Test file: Birth Cohort Effects on Cardiovascular Disease Prevalence: An Age-Period-Cohort Analysis

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Abstract
This age-period-cohort analysis examines generational trends in cardiovascular disease prevalence using national health survey data. Later birth cohorts show higher age-specific prevalence rates, suggesting changing environmental and behavioral risk factors across generations.
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1. Introduction

Cardiovascular diseases (CVDs) remain the leading cause of mortality worldwide, accounting for an estimated 17.9 million deaths annually [1]. While age-standardized CVD mortality has declined in many high-income countries, recent evidence suggests concerning trends in younger populations and shifting patterns across birth cohorts [2]. Understanding these generational changes is crucial for predicting future disease burden and targeting prevention strategies.

Age-period-cohort (APC) analysis provides a powerful framework for disentangling the complex temporal influences on disease trends [3]. This approach allows separation of three distinct effects: age (physiological aging processes), period (external influences affecting all age groups simultaneously), and cohort (generational experiences shared by individuals born in the same time period) [4]. Previous studies have applied APC analysis to CVD mortality, but fewer have examined prevalence trends using comprehensive national data [5].

This study aims to characterize birth cohort effects on CVD prevalence using nationally representative data from 1990 to 2020, and to explore potential explanations for observed generational patterns.

2. Methods

2.1 Data Source and Study Population

We analyzed data from the National Health and Nutrition Examination Survey (NHANES) from 1990 to 2020, including 85,742 participants aged 20-85 years. The study utilized a repeated cross-sectional design with complex sampling methods to ensure national representativeness.

2.2 Cardiovascular Disease Assessment

CVD prevalence was defined based on self-reported physician diagnosis of coronary heart disease, heart failure, stroke, or angina, supplemented by medication use and electrocardiogram findings where available. Validation studies have demonstrated good agreement between self-reported CVD and medical record documentation in NHANES.

2.3 Statistical Analysis

We employed the intrinsic estimator method for APC analysis to address the identifiability problem inherent in these models [6]. The analysis included:

- Age effects: 5-year intervals from 20-24 to 80-85 years
- Period effects: 5-year survey cycles from 1990-1994 to 2015-2020
- Cohort effects: 5-year birth cohorts from 1905-1909 to 1995-1999

Models were adjusted for sex, race/ethnicity, and educational attainment. Sensitivity analyses were conducted using alternative APC modeling approaches.

3. Results

3.1 Descriptive Statistics

Overall CVD prevalence increased from 8.2% in 1990-1994 to 11.5% in 2015-2020. However, age-specific patterns revealed substantial heterogeneity across birth cohorts. Later-born cohorts demonstrated higher CVD prevalence at younger ages compared to earlier cohorts at similar ages.

3.2 Age-Period-Cohort Effects

The APC analysis revealed significant cohort effects ($p < 0.001$), with progressively higher CVD prevalence rates in more recent birth cohorts after controlling for age and period effects. The cohort relative risk ratios ranged from 0.85 (95% CI: 0.78-0.93) for the earliest cohort (1905-1909) to 1.32 (95% CI: 1.21-1.44) for the most recent cohort (1995-1999).

3.3 Risk Factor Mediation

Approximately 45% of the cohort effect was explained by changing distributions of major CVD risk factors, particularly increasing obesity prevalence (explaining 28% of cohort effect) and diabetes incidence (explaining 17% of cohort effect) in more recent birth cohorts.

4. Discussion

4.1 Principal Findings

This APC analysis demonstrates significant birth cohort effects on CVD prevalence, with more recent generations experiencing higher disease rates at younger ages. These findings challenge the conventional narrative of steadily improving cardiovascular health and suggest emerging public health challenges.

4.2 Potential Explanations and Implications

The observed cohort effects may reflect cumulative exposure to changing environmental factors, including dietary patterns, physical activity levels, and environmental pollutants across generations. The rising obesity and diabetes prevalence in younger cohorts appears to be a major driver of these trends.

4.3 Limitations

Limitations include potential misclassification of CVD status, the ecological nature of cohort effects, and inability to establish causal relationships. Residual confounding by unmeasured factors may persist despite comprehensive adjustment.

5. Conclusion

This study provides evidence of adverse birth cohort effects on cardiovascular disease prevalence, highlighting the need for targeted prevention strategies addressing generational shifts in risk factor profiles. Public health efforts should focus on early-life interventions to mitigate the growing burden of CVD in younger populations.

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