Using the Framingham coronary risk appraisal functions to derive the expected annual number of UK coronary artery disease events

ARRAN SHEARER, PAUL SCUFFHAM, DAVID E NEWBY

Abstract

The Framingham Heart Study investigators have recently developed new coronary risk appraisal functions which relate risk factors to the short-term probability of experiencing cardiovascular disease events. We populated the risk appraisal functions with UK data and estimated that approximately 256,000 new coronary artery disease (CAD) events occur annually in the UK. Approximately half of the estimated CAD events were acute myocardial infarctions (AMI) and almost three quarters occurred in men. Our estimates fit well with hospital in-patient data but less well with British Heart Foundation estimates of AMI and angina. Differences between US and UK relative risks, clinical practice and populations may account for these discrepancies. Our estimates may be considered as a lower limit of the annual number of UK CAD events.

Key words: coronary artery disease, risk.

Br J Cardiol 2005;**12**:47–9

Introduction

For more than 30 years the Framingham Heart Study investigators have developed coronary risk appraisal functions that relate risk factors among disease-free individuals to the long-term (4–12 years) probability of developing cardiovascular disease (CVD).[1] These risk appraisal functions have been recommended for use to help identify patients who are suitable for preventative treatment.[2] Recently, new coronary risk appraisal functions have been developed which relate risk factors to the short-term (1–4 years) probability of experiencing CVD events for both disease-free individuals and those with a history of CVD.[3] These models have been populated with mean risk factor values from the Third National Health and Nutrition Examination Survey (NHANES) and combined with census data to estimate the annual number of coronary artery disease (CAD) events in the US.[4] We populated the short-term Framingham risk appraisal functions with UK data to estimate the expected annual number of CAD events in the UK. These expected events were then compared with previously reported numbers of CAD events in the UK.[5]

York Health Economics Consortium, University of York, Heslington, York, YO10 5NH.
Arran Shearer, Research Fellow

York Health Economics Consortium, University of York, Market Square, Vanbrugh Way, Heslington, York, YO10 5NH.
Paul Scuffham, Senior Research Fellow

Department of Cardiology, University of Edinburgh, Edinburgh.
David E Newby, Senior Lecturer in Cardiology

Correspondence to: Mr A Shearer
(email: arran_shearer@hotmail.com)

Methods

Since there are separate risk appraisal functions for those with and without a history of CAD, we needed an estimate of the prevalence of CAD in the UK. We estimated numbers of prevalent CAD cases for each of the age/sex groups using data from the 1998 Health Survey for England; this survey is an annual cross-sectional survey of a representative sample of the population. Participants were classified as having CAD if they had angina or acute myocardial infarction (AMI) diagnosed by a doctor. UK population estimates, by gender in 10-year age intervals, of persons aged 15 years and over were obtained from Census 2001. Numbers of prevalent CAD cases in each group were estimated by multiplying the prevalence rates by the group populations.

Risk factors from the short-term Framingham risk appraisal functions were age, systolic blood pressure, fasting total and high-density lipoprotein (HDL) cholesterol, prevalence of diabetes mellitus, smoking, antihypertensive medication, alcohol consumption (in women) and menopause (in women). Estimates of the annual number of initial events among the CAD-free population, and subsequent events among those with a history of CAD, were derived by evaluating the appropriate short-term Framingham risk appraisal function at the midpoint of each age interval, using mean risk factor values from the 1998 Health Survey for England (table 1). The distribution of events by type was ascertained from the Framingham cohort.

Results

We estimated that there are 255,828 new CAD events annually in the UK. These include 126,424 AMIs (World Health Organisation definition), 110,272 cases of angina (stable plus unstable) and 19,133 sudden cardiac deaths (table 2). Based on

Table 1. Population and mean values of risk factors

Age group (years)	15–24	25–34	35–44	45–54	55–64	65–74	75 +	Total
Population (000s)								
Male	3,636	4,095	4,334	3,855	3,061	2,301	1,610	22,893
Female	3,574	4,265	4,443	3,922	3,158	2,636	2,794	24,791
Mean values of risk factors								
Males								
Ratio (TC/HDL)	3.38	3.92	4.23	4.46	4.46	4.46	4.23	-
SBP	128.4	130.4	131.2	136.2	142.1	147.7	150.3	-
Antihypertensive therapy	0.0%	0.2%	1.1%	4.2%	12.3%	15.2%	17.7%	-
Diabetics	0.1%	0.7%	1.6%	2.9%	5.8%	7.0%	8.7%	-
Smokers	36%	37%	32%	27%	16%	16%	16%	-
Females								
Post-menopausal*	0%	0%	25%	50%	100%	100%	100%	-
Ratio (TC/HDL)	3.07	3.27	3.47	3.56	3.88	4.33	3.94	-
SBP	120.1	120.5	123.5	131.7	140.1	149.2	155.4	-
Antihypertensive therapy	0.0%	0.1%	1.2%	3.6%	10.5%	22.0%	27.0%	-
Diabetics	0.8%	0.7%	0.9%	1.6%	3.1%	6.6%	6.6%	-
Smokers	35%	33%	28%	27%	16%	16%	16%	-
Alcohol consumers	88%	91%	92%	91%	87%	80%	74%	-

Key: TC = total cholesterol; HDL = high-density lipoprotein cholesterol; SBP = systolic blood pressure; * Assumption based on average age at onset of menopause.

Table 2. Estimated annual number of CAD events in the UK

Age group (years)	15–24	25–34	35–44	45–54	55–64	65–74	75 +	Total
Incident CAD Events								
Males								
AMI	1,315	3,190	6,252	11,870	19,374	24,585	30,236	96,821
Angina (stable + unstable)	1,053	2,540	4,954	9,163	14,455	18,318	22,906	73,390
Sudden cardiac death	122	324	682	1,751	3,796	4,864	5,275	16,815
Females								
AMI	129	426	1,580	3,655	4,987	7,475	11,350	29,603
Angina (stable + unstable)	222	694	2,613	5,899	7,041	9,004	11,409	36,881
Sudden cardiac death	6	24	85	206	341	604	1,053	2,318
Total (males + females)								
AMI	1,444	3,615	7,833	15,525	24,361	32,060	41,586	126,424
Angina (stable + unstable)	1,275	3,234	7,567	15,061	21,497	27,322	34,315	110,272
Sudden cardiac death	128	348	767	1,957	4,137	5,467	6,328	19,133
Total	2,848	7,197	16,167	32,544	49,995	64,849	82,229	255,828

Key: CAD = coronary artery disease; AMI = acute myocardial infarction

the short-term Framingham risk appraisal functions, 73.1% of all CAD events occur in males and 57.5% of all CAD events occur in patients aged 65 years or older.

Discussion

Our estimates of the annual number of CAD events in the UK based on the short-term Framingham risk appraisal functions are lower than those reported by the British Heart Foundation (BHF), who estimate that approximately 275,000 AMIs and 335,000 cases of angina occur each year in the UK.[5] However, our estimate of AMI events fits well with hospital in-patient data. There were approximately 81,031 admissions for AMI in the UK in 2001, according to Department of Health figures.[6] That is, approximately 64% of AMI events were admitted to hospital. These figures are consistent with previous studies, which report that approximately one third of AMI cases die before reaching hospital.[7] Therefore, the short-term Framingham risk appraisal functions appear to be good predictors of annual hospital admis-

sions for AMI, but poor predictors of the AMI estimates according to BHF criteria.[5]

Our estimate for angina may appear low compared with the 134,826 inpatient admissions in the UK in 2001.[6] However, in the Framingham cohort angina occurred less frequently than AMI.[4] Given that some cases of angina might have multiple admissions, our 122% case-hospitalisation rate is not unreasonable.

CAD event rates are likely to be higher in Scotland and Northern Ireland than in England.[5] Therefore, use of English survey data may under-estimate the true number of events in the UK. However, risk factor profiles were similar in the English and Scottish health surveys, with the exception of smoking, which was slightly higher in Scotland.

The Framingham risk appraisal functions were developed for the US, and therefore may be less applicable to other countries, including the UK, due to the different relative risks, differences in clinical practice and health systems, and other factors inherent in the different populations. Important differences may exist in the primary and secondary prevention of CAD events, including pharmacological and surgical interventions. For example, in 2001 the US had substantially higher rates of both percutaneous coronary intervention (PCI) and coronary artery bypass grafting (CABG) than the UK, with the US performing 1,570 PCI and 850 CABG per million population,[8] compared with 644 PCI and 442 CABG per million population in the UK.[9] Moreover, Brindle *et al*.[10] recently used the British regional heart study to assess the predictive accuracy of the long-term Framingham coronary risk appraisal functions and concluded that Framingham overestimates the absolute coronary risk assigned to individuals in the UK. The result of Brindle *et al.* is at odds with our findings and may cast some doubt over the representativeness of the British regional heart study. However, our study used the short-term Framingham coronary risk appraisal functions. Research has shown that the short-term Framingham coronary risk appraisal functions predict fewer coronary artery disease events than the older long-term Framingham functions.[11]

It is well documented that family history is an independent risk factor for coronary heart disease.[12] A possible explanation for our estimates being lower than those reported elsewhere[5] is that the Framingham investigators do not include family history in their coronary risk appraisal functions.

Risk factors tend to cluster in individuals. For example, it is common for an individual to have diabetes, hypertension and hypercholesterolaemia. This is likely to lead to skewed distributions of risk factors. A potential limitation might be the use of mean risk factor values; this ignores the distributions of risk factors and could understate the true incidence of CAD events. Therefore, our estimates based on the short-term Framingham risk appraisal functions may be considered as the lower limit of the annual number of CAD events in the UK.

Acknowledgement

We thank the peer reviewer for providing useful comments and suggestions.

Key messages

- Coronary artery disease (CAD) is the leading cause of death in the UK
- Either previous British Heart Foundation estimates may overstate the true annual number of CAD events in the UK or the short-term Framingham risk appraisal functions may understate these events
- The short-term Framingham risk appraisal functions may not be applicable to the UK due to the different relative risks, differences in clinical practice and health systems, and other factors inherent in the two populations
- However, the short-term Framingham risk appraisal functions may be useful to estimate the lower limit of the annual number of CAD events in the UK
- Further research is needed to estimate the occurrence of CAD accurately in the UK

Conflict of interest

This study was funded by a research grant from Pfizer.

References

1. Anderson KM, Wilson PWF, Odell PM *et al*. An updated coronary risk profile. A statement for health professionals. *Circulation* 1991;**83**:356-62.
2. British Cardiac Society, British Hyperlipidaemia Association, British Hypertension Society, British Diabetic Association. Joint British recommendations on prevention of coronary heart disease in clinical practice. *Heart* 1998;**80**:S1-S29.
3. D'Agostino RB, Russell MW, Huse DM *et al*. Primary and subsequent coronary risk appraisal: new results from the Framingham Study. *Am Heart J* 2000;**139**:272-81.
4. Russell MW, Huse DM, Drowns S, Hamel EC, Hartz SC. Direct medical costs of coronary artery disease in the United States. *Am J Cardiol* 1998; **81**:1110-15.
5. Petersen S, Peto V, Raynor M. *Coronary heart disease statistics. 2003 Edition.* British Heart Foundation Health Promotion Research Group, Department of Public Health, University of Oxford, 2003.
6. Department of Health. *Hospital in-patient episode statistics*. London: Department of Health, 2002. http://www.doh.gov.uk/hes/tables/tb00301e.xls
7. Penny WJ. Patient delay in calling for help: the weakest link in the chain of survival? *Heart* 2001;**85**:121-2.
8. Ulrich MR, Brock DM, Ziskand AA. Analysis of trends in coronary artery bypass grafting and percutaneous coronary intervention rates in Washington State from 1987 to 2001. *Am J Cardiol* 2003;**92**:836-9.
9. British Cardiovascular Intervention Society. Audit Data, 2002. http://www.cardiology.co.uk/bcis/audit_data_2002.ppt
10. Brindle P, Emberson J, Lampe F *et al*. Predictive accuracy of the Framingham coronary risk score in British men: prospective cohort study. *BMJ* 2003;**327**:1267-73.
11. Nanchahal N, Duncan JR, Durrington PN, Jackson RT. Analysis of predicted coronary heart disease risk in England based on Framingham study risk appraisal models published in 1991 and 2000. *BMJ* 2002;**325**: 194-5.
12. Bertuzzi M, Negri E, Tavani A, Vecchia CL. Family history of ischemic heart disease and risk of acute myocardial infarction. *Prev Med* 2003; **37**:183-7.