity in Children with Congenital Heart Disease: A Historical-to-Contemporary Analysis

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Original Research Article

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Abstract

Background: Congenital heart disease (CHD) is associated not only with structural cardiac abnormalities but also with a substantial burden of non-cardiac morbidity. Improvements in diagnosis, surgery, intensive care, and long-term survival have changed the clinical profile of affected children. **Objective:** To compare the morbidity profile observed in an original 1989–1995 cohort of children with CHD in Tashkent with contemporary evidence and to identify changes in the structure of associated disease and health-care needs. **Methods:** This historical-to-contemporary analytical study used data from the authors' 1989–1995 social-hygienic investigation in Tashkent, which identified 278 children with CHD and evaluated medical encounters, morbidity episodes, and episode duration. Historical findings were interpreted alongside contemporary international studies. Because the observation units, diagnostic capabilities, coding systems, and study populations differed across periods, modern percentages were not mechanically combined with historical estimates. **Results:** In 1989–1995, overall morbidity based on medical encounters was 4155.0 per 1000 children with CHD versus 1105.1 per 1000 in the control group, a 3.76-fold difference. Children with CHD had 4.1 primary medical encounters per child-year versus 1.1 in controls ($p < 0.01$), and the mean duration of one illness episode was 7.7 versus 4.3 days ($p < 0.05$). Respiratory diseases accounted for $75.3 \pm 3.1\%$ of recorded associated morbidity. Contemporary hospital-based data demonstrate a broader spectrum of acute and chronic comorbidities, including prematurity/neonatal conditions, genetic disorders, gastrointestinal, neurologic, respiratory, and renal conditions; 14.54% of CHD admissions in a large U.S. database had two or more complex chronic conditions. **Conclusions:** The principal long-term change is not adequately described as a simple increase or decrease in morbidity. Rather, the morbidity profile of children with CHD has become more comprehensively recognized and clinically more complex, with comorbidity and multimorbidity increasingly shaping long-term care. Historical and contemporary estimates should therefore be compared conceptually rather than as directly interchangeable numerical measures.

Keywords: congenital heart disease; child; morbidity; comorbidity; multimorbidity; follow-up

1. Introduction

Congenital heart disease (CHD) is among the most important congenital conditions in childhood and remains associated with repeated health-care use, hospitalisation, and long-term medical needs. The health status of a child with CHD is determined not only by the anatomical cardiac lesion but also by haemodynamic disturbances, hypoxaemia, growth and nutritional problems, recurrent respiratory disease, neurodevelopmental vulnerability, genetic conditions, and complications affecting other organ systems [2–5]. Over recent decades, the clinical context of CHD has changed substantially. Echocardiography, prenatal diagnosis, genetic testing, interventional cardiology, paediatric cardiac surgery, and intensive care have improved detection and survival. Consequently, a growing proportion of patients live long enough for chronic and non-cardiac conditions to become important determinants of health-care utilisation and quality of life [4,7–10]. Contemporary CHD care is therefore increasingly organised around lifelong, multidisciplinary surveillance rather than correction of the cardiac defect alone.

Historical comparisons, however, require methodological caution. Apparent changes in morbidity can reflect at least two processes: true changes in the health of patients and changes in what medicine is able to detect, classify, and register. A disease category that was not routinely separated in older records may appear as a distinct comorbidity in modern electronic databases. Likewise, contemporary hospital-based studies describe

a selected population and cannot automatically be compared with population-based or outpatient morbidity estimates.

The authors' 1989–1995 investigation in Tashkent provides a historical reference point for evaluating the burden of morbidity among children with CHD. The present study revisits those original data and places them in the context of contemporary evidence. The objective was to assess how the level, structure, and clinical interpretation of morbidity among children with CHD have changed from the historical period to the current era, while explicitly accounting for differences in diagnostic and registration methods.

2. Materials and Methods

This study was designed as a historical-to-contemporary analytical comparison. The historical component was based on the authors' comprehensive social-hygienic investigation conducted in Tashkent during 1989–1995. A total of 278 CHD cases were identified. Medical encounters, episodes of illness, duration of illness, and the structure of associated morbidity were evaluated. A comparison group was used in the original study for the principal morbidity indicators.

The historical data were compared with contemporary peer-reviewed evidence addressing CHD prevalence, survival, hospital utilisation, respiratory morbidity, complex chronic conditions, neurodevelopmental outcomes, and multimorbidity [2–13]. Particular attention was given to large population-based or nationally representative studies and systematic reviews.

Three complementary approaches were used: historical comparison, structural analysis of morbidity, and clinically oriented interpretation of statistical indicators. Direct pooling or calculation of a single time-trend estimate was intentionally avoided because the historical and contemporary studies differed in observation units, age composition, case ascertainment, diagnostic technology, coding, and clinical setting. Therefore, the main comparative endpoint was the change in morbidity profile and health-care complexity rather than the arithmetic difference between non-equivalent percentages.

Descriptive historical indicators are presented as rates per 1000 children, mean numbers of medical encounters, mean duration of illness episodes, and proportional distributions. Statistical significance values reported in the original study are retained. Contemporary percentages are reported according to their original study populations, particularly hospital admissions, and are explicitly identified as such.

3. Results

In the 1989–1995 investigation, overall morbidity among children with CHD, calculated from medical encounters, was 4155.0 per 1000 children. The corresponding indicator in the control group was 1105.1 per 1000, indicating a 3.76-fold higher morbidity burden among children with CHD. The mean number of primary medical encounters per child per year was 4.1 in the CHD group and 1.1 in controls ($p < 0.01$). The mean duration of a single illness episode was 7.7 days in children with CHD compared with 4.3 days in the control group ($p < 0.05$).

Table 1. Main indicators of overall morbidity among children with CHD, 1989–1995

Indicator	Children with CHD	Control group	Difference
Morbidity per 1000 children	4155.0	1105.1	3.76-fold
Primary medical encounters per child-year	4.1	1.1	3.73-fold
Mean duration of one illness episode, days	7.7	4.3	1.79-fold
Statistical significance	—	—	$p < 0.01$; $p < 0.05$

Source: authors' original investigation, 1989–1995.

These findings demonstrate that children with CHD already constituted a population with markedly increased health-care needs during the historical period. The excess burden was expressed not only in the frequency of medical encounters but also in longer illness episodes.

The structure of associated morbidity was dominated by diseases of the respiratory system, which accounted for $75.3 \pm 3.1\%$ of recorded morbidity. Infectious and parasitic diseases represented $8.6 \pm 1.9\%$, diseases of the

nervous system and sensory organs $7.3 \pm 1.8\%$, circulatory diseases $3.4 \pm 1.2\%$, and digestive diseases $2.5 \pm 1.1\%$.

Table 2. Structure of associated morbidity among children with CHD, 1989–1995

Disease category	Proportion, %
Respiratory diseases	75.3 ± 3.1
Infectious and parasitic diseases	8.6 ± 1.9
Nervous system and sensory organ diseases	7.3 ± 1.8
Circulatory system diseases	3.4 ± 1.2
Digestive system diseases	2.5 ± 1.1
Other diseases	2.8 ± 1.2
Genitourinary diseases	0.1 ± 0.2

Source: authors' original investigation, 1989–1995.

Contemporary evidence reveals a broader and more explicitly classified burden of comorbidity. In a nationally representative analysis of paediatric inpatient admissions in the United States from 2003 to 2016, CHD admissions were substantially more likely than non-CHD admissions to include complex chronic conditions. Among 844,576 CHD admissions, prematurity/neonatal conditions were recorded in 14.24%, other congenital or genetic conditions in 13.39%, chronic gastrointestinal conditions in 9.87%, chronic respiratory conditions in 6.16%, neurologic or neuromuscular conditions in 5.59%, and renal/urologic conditions in 4.36%; two or more complex chronic conditions were present in 14.54% [7]. Acute associated diagnoses included sepsis (13.67%), acute respiratory disease (8.28%), acute gastrointestinal disease (3.07%), acute neurologic disease (2.65%), and acute kidney injury (1.68%) [7].

These modern figures describe hospital admissions rather than the general population of children with CHD. They therefore cannot be interpreted as direct replacements for the historical outpatient morbidity structure. Their value lies in demonstrating the breadth and complexity of contemporary recognised morbidity.

Table 3. Historical and contemporary characteristics of morbidity in children with CHD

Domain	1989–1995	Contemporary evidence	Interpretation
Overall morbidity	4155.0 per 1000	No directly equivalent national estimate identified	Direct numerical trend cannot be calculated
Respiratory morbidity	75.3% of associated morbidity	Acute and chronic respiratory conditions classified separately	Clinical importance persists, but classification has changed
Genetic/other congenital conditions	Not separately identified	13.39% of CHD hospital admissions [7]	Broader diagnostic recognition
Chronic gastrointestinal conditions	2.5% digestive diseases in historical structure	9.87% of CHD hospital admissions [7]	Different definitions/settings; broader recognition
Multimorbidity	Not specifically assessed	≥ 2 complex chronic conditions in 14.54% of CHD admissions [7]	Now a distinct dimension of clinical complexity

4. Discussion

The historical data show a substantial morbidity burden among children with CHD. The rate of 4155.0 medical encounters per 1000 children and the 3.76-fold difference from controls indicate that CHD was already associated with markedly increased demand for medical care in 1989–1995. However, the most informative long-term observation is not a simple numerical trend. The underlying concept of morbidity has expanded: contemporary studies identify a wider spectrum of chronic, genetic, neurologic, developmental, renal, gastrointestinal, respiratory, and psychosocial problems.

This transition should be interpreted in the context of improved survival. International studies have documented major reductions in childhood CHD mortality and a shift of the CHD population toward older ages [4,9,13]. Improved survival creates a larger population exposed to long-term complications, residual haemodynamic lesions, reinterventions, developmental challenges, and non-cardiac chronic disease. Thus, the contemporary burden of CHD increasingly reflects both survival success and the need for sustained multidisciplinary care.

Diagnostic expansion is a second major mechanism. The global birth prevalence reported in modern meta-analyses is considerably higher than estimates from many earlier periods, partly because echocardiography and screening identify mild lesions that previously remained undiagnosed [2,3]. For this reason, historical prevalence or morbidity indicators should not be placed alongside modern values without considering ascertainment. The same principle applies to comorbidity: genetic syndromes, neurodevelopmental disorders, and complex chronic conditions are now classified with greater specificity.

Respiratory disease deserves particular attention because it dominated the historical morbidity structure. Its relative share is lower in modern multi-category hospital databases, but this should not be interpreted as disappearance of respiratory risk. A systematic review and meta-analysis found that young children with underlying CHD had higher risks of severe respiratory syncytial virus-associated lower respiratory infection, hospitalisation, intensive care admission, mechanical ventilation, and death than children without CHD [11]. Other inpatient analyses likewise show that acute respiratory infections remain associated with increased mortality, length of stay, and cost in infants with CHD [12]. The historical predominance of respiratory disease and the modern evidence therefore describe different statistical structures but a persistent clinical vulnerability.

Contemporary data also demonstrate the importance of non-cardiac chronic conditions. The large U.S. inpatient study showed that 39.1% of CHD admissions had at least one complex chronic condition and 14.5% had two or more [7]. Population-based U.S. estimates similarly indicate that children with CHD frequently have associated comorbidities [8]. More broadly, childhood multimorbidity is now recognised as an important research and health-service problem, although definitions and prevalence estimates remain heterogeneous [10].

Neurodevelopment is another domain that illustrates the widening scope of CHD care. Current American Heart Association guidance identifies a growing population of individuals with CHD at increased risk for developmental delay or disorder and recommends risk stratification, surveillance, evaluation, and management across the life course [14]. This reinforces the need to move beyond a cardiac-only model of follow-up.

The findings have organisational implications. A child with CHD may require coordinated input from paediatric cardiology and cardiac surgery as well as general paediatrics, genetics, neurology, pulmonology, gastroenterology, nephrology, nutrition, rehabilitation, and psychological or developmental services. Follow-up should therefore address the anatomical and functional state of the heart while systematically screening for clinically relevant comorbidities and developmental needs.

This study has several limitations. First, the historical investigation and contemporary publications used different designs, populations, diagnostic technologies, and classification systems. Second, contemporary evidence cited here includes hospital-based data and therefore reflects a more severely affected population than community-based cohorts. Third, a directly comparable contemporary national morbidity indicator for Uzbekistan, calculated with the same methodology as the 1989–1995 study, was not available in the source material used for this analysis. These limitations preclude a quantitative statement that overall morbidity has simply increased or decreased over time.

At the same time, the historical dataset has value because it provides a documented reference point from an earlier phase of paediatric CHD care in Uzbekistan. Its comparison with contemporary evidence demonstrates how the clinical meaning of morbidity has evolved from predominantly encounter-based disease categories toward a multidimensional model incorporating comorbidity, multimorbidity, chronic complexity, and long-term follow-up.

5. Conclusions

In the 1989–1995 historical investigation, morbidity among children with CHD was 4155.0 per 1000, 3.76 times the level observed in controls. Children with CHD also had more primary medical encounters and longer illness episodes.

Respiratory diseases dominated the historical structure of associated morbidity, accounting for $75.3 \pm 3.1\%$. Contemporary evidence confirms that respiratory disease remains clinically important but also identifies a much broader spectrum of genetic, perinatal, neurologic, gastrointestinal, renal, and other chronic conditions. The major temporal change is best characterised as increasing recognition of clinical complexity rather than a directly measurable rise or fall in a single morbidity indicator. Modern diagnostic systems and improved survival have made comorbidity and multimorbidity central components of paediatric CHD care.

Historical and contemporary morbidity estimates should not be compared mechanically when their observation units and diagnostic frameworks differ. Future national studies using standardised definitions and longitudinal data are needed to quantify the current burden of comorbidity and multimorbidity among children with CHD in Uzbekistan.

Declarations

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Conflict of interest: The authors declare no conflict of interest.

Ethics statement: The present study is a secondary analysis of aggregated historical data from the authors' 1989–1995 investigation and published contemporary literature. No personally identifiable patient information was used in the present analysis.

Data availability: The historical aggregate data analysed in this manuscript are derived from the authors' original investigation; contemporary evidence was obtained from the cited published literature.

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