The economic impact of rheumatic heart disease in developing countries

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I, David Watkins, DO NOT have a financial interest/arrangement or affiliation with one or more organizations that could be perceived as a real or apparent conflict of interest in the context of the subject of this presentation.
Outline

• What is RHD, and why should you care?
• Brief introduction to mortality risk valuation
• Data and methods used in this study
• Results: variations in economic impact of RHD by region and sex
• Take-home points for the NCD community and larger global health community
Background and motivation
What is RHD?

Neglected disease of poverty

Poor sanitation, crowding, malnutrition

Untreated strep throat in children 5-14

Lack of “secondary” prevention w/ penicillin

Early adult mortality, especially during pregnancy

Carapetis 2007
Wealthy countries don’t have RHD*
Why do I study RHD?

• Completely preventable (unlike most NCDs)
• **Litmus test** for chronic health systems
  – Social determinants: sanitation, poverty, crowding
  – Primary care pediatrics (sore throat treatment)
  – Antenatal care (RHD: high risk during pregnancy)
  – Level 1/district services (ultrasound, anticoagulation, etc.)
  – Tertiary cardiology and cardiac surgery capacity
• **Opportunities** for health system strengthening
• **Social justice**: women and children most affected
Objective: estimate the global cost of the preventable (premature) mortality from RHD, comparing across regions

Wait, what? Cost of human life??
How do you put a dollar figure on mortality?
Really, tradeoff between health and wealth

Option A

Annual household income: $53,000
Life expectancy at birth: 54 years

Option B

Annual household income: $16,000
Life expectancy at birth: 79 years

Historically, increases in healthy life expectancy, all else equal, have lead to gains in “real income” (or per capita GDP as a proxy)

Adapted from Nordhaus 2002; Bureau of Labor and Statistics 2015
Methods
Modeling approach, data sources

• Cause-deleted life tables: change in mortality/life expectancy when “preventable” RHD deaths are eliminated (compared to HIC mortality rates)
• Age- and sex-specific estimates of RHD and all-cause mortality & population size (GBD 2013)
• Analysis done at level of 7 World Bank regions
• Practically, assessing an ~72% reduction in RHD mortality (range, 36-86% by age/sex/region)
Economic methods/assumptions

- Used the “full income” method for mortality risk valuation (approach to VLY/VSL used in benefit-cost analysis)
- Calculated avoidable mortality in “standardized mortality units” (SMUs) defined as a $10^{-4}$ probability of death
- Empirical data on what individuals are willing to pay to avoid an SMU (~1.8% per-capita GDP)
- Aggregated values for all avoidable RHD deaths as reduced mortality (SMUs averted) across ages → stream of life-years over next 20 years
Results
Health impact of avoidable RHD - females

Total deaths averted: 96,600
Health impact of avoidable RHD - males

Total deaths averted: 84,800
Cumulative economic impact

2013 alone: $56 billion
5 years: $278 billion
10 years: $581 billion
15 years: $910 billion
20 years: $1.25 trillion
Variation in costs by region

![Graph showing variation in costs by region](image-url)
Inadequate donor response

$56,000,000,000 annual economic losses

$1,700,000 annual donor funding

3300:1

$5 to treat a case of sore throat

$29,000 lifetime cost of valve surgery

Remenyi et al. 2013, Watkins et al. 2015
Conclusions and final thoughts
1. RHD is a **totally preventable** disease
2. The economic **cost of RHD is tremendous** and justifies a coordinated global investment
3. Addressing RF and RHD is a **matter of health equity** for women and children
4. RHD is a **model** condition for **health system strengthening** around NCDs in Africa and South Asia
Thank you!

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VSMU (VLY) theory

Estimation of life expectancy at age (a):

\[ e(a) = \frac{1}{s(a)} \int_a^\infty s(a) \, da \]

Define a Standardized Mortality Unit (SMU) as a $10^{-4}$ probability of dying during a given year.

In high-income countries, this has been estimated empirically (Hammitt and Robinson, 2011) as being “worth” 1.8% of per capita GDP to a 35 year-old.

The value of an SMU at age (a) is then,

\[ VSMU(a) = \frac{e(a)}{e(35)} VSMU(35) \]

And the aggregate value of all SMUs, leading to a change in \( e(0) \) from \( e_i \) to \( e_j \), is:

\[ V(e_i, e_j, y) = 0.018 \int_0^\infty n(a) \triangle SMU(e_i, e_j) \frac{e(a)}{e(35)} \, da \]

Adapted from Jamison et al., 2013
Cause-deleted life table theory

Assume mortality from cause $i$ is proportional to total mortality at any given age:

$$\mu^i(a) = R^i \cdot \mu(a)$$

$$R^i = \frac{n D_x^i}{n D_x} \quad \Rightarrow \quad ^*P^i_x = \left[ n P_x \right]^{n D_x^i}$$

Proof:

$$^*P^i_x = e^{-\int_x^{x+n} \mu^i(a) da} = e^{-\int_x^{x+n} R^i \cdot \mu(a) da}$$

$$^*P^i_x = e^{-R^i \cdot \int_x^{x+n} \mu(a) da} = \left[ e^{-\int_x^{x+n} \mu(a) da} \right]^{R^i} = \left[ n P_x \right]^{R^i}$$

Courtesy of Haidong Wang