High coronary heart disease rates among Dutch women of the baby boom, born 1945–1959
Age-cohort analysis and projection

L. BONNEUX, C.W.N. LOOMAN *

Background: After a steep decline in older generations, coronary heart disease mortality is stagnating in female cohorts born after the Second World War. We analysed past trends and predicted future health care needs for coronary heart disease in the Dutch population. Methods: A loglinear age-cohort model relates numbers of deaths and hospital admissions for coronary heart disease to sex, age, birth cohort and population size, and projects age-cohort changes over the future population. Population size, population forecasts and coronary heart disease mortality (period 1970–1999) are from vital statistics. Numbers of hospitalised acute coronary events are from the nationwide hospital register (period 1980–1999). Results: Among men, the rate ratios of deaths and hospital admissions were, respectively, 0.21 (death) and 0.78 (survivors at discharge) in the cohorts born in the period 1948–1962 compared to the period 1918–1922. Among women, the same rate ratios were 0.41 and 1.89. The projection model predicts 22% less deaths from coronary heart disease and 22% more survivors of an infarction in 2015, among men. Among women, there will be 5% less deaths and 70% more survivors of an infarction, most of these being middle age members of the baby boom cohorts. Conclusions: Stagnating all-cause mortality is correlated with an upward trend in coronary heart disease risk in the female baby boomers. Health care needs among middle-aged women will increase sharply. These changes are correlated to high lung cancer mortality and high smoking rates in these cohorts.

Keywords: baby boom cohorts, coronary heart disease, lung cancer, smoking, women

Since the beginning of the 1970s, coronary heart disease mortality rates have been dropping steadily in the Netherlands.1 This strong decline was one of the primary causes of increasing life expectancy. In the middle of the 1980s, that increase in life expectancy among Dutch women, but not men, started to stagnate.2 Since 1995 signs have appeared of increasing coronary heart disease mortality in younger women. These younger women are members of the large baby boom cohorts, and changes in disease occurrence and health care needs will soon be amplified by demographic numbers. We analysed changes in mortality rates and hospitalisation rates, attributed these changes to birth cohorts and projected the age trajectories of these cohorts to 2015.

METHODS
Coronary heart disease mortality and population numbers were obtained from Statistics Netherlands.3 Data used were the primary cause of death by sex, 5-year age group and calendar year during the period 1970–1999. From 1970 to 1994, ICD 8th and 9th revision classify coronary heart disease as 410–414. From 1995 to 1999, ICD 10th revision use I40–I45. Numbers of patients discharged in the period 1980–1999 with acute coronary heart disease as primary cause of admission were taken from the nationwide hospital register (PRISMANT, before SIG).4 Acute coronary syndromes were coded 410 (myocardial infarction) and 411 (unstable angina pectoris). We omitted chronic coronary heart disease as cause of admission, because steep rises in elective intervention rates confound an appraisal of disease occurrence. On each data set an age-cohort model with 5-year age groups was fitted, using log-linear regression analysis:5,6

\[
\hat{y}_{a,y} = N_{a,y} \exp(\alpha_a + \sum c \beta_c n_{a,y,c})
\]

Where \(\hat{y}_{a,y}\) are the expected number of deaths or discharges in age group \(a\) in year \(y\); \(N_{a,y}\) are the number of person-years at risk in age group \(a\) in year \(y\); \(\alpha_a\) is the log (risk in age group \(a\) in baseline cohort); \(\beta_c\) is the log (relative risk of cohort \(c\) relative to baseline cohort); \(n_{a,y,c}\) is the fraction of person years at risk in age group \(a\) in year \(y\) belonging to cohort \(c\) (baseline cohort is excluded). The relative risk of the baseline birth cohort 1918–1922 is arbitrarily set to 1.0. The model assumes that the annual age-specific death rates are composed of an age-specific rate at baseline, multiplied by a birth-cohort-specific relative risk. Adding period to the age-cohort models did not improve the fit or change the cohort estimates significantly.

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The past experience of the cohorts is then projected to the future: the age-specific rates at baseline are multiplied by cohort-specific risks to obtain the future age-specific rates as the cohort is ageing. These rates are then applied to the population forecasts, obtained from Statistics Netherlands.3

RESULTS

Figure 1 summarises the observed trends in death and discharges of the birth cohorts, expressed as relative risks compared to the birth cohort of 1918–1922. Figure 2 shows observed and expected rates of the younger age groups (older age groups are omitted to keep figure clear). Men showed a steep and regular decline of mortality. The risk of dying for the male cohorts of 1948–1962 was nearly five times lower (rate ratio 0.21) than that of the cohort 1918–1922. Women witnessed a similar steep decline in the pre-war birth cohorts, but in the cohorts after the war CHD mortality decline stagnated (rate ratio 0.41). The male discharge rates for acute coronary events (myocardial infarction and unstable angina pectoris) remained more constant, the rate ratio levelling at 72% of the level of the 1918–1922 cohort (78% if we consider only those surviving at discharge). In women, the risk of hospital admission rose steeply in the post-war baby boom-cohorts to a rate ratio of 1.72 (1.89 among the survivors).

The effects of demography and epidemiology are shown in table 1, giving absolute and age standardised figures of observed and predicted periods. The projections show the increasing influence of the ageing baby boom cohorts. Numbers of deaths decrease among men by 22%, but only by 5% among women. Numbers of discharges will increase by 19% among men but by 62% among women. The observed sharp increase in discharge rates (mirrored in the stagnating mortality) among the 30–49-year-olds, is propagated in the projected future increase among the 50–64-year-old women (mirrored in the projected stagnating mortality) (see also figure 1).

DISCUSSION

Administrative data from two independent sources (vital statistics and the nationwide hospital register) suggest increasing coronary heart disease risks in the large female baby boom cohorts, born after World War II. If these trends are true and the predictions hold, the number of women needing heart health care will increase sharply in the future decades, when these cohorts move further into middle age: we expect 70% more female survivors at discharge (see table 1) in 2015 than in 2000. This is caused predominantly by the baby boom, carrying a high risk and moving into middle age.

Administrative data are cheap, which is why they are available over longer periods for large populations. They are not collected to test epidemiological hypotheses. In the Netherlands, there is no financial incentive to attribute one or other code to a certain disease. The assessment of time trends in coronary heart disease might have changed because of increased detection or changing coding practices. Coronary heart disease was considered predominantly a male disorder, but in the 1980s coronary heart disease among women started to attract more attention.7,8 This might have caused spurious increases of
observed discharge rates (and even mortality rates), as the diagnostic activity among women increased. However, there is ancillary evidence for increased risks through an unhealthy lifestyle. Using lung cancer mortality rates as a biological marker of smoking intensity,\(^9\) steeply increasing smoking intensities in the Dutch women born after the war have been shown.\(^6\) In the baby boom cohorts, lung cancer mortality among women is now equal to or higher than that of men (figure 3).\(^3\) Two epidemiological surveys showed high smoking rates in these cohorts (figure 4), and total mortality in the 30–49-year-olds has stagnated since the 1980s.

In the history of these diseases, coronary heart disease and lung cancer are not directly related.\(^10\) But first, the different time lags after quitting smoking should not be ignored. While quitting is a period effect, it takes many more years of quitting to decrease lung cancer rates than to decrease cardiovascular disease rates.\(^11\) In the Netherlands, age-cohort models fit recent mortality rates of male lung cancer badly without a period effect, probably as a consequence of high quit rates in the 1970s. Second, smoking is heterogeneous in the Dutch female population, with very low rates among the elderly and very high rates among the baby boom generation. The figures for England and Wales, shown by Lawlor et al., show the same steep decrease in male/female ratios of CHD mortality among women of the baby boom generation (figure 3 in reference 10).\(^10\)

**Table 1** Observed and projected populations, numbers (N \(\times 10^3\)) and age-standardised rates (R \(\times 10^{-3}\)) of death, discharges and survivors at discharge by selected periods (ages 30 and older)

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
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<tr>
<td></td>
<td>Observed</td>
<td>Projected</td>
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<tr>
<td></td>
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<tr>
<td></td>
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</tr>
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<tr>
<td>2015</td>
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\(\text{15/00}^d\) 12% –22% –45% 19% –11% 22% –8% 10% –5% –21% 62% 31% 70% 38%

\(^a\) Deaths coded as coronary heart disease.
\(^b\) Discharges with acute myocardial infarction or unstable angina pectoris as primary diagnosis.
\(^c\) Survivors at discharge. The difference between \(^a\) and \(^c\) is the mortality in hospital.
\(^d\) Change 2015/2000 (expected by age-cohort model).
We choose an age-cohort model to demonstrate the influence of the birth cohort. Caution is necessary, as an age-cohort model attributes (regular) period effects to the birth cohort. Taking this caveat into account, the main strength of this model is that it maximally takes into account the observed past (there is no period variable in the model) and minimally, the uncertain future. The main assumption is that this increase in coronary heart disease risk is a cohort characteristic, documented by high smoking rates and high lung cancer rates (figures 3 and 4). Obviously, if quit rates were high, the period characteristic of quitting might cause unpredictable decreases in coronary heart disease mortality.

We conclude that the projected health care load of coronary heart disease among Dutch women will increase sharply. While the male coronary heart disease patient population is ageing, female patients are becoming younger and more numerous. However, the consequences of smoking for heart disease soon wear off after quitting. Our predictions may prove to be wrong if large numbers of smokers from the baby boom generations decide to stop. Sadly, the Netherlands have a bad record, being the worst performer of 16 European countries in notifying smoking as a health problem.

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REFERENCES

8 Khaw KT. Where are the women in coronary heart disease? BMJ 1993;306:1145-6.

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